Designing for Environmental Stewardship in Formal and Non-Formal Learning

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Abstract

This project explores how learning spaces can educate young learners about the environment. As green design continues to be one of the fastest growing fields in the country, the intersection of green school design and environmental education becomes more critical. Through architectural analyses that map certain design features onto the space and supplemental interviews with school administration, I have generated a design-based understanding of how learning spaces can be created to influence environmental education. At a variety of learning spaces–I have found patterns, in how certain design strategies aimed to tie the building to the environment can influence sustainable behaviors. Furthermore, this research indicates that more formal learning spaces tend to use spaces beyond their given architectural space, to enable learners to connect with their environment. From this understanding, this research is positioned to inform school designers on constructing spaces that foster strong collective and individual relationships to the environment. This has the potential to contribute to a positive change in how education spaces are imagined, in respect to the environments that surround them.

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Introduction

How children learn–specifically how they learn from nature–is shaped by the architecture of their learning spaces (Taylor 1993, Chawla 2015). The research on how nature in learning spaces can affect children and learning is rich (Cole 2014; Chawla, Kenna, Pevec, Stanley 2014; Moore 1986). The field primarily focuses on related health or conservation benefits. Consistently, these studies have found that connecting youth to natural environments holds benefits for developing brains, such as higher levels of focus and better physical health (Chawla 2015). The field does not analyze how the design and learning benefits are linked. My research investigates the question: how do learning institutions, ranging in curricular structure, use space for environmental education? The report below explores answers to this question that range from sustainable building features to environmental curriculum features. This brings awareness the intersection of architecture and environmental education–learning about the natural world. The potential lies in educating school designers and administrators on how space and curriculum can be imagined to create environmental connection.

Importance of Green Learning Spaces

There has been a dramatic increase in resources invested to make school buildings greener. Between the years 2008 and 2010, the U.S. increased spending on schools by roughly $7 billion (Hiskes 2011). The movement to “green” schools is not just taking place in the US. A push to create sustainable schools with environmentally focused curriculum

are in affect all over the globe–including *Enviroschools* in New Zealand; *Green School Award* in Sweden and *Green Schools* in China (Henderson and Tilbury 2004). The UK has mandated that every new school built must meet a set environmental assessment (Lockie et al. 2008). In Australia, a growing 30% of schools have joined the Australian Sustainable Schools Initiative, an organization intended to grow school curriculum as well as improve the school grounds (Australian Sustainable Schools Initiative 2012). Emerging from this new global movement, a unique type of learning environment has been born, known as a "Teaching Green Building" (Cole 2013). This term gives a specific name to all buildings acting as "3-dimensional textbook" for environmental issues (Nair & Fielding, 2005: Taylor 1993: United States Building Council, 2008). "Teaching Green Buildings"—or TGBs—engage users of the space with the environmental components addressed in the building. Design interventions in these spaces vary greatly, they range from interactive touch screens to vegetable gardens.

Fortunately, in the last ten years, the movement towards greening formal learning settings has been steady. All around the world, initiatives are to bringing nature back into education. Literature produced on these initiatives is increasingly accessible–put forth by organizations such as the Children and Nature Network. This organization, offers a library of research as well as local community resources that connect developing brains to nature (Children and Nature Network 2005). As the societal disconnect with nature grows stronger, an opportunity reinserts itself: to design spaces for children that engage with the natural environment. Considering learning spaces as the primary institution for shaping developing minds, this occasion puts designers in a powerful position.

A Brief History of Designing for Environmental Education

In 1949 a famous Danish landscape architect, Professor T.C Sørrenson, developed a model called adventure playgrounds. The premise of this movement was that children liked to be in junkyards much more than polished parks. He created a place where children could construct their own environments. Using natural materials, hammers, nails, and whatever resources were around, children found a sense of play in building. This idea promptly spread to other parts of Europe, to the US and then all over the globe. Adventure playgrounds brought a focus back to children in the natural environment through the employment of a medium they are comfortable with: play. The adventure playground model kick-started a movement that inspired the birth of forest kindergartens, natural playgrounds, child friendly parks. Largely, these models have remained limited to informal spaces or play spaces. Examples include play: ground, New York City (2017); Adventure Playground, Berkeley (1979); and Waldkindergarten, Karow, Germany (2013).

Figure 1 Adventure Playground, Berkley. Credit: City of Berkeley:

Figure 2 play: ground, New York City. Credit: play:ground

Figure 3 Waldkindergarten, Germany. Credit: Blog–Forest Kindergartens in Germany

With the start of the 1970s came invigorated place-based fieldwork with children. Efforts such as *Children's Experience of Place* (Hart 1979), and *Growing up in Cities* (Lynch 1977) kick-started the drive to understand what role environments have in childhood development (Chawla 2015). Roger Hart, Robin Moore, and Kevin Lynch distinguished themselves as a team of leaders in this discipline. During investigations for *Growing up in Cities*, Lynch and his colleges interviewed children about their perceptions of space. When asked to imagine the best place to live, children frequently mentioned trees, gardens, and parks as beautiful places. From these interviews, Lynch resolved that the desire for trees was ostensibly universal. He advised landscaping to be as considered

as critical as electric and water systems. Lynch also noted that wastelands should be made accessible, for child recreation–in addition to traditional means such as playgrounds and parks. His research had indicated wastelands were often the only spaces where children described creative play and adventure (Lynch 1977).

Entering the 21st century, Richard Louv published *Last Child in the Woods: Saving Children from Nature Deficit Disorder* (2005). The book made it clear to a large audience that bringing children and nature together was not simply ideal–it was urgent. Louv asserts that *nature deficit disorder* is forming a cultural autism in children. In the years following the book's release, work focused on the psychological benefits of nature's presence during the developmental years (Chawla, Kenna, Pevec, Stanley 2014; Edwards 2006). One study explored the effects of green schoolyards on stress in children. The results show that young children–who chose to play in wooded areas during recess–reported benefits of physical independence, strong social relationships, and imaginative play time (Chawla, Keena, Pevec, Stanley 2014). This same study observed that 98% of high school students participating in gardening programs reported positive effects on their attentiveness. This research exemplifies the commanding implications of introducing the natural world into learning spaces.

Green Learning Spaces

In the United States, one of the most widely used measures of sustainability in buildings, LEED, addresses the design challenge of connecting with the environment through architecture. LEED, Leadership for Energy and Environmental Design, is a US-

based set of standards for green development. This credit-based certification program, developed by the United States Green Building Council, has a special chapter devoted to giving schools credit for meeting certain green design criteria. One of the credits LEED schools can obtain is IDc3, "The School as a Teaching Tool" credit. The intent is "to integrate the sustainable features of a school facility with the school's educational mission." To earn the one-point credit, schools must,

> Design a curriculum based on the high-performance features of the building, and commit to implementing the curriculum within 10 months of LEED certification. The curriculum should not just describe the features themselves, but explore the relationship between human ecology, natural ecology and the building. Curriculum must meet local or state curriculum standards, be approved by school administrators and provide 10 or more hours of classroom instruction per year, per full-time student (US Green Building Council, 2017).

While this tool is certainly useful in the identification of sustainable design elements, checklists cannot ensure that education about sustainability occurs in a sincere way (Derr 2015 in review). LEED credits are a step in the right direction–however, the solution to this issue demands a whole-school sustainability approach. The notion of whole-school sustainability supplements learning from the physical space with sustainable curriculum elements. Figure 4 illustrates the components of this model (Barr et al 2011). This model attempts to foster a sense of place in building users, motioning to the idea that sustainability that expands beyond the physical space (Kudryavtsev, Stedman, Krasny 2012).

Figure 4 Whole-school sustainability wheel. Credit: Center for Green Schools

The relationship between humans and place in natural spaces is long standing research for architectural and environmental scholars. Place-based learning deepens ones learning through hands on experiences in the ecosystem (Gruenewalks 2003; Somerville and Green 2011; Pevec 2016). From this thought, Teaching Green Buildings have emerged. Teaching Green Buildings (TGBs) include learning spaces in which, architectural features engage the building user with the environment (Cole 2014). These buildings can be highly rated LEED buildings, using efficient energy performance building systems. The Adam Joseph Lewis Environmental Center at Oberlin College (Figure 5) and the Bullitt Center in Seattle, Washington (Figure 6) are among the first prominent examples of the Teaching Green Building philosophy in practice (Orr, 2006). TGBs can also use passive heating, cooling systems and low-tech design that highlights the surrounding environment. The Green School in Bali is a TGB focused less on technical intervention and more on place based environmental connection (Figure 7).

From the existing body of case studies, Laura Cole has distilled the approaches into five major theoretical perspectives for Teaching Green Buildings (Cole 2016 in review). Teaching Green Building as Symbol, Science Museum, 3D-Textbook, Call to Action, and Place.

Figure 5 The Adam Joseph Lewis Environmental Center at Oberlin College. Credit: McDonough Partners

Figure 6 The Bullitt Center. Credit: Bullitt Center

Figure 7 The Green School in Bali. Credit: Lawrence Flynn

Understanding how these buildings are created and the paradigms that support them is critical in progressing the movement to reconnect children with nature. Study of Teaching Green Buildings is an interdisciplinary study. It draws on the fields of architecture, environmental education, museum studies, environmental psychology, and has impacts beyond these fields. In landscape architecture, connections have been made between environmental education and landscape design (Malone and Tranter 2003; Ozguner et al. 2011; Tranter and Malone 2004). Other research has examined institutional and organizational factors within TGBs from the differing disciplines of environmental design (Barr 2011; Day 2009) and education (Henderson 2014). Despite this theory and logic based work, empirical research in this field is lacking (Cole 2013).

Moving forward, I begin with an exploration of theoretical frameworks that influence the research design, to give insight into rational of its structure. Chapter 2 details methods employed–the framework created for analysis, case study selection and instruments used

to carry out the research. Chapter 3 discuses the findings of each case study. Chapter 4 begins the conversation on what these findings mean and the potential they hold.

Chapter 2 / Research Design: Connecting learning, space, and nature

This chapter explores literature that evaluates how design engages learners with the natural environment. Theory from architecture, education, and environmental psychology make the foundation. These theories inform the construction of a framework employed in this research. The methods and tools engaged with this study asses design and curriculum for environmentalism in a range of learning spaces.

Theoretical Frameworks

Looking specifically at the intersection of architecture, design and environmental education has brought my focus to a few scholars. The first is Laura Cole. Laura Cole has contributed frameworks, case study research and theory–progressing the present understanding of the interchange between architecture and environmental education. Cole is a leading researcher on Teaching Green Buildings (TGBs). Though this building typology ranges in form, Cole has assigned this name to spaces that employ architectural features to engage building users with the surrounding environment. Cole explains that there are four design strategies to Teaching Green Buildings. Each strategy is backed with literature from conservation psychology, architectural studies, and environmental psychology. While the physical design features and concepts behind them are not exclusively her original thoughts, the framework is. The typologies for design approaches are factual information, physical engagement, social interaction, and social norms (Cole 2014) (Figure 12).

Teaching Green Building design strategies

Factual information is a way of explicitly stating how the building addresses the environment. This can be an interactive touch screen, visual overlays on architectural elements, signs, brochures, websites, and other text based interventions (see Figure 8 for an example). Factual information is passive in its approach and aims to teach through visual and verbal information. It can manifest as flat signage on recycling bins or real time feedback of how many plastic water bottles have been saved using the fountain. Individually, informing designs have been found to only slightly effect behavior towards sustainability (Liley and Wilson 2013).

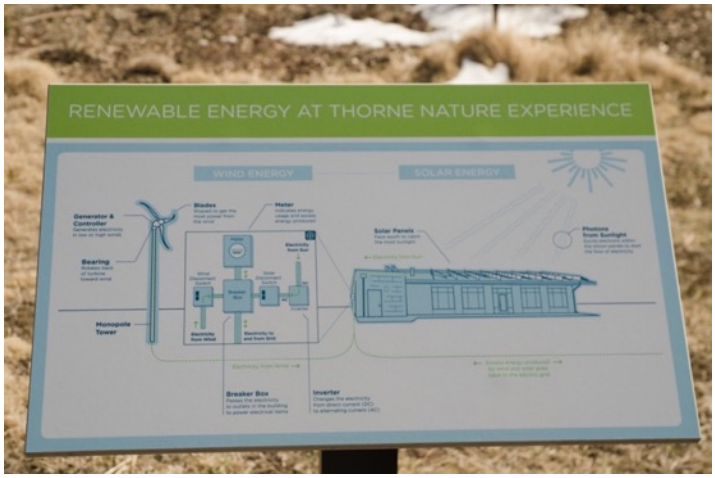

Figure 8 Example of factual information at Thorne Nature Experience

Physical engagement is design that promotes hands on learning and interaction. This type of design indicates that part of the building can be engaged with by the building users (Figure 9). The United States Green Building Council (2008) states that for a building to be classified as a teaching tool, it must have these physical features. An excellent example is a vegetable garden–where learners directly interact with the earth. Physical engagement design calls on landscape architecture and play design (Gardsjord et al.

2014). This research focuses on creating spaces that actively engage children with the outdoors. Physical engagement can also be applied to other places in the building that are not necessarily set on by the design feature but, by a habitual motion like shutting the sink off after using it. This ignites a challenge for designers–how can opportunities for meaningful engagement that promotes an environmental theme be intertwined into the building? Cole suggests that physical engagement spans along the spectrum from personal to social contexts, from thinking to action.

Figure 9 Example of physical engagement at The GrowHaus

Social interaction is a way of organizing space as a venue of interaction, exploring, and learning. The building layout encourages unplanned interaction with the environment (see Figure 10). This strategy lends itself to architecture programmed to support social functions. Social interaction is rooted in place-based learning theory (Cranz et al. 2013). In completing *Children's Experience of Place,* Rodger Hart concluded that children were learning about themselves as they were learning about environment. They began to develop understanding, skill, and confidence in using their environment to complete

purposes and heighten their experiences (Hart 1979). Social interaction is commonly seen in Reggio Emilia and Montessori type schools–place serves as a venue of discovery. This begins conversing with the idea of how building layout can encourage unplanned exchanges (Hillier et al.).

Figure 10 Example of social interaction space at The GrowHaus

Perhaps the most abstract of the design strategies is social norms. Social normative spaces provide enough social information to stimulate sustainable conducts. The individual is viewed as a person participating in social patterns (Figure 11). The environment sets up a social culture of information–engaged with proxy of being a building user. The research that emerges from museum studies explores this idea (Falk, Dierking 1992, Falk, Dierking, and Foutz 2007). It explains that physical context, socio-cultural context, and personal context all contribute to creating learning experiences (at museums). Research attempting to understand patterns in conservation psychology illustrates that normative behaviors have influence over the sustainable nature of our lives (Nolan et al. 2008). Cole writes that overlapping these concepts with a Teaching Green Building

introduces consideration of buildings promoting norms of environmental stewardship. Setting up this type of social culture is achieved through strategic steps, such as making recycling visible, attractive, and potential interactive (Cole 2014).

Figure 11 Example of social norms at The GrowHaus

These design patterns, drawn from research in environmental education, museums, and conservation psychology help construct this notion of a Teaching Green Building. The design patterns speak primarily to features within a space–not necessarily to the space syntax, or architectural configuration. In respect to architectural configuration, it is most important to note visual access and movement based access. Visual access is concerned with the views that can be seen from certain locations within a site. Movement-based access refers to the capability to move between areas of the building. This simply notes the ability to move, not the quality of the route (Hillier et al.,1987).

Cole has developed a framework for judging the engagement of different schools and learning spaces. Intertwined with the TGB design strategies, this framework draws upon three scales, aimed to contextualize the design strategies. Figure 1 illustrates how

Cole has woven in the *Spectrums of Engagement* with the *TGB design strategies (Cole 2014)*.

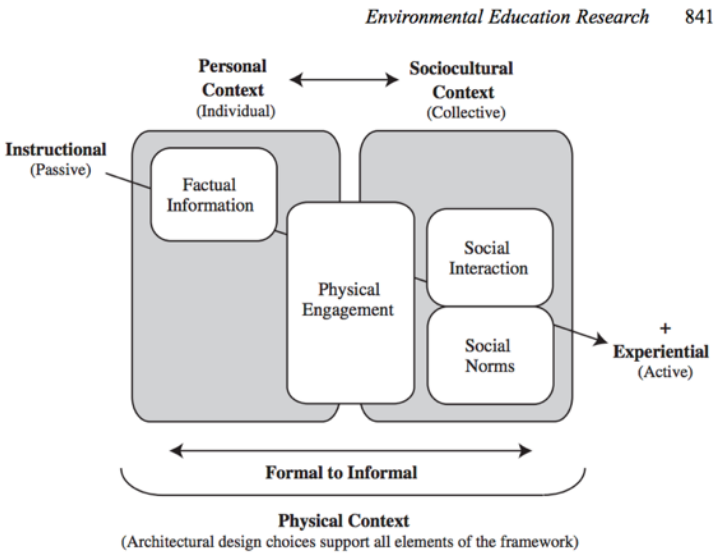

Figure 12 Spectrums of engagement and TGB design strategies (Cole 2014)

Cole's Spectrums of Engagement

Cole's framework serves as a starting point for looking at how schools are constructed with variant engagement across three spectrums. The spectrums indicate the programmatic and pedagogical nature of the learning space.

The first of these is formal to informal. Formal learning constitutes specific plans curated to educate or engage. Informal learning opportunities can occur in between classes, at recess, etc. Informal moments happen outside of the curriculum plan. Cole notes non-formal activities can be organized, such as a gardening clubs. She writes that buildings can scaffold activities across a range of formality. This spectrum addresses the curriculum engagement in learning spaces. The discussion of this framework, notes the

critical advantage of day to day building occupation that schools have over non-formal learning spaces like museums or zoos. (Cole 2014).

The next spectrum is passive to active learner engagement. Active engagement or experimental learning, could be explicit, like a tour that explains how the building teaches students about the environment. It can also be any type of hands on activities or curriculum. Passive learning in these spaces could be signage hinting to a building feature, expecting users to engage with it (Cole 2014). Literature from conservation psychology indicates that visible information (e.g., factual information) contributes to environmentally conscious behaviors–at least partially (Katzev and Johnson 1987).

The last spectrum is individual to collective engagement. To what degree do personal and social context impact learning? Individual engagement is learning that happens on a personal level. This level of engagement to the Contextual Model for Learning in museum scholarship (Falk and Dierking 2000) (Figure 13). Individual learning speaks to the personal context aspect of the model. Collective learning draws on the sociocultural context of this model, speaking to place-based education.

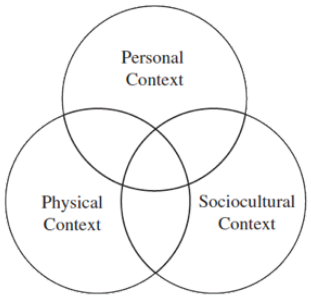

Figure 13 Contextual Model for Learning. Falk and Dierking 2000. Credit: Diagram from Cole (2014)

Design for Sustainable Behaviors

Design for Sustainable Behaviors (DfSB) is an emerging research field and design methodology under the umbrella of sustainable design. This research aims to control products' environmental and social impact by curating how users interact with them (Bhamra, Lilley & Tang 2011).

Emergent out of product design, Debra Lilley and Garrath Wilson have pioneered research investigating if the design of certain products can influence behavior change, specifically in a more sustainable manner (2013). Basic strategies of this method either guide change towards sustainable behavior, maintain change, or ensure change. My research adapts the DfSB model to informing, determining, and persuading design. This creates an important question for TGB designers—what is the efficiency design strategies in of instilling environmental behaviors within a green building?

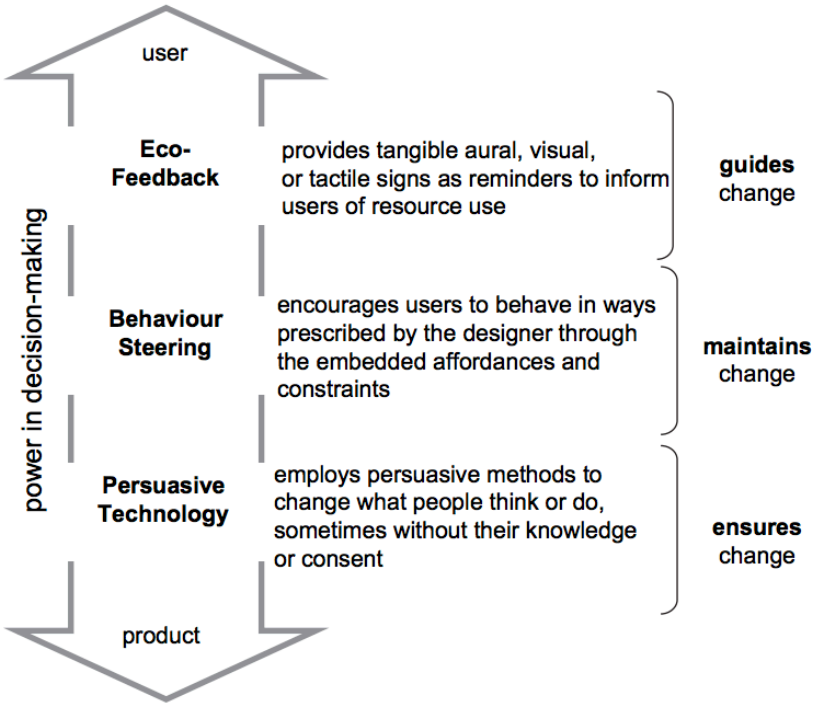

Figure 14 Design for Sustainable Behaviors Diagram. Credit: Liley and Wilson (2013)

Informing design interventions make participants aware of the environmental action they could take. This type of design encapsulates three different design intervention strategies, eco-information, eco-choice, and eco-feedback. Eco-Information is design oriented education. This could be signage over recycling and composting bins. These designs make consumables visual and accessible–enabling users to think about their use of resources. Eco-Choice is design oriented empowerment, encouraging consumers to consider their use behavior and hold themselves accountable for their actions by providing the product user with choices. Eco-Feedback design clearly informs users about their actions. It facilitates the user's ability to make environmentally or socially responsible choices through real time feedback. Eco-Feedback is considered as a design oriented link to environmentally or socially responsible actions (Bhamra, Lilley & Tang 2011).

Persuading design interventions intend to maintain sustainable change. It is designed to push participants towards a certain type of behavior. Persuasive design strategies include eco-spur and eco-steer interventions. Eco-spur is designed toward rewarding incentive and penalty. Eco-spur inspires users to explore sustainable use of a product by prompting good behaviors or penalties that discipline unsustainable behaviors. This could take shape with waste stations. Perhaps recycling bins are designed to be more appealing while the waste basket is labeled "landfill" and is less attractive. Eco-steer design is oriented towards affordances and constraints. The mission is to have users adopt more environmentally or socially advantageous habits through the allowances and or constraints embedded in the product's design.

Finally, determining behavior entails designing products and spaces to essentially limit the participants' behavior to a sustainable one. Determining design strategies employ eco-technical intervention and clever design. Eco-technical intervention is defined by design oriented technical interventions. The aim is to restrain current use habits and persuade or control the users' behavior. This is accomplished through design that is paired with advanced technology. Clever design enacts design combined with advanced technology. It automatically reacts environmentally or socially without raising awareness of doing so. Using our example, landfill bins would be small and in fewer quantity, whereas recycling and compost bins are largely accessible.

Towards a Holistic Framework for Connecting Environmental Education and Design

To understand how different design strategies, enable environmental education–in a range of learning spaces–I have built a new framework from Cole's TGB design strategies and Lilley and Wilsons DfSB theory. This framework analyzes learning spaces with a focus on environmental education. The goal is to highlight how a variety of learning environments use design for environmental engagement.

Cole's Teaching Green Building strategies identify patterns in design that connect building users with environmental *architecture*. But, it does not necessarily identify patterns in design that connect building users with environmental *program,* tied to the architecture. To employ design as a tool for creating holistic, sustainable environments–design that engages building users with the sustainable themes beyond the architecture must be considered.

Design for Sustainable Behaviors framework explores how products can influence sustainable behaviors. For the purposes of this research, products will be categorized as informing (guides change), persuading (maintains change), or determining (ensures change). This framework does not necessarily encompass how whole spaces and designed program can inform, determine, or persuade sustainable behaviors.

I combine Cole's TGB Strategies and Liley and Wilson's DfSB methods to generate an evaluative framework–used to study design that calls on the environment–in five learning spaces. This framework creates deductive guidelines for looking at environmental education spaces. The TGB design strategies identifies patterns of engaging building users with the environmental features of the architecture. This framework expands the TGB strategies to encompass design that engages learners with the environmental program of the space addresses whole-school sustainability (Figure 15).

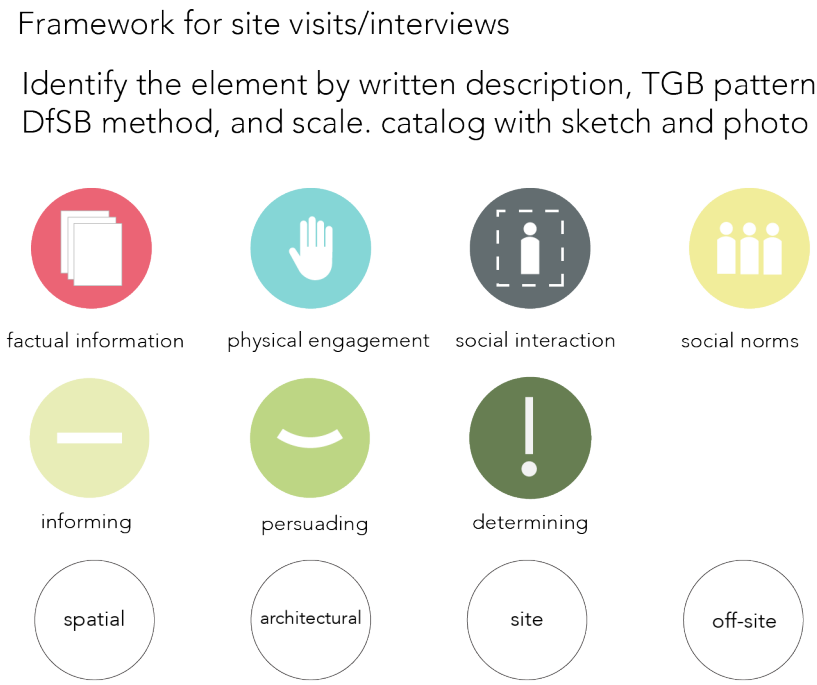

Figure 15 Framework for analyzing design in case studies

Whole-school sustainability is comprised of three elements–the organizational space, the physical place, the education program. Whole-school sustainability was born from a research report done in 2004. An Australian team reviewed school sustainability programs across the globe. The results found whole-school sustainability approaches to be critical to grow sustainable communities. Existing research addressed curriculum and physical space independently as factors of sustainable education. This was the first report to express school sustainability in terms of organizational space in tandem with curriculum and physical space (Henderson and Tilbury 2004).

With interest in how TGB strategies inform sustainable behaviors, I employ the DfSB framework. The scope of this project pushed me to pair TGB with DfSB to begin

understanding these social implications, rather than working with children in the space. In this study, DfSB is used to gauge sustainable behaviors of products and places.

This framework investigates if the design of certain products can influence behavior change, specifically in a more sustainable manner. Though created within product design, DfSB has been used to understand sustainability on larger scales (Tracy Bhamra, Debra Lilley & Tang Tang 2011). For the purposes of this research, products and places will be categorized as informing, persuading, or determining.

Each analysis begins context and engagement, to give perspective to each case study. This provides understanding of programmatic content at each space. This framework is heavily adopted from Laura Cole's Spectrums of Engagement Framework (2014) (Figure 12) Cole's framework serves as starting point examining how schools are constructed across three spectrums of engagement. These spectrums locate program of education spaces.

I adapt Cole's definition of formal to informal, which presently speaks about individual learning moments to speak more to the categorization of the learning space. Formal means learning environments with curriculum that leads to widely accepted forms of education credentials. Non–formal designates learning spaces which may loosely follow curriculum but do not ensure qualifications. I will add a category called Metropolitan to Open Space. Metropolitan is used to describe environments that are primarily hardscape, situated in an urban context. Open space indicates land that has been intentional preserved for exploring natural elements on the site. This spectrum aims to gives a measured, generalized context, to each learning space.

Methodology

The analytical framework outlined in the previous section built an understanding how design works with environmental engagement. This foundation has informed the methodology. Case studies are employed as a methodology for conducting research, rather than a mere selection of what is being studied (Creswell 2007). I have carried out embedded, multiple case study analysis (Yin 1994).

Data collection comes from site visits, driven by a field guide–looking for architectural, spatial and site elements that speak to the framework. These observations are supplemented with interviews of administration at each space.

Case Study Selection

Case studies explore the phenomena of using space to facilitate environmental education, rather than test the phenomena. Supplemented with documents, observations, and interviews, case studies are a compelling way to analyze a contemporary phenomenon (Yin 1994). These projects exist in real time and the findings reflect an exact moment in time.

There are several ways to successfully complete a case study analysis. A holistic case study, looks at the entire site or situation. An embedded case study focuses on one predefined element–the design of the building as pedagogy for environmental education. A multiple (or collective) case study replicates the same type of analysis on more than one project (Creswell 2007). This method does not imply sampling. Inherently, sampling holds the capacity to exclude certain types of studies. Replication in a multiple case study

creates a more convincing and robust study than a single case study (Yin 1994). An embedded pitfall of this analysis type is the focus on one element–rather than investigating the case study as a larger unit.

The primary distinction in my case study is between non-formal and formal learning. The variation stems from the idea that some learning spaces lead to certain credentials, such as graduation status, while others do not. For the purpose of this research, I study three formal learning spaces and two non-formal learning spaces. I have chosen this range in formal to non-formal spaces to explore how different levels of curriculum relate to use of design.

Formal learning leads to largely accepted forms of learning credentials. These are the spaces that follow state and national accredited curriculum. Most commonly, these spaces include public schools, private schools, and charter schools. Essentially, this is the K-12 learning that, in theory, every student has access to.

Non-formal learning is usually funded privately, with a loose curriculum. It's not necessarily intended to help its learners gain those widely accepted credentials (Sefton-Green 2013). This kind of learning has also been called "free choice learning" or "interest based learning." Primarily, research on this learning comes from museum studies (Falk 1999). Non-formal learners are motivated by their own personal interest, in combination with support from the surrounding environment or encouraging mentors (such as parents). Not all children have equal access to these spaces and it is not assumed they will learn in these kinds of spaces.

There is a third kind of learning, referred to as in-formal learning. This learning is framed by agency and guided direction by the learner itself. This type of learning is not consistently connected to a certain space or set of curricular goals. Despite the large infrastructure of schooling–set up by the government, church organizations, and other education interest groups–a large amount of learning occurs outside of traditional schooling (Falk 1999).

The spatial organization and construction of space varies across formal, non-formal, and informal learning spaces. The differences in requirement across case studies gives my research the opportunity to explore how those differences influence approach in the Teaching Green Building philosophy. Are non-formal spaces more apt to create a Teaching Green Building because of the allowed freedom in their curriculum? Do formal learning spaces seek out teaching green spaces because of their curricular and spatial constraints?

The distinction between formal and non-formal learning spaces lends insight into how a space, bound to a multiple set of standards and curriculum, responds to this design challenge–opposed to a space exclusively bound to its mission statement. This distinction does not necessarily follow a strict binary. Some schools on the curricular side of the spectrum follow a mandate that enforces visitation to a non-formal space. The reverse is also true; Thorne Nature Experience is an example of this nondescript space. Thorne is a non-formal environmental education program that, in supplement to holding camps and courses in their own space, travels into curricular spaces to educate students during and after school hours.

I have selected five learning spaces, ranging in degree from formal to non-formal. The selection of multiple case studies injects context into the design understanding, following the differences in learning models. Beyond this distinction, learning spaces reviewed in this project must meet the following criteria–to be in the Rocky Mountain West, educate elementary age students (6 to 12 years) and direct energy into creating a connection between the environment and the building users.

I begin my analysis with the non-formal case studies–giving the context and engagement of each space, followed by insights from interviews and observations supplemented with images and plans. See Figure 16 to understand relative location of the case studies.

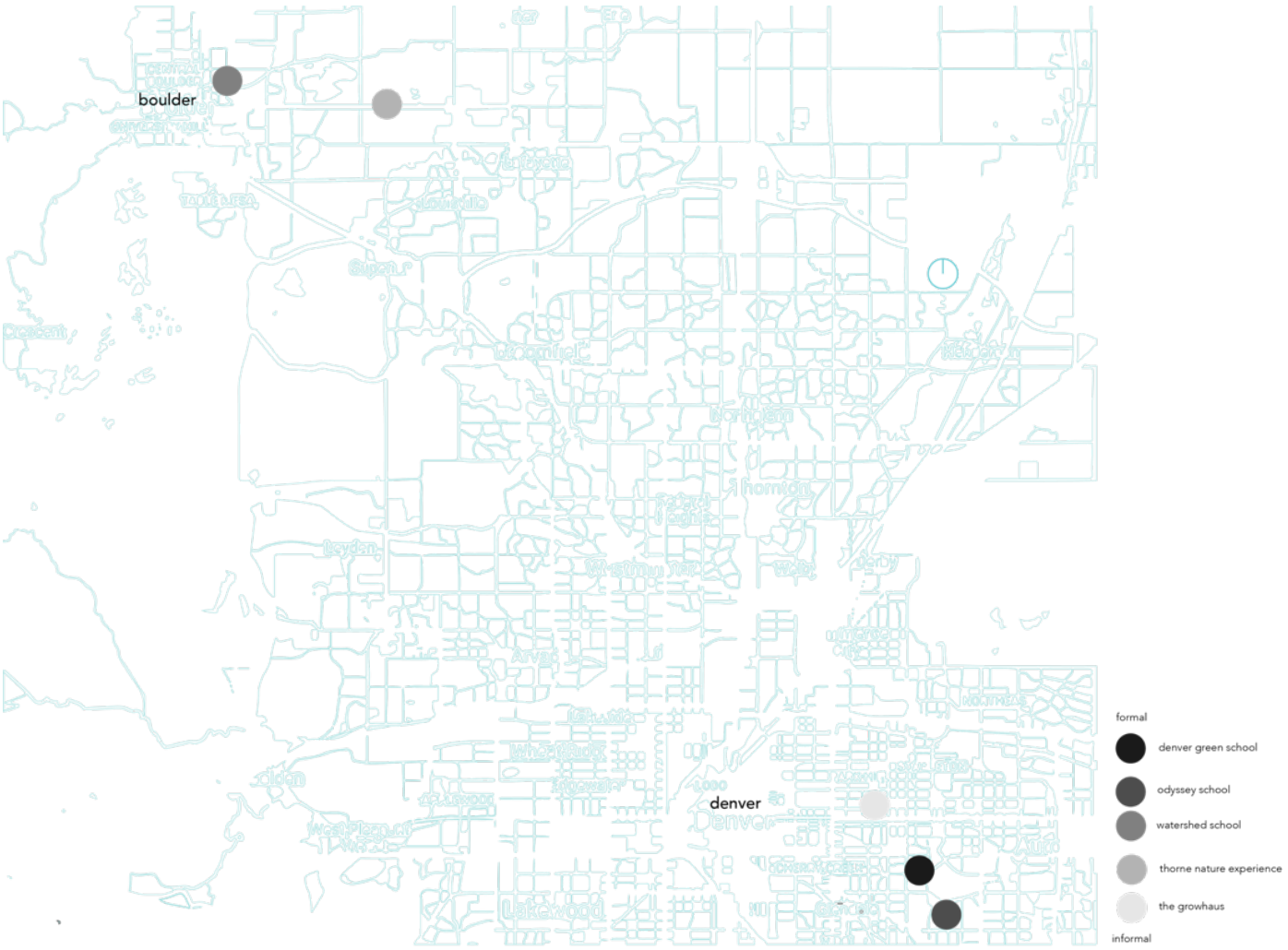

Figure 16 Map of case study selection

Methods

At each case study, TGB and DfSB patterns were identified, photographed, sketched, and labeled. The analysis lead to a catalog of architectural, spatial, site, and off site elements. The elements address the space's interaction with the natural world. This field guide scaffolds visual note taking in a space. Beyond identifying design features, the field guide includes guiding questions about the space–prompting insights that may be underrepresented when looking specifically for the design patterns (Appendix C).

Additional photographing, sketching and note taking generated a visual understanding of the space. Collectively, the field notes from each case study, form a set of observations.

After spatial analysis, I interviewed select administration. Selected administration are directors of the school or learning program at each space. Interviews prompted insights on how and where learning, in general, occurs at each space. The conversation progressed to discussing environmental education programs and how space supports that–both onsite and offsite. I briefly described each TGB and DfSB method to the interviewee. The administrators replied with places, products, and activities that they felt matched each definition. Interviews spoke directly to the framework (Figure 15).

After each site visit, I scanned sketches and field notes into digital format. Field notes taken during each interview were transcribed. Subsequently, interviews were coded to identify TGB and DfSB patterns in the responses. Key words, phrases, and ideas were color-coded to highlight elements from the framework outlined in Figure 15. After criteria guided I reflected on each site visit–noting thoughts that ignited during the visit, interesting points in the conversation, and other understandings that came from each space (Appendix E).

Limits of Methods

There are limits in creating a study perpetuated by the outlined methods. The deductive field guide and interview questions are specifically addressing the selected frameworks. This look at the space is exclusive. Leading questions point answers to speak to the frameworks, leaving out opportunity to explore topics not addressed in the

frameworks. The scope of this project narrowed interview participants to administration at each space. Excluding interview participants such as children, architects, and parents limits the perspective of each space. The case study selection excludes LEED rated schools, excluding the opportunity to look at USGBC certified learning spaces. Case studies were selected in part because of access. Access also limited the selection excludes to the Rocky Mountain West, excluding interesting studies beyond the geographic region.

Chapter 3 / Findings: differences in learning, from informal to formal

This chapter is composed of five case studies and the analysis that has taken place at each site. Case studies were explored through the analytic framework set up by and discussed in Chapter 2. Supplemental field notes and supporting images can be found in Appendix E. Each site visit lasted roughly two hours. The first hour was devoted to analyses lead by a field guide. The next hour consisted of interview conversations, I spoke to six subjects, one administrator at each space and an intern at The GrowHaus. After each site visit, I spent approximately three hours of data organizing and coding. Chapter 3 details observations at each space, Chapter 4 synthesizes the data and probes contributions.

Non-formal Case studies

The GrowHaus and Thorne Nature Experience represent non-formal learning spaces in this study. These are two spaces which have learning programs, loosely directed by a curriculum that does not give learners any type of widely accepted credentials. Rather, these spaces' learning experiences are aimed at providing students with the foundation create lives fueled by sustainable behaviors and perspectives.

Case study #1 / The GrowHaus

Figure 17 Exterior view of The GrowHaus. Elyria-Swansea neighborhood in Denver

Context and Engagement

The GrowHaus is a non-profit organization, located in the Elyria-Swansea neighborhood in Denver. Committed to bringing a healthy, sustainable food culture to the community, The GrowHaus drives their programs forward with a mission statement of "Healthy food is a right not a privilege" (thegrowhaus.org 2014). The organization has three branches: food production, food distribution, and food education. Food production is hydroponic, aquaponic, and mushroom farming–where GrowHaus team members and community volunteers produce vegetables and fish. Food distribution happens through weekly food boxes and a marketplace where residents of the community can purchase organic goods on a sliding scale of where they can afford to pay. Lastly, The GrowHaus

focuses on food education, teaching community members as well as participants outside the zip code about nutrition, wellness, and social justice issues.

The GrowHaus is situated in a food desert, where there no access to fresh food within one square kilometer (USDA 2012). The site's soil has been contaminated by previous occupants, known as a brownfield. The GrowHaus is situated next to train tracks and the intersection of major high ways as well as close to contaminating factories, creating noise and smell barriers. These environmental factors suggest an atmosphere that deters residents from spending time outside.

The GrowHaus combats the harsh environmental conditions, providing the community with a place to connect with nature. The growing, distributing, and educating at The GrowHaus takes place in a 20,000-square foot warehouse–repurposed as a green house. In the past year, the organization has built an outdoor class room, on which they are still expanding, primarily to purpose children's classes and camps in the summertime.

I spoke with Isabel Sanchez and Makenna Golumbuck at The GrowHaus to get a better idea of how the GrowHaus facilitates environmental education. Isabel coordinates the education programs and Makenna works as an intern at The GrowHaus. In one sentence, Isabel said learning at the GrowHaus is a leadership, empowering program of sustainability. Golumbuck replied that, the GrowHaus was an "open, creative space where people can have fun while learning." The GrowHaus serve all ages from two to ten, service learning for all ages, and adult classes. They teach residents how to create habitats for different animals. GrowHaus brings in different animals to teach about the circle of life and the place each thing has in our ecosystems.

> At the GrowHaus we do the best we can to educate about our footprint, mostly through food and animals education. We educate about harvesting and foresting, permaculture, water, and how to mimic nature.

Golumbuck reinforced Sanchez's point. She enthusiastically talked to me about how The GrowHaus educates people in different age ranges and people low on the socio-economic scale. She told me, "Most of the education is about urban agriculture, it's also about community and how you can rely on the people around you - it teaches you to work in groups."

Learning about the natural world happens mostly through experiential learning. Educators begin classes with a PowerPoint to position the lesson, and then engage directly with the material. Field trips bring GrowHaus learning into other spaces; like the wellness class who travels to a park for yoga walking, and to use the park to learn about natural systems.

I asked Sanchez *where* she thinks learning happens most at The GrowHaus; she replied, "everywhere." She explained that just being at The GrowHaus is a learning experience. From the market, where you can see we are trying to make healthy food more sustainable to the signage, or the farm, or the models we have in The GrowHaus–learning happens everywhere.

Both women told me if they *had* to assign a spot in the GrowHaus to learning, they would say the Growasis.

Figure 18–The Growasis at The GrowHaus

> I think we have more targeted education there, with curriculum and other supports. However, I don't think that necessarily means there is more learning going on there.

When exploring the idea of connecting the architecture and nature at The GrowHaus, I got the feeling that there are constant moments of this connection at the GrowHaus. The GrowHaus exists in a repurposed warehouse, spatially redesigned to embody the GrowHaus' mission to sew sustainable food and lifestyles into the community.

> The Growasis feels like one of those places (where you can be connected to nature inside) because of the plants and the natural light, the temperature is fluctuating so it feels like you're outside.

Sanchez explained that if they can get learners outside, they try to. Movements to bring learners outside of their space can last a day or half of a day for a class. GrowHaus staff members can travel for weeks at a time–for permaculture workshops and conferences. Usually, just staff members travel on these longer trips while learners are

more likely to participate in field trips. The environments used for learning off-site range from buildings and conference centers to retreat spaces, to gardens and parks, to the homes of the learners.

Teaching Green Building Design Strategies

While talking with Sanchez and Golumbuck, I briefly described each TGB design strategy and they responded with how they felt the space embodies this strategy. This section recounts and diagrams the responses of Sanchez and Golumbuck. Figure 18 diagrams where the strategies appear in the space, as collected from my spatial analyses and recorded from the interviews.

The participants felt there was a great deal of factual information at The GrowHaus. In addition to the free tours that explain how the grow spaces keep stable environments to grow what they are intending to grow, there is signage all over the building. This signage explains what each space facilitates, programmatically and how it connects to their mission. There is also an informative website where visitors can read about The GrowHaus, their mission, programs, and products.

While discussing physical engagement, I heard about volunteering at The GrowHaus and the classes offered at the space, rather than design features. Two Tuesdays a month they have volunteers come–tending to plants in the Growasis and in the backyard, caring for animals, turning the compost. Isabel gets a large volume of emails from companies and organizations wanting to bring in a crew to get their hands dirty.

Makenna told me about the different classes at the space that are facilitated by physical engagement design. Seed 2 Seed is a program at The GrowHaus, directed at teens, focused on a healthy diet, healthy soil, and healthy communities (The GrowHaus 2014). Cosechuando Salud, is a program designed to help community members learn how to cook with ingredients they have grown, in addition to local and ethnically familiar ingredients. There are also "Second Saturday" classes, where learners can pay to participate to learn new skills about hands on farm to table practices. As you explore the space, there are children playing with the chickens while other learners building things like beehives and garden beds, or pickling vegetables.

In response to social interaction, the type of design where the space serves as a venue for learning through exploration, I got nods of agreement.

> Yes, this one is totally us! I mean, we have baby chicks, with signage on what their needs are. We have a mushroom farm and explanation on what the importance and process of that is. So, I feel like when people walk in, they have an understanding the we are trying to bring social and economic growth through sustainable practices.

Anyone who comes in can see that is the space is set up for a purpose. The GrowHaus allows people to ask questions to see what's going on. The open plan and inviting people create an atmosphere where visitors can almost give themselves a self-tour.

When I described social normative design strategy, both women agreed that this strategy, sounded like the whole space rather than a room or a design element within the space. To Isabel and Makenna, social norms is *what they do* at The GrowHaus. Anytime

someone comes into the GrowHaus to visit, to volunteer, to shop, they get the feeling of that something powerful and something sustainable is happening.

Design for Sustainable Behaviors Methods

I presented the *Design for Sustainable Behaviors* ideas to Isabel and Makenna– explaining the informing, persuading, and determining concepts. Sanchez responded not specifically to one item but to the concept. Rather than naming specific products or places that accomplish these behavioral choices, she noted that the whole place pushes you towards sustainability.

> The minute you walk in, you start knowing there is something happening with sustainability here, there is signage around, the Growasis, the market, these things point towards sustainable happenings.

I asked Isabel if she thinks the DfSB factors are present when she takes GrowHaus learning outside of the GrowHaus building. She thought people were starting to use design to communicate sustainability more and more. She specifically mentioned the Denver Urban Gardens office space.

I closed the interview asking them both if there was anything beyond what we had covered that speaks to how the GrowHaus environmentally educates. They explained that learning at The GrowHaus is very inclusive. The tours enable a lot of different people to see the space. Furthermore, the price structure is inclusive. If someone wants to take a class but only has $2 to contribute instead of the required $30, they are still allowed to come.

They might trade some volunteer hours for the class, but learning is still very accessible for anyone that wants to partake.

Appendix E1 illustrates specific design elements mapped in

Figure 19. The mapped design strategies in Figure 17 demonstrate a variety of design strategies employed. The design elements range from small scale signage to passively conditioned, naturally lit grow spaces. The GrowHaus has a high concentration of social normative spaces. Spaces like the hydroponic farms, the mushroom farm, and the Growasis are mapped as places where environmentally sensitive behaviors are normed. Generally, social norm design transcends the scale of factual information (signage). Social norm as a design pattern speaks more to a building's ecosystem rather than a design feature or product.

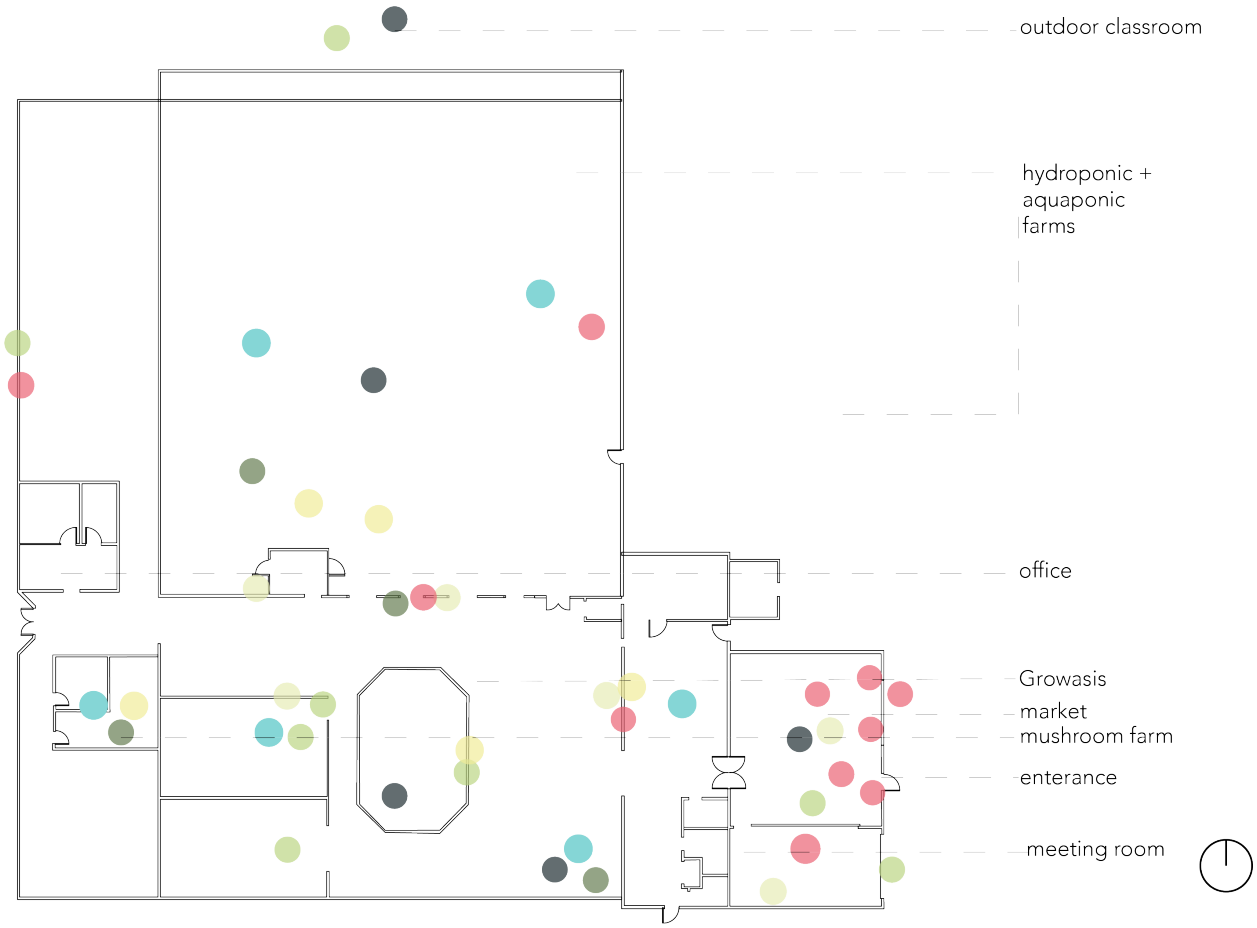

Figure 19 TGB + DfSB design patterns mapped at The GrowHaus

Case Study #2–Thorne Nature Experience

Figure 20 Exterior view of Thorne Nature Experience. Eastern Boulder, Colorado

Context and Engagement

Thorne Nature Experience is a non-formal learning space–guided by their mission "to build earth stewardship by connecting youth to nature through joyful, hands-on, place-based environmental education experiences" (Thorne Nature Experience 2016). Thorne hosts summer camps, after school programs and field trips. Thorne also goes into schools within Boulder Valley School District for in-school demonstrations as well as after school programs.

Thorne has an environmental education center in Boulder, as well as one in Littleton, Colorado. I have chosen to study the location in Boulder, Sombrero Marsh Environmental Education Center. This space and its program is partially facilitated in partnership with the City of Boulder Open Space and Mountain Parks Department (OSMP) and the Boulder Valley School District (BVSD). Located in a salt marsh ecosystem and surrounded by views of the Flatirons, the facility backs up into open space trails. It is home to a bird viewing bind, a classroom, laboratory, and mini-wetland. The marsh has four main stations; birds, plants, wetlands, and water pollution. It is also home to native garden habitats, a 30-ft. wind turbine, and a photovoltaic solar system–used to demonstrate the concept of conserving natural resources in the interest of protecting the environment. Thorne's Sombrero Ranch site and building communicate the design elements and goals of a TGB.

I spoke with Gwen Tenney at Thorne Nature Experience to understand environmental education at Thorne a little bit better. In one sentence, learning at Thorne is "Hands on, place based, environmental education that connects kids to nature."

At Thorne, environmental education happens in three major ways. The first is through second grade field trips. Essentially, every school in the BVSD program is invited to bring their second-grade class to Thorne's facilities at Sombrero Ranch. Students are in the building and on the land, taking on environmental education. The second is through the summer camp programs. Summer camps run for three to six year olds. The summer camps occur within the building, on the open space surrounding it, and on various field trips. The third way environmental education happens at this space is through informal and

sporadic interaction. Examples include birthday parties hosted at the space, open hours– where families and community members are invited to come by and check out what Thorne is about, meetings hosted at the space, or community members exploring the open space surrounding the building.

Beyond learning at the space, Thorne has a strong after-school education program. After-school programs run at formal learning spaces. These programs are provided at a range of economic degrees. Thorne subsidizes the after-school programs for schools with a high percentage of free and reduced lunches, high percentage of Latino communities, and a staff that is ready and willing to facilitate this type of activity. Some of these programs come at absolutely no cost, while others are brought down from a $140 fee to a $20 free. The revenue generated from summer camp enables this subsidy. Thorne selects these schools, provides in-school demonstrations, after school program, the field trip, and summer camp. These students will have spent about 100 hours with Thorne by the end of their time at the primary school.

> At Thorne, learners learn most by getting outside! At Thorne, a ton of self-guided exploration takes place. The staff ensures that the exploration is safe, and is guided by questions.

Learning outside is supported inside with factual information and explanation of examples. However, Tenney made it clear that Thorne takes pride in employing a mentorship model rather than an instructive model.

When we spoke about what the specific moments of connection between the building and the environment are, Tenney brought up the bird bind. There is a shelter by

the marsh with bird watching slits cut into the building, facing the mountains, known as the bird bind. This is a destination for learning at Thorne. Students frequently travel from the classroom, to the bind to explore, and back to the classroom. When students return, they discuss what they saw between the building and the bird bind on the trail. Beyond the bird bind, the murals are a huge help in facilitating learning. Gwen mentioned a child sized bird nest in the class room that provides opportunity for fun learning and connection to the natural environment. About four years ago, Thorne did a remodel the space. The design work was done by one of the staff members and was ultimately driven by their mission. Landscaping was completed by an outside contracted company, under the direction of the same staff member.

As a part of the summer camp program, field trips are involved in the curriculum. These trips are usually day trips with staff and volunteers, occasionally there is an overnight, but those are rare. In general, field trips occur within foothills regions where natural exploration is plentiful. Field trips include places like Chautauqua, Wonderland Lakes, St. Vrain State park, and an overnight trip at Calwood (an environmental education center where BVSD is required to take students).

Teaching Green Building Design Strategies

Throughout the site and the building, it is easy to notice factual information (Figure 22). Inside the building, there is signage for the murals and field guides to facilitate signage and elements within the building. There are backpacks with field guides for exploring both the site and the building. Visitors can check out the backpacks on informal visits, like open

hours or a birthday party. Outside the building, the field guide booklets that provide text and images about how the pollinator garden, the bird sanctuary, and the mini marsh work and what natural elements can be identified in the spaces. There is also a detailed site map–illustrating where sustainable energy is coming from around the building and around the site.

Physical engagement manifests at Thorne in areas like the mini marsh where kids are sometimes given guided questions to explore in. The outdoor spaces provide many opportunities for hands on learning and interaction including the pollinator garden, bird feeders, the marsh, and surrounding trails and vegetation. Inside the building, learners use the animal tanks with snakes, fish, and other animals to engage in hands on learning. Furthermore, the microscopes in the science lab push this type of learning along. In the classroom, there are fossils that students are able to touch serve as another example of physical engagement design.

In regard to social interaction design, Tenney explained that the whole site is intended to encourage exploration. The open space and trails inspire investigation of the natural world. The trail from the building to the bird bind is especially telling of this– students travel from the class room to a structure intended for bird watching, next to the marsh with surrounding vegetation.

Inside the building, Gwen brought up the birds' nests in the classroom. The child size birds nest sits above the rest of the room and the corner book bird nest sits on the floor, both spaces allowing this exploratory interaction. Kids crawl up there and start to

make up their own animal games, or look at the room for a new perspective and notice things they had not previously seen.

Figure 21 Bird Bind at Thorne Nature Experience

While discussing social norm patterns at the space, Gwen referenced a few specific features. The path that goes around the building, the bird feeders and bird branching outside are characterized by social normative spaces–where learners are participating in patterns of environmental engagement. Also, the classrooms create this social culture. The rooms direct attention to the exhibits so one cannot escape environmental education within the space. However, this encompassing feeling is not represented in the office areas (Figure 22).

Design for Sustainable Behaviors Methods

I discussed the sustainable behaviors methods with Gwen, who explained how she thought they were employed onsite. (See Figure 22 for how design patterns map across the space. Appendix E2 details specific design features).

On site, there is substantial signage informing sustainable decisions that the members of Thorne have made. However, because Thorne works with younger learners, there is an intentional shift away from informing behaviors to just encouraging connection. Gwen says, “If we are able to create a connection with nature, they will care and hopefully make their own decisions that follow that care.” When asked about the presence of DfSB outside of the classroom, Gwen did not connect any products or places to the framework. Beyond staff members speaking to learners, there is limited outside use of products or handouts.

I closed the interview by asking about other ways Thorne uses the space to facilitate environmental education. Gwen mentioned call for involvement. Thorne does a lot of advertising about involvement–to get people to donate, volunteer or intern. “No one can go too far into the building without noticing the idea that they could be involved. This includes emphasis of kids’ involvement and accessibility”. It is a big part of the spatial arrangement, making sure kids presence is noticed. This visualizes the idea that there is a continuum of involvement and anyone can be involved, at different ages and at different scales.

The plan below shows a diverse range of TGB methods and DfSB strategies mapped from observation and interviews (Figure 23). Thorne is the most prominent case study for highlighting TGB methods. Social interaction is evident at Thorne. The site sets up a venue for spontaneous interaction with the environment. The classrooms echo this interaction-based design. The main classroom is crowded with educational signage, murals, artifacts, plants, and visual access to the mountains and surrounding open space. The classroom and site’s educational exhibits model the physical engagement. The social

interaction and physical engagement elements are supported with factual information. This means illustrated and educational panels informing building users about what flowers are in the pollinator gardens, how wind and solar energy used in the building, or what birds are native to the site.

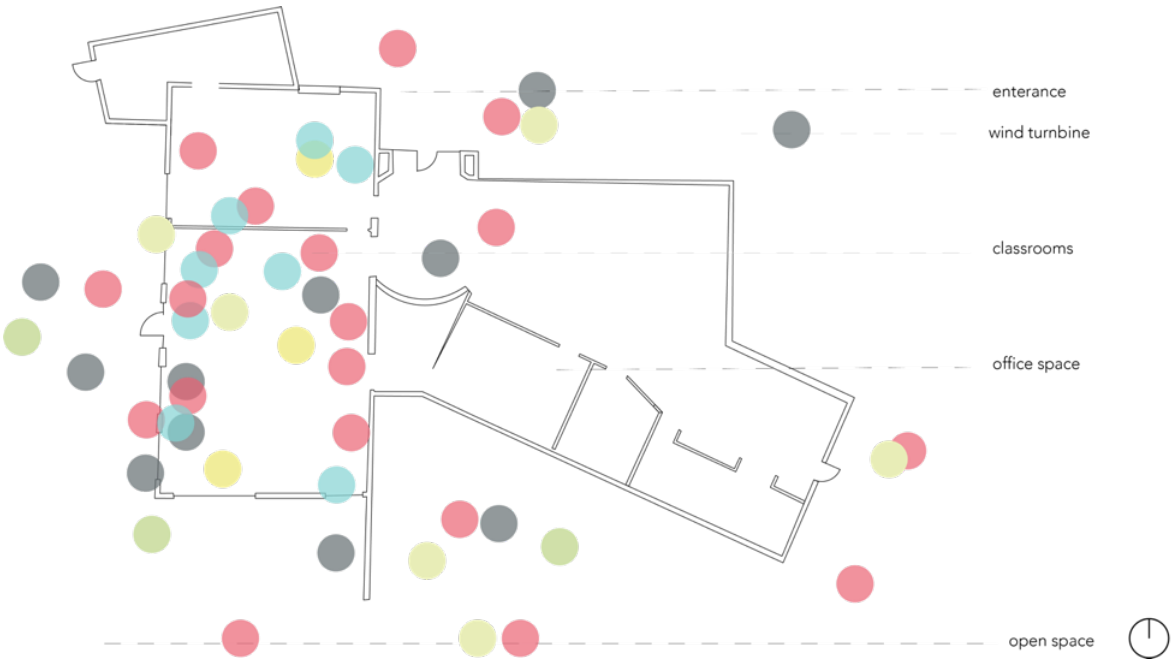

Figure 22 TGB + DfSB mapped at Thorne Nature Experience

Formal Case Studies

These case studies explore the findings of architectural analysis and interviews in schools. These learning environments follow specific curriculum that eventually gives students credentials to move onto more education. The range of formal schools includes a private school, a charter school, and a public school.

Case Study #3 - Watershed School

Figure 23 Watershed School. Central Boulder, Colorado

Context and Engagement

The Watershed School is a private school located in Boulder, Colorado. I became connected with Watershed school through a CU environmental design program alumnae, Cinder Trout. I began interning at the Watershed School, helping Cinder teach a design-build class. Watershed serves middle school and high school students, operating under an expeditionary learning model. Watershed is a part of the nationwide expeditionary learning network, committed to reforming education based around a set of guiding principles.

Essentially, this type of school places heavy emphasis on learning outside the classroom. Learning does not take place exclusively in classroom spaces. Rather, learning happens out in the world, in spaces most appropriate for the learning objectives.

I sat down with Andrew Chernow, an environmental educator at Watershed School. Chernow and I talked about learning and space at Watershed. He told me that, in short, learning at Watershed is self-directed. More specifically, environmental learning happens by getting out in the world. These experiences are not necessarily designed into the curriculum, more in the moment (or informal). However, some of these learning opportunities are built in. On the day of the interview, middle school students had just gone to Rocky Mountain National Park, to study snow pack and water. Watershed takes days or half days to apply what they are learning into the curriculum into the field.

Watershed runs a program called Wilderness. This program runs the first two weeks of school and students go camping with their class. Generally, they travel to mountain parks in Colorado. With a combination of formal and informal learning, these trips anchor the curriculum. Andrew says as an environmental educator, he can't help but take advantage of the learning opportunities.

> The students get one layer in class and then a deeper layer out in the world. For example, I took the students to a Clinton rally and a Trump rally this year. We watched videos, read their policies, but they never really got it until they were physically there, in that space, experiencing it.

These expeditions are also where learning about the environment happens. Andrew feels like in the building, there are not necessarily spaces that connect with the

environment. He told me that they use the site's outdoor space and there is an outside classroom. Yesterday, he walked with his math class to a park where students measured the diameter of trees. He remarked, "It's not in our school or on our land but, it's a five-minute walk."

Outside of the school, students partake in excursion trips, which play a large part in outdoor immersion. These trips range in duration and activity. The Wilderness program lasts 8 days with a focus on environmental connection. Students travel to places like Moab, Utah and Indian Peaks, near Boulder. There are two-week long May-term trips, with an academic focus. These trips bring students far–to places like Nicaragua, Peru, and China. There are also intermittent 4/5-day focus trips like to Silicon Valley to learn about the tech industry or the US/Mexico border, to focus on the environmental impacts of immigration. On a smaller scale, there are field trips about twice a month. Locally, the students go on hikes in the foothills to do things like collect data by counting and sorting pinecones, trees, insects. On an even smaller scale, Watershed has a mobile science lab, parked on site that is an extension of student's workspace, and can be towed around on excursions.

On expedition trips, there are two teachers present–one mostly for transit, one for instruction and if a third teacher is needed, it is accommodated. When visiting specific places, there are guides and experts to educate the group as needed. In general, Watershed discourages parents from coming along.

Teaching Green Building Design Strategies

I described each TGB strategy to Chernow and we discussed how each strategy was, or was not represented in the spaces used for learning at Watershed (Figure 24). We began to discuss factual information design. At first response, Chernow said, “No, not really.” There is recycling all over the place but that covers the signage. The school is not in control of their building, what so ever, says Chernow. He remarked that the air conditioning is up full blast when it’s hot and the heat is going when it’s cold. If Watershed had any say in their building, they would have solar panels.

When I described physical engagement, Chernow’s mind went to two spaces within the building. The first being the ideas kitchen. This was a break room, converted into a classroom for hands on learning. This learning is not specific to learning about the environment. Classes held in the ideas kitchen are design build, music, and some math and science classes. The other space is the art classroom. This classroom was re-vamped to include a garage door so the classroom can spill out into the outdoor classroom, directly in south of the room.

When traveling outside the building, physical engagement sparked conversation of students taking water, soil, or snow samples. In the wilderness program, students are interacting with physical engagement spaces for 8 days straight–learning how to manipulate the environment with their hands. This includes cooking food, building rain and sun shelters, identifying plant types. Other activities like making rock formations, measuring trees, or counting insects also got brought up.

When exploring the notion of social interaction design, Chernow mentioned what he thought Watershed school has done to try to make this type of space. He mentioned that all of their tables were on wheels so the space could always be rearranged. He also noted the garage door put in the art room that opens up to the outdoor space.

Beginning to shift the conversation outside of the school building, Andrew talked to me about the mobile science lab again. They bring it with them or sometime just use it as a quiet place to work on site. This is a relatively new design feature of Watershed's so they are still figuring out how to use it.

> Here, there is not a lot of this in the classrooms, it does not feel like a social norm. Outside the classrooms–certainly! Even when I take students to Boulder creek to pick up garbage, I think it kind of instills this sense of responsibility toward the earth or at least persuades students towards it.

Students interact with social normative spaces mostly outside of the school building. Spaces like campsites–where learners embody the "leave no trace" behavior model and teachers talk about the ethics of backpacking with the learners–begin to create social norms. Chernow told me that when students are backpacking and someone litters, others call the litterer out. It starts becoming cool to leave no trace. Does it translate back to the classroom? To some degree.

Design for Sustainable Behaviors Methods

Andrew and I discussed DfSB–how products and places can influence sustainable behaviors (Figure 25). I explained the DfSB methods to him and he gave me his reactions. Onsite, there are compost and recycling bins everywhere–informing sustainable behaviors

and there are bike racks to persuade the students to cycle to school. Chernow reiterated, Watershed has little control over their building, the Mount Zion Lutheran Church, right behind the school, owns the building.

When Watershed travels offsite, they encourage no waste behaviors–to only cook what you need and pack in, pack out. While on camping excursions there are signs and videos that inform the kind of behavior students need to embody while in the space. In Moab, for example, students watch a 30-minute video showing visitors how to treat the ground cover and live in accordance with the surrounding environment.

As the lively conversation with Andrew began to wrap up, I asked him if there were any other insights he could share about how space facilitates learning about nature at Watershed. He told me, “through a lack of space, it somewhat facilitates that because we are forced to go outside. You see our space, it’s kind of a tricky one.”

Andrew explained that the space is mostly concerned with how to house everybody, it exists for function. Beyond that, the constraints enforced by the building owners deter them design improvements like from transforming their upstairs classroom that opens onto the roof into a green house. In the front of the school there were attempts at a garden, which he plans to bring back to life. Beyond the buildings, he thinks the busses are key, they allow administration to take the students to different spaces. See Appendix E4 for additional field notes.

Figure 24 and Figure 25 illustrate design strategies both at Watershed’s school building and on excursions. Design strategies mapped to the excursion trips came from interview questions about the design frameworks off-site. The on-site design patterns

primarily reflect factual information with small concentration of physical engagement and social interaction. The school building principally informs sustainable behaviors. The off-site spaces include social normative design and persuading DfSB methods. This shows that the Watershed school building (not a TGB) does not set up a social culture of sustainable norms. To inhabit this normative environment, Watershed travels beyond the school to natural spaces.

Figure 24 TGB + DfSB mapped at Watershed School

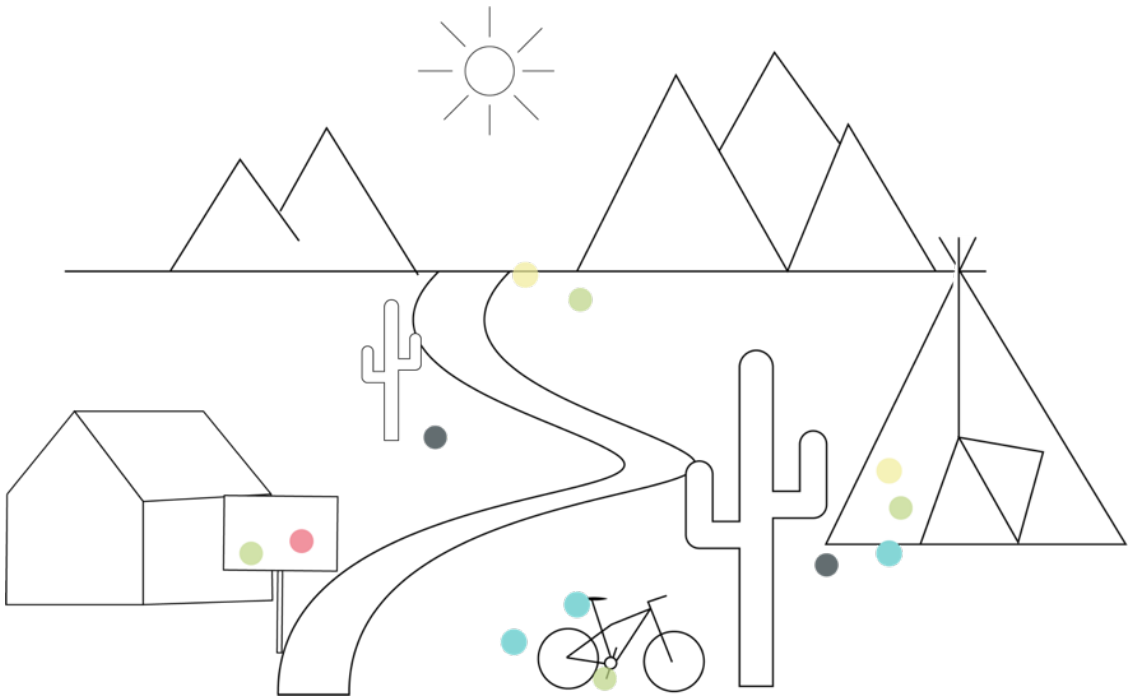

Figure 25 TGB + DfSB mapped to excursions at Watershed

Case Study #4 - Odyssey School

Figure 26 Odyssey School. Stapleton suburb of Denver, Colorado.

Context and Engagement

The Odyssey school is another expeditionary learning school, in Stapleton, a suburb of Denver. I became aware of Odyssey as a school with high value on environmental education through Thorne Nature Experience. Odyssey is a charter school, adhered to a charter school contract, CO state standards and public school requirements, and expeditionary learning principles. What differentiates Odyssey from other public schools, is the many contact hours off campus. Still learning and meeting set objectives, just in a different space. In the realm of the learning environments I've chosen to study, this seems to be the least design oriented TGB building.

I had the privilege of speaking with Elki Neigberger, Communications and Enrollment Director at the Odyssey school. She helped give me a better idea of what the concept of teaching green spaces looked like at the Odyssey school. In short,

environmental education happens out in the field at Odyssey. They take kids on adventure trips. The trips typically last around a week, though there are day excursions with.

Adventure trips range in location, activity, and duration. Each grade level has a trip designed to students them learn from their surrounding environment. For one or two days, kindergarteners stay in cabins or yurts in Spruce grove and first graders travel to La Foret retreat center to learn about bouldering. Second and third graders either go to the Sand Dunes National park to camp or to Rifle Falls to climb, for around a week. Fourth and fifth graders are off to Moab, Utah to bike for the week. Sixth graders go on a twelve-day excursion to Texas, visiting the US border with Mexico. Students spend their time learning about immigration, border patrol and the process of becoming a citizen. Alongside this collective learning, students camp and participate in climbing and hiking activities. The seventh-grade class does a bike tour around the city. The tour takes five days to bike 100 miles around Denver. During the tour, students camp at local spots, bringing awareness of the natural spots close to home. Eighth graders do a backpacking trip. Students are allowed to choose either a rafting, climbing, or biking trip.

The school's structure was handed down to Odyssey from a previously existing neighborhood school. Budgetary and physical constraints hold Odyssey back from designing their own space that embodies their learning mission. In turn, most environmental education happens off site, on excursions and field trips.

Teaching Green Building Design Strategies

I began describing about factual information to Neigberger. This design strategy made her think about the preparation of excursion trips. Before each trip, parents and students get handouts about what the space is like, what the boundaries are, and what to bring to accommodate needs–sometimes by physical handout or factual information form. Other times, they receive a presentation by Paul, the school's adventure coordinator. Inside the space, the bulk of the factual information is about waste management, composting, recycling, and waste. There is also factual information about nutrition and how a lunch is meant to be composed.

Physical engagement happens on excursions. Students are hiking, climbing, and exploring the natural areas on their adventure trips. The school used to have a partnership with Denver Urban Gardens, where students would go over to work in the gardens. Budget constraints have put the program on hold. For similar reasons, Odyssey has paused an extra-curricular program called nature rangers, where students go outside and learn about their immediate environment.

Social interaction describes in many of the spaces that Odyssey faculty and students visit on their adventure trips. The backpacking trip especially caters to this type of design–where the space is a venue for exploring, interaction, and learning. Neigberger described a few times when they were on expeditionary trips and the factual information onsite (trailhead maps, signage) helped direct the social interaction of the space, this struck me as an interesting point.

After hearing the description of social norms, Neigberger told me this is something they try to integrate into their school's reputation.

> When parents come to visit the school or there is an open house, the faculty makes a strong point to introduce the idea that camping, hiking, and outdoor adventuring is not an optional activity. Rather, these activities make up who Odyssey school is and what they stand for. It's a part of who we are

Even if a child is terribly uncomfortable with camping or the broader idea of engaging with the natural world as a learning space, they push the student to try. Maybe the learner is uncomfortable with climbing. Then they just have them put the harness on and touch the rocks. Odyssey wants students to take a step at connecting with the natural world, to get out there and push themselves to understand it more.

Design for Sustainable Behaviors Methods

While discussing the DfSB spectrum with Neigberger, we spoke mostly about the waste management at the space. The notion of composting and recycling at Odyssey school is strongly encouraged and is evident throughout the space. In the lunchroom, there are three large composting bins with informing signage that details what can be composted, two recycling bins with similar signage, and one smaller trash bin with no signage. This is the idea of persuading towards a sustainable behavior. When students go to national parks they stop at the ranger station to read all the literature and sometimes watch a video. For example, the sixth-grade class makes a trip to Huero Tanks Campsite, as a part of their border excursion. Before they camp, they watch a video about the petroglyphs that exists on site–where they are, and how to treat it. Furthermore, students

bring composting and recycling bins on their camping trips. The combination of the environment and the product may be categorized as persuading or possibly determining their sustainable behavior. The learner's environment essentially mandates that they pack in, pack out and only have equipment to sort waste sustainably. Figure 27 and Figure 28 show a map of DfSB strategies employed at Odyssey school and on excursions.

As the discussion wrapped up, Elki thought of other ways Odyssey uses space to address environmental education. After some thought, she closed the interview by adding,

> Ideally we really want to build our own space. If we had the money, so much thought and attention would be put into the design of the school and what the best practices are to create an environment that sets up this kind of relationship, here on site. We want to install solar panels but with our budgetary constraints, we have so many other issues demanding that financial attention.

Figure 27 maps the framework to the Odyssey space and Figure 28 maps to the other spaces learning at Odyssey happens. In the school building itself, there is almost exclusively factual information aimed to inform learners on sustainable decisions. Looking to the design encountered on excursions, Odyssey interacts with a wider diversity of design elements, including a high concentration of social normative and physical engagement design. As Elki mentioned, the social design elements are often facilitated by factual information signage.

Figure 27 TGB + DfSB at Odyssey School

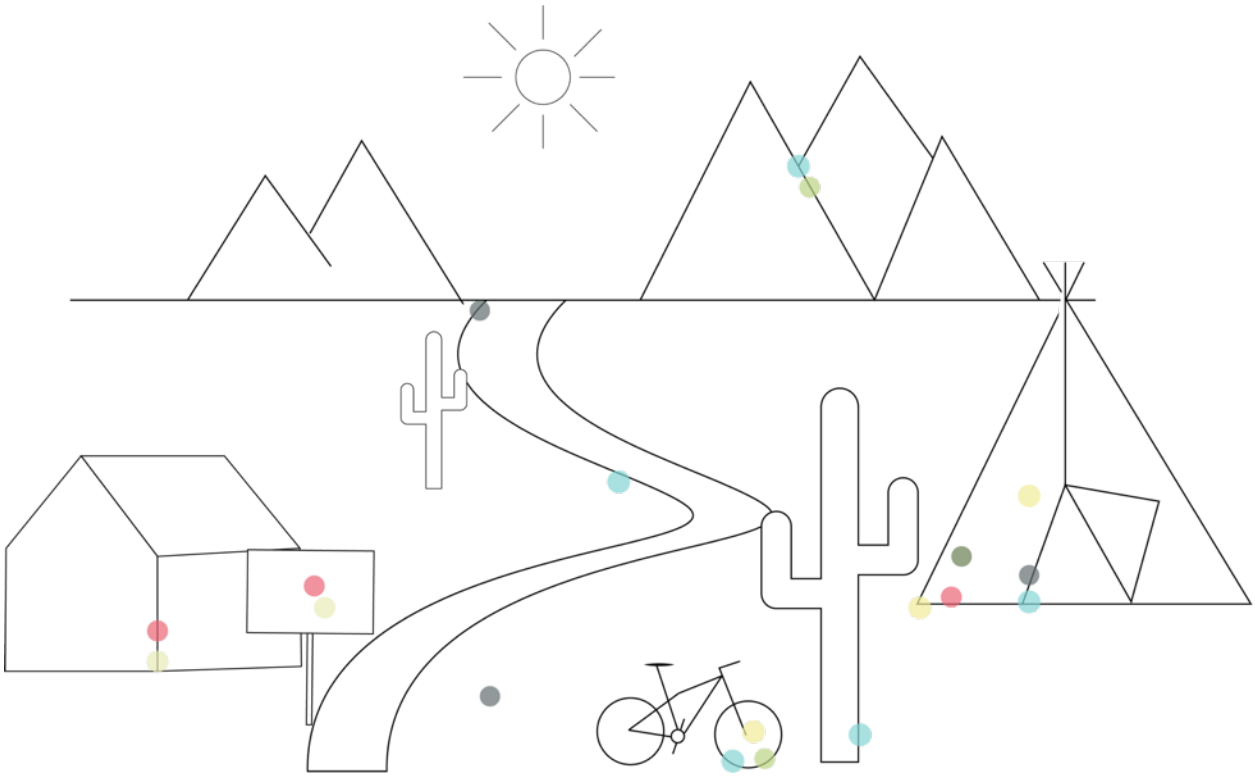

Figure 28 TGB + DfSB on Odyssey Excursions

Case study #5 - Denver Green School

Figure 29 Denver Green School. Glendale neighborhood of Denver, Colorado

Context and Engagement

The Denver Green School (DGS) is a public school located in the Glendale neighborhood of Denver, about six miles from downtown. Although DGS is part of the Denver Public School system (DPS), it is also an innovation school. Innovation schools are formal learning spaces with an element of choice in their curriculum. Innovation schools have the ability to waive district policies to pursue other academic goals. DGS focuses on sustainability, hands-on, and project-based learning. Denver Green School still functions as a neighborhood school, where residents living in the zoned district have priority of enrollment. However, they do things a little differently than your average neighborhood school. According to Frank Coyne, one of the founders of DGS, Denver Green School operates more like a law firm where the seven partners collaborate on decision making in policy and practice, rather than a principal dominated system.

DGS has the choice of DPS curriculum or applying to waive it, more control over the budget, control of the lunches served, and more control over the building. Despite the marginally larger than standard control over the building, most the school's space was handed down from schools built in 1960s and the 1990s. There is one small building on the property built while DGS was up and running. The school petitioned to build a small building for middle school classrooms in replacement of the trailers that were proposed by the school district. This building has been given the merit of a Green Ribbon School–an award for sustainable school design. The inherited buildings have been retrofitted with solar panels on the roof. The site has also been repurposed to accommodate two vegetable gardens. With a substantial grant from the USDA, Denver Green School runs both a community farm and a school garden. Each year, DGS harvests around 100 pounds of vegetables, used directly in the lunches of the students.

Beyond the school's site, DGS takes students on excursions that supplement the curriculum, rather than drive the curriculum (as the Odyssey School does). From visiting the DPS food processing plant to further learning in science class to snowshoeing in Rocky Mountain National park for math class–DGS is committed to bringing their students a sustainable education, no matter where that may be.

I had the privilege of interviewing Frank Coyne, one of the founders of DGS. Coyne helped me gain a better understanding of what environmental education was at Denver Green School and where it happens. Coyne said, in one sentence, Denver Green School is "hands on, brains on learning."

At DGS, employs a program called Education for Sustainability or EfS. EfS draws from inquiry based learning and aims to diminish gaps in the current K-12 education system (Cloud 2014). EfS promotes whole-systems thinking by integrating built and organic features of schools into the curriculum. EfS has its own set of standards, integrated with the DGS core content. Students learn about sustainability as a holistic concept–including the economic and social facets, not exclusively environmental sustainability. For example, when students learn about the concept of the commons, they discuss how to share space, share knowledge, share resources. The fourth graders recently completed a climate summit through EfS. They spent a module on sources of climate change and types of alternative energy. They procured a presentation on the logistics of converting from conventional energy to alternative energy methods. Then, the students took a field trip to the Colorado State House, to present their research and see where legislation surrounding climate change is created, debated, and passed.

Learning about the environment happens primarily on excursion trips. Teachers do their best to connect the excursion trips to what is happening in the classroom, where the bulk of learning happens. Admittedly, says Coyne "We could do a better job of connecting the trips to the classrooms."

On site, DGS tries to maintain some connection between the built space and the natural environment. Connection happens most in the community farm and the school garden. The community farm is a one acre farm where community members can farm and harvest, made possible by Denver Green School's partnership with Sprout City Farms–a local non-profit focused on sewing community farms into communities. The school garden

is dedicated to the students. Each classroom has a garden plot and there are additional plots for community members.

Offsite, DGS travels to state and national parks, there are about two to three dozen sites. These sites include nearby parks like Cherry Creek State Park or Rocky Mountain National Park and further parks such as Moab, Arches, and Canyonlands in Utah. On these excursions, staff and chaperones facilitate the experience. An adventure coordinator was recently hired full time. He is responsible for the logistics of the learning experiences. DGS administration hopes that bringing an adventure coordinator on full time will lead to a stronger connection between the excursions to the classroom.

Teaching Green Building Design Strategies

After explaining each design strategy to Coyne, he responded with how he feels DGS relates to these strategies. These responses have been mapped with analysis findings in Figure 30 and Figure 31. Beginning with factual information, he noted the signage around the hallways. Recently, the administration has put up visual evidence of EfS excursions with statements about the trips to help connect the trips back to the classrooms. Coyne said, “I think having those quotes and photos pinned up really helps bring it (EfS) back into the classroom.”

I explained the concept of physical engagement as a design strategy–where design promotes physical contact with the environment. Hands on learning elicited a confident reply from Coyne.

> Physical engagement is our wheelhouse. We are hands on learning a lot of the time. From getting our hands dirty in the parks to collecting evidence at bluff lake, students at different grade levels are engaging with the environment in a direct manner as frequently as we can get them to.

The manifestation of social interaction is in the EfS program. Perhaps more in a programmatic manner than an architectural one. EfS is an hour a day, which gives DGS a longer school day than other neighborhood schools. During this hour, students work on independent projects, using problem solving to work through them. On excursions, teachers, and the adventure coordinator work together to develop a program. For example, students go to Bluff Lake Nature Center frequently. There is a set curricular program that the center has set up for learners to explore the space. However, DGS feels they could do that program in their sleep–so, they create a program fit to help their students explore and learn. Kindergarteners may be going just to find a piece of nature while the second graders are looking to journal about what they find at the space and the fourth graders are trying to find a connection to make a piece of environmental art–it all depends. When the fourth graders went to the capital, the learning did not necessarily come from the capital space, said Coyne. Rather, it came from DGS and was brought into the capital space.

I articulated the concept of social norms, which is a more social design, driven by social patterns and an environment set up by the learner's actions. "That's interesting", remarked Coyne. "I've never thought about it like that." He explained to me that there are expectations–as a highly functioning school– to perform well. Then, there are expectations when you go out camping–how to act, what to bring, etc.

> There are some students who have never been camping in their life. So, they are aware of these expectations but do not feel normed yet. Denver Green is attempting to create these norms for students.

Design Sustainable Behaviors Methods

Coyne and I spoke about DfSB philosophy and any products or places at DGS that inform, persuade, or determine sustainable behaviors. When reflecting on DGS's building, Coyne, did not necessarily think the school had any design features that spoke to this spectrum. There are murals and some art pieces around the school but there are not specifically things that are changing behaviors in the school. When we shifted our conversation to thinking about how this might happen offsite, he spoke of persuasion. To Coyne, when students are out exploring–connecting with nature–they are persuaded towards sustainable behaviors.

Denver Green inherited their building from a previously existing building. Largely, the design of the school does not reflect the TGB philosophy, it was not designed with the environment in mind. DGS built a middle school building, named a Green Ribbon school, only holds small signage on the award, not specific ways the building addresses the environment. During the interview, Coyne did not feel the building reflected much of the TGB or DfSB spectrum. In my spatial observations, I noted a few examples of factual information. The school's landscaped grounds embody a Teaching Green Landscape or TGL (Cole 2015). The gardens provide plenty of physical engagement opportunities as well as opportunities for social interaction with the surrounding landscape (Figure 30and Figure 31). On site, DGS uses their landscape to engage their students with the environment. Select off-site landscapes further this engagement (Figure 31).

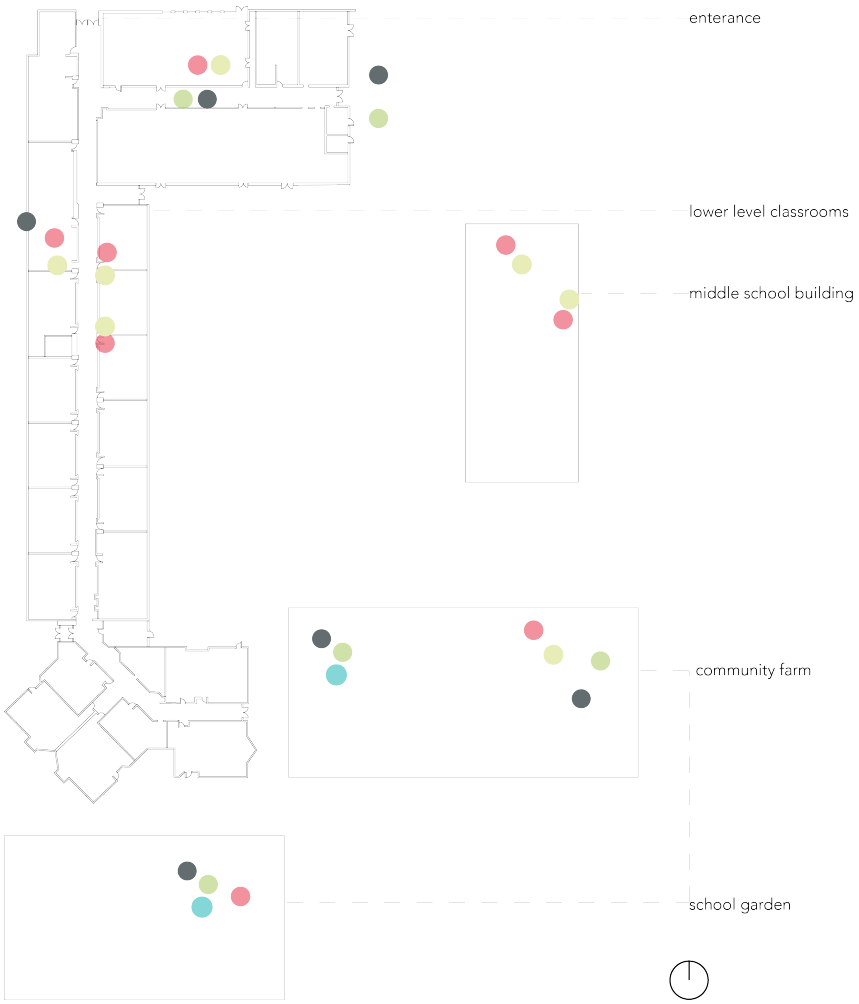

Figure 30 TGB + DfSB design patterns mapped at Denver Green School

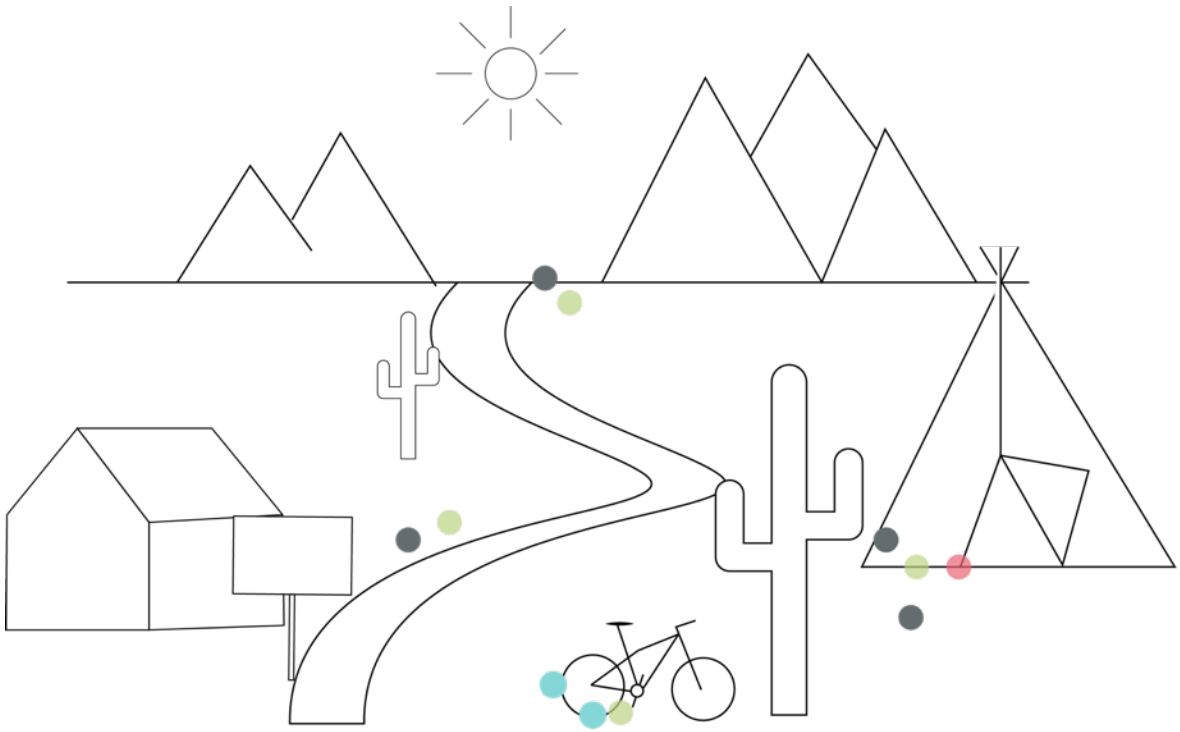

Figure 31 TGB + DfSB mapped on DGS excursions

Chapter 4 / Discussion

In reviewing the analyses and coding supporting interviews, I have found patterns across the Teaching Green Building design strategies, Design for Sustainable Behavior methods, and degree of formality in each learning space. When I began my interviews and analyses, I was hungry for insights about the design of schools interested in environmental education. But, I was unaware of which ones would come through this process. I wanted to know what was happening in different learning spaces–did design work to create cultures of concern for the environment? If it did–how?

I went on multiple site visits before analysis, to get a sense of each space before applying the framework to it. I prepared a set of inductive questions in the field guide, positioned to enable new understandings. I let interviews flow organically–to explore topics beyond what I had scripted–allowing space for participants to expand on thoughts they felt were important to share.

During my first interview at the Odyssey school, something sparked in my interview with Elki Neigberger, the communications and recruitment director. When we were going over the different design elements from Cole, I explained the basic idea and aim behind social interaction designed spaces. She began describing an experience from an excursion trip. Elki said that they often decide to explore areas just to see what they find. But first, they look to the trail map to inform what areas to explore. This response indicates a connection between factual information or informing design and social interaction or persuading design. Does factual information enable social exploration? Is there a scale

factor in which certain design strategies facilitate other ones? In certain groups, at least? Do people conditioned to learn in formal schools need learning material to explore?

In this chapter of contributions, I explain my findings and provide evidence that supports these claims. I begin with a connection between TGB strategies and DfSB methods. Next, I apply this connection to the formality in learning spaces. These findings inform my main contribution–the notion of teaching green spaces vs. teaching green buildings.

Influence of Teaching Green Building Design on Sustainable Behavior

The first indication I have pulled from this analysis is a relationship between Cole's TGB design strategies and Liley and Wilson's DfSB spectrum. In the case studies, the four design elements appear to map across the spectrum of guiding sustainable behaviors (Figure 32). Factual information design primarily informs sustainable behavior. Physical engagement begins to foster relationships with the environment which, persuades sustainable behavior. Social interaction spaces advance the persuasion toward environmental stewardship. Lastly, social normative spaces are targeted to determine sustainable attitudes and behaviors. This correlation indicates that certain designs push building users harder than others toward sustainable behavior. This insight is preempted by research in conservation psychology, specifically studies from DfSB. In one if Liley's studies (2009), testing mobile phone use with design interventions at the level of informing, persuading, and determining, came back indicating that the most successful way to sow sustainable behaviors is through persuading design.

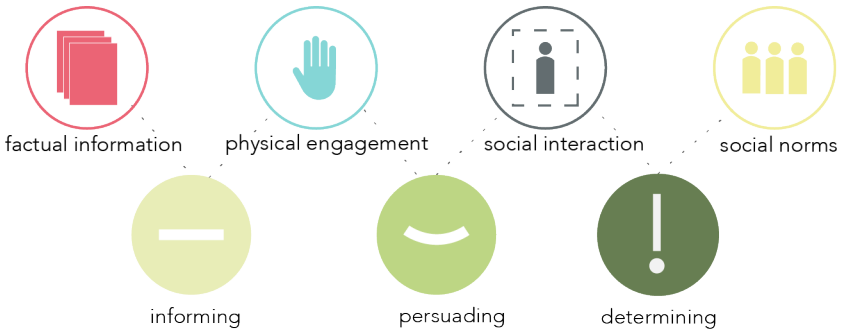

Figure 32 TGB + DfSB connection

Learning Formality in Design Choices and Sustainable Behaviors

The degree of formality maps along this newly connected framework (TGB + DfSB) (Figure 35). I have found that formal spaces tend to predominantly employ factual information and physical engagement. While informal spaces represent a more diverse set of design patterns and are comparatively more robust in the areas of social interaction and social norms. Figure 33 shows a comparison of the GrowHaus with the Odyssey school space.

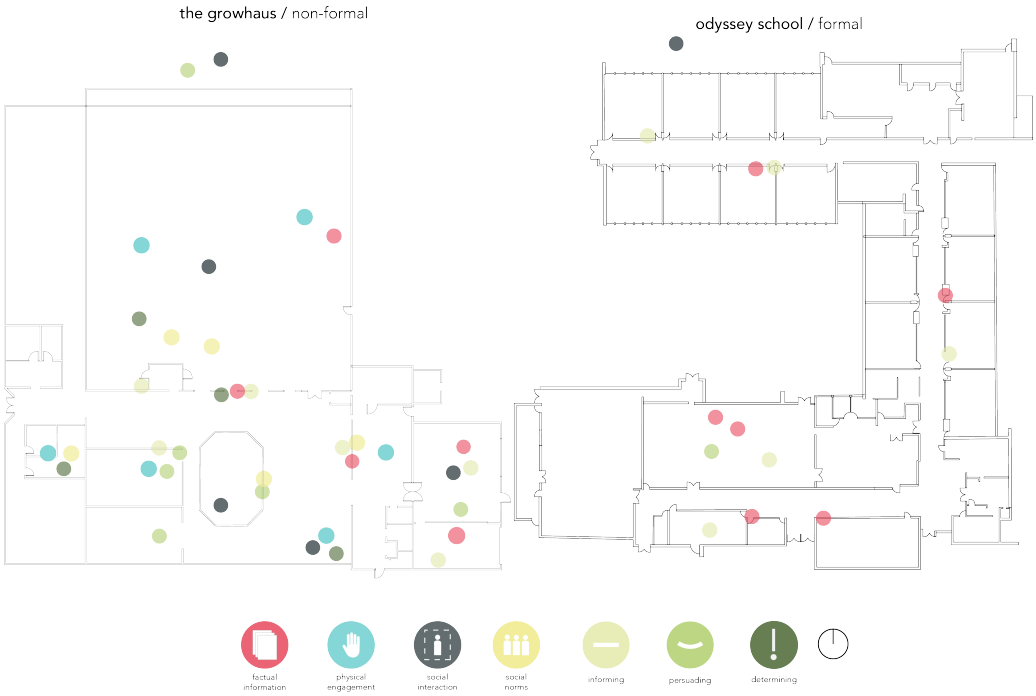

Figure 33 A comparison of the GrowHaus building and Odyssey building

This preliminary insight indicates that more formal spaces experience spatial limitations. This can be attributed to numerous variables, including budgetary constraints, policy constraints, the conflicting interest of building owners, and having a curriculum focus that extends beyond environmental education. Learning spaces with these limitations tend to be on the more formal side of the spectrum. In response, these spaces employ these first two strategies because their space is able to facilitate them more fluidly. To interact with the latter two design strategies of social interaction and social exploration and achieve the influence on sustainable behaviors, these spaces seek fulfillment outside of their given “Teaching Green Building” to a “Teaching Green Space” or a space where learning through exploration and sustainable behavior as a social norm becomes more accessible. One example would be Watershed school. A church owns their building, and shares half of the space, so they do not have much control over the design of the space. Figure 24 shows a small number of design strategies, mostly factual information that informs sustainable decisions. Figure 25 illustrates a diversity of design strategies, including strategies that push towards sustainable behaviors, rather than simply informing them. Figure 34 shows a comparison of the GrowHaus space to the Odyssey space combined with excursion spaces.

Figure 34 Comparison of GrowHaus and Odyssey + Excursions

Perhaps the notion accessibility in this context extends beyond logistic ability to create a TGB, into perceptions of ability to create this kind of space. In non-formal learning spaces like Thorne and GrowHaus, creating a TGB through a variety of design strategies is more feasible. These spaces curriculum follows environmental education, somewhat exclusively. The architectural program of the building should interact with the environment, that is the intent of the organization. Signage explaining how wind turbine powers Thorne Nature Experience, only enhances the goals of the organization. If this same signage was applied at Watershed, it would add to the pillar of environmental education but not the school's goals to educate students on history, mathematics, studio arts, etc.

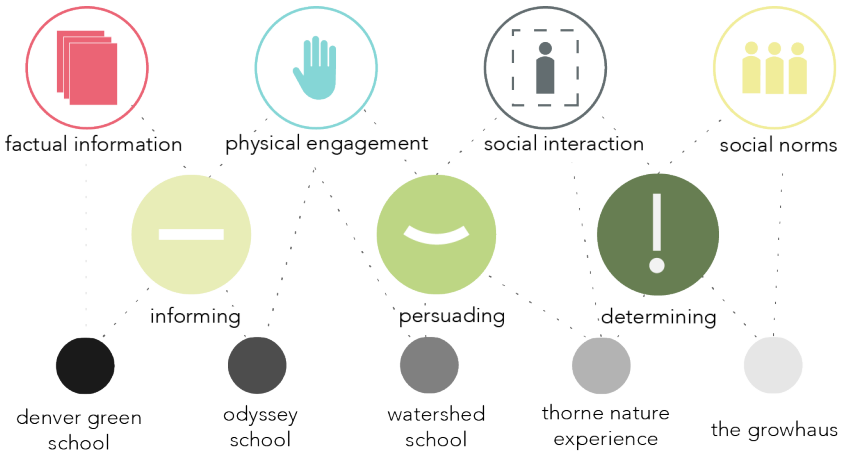

Figure 35 Formality across TGB + DfSB spectrum

Given the correlation between TGB + DfSB, more formal spaces inform learners of sustainable behaviors more often then they persuade or determine them. Spaces on the more informal side of the spectrum, are enabled to use space to persuade or determine sustainable behaviors.

This insight supports Cole's TGB Model for learning. Moving from instructional methods (factual information) to experiential methods (social norms) moves across the formality spectrum. Figure 12 shows that architectural design choices support all elements of this framework.

Teaching Green Buildings vs. Teaching Green Spaces

The notion of Teaching Green Buildings is an emergent, but established building typology which has a greater aim to inform school designers about how they can use architecture to facilitate environmental connection for their learners. My research indicates that *Teaching Green Spaces* may be an addition to the building typology–TGB–or a spatial typology. This addition informs school designers working in both the physical and the

pedagogical space on how space, perhaps beyond architecture, can be used to encourage environmental stewardship.

The idea is that the formal learning spaces do not explicitly inhabit TGBs. Enabled by models such as expeditionary learning (Watershed, Odyssey) and EfS (Denver Green School) schools take students out of the classroom to either supplement or drive the learning objectives explored in school. Though this is not necessarily true for all formal learning environments, it holds true for this set of case studies. For example, Denver Green School takes students out of the school building to Rocky Mountain National Park to go snowshoeing. Students relate this experience to velocity lessons in science cases and the book, *Wild*, they are reading in English. Additionally, there are two gardens at DGS. One is primarily for community gardening. The other aims to provide vegetables for student lunches. Students gardening is physical engagement–informing and beginning to persuade sustainable practices. Students travel Denver Public School's food processing plan–discovering how their food is produced. The food processing plant serves as supplemental, social interaction space–advancing the introduction of sustainable food practices. This exemplifies a learning institution moving beyond their everyday architecture to another space that engages students with the environment and motivates sustainable routines.

My investigations show schools on the more formal end of the spectrum tend travel to *Teaching Green Spaces* rather than create a *Teaching Green Building* in their daily learning space. Even when named Denver Green School, these schools are frequently handed their buildings by the public-school system. There is little flexibility in budget and

policy to develop the physical building. Furthermore, these spaces do not exclusively focus on environmental education. The wider curricular focus may cause hesitation in transforming the space. For a space like Thorne Nature Experience, creating a TGB or even adding TGB elements seems obvious, it supports the program. These insights speak to the idea of whole-school sustainability–employing the organizational, programmatic, and physical space to promote environmental stewardship (Henderson and Tilbury 2004). It is more accessible for more formal learning spaces to employ design that primarily informs sustainable behaviors (Figure 36). More formal spaces reach–beyond their building–to engage with spaces designed to persuade and determine sustainable behaviors (Figure 37).

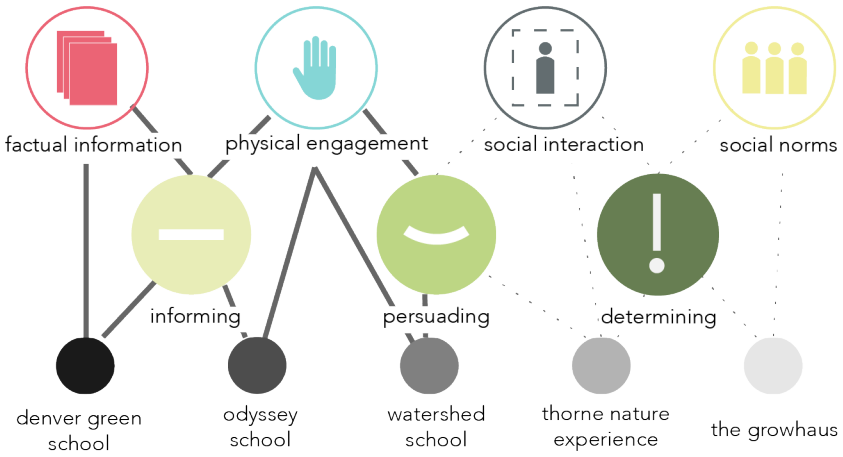

Figure 36 Formal spaces employ factual information and physical engagement

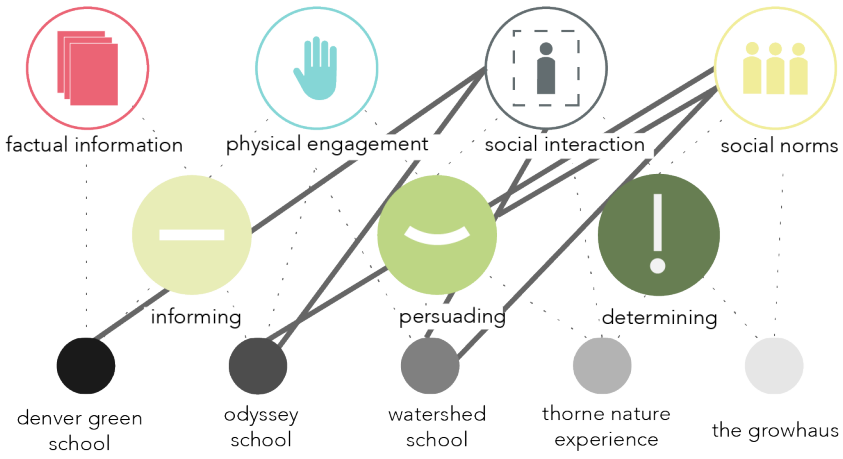

Figure 37 Formal schools reach for social design spaces

Contributions

The central argument of this research is that non-formal learning spaces can use design in their physical building that strongly encourages environmental behaviors while formal learning spaces seek this strong encouragement from spaces beyond the school's architecture.

Beyond this insight, my research is positioned to further investigation, design, and knowledge creation. In respect to the literature in architecture, this research illustrates how existing frameworks in architecture literature can be applied to study current phenomena of learning environments that sow environmental stewardship into learning. It also gives examples of whole-school sustainability. This project introduces a diverse range of learning spaces that supplement building design with program, to promote sustainable attitudes and behaviors.

This research builds on existing education literature–adding to the work on formality in education. It brings awareness to how spaces, both formal and non-formal, can employ design strategies and curriculum to spark informal environmental learning opportunities.

This project makes architectural knowledge accessible to education professionals. Architectural vernacular and research can be exclusive to professionals in the field. This research begins to bridge that gap. There are possible school curricular system benefits. Administrators of schools can look to this study to inform spatial and programmatic school creation.

I intend to publish a print publication including a graphic language, photographs, and the deeper exploration of this research, aimed to make this knowledge accessible to a large audience and ignite paradigms that believe in the critical nature of creating positive relations between space, learning, and nature.

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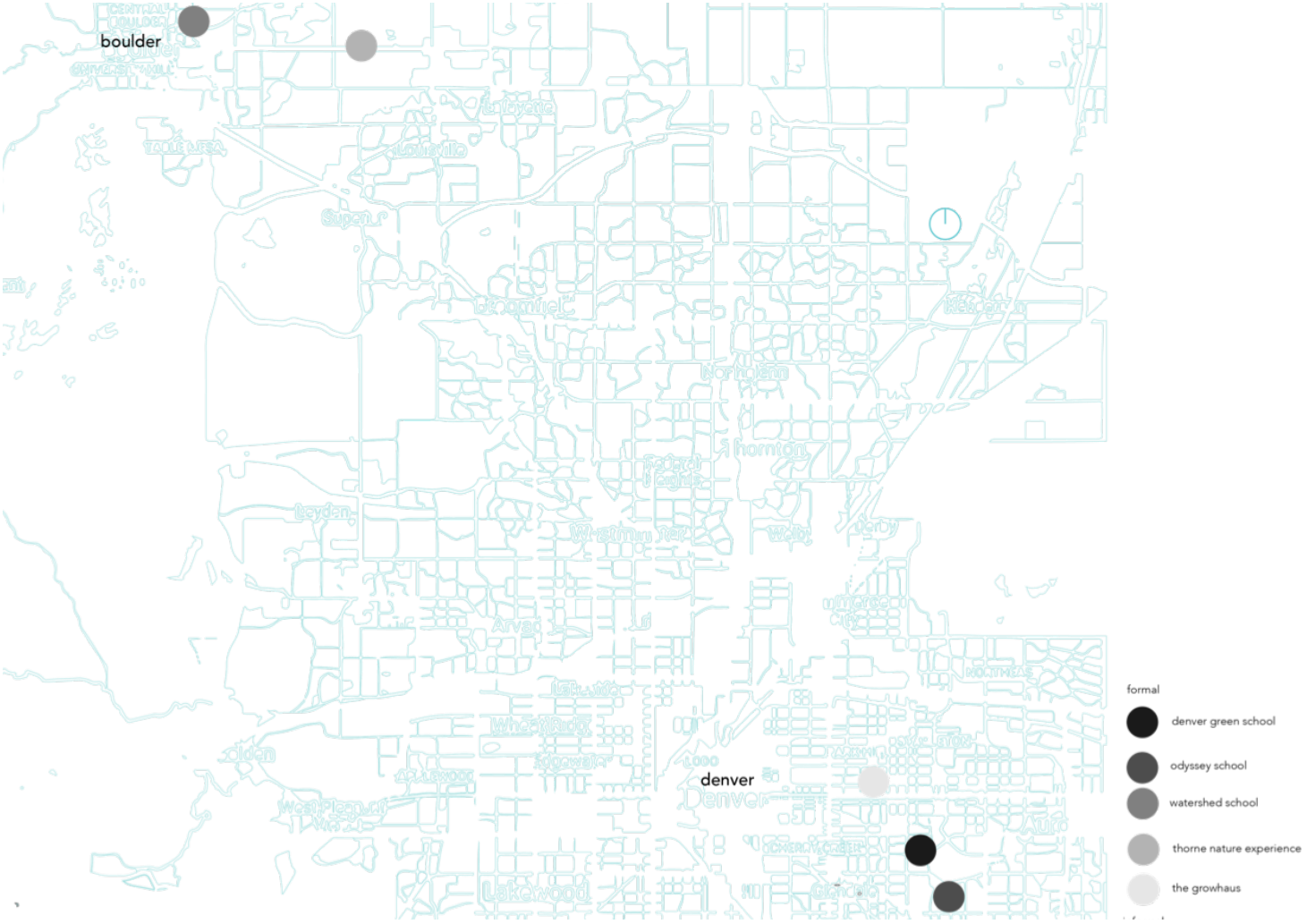
Appendices

Appendices include supplemental resources used to complete this research. This resources deepen the understanding the research design and construction of this project.

Appendix A: Site Information

This appendix displays each case study selection, it's location, an online resource, and the person interviewed at each space Case Study selection.



The GrowHaus

Denver, Colorado, USA

http://www.thegrowhaus.org/

Isabel Sanchez–Education program coordinator

Thorne Nature Experience

Boulder, Colorado, USA

http://www.thornenature.org/

Gwen Tenney–Program manager for After-school programs and volunteers

Watershed School

Boulder, Colorado, USA

http://www.watershedschool.org/

Odyssey School

Denver, Colorado, USA

http://odysseydenver.org/

Elki Neigberger–Enrollment and Communications Director

Denver Green School

Denver, Colorado, USA

http://www.denvergreenschool.com/

Frank Coyne–Lead Partner

Appendix B: Frameworks for Analysis

These graphics represent the framework for analysis, informed by TGB design strategies, DfSB spectrum, and formality across schools. These graphics begin to give visual language to scholarly ideas surrounding architecture and environmental education.

Appendix C: Field Guide

This appendix includes a condensed copy of the field guide–each page containing an image of a page in the guide. This field guide was created to facilitate spatial analysis at each case study site. Field guide includes spaces for guided sketching and note taking, guiding inductive questions, plans to diagram on, and questions for teachers and administrators.

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

Map the design elements below with number assigned in chart

insert plan or map of site

Inductive Spatial Analysis
/ Guiding Questions

1. What do you see that makes you think of TGB philosophy? Does it fit within the design elements?
2. Did your interview give you any insights on where or what connects students the most to nature? What were those things? Do they fit into the framework? Are they informing determining or persuading behavior? How so? Whats happening there?
3. What parts of the space make YOU feel most connected to nature? Why do you think that is? Is it personal or linked to something you've read?
4. Any areas you think are really powerful in this respect? Why? Where are they?

Questions for Administrators and Teachers/

1. If you had to sum up learning at _____ in one sentence, what would you say?
2. Can you tell me about environmental education at this learning space?
3. How do you feel learners learn about the natural world most at this learning space?
4. Where do you feel learning happens most frequently here?
5. What spaces do you think learning about the environment happens here? In the building? Off site?

If in the building….

1. Where are those moments of connection? What architectural elements or site features facilitate this connection?
2. Are there any specific places or products in the buildings that either inform, determine, or persuade learners towards sustainable behavior? (give trashcan / recycling example for further explanation)
3. Do these spaces of environmental connection overlap with the learning spaces?
4. Was that an intentional design? If so, why did you pick that specific spot for connection?

If offsite….

1. Where do students learn about the environment outside of the school?
2. How long are students away from campus? What kinds of activities are they partaking in?
3. Who else is present? What roles do they place and what is their interaction with the learners?
4. What kind of environment is it?
5. Outside of the building, Are there any specific places, objects, or products that either inform, determine, or persuade learners towards sustainable behavior? (give trailhead sign / camping regulations example for further explanation)

According to one scholar on Teaching Green Buildings, there are four types of design elements as far as environmental education….

Factual Information is a way of explicitly stating how the building addresses the environment. This can be an interactive touch screen, visual overlays on architectural elements, signs, brochures, websites, and other text based interventions.

Do you encounter any of those features in the building or in expeditions? Any signage or videos? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and transfer)

Social interaction is a way of organizing the space as a venue of interaction, exploring, and learning. The building layout encourages unplanned interaction with the environment. This type of design is commonly seen in Reggio Emilia and Montessori type schools, where place serves as a venue of interaction, exploring, and learning.

Do you encounter anything that sounds like this kind of interaction in the building or in expeditions? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and label)

Social norms This type of design is where Individual is viewed as a person who participates in the social patterns. The environment sets up a social culture in which the entire channel of information (in this case about the environment) is set up by the learner. Think science museums?

Do you encounter anything that sounds like this kind of interaction in the building or on expeditions? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and label)

Thank you so much for thinking through this with me. Can you think of any other insights you have to share about the way your learners learn about nature that I haven't covered here today? (sketch as needed)

Ap*pendix D: Interview Questions*

Interview questions asked to administrators at each case study site. Interviews were conducted in person after an hour of site analysis. *except for The GrowHaus–in which one interview was conducted over the phone and another in person, not directly after spatial analysis.

Questions for Administrators and Teachers/

1.If you had to sum up learning at _____ in one sentence, what would you say?

2.Can you tell me about environmental education at this learning space?

3.How do you feel learners learn about the natural world most at this learning space?

4.Where do you feel learning happens most frequently here?

5.What spaces do you think learning about the environment happens here? In the building? Off-site?

If in the building….

1.Where are those moments of connection? What architectural elements or site features facilitate this connection?

2.Are there any specific places or products in the buildings that either inform, determine, or persuade learners towards sustainable behavior? (give trashcan / recycling example for further explanation)

3.Do these spaces of environmental connection overlap with the learning spaces?

4.Was that an intentional design? If so, why did you pick that specific spot for connection?

If offsite….

1.Where do students learn about the environment outside of the school?

2.How long are students away from campus? What kinds of activities are they partaking in?

3. Who else is present? What roles do they place and what is their interaction with the learners?

4. What kind of environment is it?

5. Outside of the building, are there any specific places, objects, or products that either inform, determine, or persuade learners towards sustainable behavior? (give trailhead sign / camping regulations example for further explanation)

According to one scholar on Teaching Green Buildings, there are four types of design elements as far as environmental education….

Factual Information is a way of explicitly stating how the building addresses the environment. This can be an interactive touch screen, visual overlays on architectural elements, signs, brochures, websites, and other text based interventions.

Do you encounter any of those features in the building or in expeditions? Any signage or videos? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and transfer)

Physical engagement is design that promotes hands on learning and interaction. Excellent examples of this would be a vegetable garden where learners directly interact with the earth or a water study where students are taking samples.

Do you encounter anything that sounds like this kind of interaction in the building or in expeditions? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and label)

Social interaction is a way of organizing the space as a venue of interaction, exploring, and learning. The building layout encourages unplanned interaction with the environment. This type of design is commonly seen in Reggio Emilia and Montessori type schools, where place serves as a venue of interaction, exploring, and learning.

Do you encounter anything that sounds like this kind of interaction in the building or in expeditions? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and label)

Social norms This type of design is where Individual is viewed as a person who participates in the social patterns. The environment sets up a social culture in which the entire channel of information (in this case about the environment) is set up by the learner. Think science museums…

Do you encounter anything that sounds like this kind of interaction in the building or on expeditions? What do they look like? Could you sketch it out? Or describe it for me and I will sketch it out? (Sketch in sketchbook and label)

Appendix E: Field Notes

This appendix details the field notes collected onsite at each case study location. Sketches and notes from the created field guide (Appendix D). These sketches illustrate specific design elements employed at each case study. The next few pages include sketches and notes from each case study. The sketches were analyzed and translated into TGB and DfSB strategies–documented in the floorplans in Chapter 3. The notes from interviews and observations were translated to the discussions in Chapter 3.

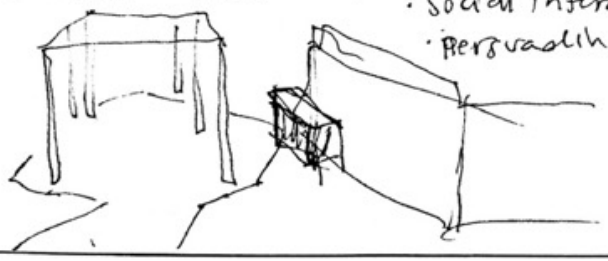
Appendix E1: The GrowHaus

The following pages detail sketches and notes from The GrowHaus. The GrowHaus is the furthest on the informal scale of learning, and represents a robust set of TGB design strategies that connect with DfSB methods.

GROWHAUS!

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

(1) OUTDOOR CLASSROOM
- Architectural
- social interaction
- persuading.



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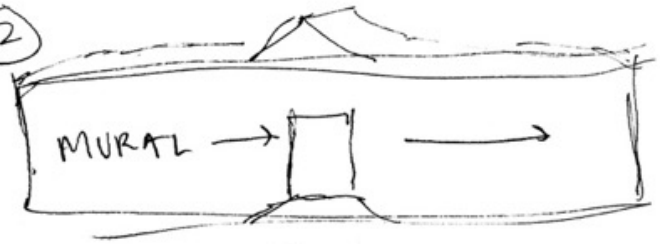


- spacial?
  - not sure

(3)

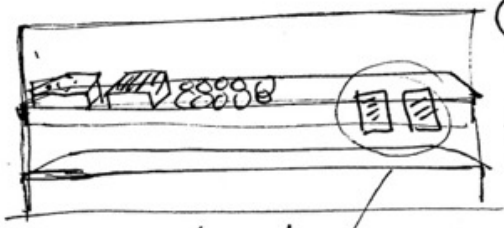
- SPATIAL
- FACTUAL
- INFORMING

(4) MURAL ON FRONT.

PHOTOS!

- spatial? Architectural?

(9)



(7)

- marketplace / food.
- social interaction.
- spatial

HUMAN
community
members

(6)

- factual
- informing
- spatial

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

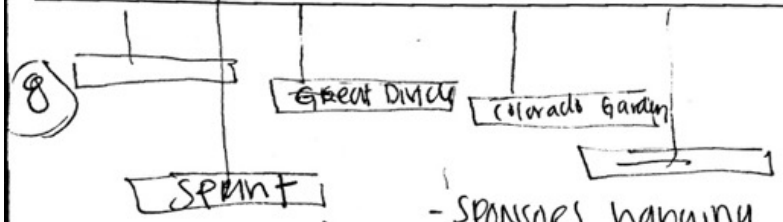
(7) cont from last page.

- informing
- factual

?

- HUMAN / NON SPATIAL!
- DOESN'T FIT!

(8)



- informing?
- factual?

- SPONSORS hanging from ceiling.

(9)

- Paintings / murals.
- informing?
- Persuading?

- spatial

(10)

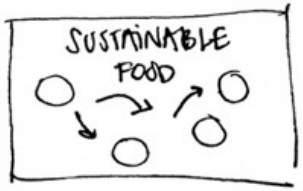
- informing
- spatial
- factual info.

things tangential to GRUMPAUS in community.

- informing
- spatial
- Factual

(11)

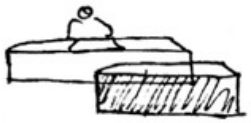
(12)



- INFORMING
- SPATIAL
- FACTUAL

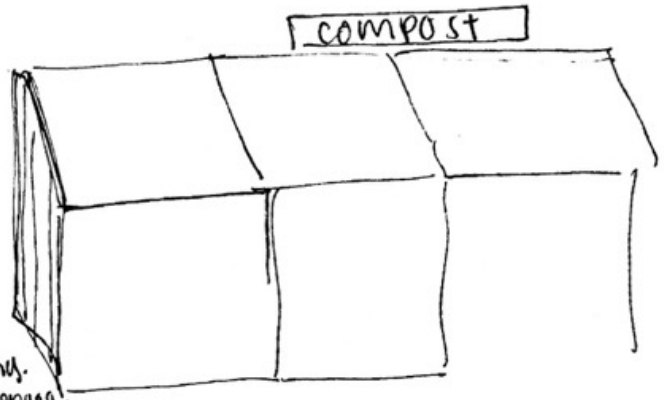
design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

13



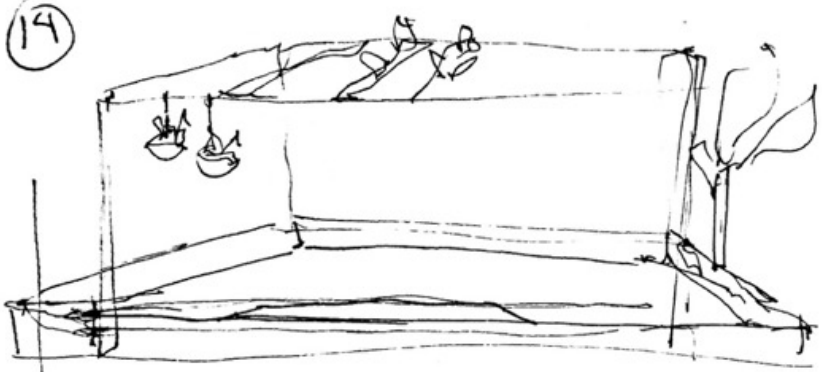
- KITCHEN
- PHYSICAL engagement.
- Determining / pervading.

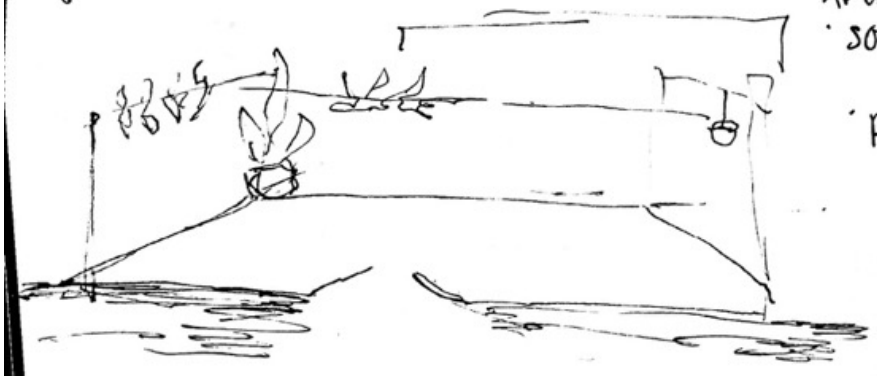
15



- spatial
- determining.
- phys. engag.

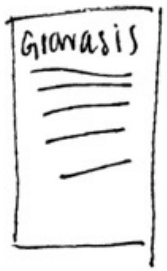
14





- Architectural
- social interaction.
- pervading?

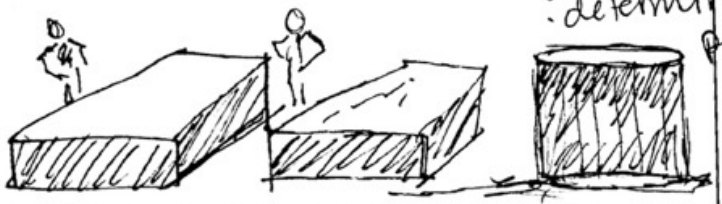
16



- signage = same as #3
- informing
- spatial
- factual

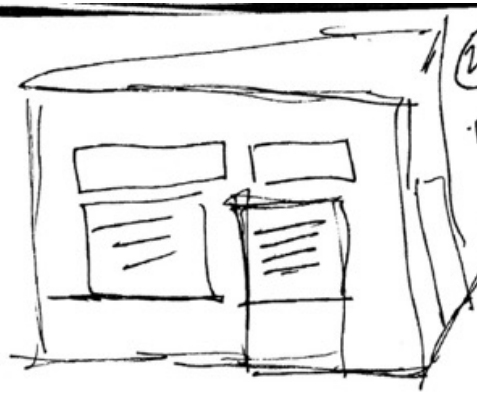
17

(18) AQUAPONIC FARM.



· Architectural / Spatial?
· Physical engagement.
· determining / persuading

(21)

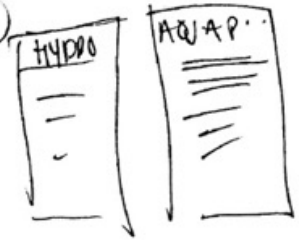


· MUSHROOM FARM
· Architectural
· Physical engagement
· determining.

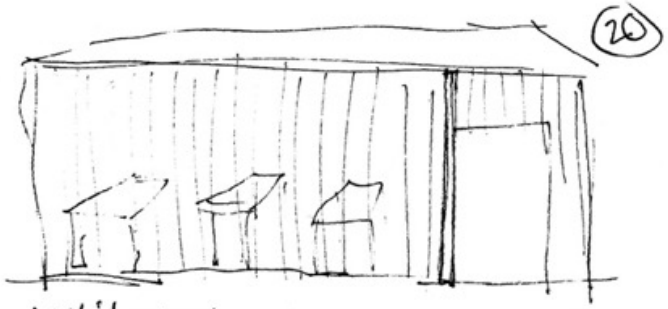
PLANTS! everywhere!
· Spatial
· Social interaction
· persuading.

(19) (facilitating?)

(22)



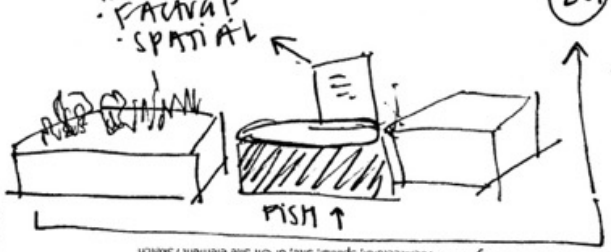
· SIGNAGE.
· SPATIAL
· informing
· FACTUAL.



(20)

· Architectural
· Physical engagement.
· persuading

(23)

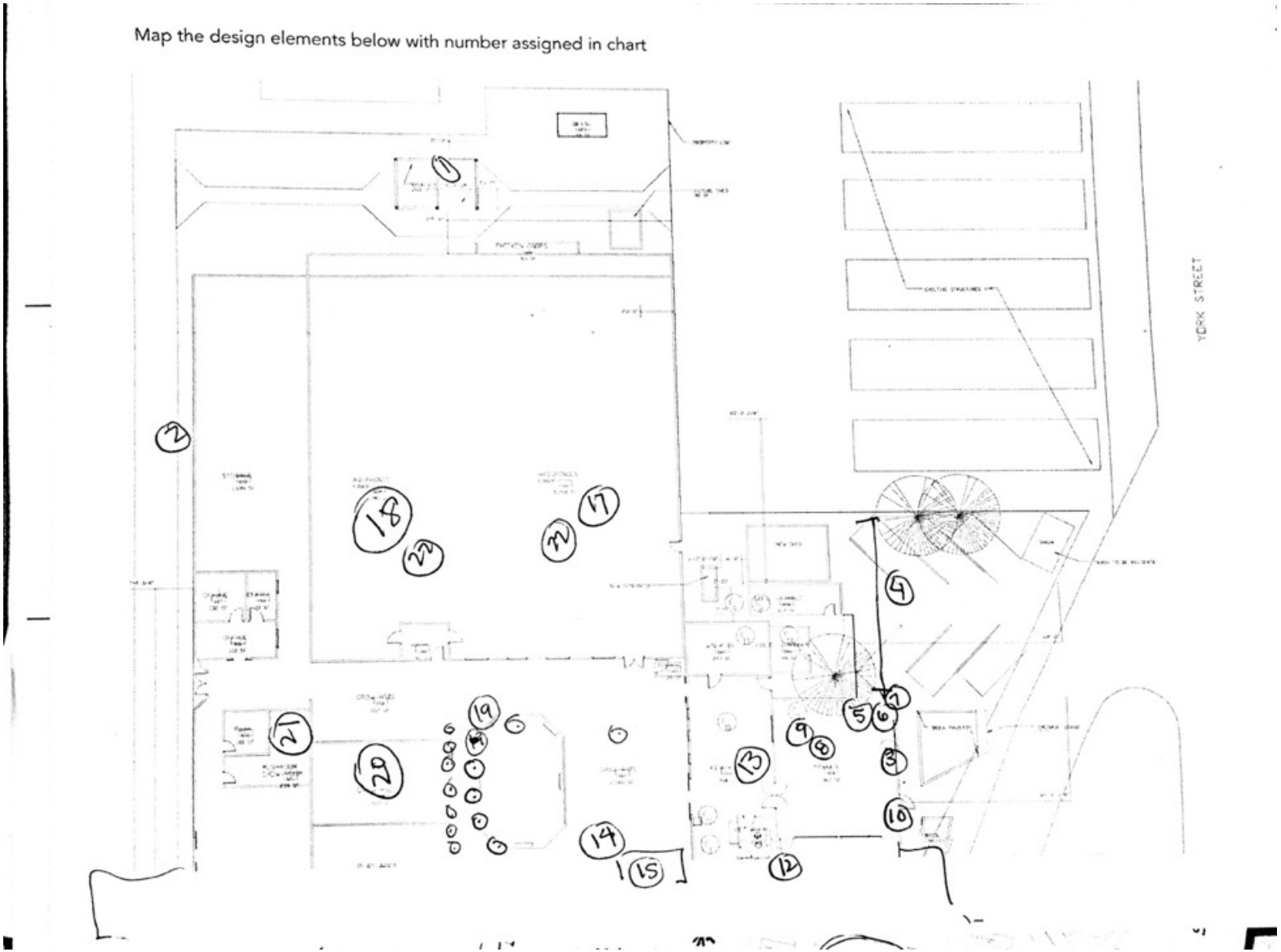


(24)
· social interaction
· SPATIAL.
· ~~PERSUASIVE~~
· informing?

!!

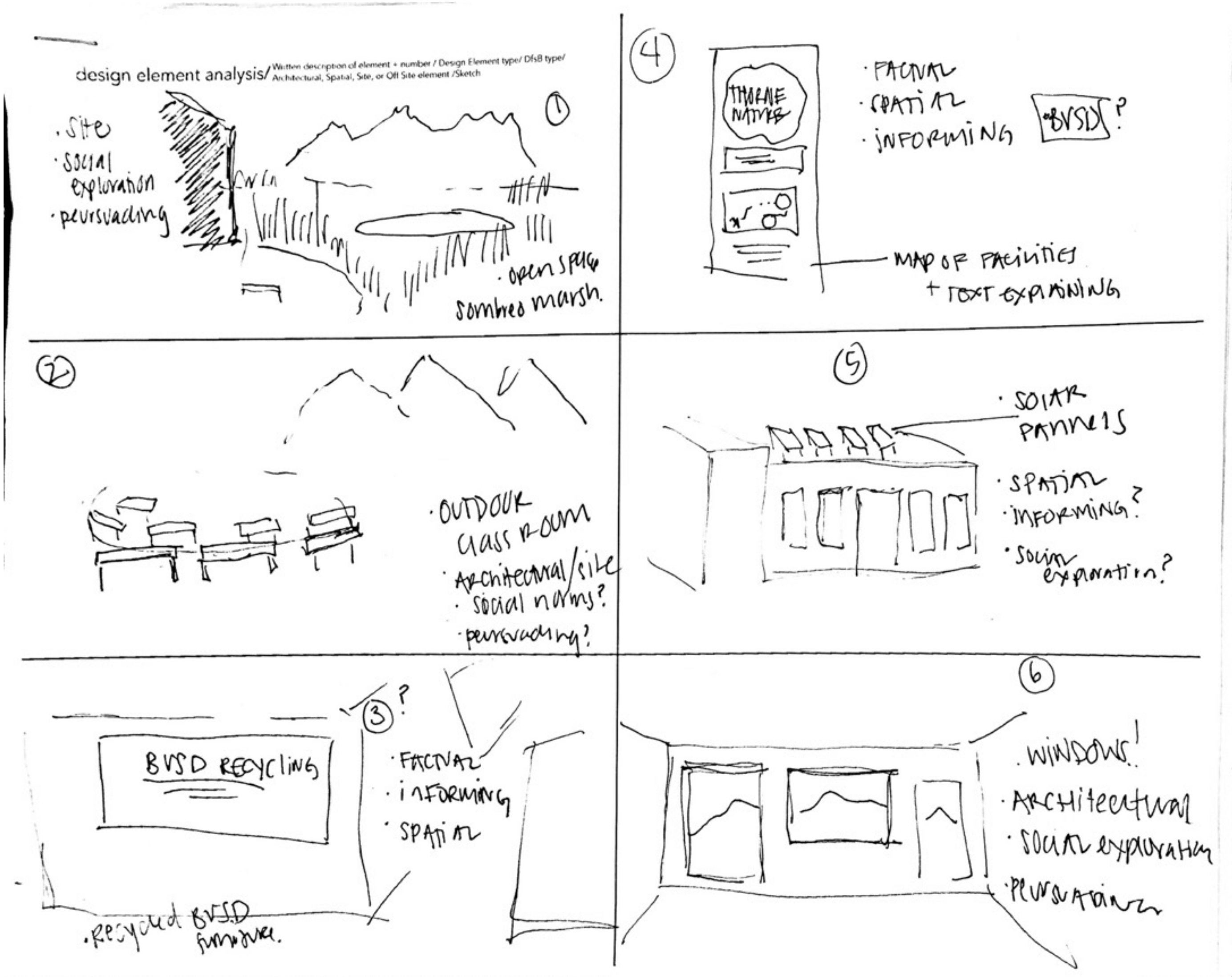
design element analysis/ Written description of element + number / Design Element type/ Dfab type/ Architectural, Spatial, Site, or Off Site element /Sketch

Map the design elements below with number assigned in chart



Appendix E2: Thorne Nature Experience

Images and field notes collected from the field studies conducted at Thorne Nature Experience. Thorne is an informal learning space, with a focus on place-based environmental education. Thorne's space has a strong dialogue with TGB design strategies.


design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch
1
· Site
· Social exploration
· peursuading
· open space
sombreo marsh.
4
THORNE NATURE
· FACTUAL
· SPATIAL
· INFORMING
BVSD ?
MAP OF FACILITIES + TEXT EXPLAINING
2
· OUTDOOR CLASS ROOM
· Architectural/site
· social norms?
· peursuading?
5
· SOLAR PANNELS
· SPATIAL
· INFORMING?
· Social exploration?
3 ?
BVSD RECYCLING
· FACTUAL
· informing
· SPATIAL
· Recycled BVSD furniture.
6
. WINDOWS!
· ARCHITECTURAL
· SOCIAL exploration
· PERSUADING

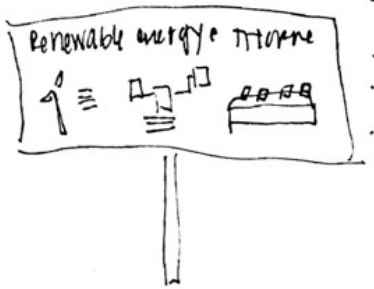
design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

9

- FACTUAL
- INFORMING.
- SPATIAL

10

- sign for wetland garden
- FACTUAL
- INFORMING
- ~~SITE~~ SPATIAL



8

- FACTUAL
- INFORMING
- SPATIAL

11

- site
- social exploration
- persuading

~~SITE~~ 7 wetland garden

- social exploration
- persuading
- site

12

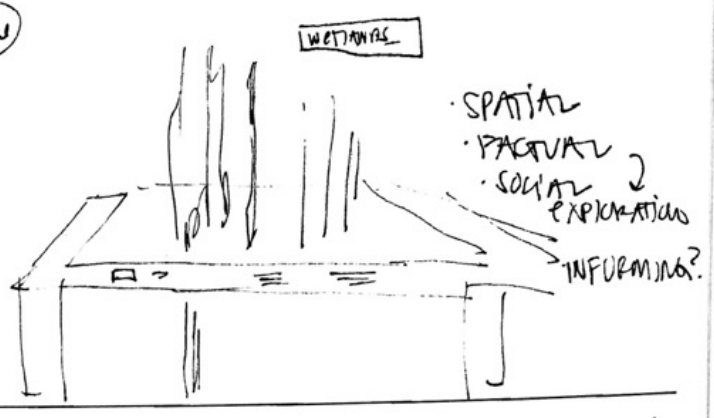
- FACTUAL
- INFORMING
- SPATIAL

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

13

: WIND TURBINE
· SOCIAL EXPLORATION
· SPATIAL
· INFORMING

16



· SPATIAL
· FACTUAL
· SOCIAL EXPLORATION
INFORMING?

14

· pollinator garden
· site
· social exploration.
· persuading

17

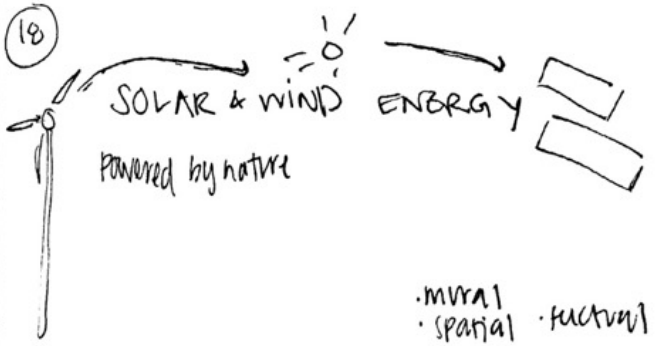
· CLASSROOM! LOADED W/ TGIB.
· SOCIAL EXPLORATION?
· SOCIAL NORMS.

18 - WITHIN CLASSROOM

15

· FACTUAL
· INFORMING
· SPATIAL

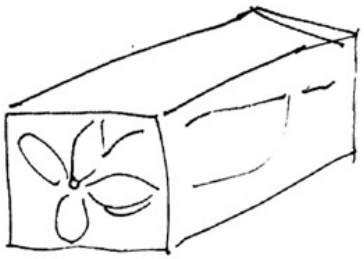
18



· mural
· spatial · factual
· informing

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

19

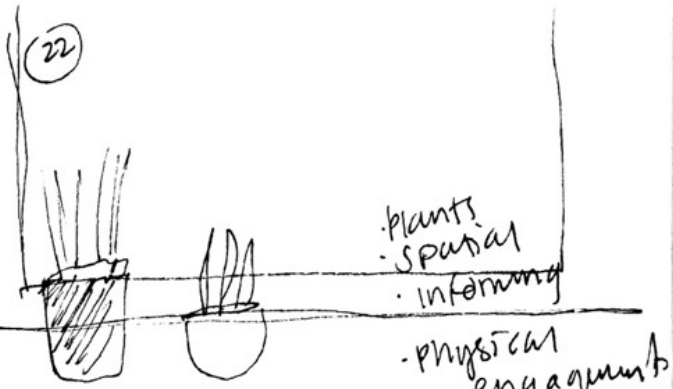


WIND TURBINE

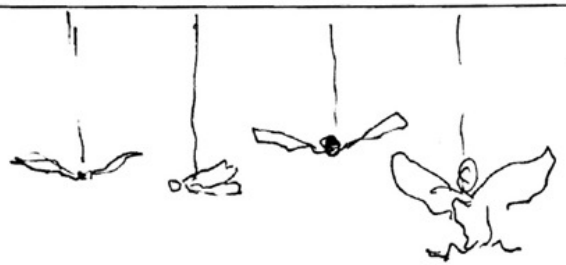
~~External~~ Exhaust

- SPATIAL
- INFORMING
- FACTUAL / PHYSICAL.

22



- plants
- spatial
- informing
- physical engagement

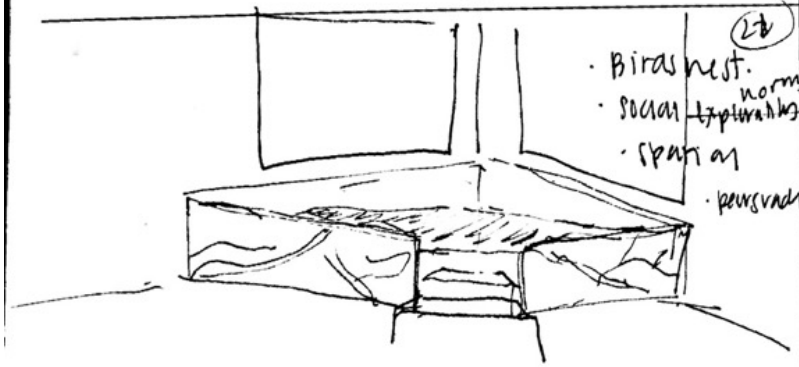


- Bird hanging from ceiling.
- spatial
- performing.
- social exploration.

23

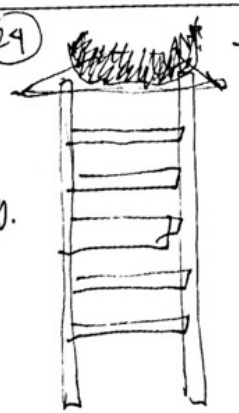
- WASTE STATION
- INFORMING
- FACTUAL
- SPATIAL

20



- Bird nest.
- social ~~exploration~~ norms
- spatial
- persuading.

24



- NEST
- SPATIAL
- PHYSICAL ENGAGEMENT
- PERSUADING.

design element analysis/ Written description of element + number / Design Element type/ DSE type/ Architectural, Spatial, Site, or Off Site element /Sketch

25

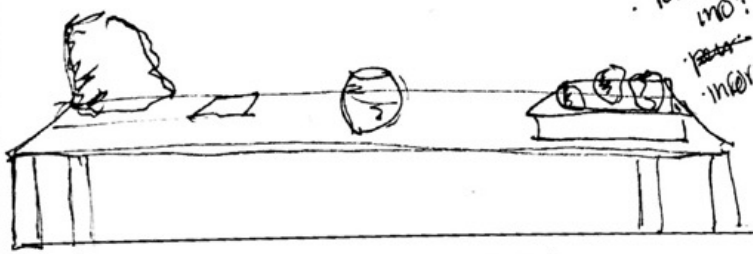
WHAT DID YOU FIND ON YOUR NATURE EXPERIENCE TODAY?

Leave it here to share with others

·mural. ·spatial, ·informing, ·factual.

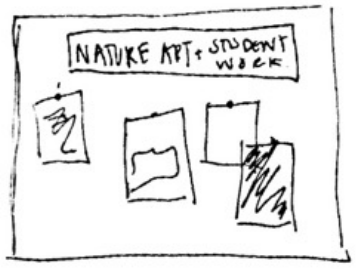
right below

26



· artifacts found outside.
· spatial.
· factual
and?
· informing

27



· bulletin.
· spatial
· informing / reminding
· factual

28

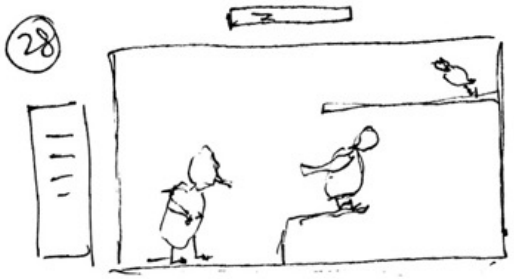
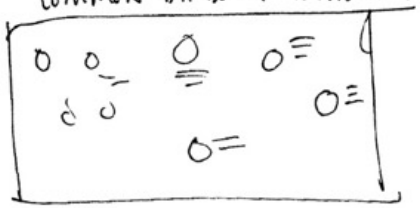


exhibit on birds.

· spatial
· factual
· informing.

29

COMMON BIRDS OF SOMBRERO RANCH



· spatial
· factual
· informing.

30

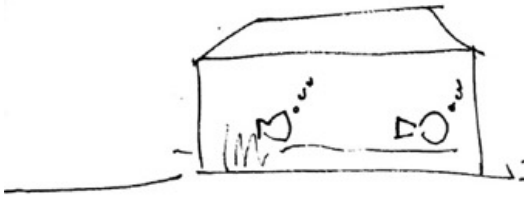
COMMON MAMMALS OF SOMBRERO RANCH

· exhibit w/ fossils.
· spatial
· informing
· factual.

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

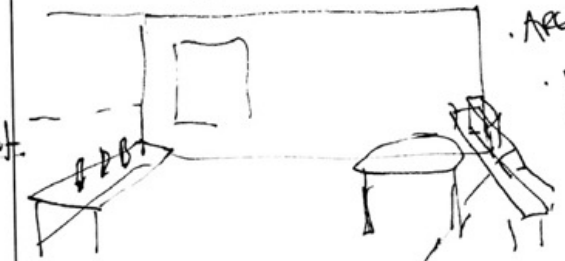
- backpacks w/ field guides
- PERSUADING
- informing
- FACTUAL info to FACILITATE SOCIAL exploration.

- MICROSCOPE
- spatial
- physical engagement
- persuading



FISH TANK

- spatial
- physical engagement
- informing.



- LAB
- Architectural
- social norms
- persuading

MURAL of the ecotones

- spatial
- informing / social Exploration / factual info.

- tanks w/ animals.
- spatial
- physical engagement
- informing.

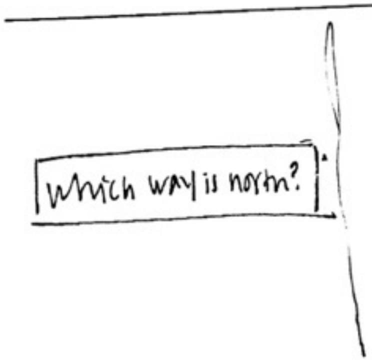
design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

(Flyn)

(41)

- ·Spatial
- ·Informing
- ·Factual

(42)



- ·spatial.
- ·factual.
- ·informing./ persuading

Bird bas

.orn. .social explor.
.persuading

Map the design elements below with number assigned in chart

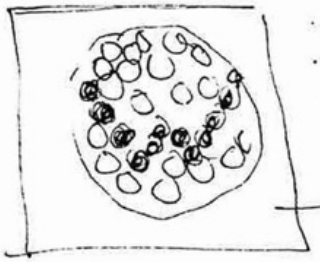
Appendix E3: Watershed School

Images and field notes collected from the field studies conducted at Watershed School

Watershed is a private school that follows an expeditionary learning model Most environmental education happens off-site at Watershed.

WATERSHED

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch



(1)
- SPATIAL
- FACTUAL
- INFORMING

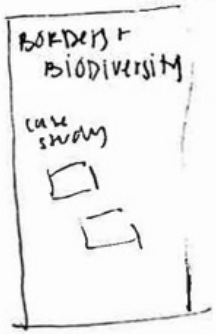
MURAL OF RECYCLED MATERIALS

(2)

- plants!
- spatial
- ~~spatial~~ physical engagement

TO SPARK ADVENTURE and wonder, foster inquiry and community, and build the character and ability of students to take on the world's greatest challenges

(3)

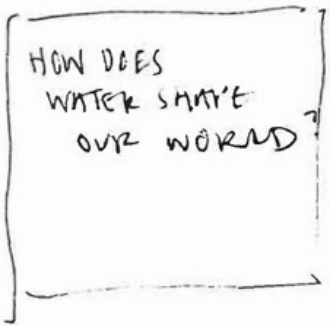


- SPATIAL
- FACTUAL
- INFORMING

(2) ↑
- FACTUAL
- INFORMING
- SPATIAL

WORDS on WALL @ FRONT DESK

(4)

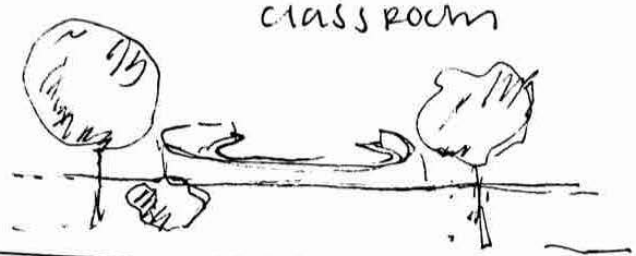


- SPATIAL
- FACTUAL
- INFORMING

design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element / Sketch

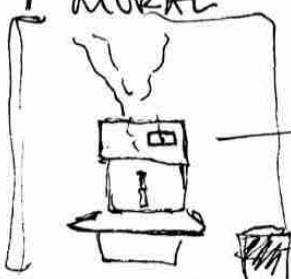
(5)

CUTDOOR CLASSROOM



(8) BOULDER CREEK WATERSHED MURAL

- spatial
- informing
- factual



(9) water fountain w/ feedback of saved bottles

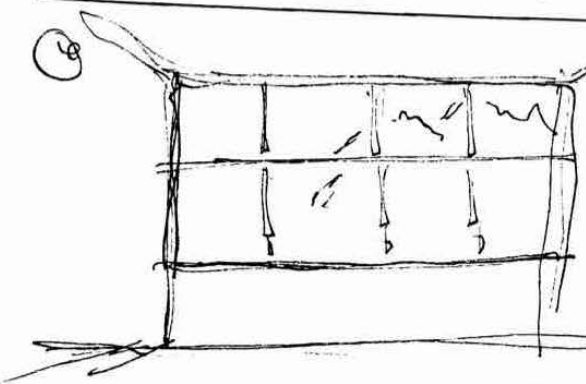
- spatial
- informing
- factual

(10)

- Spatial
- Factual
- informing

* 2 TRASH CANS, 1 RECYCLING BIN

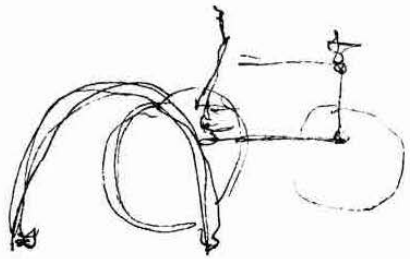
(6)



- ARCHITECTURAL
- social interaction
- persuading

garage door that opens to out door classroom/ view of mnts.

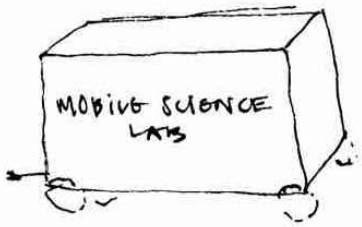
(7)



BIKE RACKS

- SPATIAL
- persuading
- ~~physical~~ engagement

(11)



- SPATIAL?
- PERSUADING
- SOCIAL INTERACTION.

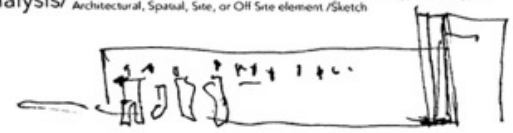

BUILDING OWNERS'
Mt Zion Lutheran Church
WATERSHED

Appendix E4: Odyssey School

Images and field notes collected from the field studies conducted at Odyssey School. Odyssey is a charter school in Denver, also adhered to an expeditionary learning model. Most environmental connection happens on excursions, offsite. Onsite, school's building is low in TGB elements.

design element analysis/ Written description of element + number / Design Element type/ Dfs8 type/ Architectural, Spatial, Site, or Off Site element /Sketch

waders + boots. hung in a hallway



- social exploration /
- physical engagement.
- OFF site activity!
  - on-site display!

(1)

- spatial
- INFORMING
- FACTUAL INFO.

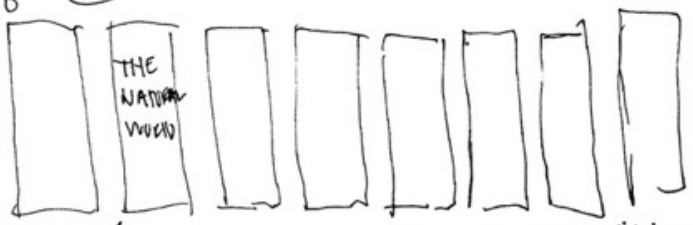
(4)

(2) plants on window sill

- physical engagement
- social exploration
- SPATIAL!

science class room. (in most class rooms)

(5)



FACTUAL INFORMATION

-pillars of expeditionary learning.

- SPATIAL

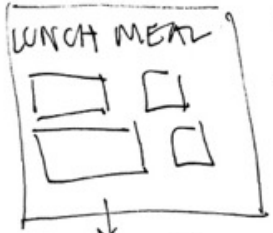
(3)

- spatial
- factual
- description of experiment

images + ART

e south platt river

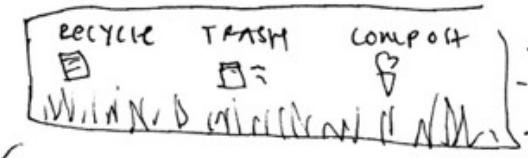
(6)



- FACTUAL INFORMATION
- INFORMING

EDUCATING LEARNERS ABOUT FOOD/NUTRITION DECISIONS.

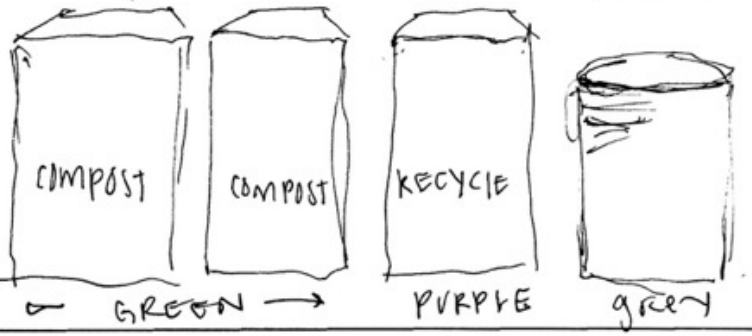
sign element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch (7)



-spatial
- informing
-factual

↳ chalkboard illustration of various waste disposal types.

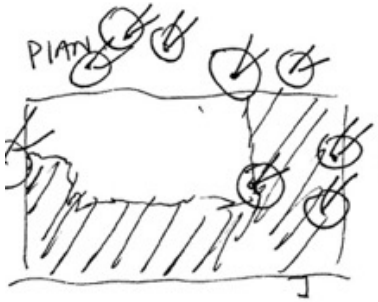
(8) -FACTUAL INFO ON LIDS



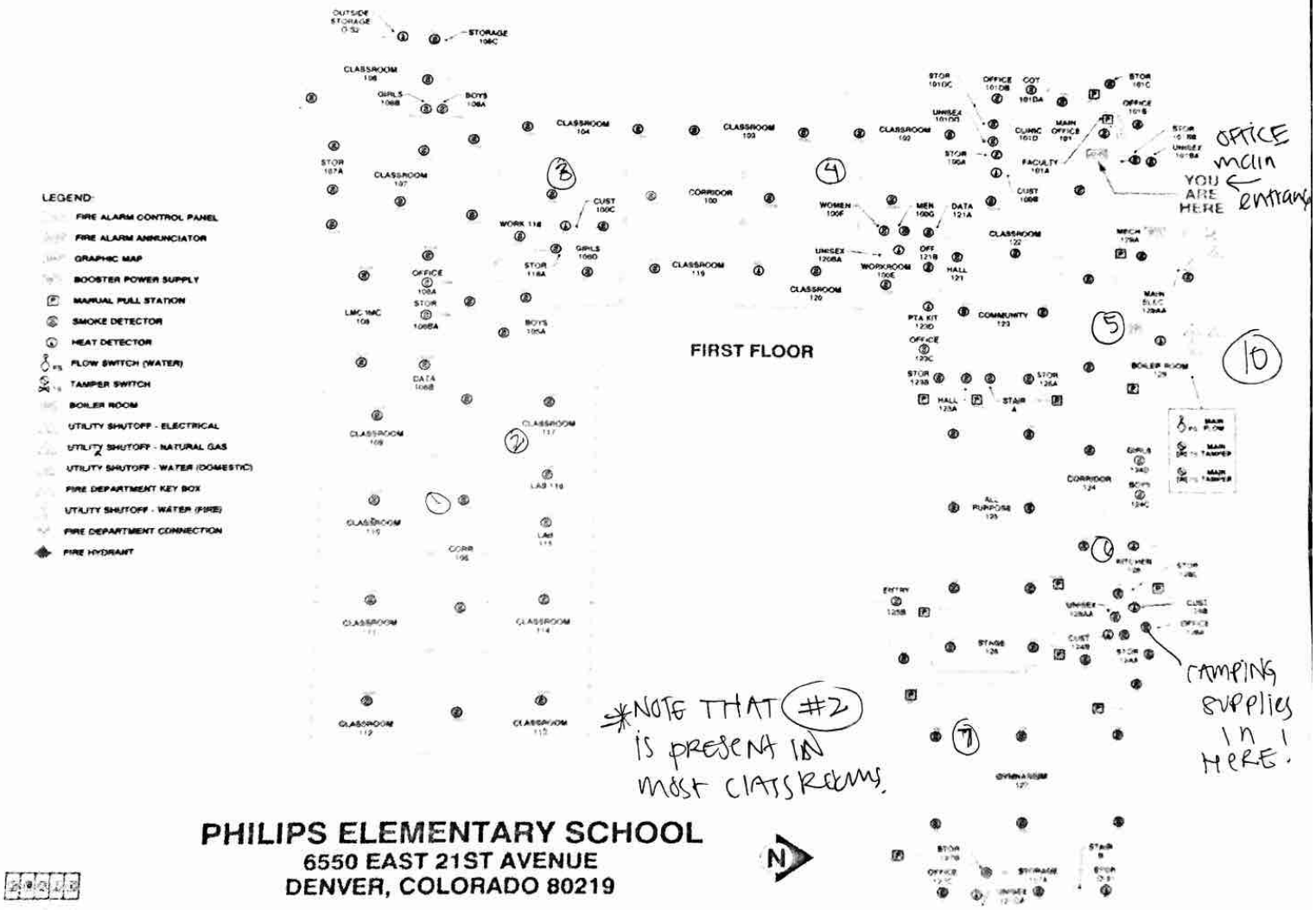
- informing
-FACTUAL
- SPATIAL

(9) PLAYGROUND / OUTDOOR PLAY.

- SPATIAL
- SOCIAL exploration
- PERSUADING



ap the *design elements* below with number assigned in chart

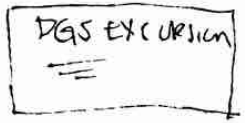


Appendix E5: Denver Green School

Images and field notes collected from the field studies conducted at Denver Green School. Denver Green School is a public, neighborhood school in Denver. It is an innovation school; this provides flexibility with program. EfS–Education for Sustainability– education is included in the school's core program.

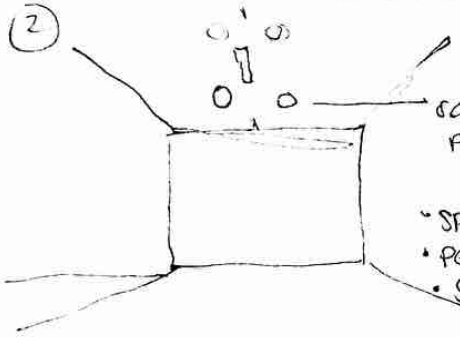
design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

(1)



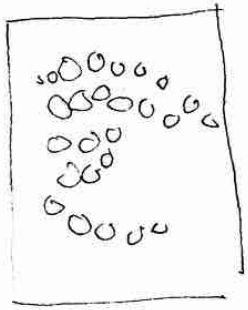
- FACTUAL
- INFORMING
- SPATIAL

(2)



- SPATIAL
- PERSUADING
- SOCIAL INTERACTION

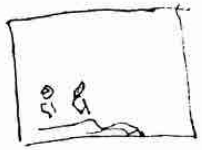
(3)



MURAL OF RECYCLED MATERIAL

- SPATIAL
- PERSUADING
- SOCIAL INTERACTION

(4)

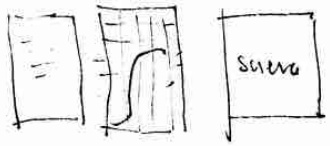


- INFORMING
- SPATIAL
- FACTUAL INFO

(5)

- MURAL ABOUT LEARNING W/ KITCHEN NEXT DOOR
- SPATIAL
- FACTUAL
- INFORMING

(6) Science classroom



- SPATIAL
- FACTUAL
- INFORMING

Analysis/ Description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

(7)

PHOTO OF FIELD TRIP @ BALLARAT

- FACTUAL
- INFORMING
- SPATIAL

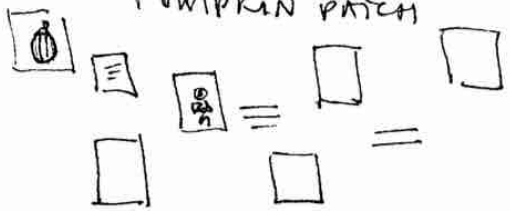
~~SUMMARY OF TYPES~~

10

- SPATIAL
- INFORMING
- FACTUAL

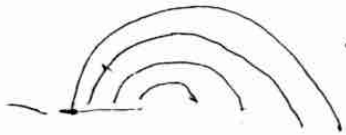
(8)

GROWING A LEGACY PUMPKIN PATCH



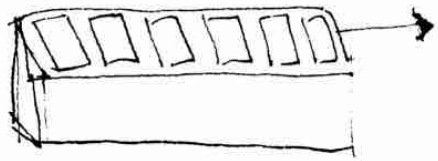
- SPATIAL
- FACTUAL
- INFORMING

(11)



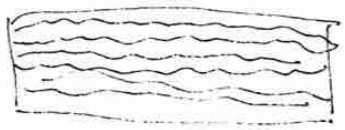
- ARCHITECTURAL
- HOOPHOUSE (MOVABLE GREEN HOUSE)
- SOCIAL INTERACTION / PHYSICAL ENGAGEMENT
- PEURSUADING

(9) SOLAR PANELS ON ROOF



- SPATIAL
- SOCIAL INTERACTION
- PEURSUADING

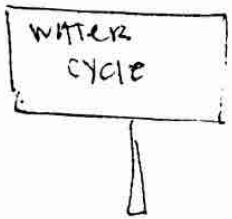
(12)



- SITE
- SOCIAL INTERACTION / PHYSICAL ENGAGEMENT
- PEURSUADING

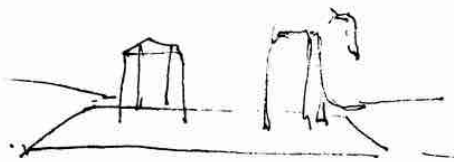
. ·gn element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

(13)



· FACTUAL
· INFORMING
· SPATIAL

(16)

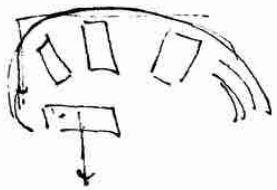


· SITE
· ARCHITECTURAL
· SOCIAL INTERACTION
· PERSUADING

PLAYGROUNDS.
· GREEN
· FIELDS · FARMS

(14)

· GARDEN #2



· SITE
· SOCIAL INTERACTION
PHYSICAL ENGAGEMENT
· PERSUADING.

(17)

· SPATIAL
· FACTUAL
· INFORMING

(15)

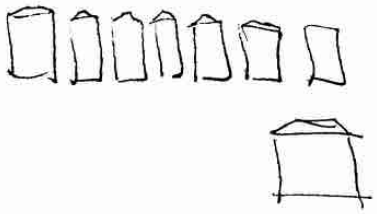
· SPATIAL
· FACTUAL
· INFORMING

(18)

· SPATIAL
· FACTUAL
· INFORMING

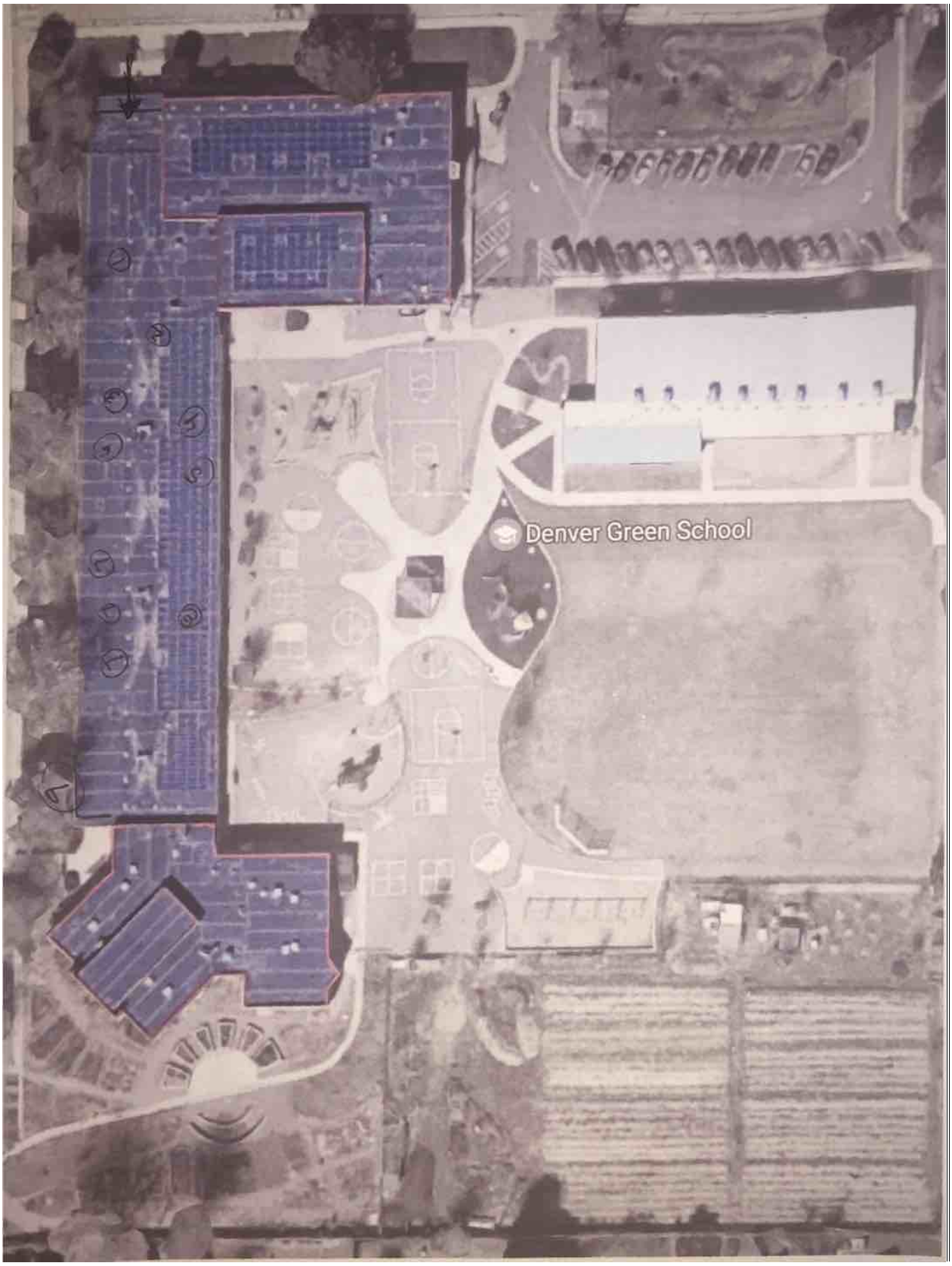
design element analysis/ Written description of element + number / Design Element type/ DfsB type/ Architectural, Spatial, Site, or Off Site element /Sketch

(19)



-SPATIAL
-PERSUADING
-SOCIAL INTERACTION

trashcans


Denver Green School