Learning Spaces in School:
Comparing Math Instruction and Learning in School Gardens and Classrooms

by

Christine Mary Boynton

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San Francisco State University

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Committee in charge:

Professor Bernard Gifford, Co-chair
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Professor Emily Ozer

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ABSTRACT

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In 2006, the California legislature released $14 million to the schools of California to create school gardens through the California Instructional School Garden Bill (CA Assembly Bill 1535, 2006). This study examined the differences and similarities of school gardens as learning spaces by exploring a fifth grade school standards-based mathematics lesson in both a classroom and school-garden setting. Using the place notions of Gieryn (2000), I constructed a methodology that articulated and then combined the different strands or elements that contribute to space production. The methodology combined both qualitative and quantitative methods to deepen the understanding of place and corroborate the evidence. I asked two research questions:

(a) What were the similarities and differences between school gardens and classrooms with respect to instruction?
(b) Specifically, did gardens offer opportunities for better academic performance, both generally and with respect to individual students?

Evidence indicated that school gardens may afford a higher use of space for lessons and higher bi-directional interactions for participants in those lessons. Data also indicates that school gardens may be more effective for lower achieving rather than higher achieving students. Further research is needed to validate these effects.

DEDICATION

To my first Dr. B – Dr. Mary Boynton, my grandmother,
my amazing partner Kip,
and incredibly patient children, Damon, Sarah and Jacob.

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So many people have contributed to this study in so very many ways and I want to thank all of you who have supported, assisted, prodded and generally lead me through this process. Primarily, I want to thank my committee of three: Dr. Bernard Gifford, Co Chair, Dr Barbara Storms, Co Chair and Dr. Emily Ozer. Thank you Dr. Barbara Storms, for your inspiration and mentorship from the time I entered graduate school at CSU East Bay to this final goal. Thank you also for your hours of input from the beginning fragments of thought to the finished product. Without you I can't imagine having the confidence and persistence to do this. Thank you Dr. Bernard Gifford, for believing in this crazy idea and helping it flourish and grow into a cogent thesis and experiment. Your ability and enthusiasm to direct me and help me define and research learning spaces was invaluable. Thank you for sharing your vast knowledge of the literature and your time to have lively and insightful conversations. I learned so much. Thank you, Dr. Ozer for lending your expertise and demanding clarity – you honed this to a fine edge and allowed me to better argue my point. I appreciate your hours of attention to the multiple renditions of text and your patience in the final hours of the project. I want to thank my cohort for all your support. Thank you, Dr. Ingrid Seyer- Ochi for your leadership and assistance with my topic and for chairing my orals. You inspired my choice of research methods and using what the students actually thought and said. In addition, thank you, Dr. Cynthia Coburn and your research cohort, it was amazing to see the actual process of writing in motion and to be exposed to such a broad range of scholars. Thank you, Dr. Coburn for all your support for writing and researching. Thank you, Dr. Rosa Rodriguez for all your hand holding through the process. Thank you Dr. Ruth Love for your inspiration and guidance about working for justice in school districts Also, thank you Debra Israel, Kim Cosby, and Emily Harris for the assistance with the actual project. Thank you to the dear teachers who participated in all the hours of classroom work and collaboration about the process.

Most of all thank you to my dear partner Kip for his patience and unrelenting support for my accomplishing this goal of thirty years. What will we do on the weekends? Also, thank you to my children who did not take it personally when I said, " No honey, I have to study." I love and appreciate all of you.

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CHAPTER 1: INTRODUCTION

This inquiry concerns itself with the micro-settings of 'school'—the learning spaces that define the parameters of how students react, respond, and relate to themselves, one another, and their teachers. In particular, how does the established learning space, the classroom, compare with another learning space, the school garden?

In 2006, the California legislature released $14 million to the schools of California to create school gardens through the California Instructional School Garden Bill (CA Assembly Bill 1535, 2006). Seventy percent of all schools in Alameda County applied for and received funding for school gardens. However, no requirements were established and no money was distributed to provide professional development or other infrastructure support (such as maintaining the gardens) to integrate the gardens into the 'academic' core of schools.

As an educator and administrator of the largest garden-based nutrition education program in California, I have had many experiences in school gardens. I spend many hours watching students, providing professional development to teachers, and providing community education around the use of school gardens. Over the years, I have noticed that some students who don't engage academically in classroom environments flourish in school gardens. I have wondered why. The school garden learning space seems to offer them something, but what is it?

In addition, these outdoor learning spaces are not used systemically in the schools. Support for school gardens is often local and voluntary—usually led by enthusiastic teachers and members of the community. As a consequence, school gardens are often used by passionate teachers and parents, but not available to all students in the school. Usually, gardens are not viewed as a part of the normative academic infrastructure of the school. Teaching in school gardens, consequently, is typically not subjected to the 'academic rigor' expected of an indoor classroom. This lack of rigor in the current accountability environment also marks gardens as nonessential to the school academic environment.

Due to this peripheral status, garden-based teaching strategies and learning activities are not subjected to the same level of attention and discussion devoted to classroom-based strategies and activities. Given the emphasis placed on accountability-based instructional metrics featured in the *No Child Left Behind Act* (NCLB, 2002), the lack of attention on the part of educational policymakers to the potential educational advantages afforded by non-classroom learning spaces is understandable. This lack of attention is shortsighted, however, because it leaves unexplored the possible educational synergies between the learning taking place in classrooms and other settings within a school.

This study began with this possibility that school gardens are learning places, and explored a specific fifth grade school standards-based mathematics lesson in both a classroom and school garden setting. I undertook this study with the intention of subjecting to more rigorous study my numerous observations of students actively engaged in productive learning in school gardens. My research questions were sparked by my practice and observations. I created questions to systematically analyze school gardens and their contributions to schools as productive learning spaces.

In order to examine how school gardens work as settings for learning in schools, this study focused on how math instruction differs in school gardens and classroom settings. The research questions that guided this research were:

(a) What are the similarities and differences between school gardens and classrooms with respect to instruction?
(b) Specifically, do gardens offer opportunities for better academic performance, both generally and with respect to individual students?

At the base of this study is the question of whether school gardens may provide better learning spaces for some students, most notably the students who traditionally fare poorly in classrooms. That question is informed by some fundamental concept of equity in schools. I propose that the quality of student learning opportunities is determined by their participation which is dependent upon the flexibility of the learning spaces made available to them and to their teachers. Current research suggests that learning spaces that encourage student sense-making activities that are culturally aligned are more equitable than those that constrain these interactions. Learning spaces that encourage students at different levels of academic proficiency to collaborate with one another are more equitable than those that keep these students isolated from one another. Learning spaces that make it possible for students to communicate with one another using language protocols appropriate to their current situation are more equitable that those that compel students to communicate with one another using highly formalized language protocols. Putting things even more broadly, this conception of educational equity is informed by the belief that society can produce learning spaces that are more equitable, that allow students to be full participants in their schooling. When teachers and administrators recognize the attributes and possibilities of these spaces, the cause of educational equity on the ground is materially advanced. (B.R. Gifford, personal communication, May 2010)

CHAPTER 2: LITERATURE REVIEW

The first section of the literature review focuses on reviewing empirical studies of place and the specific places of classroom and garden. I also look at the limitations of the existing literature and how this study proposes to fill some of the gaps, specifically by drawing on the approaches taken in other exploratory design experiments. In the final section, I talk about the place theory from Gieryn (2000) and how it creates a broad frame for empirical study as a guide to investigating these learning spaces.

Empirical Studies of Place

General Place

Place has been studied with profound elegance by anthropologists who have spent years understanding cultures that arise in those places (Basso, 1998; Hayden, 1997; Low, 2000; Low, 2003; Low, Taplin & Scheld, 2005; Seyer-Ochi, 2006). Basso (1998) in *Wisdom Sits in Places* brings to light the culture of the Western Apache. His lyrical study describes how landscapes reveal the culture of Native Americans and their profound and integral attachment to the places of their nation. Low (2000) reveals how plazas determine and define culture and the way that people relate and interact with one another. Both Hayden (1997) and Seyer-Ochi (2006) investigated urban landscapes and the way place informs and affords the people living there a way to be and live. These general place ethnographies show how place forms the culture of those living within it and describes the 'affordances' of place, how place can define the interactions and relationships of those who dwell there. My most profound learning from this literature was the importance of place, leading me to ask how the learning places of schools define the interactions of students and how educators produce spaces for their students.

From the perspective of an educational reformer, however, these anthropological studies of place have limitations: (a) they are studies focused on understanding of cultures, not identifying opportunities for reform, and (b) they require at least a year of immersion in the culture to gain that understanding. As an educational reformer, my intent is to understand the schools and learning spaces within them, but with the purpose of changing that space to improve teaching and learning.

Classrooms

Many disciplines study classrooms. Architecture and design study classrooms as physical spaces. Environmental psychology investigates how and why places such as classrooms are important to children, often with reference to the psychosocial welfare of the student (Fraser, 1987; Rivlin & Weinstein, 1984;Weinstein, 1979). Studies of design add to investigation of place (Ahrentzen & Evans, 1984; Cottrell, 1984) by looking at the effects of lighting, sound, and other physical contributions to place. Martin (2002, 2006) in her articles investigates how students' environments in schools affect them. Martin writes about how the fixed and flexible physical elements of the classroom affect teaching and learning through flow and patterns of movement, lighting, and noise levels.

School Gardens

Peer-reviewed research on school gardens is relatively new. As of November 2010 the PSYCH Info database indicated 23 peer-reviewed articles, all written since 2004 and half of them published in the last two years. Some studies report that school gardens increase science, language arts, and environmental knowledge (Lieberman & Hoody, 1998; Mayer-Smith, Bartosh, & Peterat, 2007; Mason & Barba, 1992; Smith & Motsenbocker, 2005); self-esteem (Sheffield, 1992); and positive interactions with adults (Alexander, North & Hendren, 1995). Ozer's (2007) review notes the lack of rigor in the empirical literature up to that point and calls for more systematic research. In a more recent review, Blair (2010) finds sufficient rigor in the evaluation of nutrition outcomes (McAleese & Rankin, 2007; Morris, 2005), but not in the domains of positive behavior change and better connections to the environment.

Place Attachment

In addition to studies on the physical aspects of place, there are studies about how places affect people and their actions within the place. Environmental psychology studies this as *place attachment*. Personal place attachment (Prohansky, Fabian, & Kaminoff, 1983) is the 'mixture of feelings about physical settings and symbolic connections to place (Raymond, Brown & Weber, 2010). However, there are few articles about school and place attachment. As of November 2010 the PYSCH INFO indicated 36 articles in a search for 'place and attachment', but a search for 'place and attachment and school' returned only four articles—three articles about schools and one about the classroom. Raymond, et. al (2010) identify four proposed dimensions to place attachment, three psychosocial dimensions and a fourth about attachment to a 'non-human natural environment, based on history, emotional response or cognitive representation' (Raymond, et al, 2010). Besides place identity, place dependence 'is the physical affordance of the place to provide or support the use of the place' (Schreyer et al, 1981). Community social bonding is described in similar ways to school bonding as it represents 'feelings of belongingness or membership to a group and the emotions that go along with it' (Raymond et al, 2010).

The place attachment of people to an environment exists outside of attachment to people in that place. Kals (1999) notes that there is a strong emotional affinity and attachment to nature aside from rational thought. Shultz and Tabinica (2007) argue that connection to nature is implicit and outside egoistic structures. Their study uses a computer Implicit Association Test to compile and analyze data that measures the implicit connection. Information in these studies suggests the possibility that students may connect to school gardens implicitly.

Limitations of Existing Research: Learning Spaces are Still "Black Boxes"

What I did not find in any of the empirical studies of place was a combined approach needed for the educational reformer, one that has both a broad reach of understanding of learning spaces within schools and a way to target specific factors within the place in order to change the learning spaces. Most of the research about place attachment is analysis of surveys or reported tests or long term ethnography. While these studies shed light on the existence of place attachment, they do not reveal how place attachment affects use and understanding of the space. Langhout's (2004) qualitative observations of the classroom are an exception in that she puzzles out how students attachment to school classrooms connects to their behavior in that classroom.

Exploratory Design Experiments as Models

My goal in designing this study was to create a practical framework for the study of learning spaces in schools in order to create more equitable classrooms. As an exploratory study meant to be a baseline for future interventions, my research relied primarily on qualitative methodologies while exploring in a small sample size ways to proceed with future investigations quantitatively. In order to combine empirical approaches, I turned to space theory to discover a practical way to piece rich information together in a cohesive manner. The design goals of this study were to:(a) create a broad methodology to capture some of the richness of anthropological ethnographies of place, and (b) design a practical experiment to start to discern the differences of learning spaces in action.

In designing my research, I found it useful to look at the class of education design experiments (Brown, 1992) in which the comprehensive nature of the classroom is examined as a holistic entity with situated learning (Brown, Collins, & Duguid, 1989). In particular, the questions addressed here around micro-settings and the methodological approach of this study can be described as at the formative design stage referenced in Akker, Gravemeijer, McKenney and Nieveen, 2006. Empirically based, an exploratory study at the formative design stage draws observations from data and examines data for indications of next steps. Results and findings are tentative and lead to other studies to refine understandings and then larger studies to validate information and findings. In line with Brown et al.(1989) this study seeks to discern how to create spaces that have a culture of learning and allow situated learning.

Gieryn's Theory of Place

I derived an empirical frame from Gieryn's theory of place (2000), which incorporates the rich understandings of place ethnographies by thinking about learning spaces in a broad manner. Following Lefebrve (1984) and Gieryn (2000), I wanted to define learning spaces not only in terms of the physical spaces, but to include the meanings that people bring to the space. I did this to understand how the physical space and the meanings and expectations of the actors (the students and teachers) define how the space is produced or used. Gieryn (2000) argues that examining place requires the examination of three factors:(a) the geographical or physical space, (b) the material resources or affordances of the place (what can happen there), and (c) the meanings and expectations that people bring to that space. By investigating these elements as they pertain to the different learning spaces,I hoped to develop a deep understanding of similarities and differences of school gardens and classrooms.

CHAPTER 3: METHOD OF RESEARCH

Overview of Design

This study was conceived to investigate how teachers and students 'produce space' (Lefebrve, 1984) in different micro-settings in schools (classrooms and school gardens) and how learning spaces and the use of space differs those micro-settings. The study attempted to achieve this by comparing student and teacher interactions within and across two different "learning spaces": indoor classrooms and outdoor school gardens. By observing a mathematics lesson within a conventionally organized (traditional, indoor) classroom, and a comparable mathematics activity in a school garden, the study tried to understand the individual and collaborative possibilities with regards to each of those spaces. In order to understand how places affect students and teachers—how places define their expectations about use of the space—I used Gieryn's theory that examines place as comprised of three factors or strands: (a) the geographical space, (b) the material resources or affordances of the place, and (c) the meanings and expectations that people bring to that space. By investigating these elements as they pertain to the different learning spaces, I hoped to (a) develop a deep understanding of similarities and differences between school gardens and classrooms, (b) determine if the participation activities afforded in the garden setting are more equitable, and (c) determine how participation in these activities may be organized to increase advantages afforded to students who are not proficient learners of mathematics within conventionally organized classroom settings.

This section discusses the application of the three strands of Gieryn's theory of place to this investigation, including looking at the observable elements associated with each strand, the data to be collected with respect to each strand, and the framework for analysis of the data. Figure 1 below represents a graphical summary of the research methodology as it applies to each of these components.

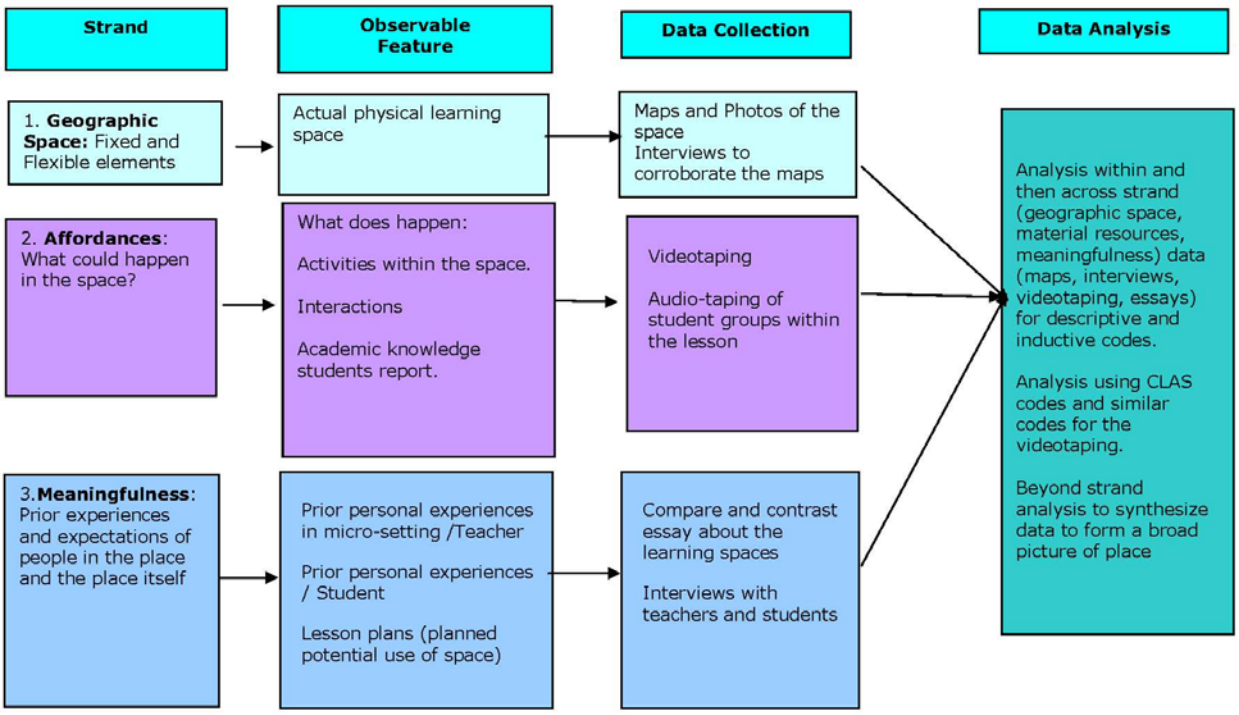

Figure 1: Empirical study design based on place theory.

In the first column, the strands of place are listed: geographic space, material resources, and meaning. These represent the elements of place used to define space in this study. In the second column, I listed the observable features of that strand. For instance, for affordances, the observable feature for what *could* have happened within a space, was what *did* happen in the space, and so the observable feature was seeing the activities and interactions in the place. To understand meaning about the learning space, I asked questions about how people feel about the place (Manzo, 2005). In the next column, I listed data to be collected in order to report on the observable features. For instance, to examine geographic spaces, I collected self-drawn maps (Ingrid Seyer-Ochi, personal communication, 2008). Finally, in the last column, I described my analysis structure, including the video analysis. There is only one box for analysis because all the data from the elements of place were analyzed together to understand the broad notion of place.

As an exploratory study at the formative design stage, the goal was to draw meaningful observations from the data and examine data for indications of next steps. Results and findings, although tentative, were intended to lead to other studies to refine and validate understandings, all with the hope of identifying how to create spaces that have a culture of learning and allow situated learning (Brown, 1992).

Identification of Participants

The sample for study was chosen from established garden–based nutrition education programs in one school district in Northern California in Alameda County. There were several criteria for selection:(a) representative school demographics for schools in Alameda County; (b) stable administrative and teaching populations as defined by consistency of staffing; and (c) active use of a school garden as an academic learning space. Students received permission from

their parents to participate in the study, and the Institutional Review Board (IRB) at UC Berkeley approved the study protocol.

Demographic Breakdown

The school chosen was representative of the district demographically. At this school the only two subgroups larger than 10% were Hispanic and African American. Consequently, scores for the other ethnic subgroups in math were not reported on the California Department of Education website (California Department of Education, 2008).

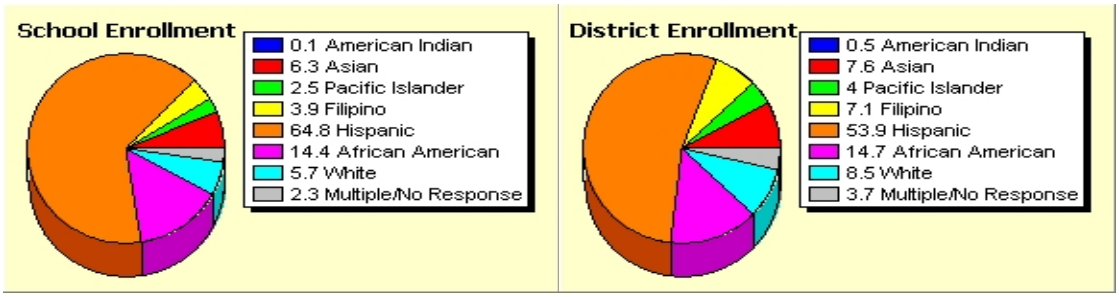

Figure 2: Demographics of the school selected for the study.

The achievement gap in mathematics was evident in the school. Fewer students reached "proficiency and above" in math at this school than students at other district schools. As reported on the California Department of Education website (California Department of Education, 2008) in mathematics, 7% of the African American students reached proficiency and above as determined by the California Star Testing (CST) scores. Only 22% of Hispanic students scored at proficiency and above in math. Also, only 25% of the African American and 31% of the Hispanic students reached the status of proficiency or above as compared with 53% of the white students.

Stable Administration and Teaching Staff

This school was chosen because it had the same principal for three years. The fifth grade was chosen because its teachers had been teaching as a team for two years. This criterion was intended to reduce variables associated with teacher skills.

Use of Gardens as an Instructional Space

Because this study was about exploring school gardens as learning spaces, finding a district with a representative school engaged in such use was an important selection criterion. The chosen district had been using gardens for the last six years as instructional settings to address academic standards and nutritional education competencies. Of the 26 schools with gardens in the selected district, one was selected for this study because it was generally representative of the district schools with gardens. In this district, schools that qualify for Title I (with 50% or more of the students receiving Free and Reduced Lunch) provided school gardens.

Each school site with a garden in this district had a full-time garden–based educator who co-taught classes with classroom teachers. The selected school site had:(a) a garden in existence for four years; (b) a garden–based educator in the process of becoming a credentialed teacher; (c) a principal who had been at the school for three years; and (d) teachers who had been teaching for at least two years in the garden. The entire fifth grade (three classrooms) participated in the garden program, representing two English Language Development (ELD) classrooms and one Bilingual (Spanish) classroom.

Participants

Participants in the study were the 5th grade students and teachers in classrooms that used the garden for learning space. Students were videotaped doing standard educational work and so did not need human subject forms to participate. Ten percent of the students and the four teachers signed human subject forms to participate in individual interviews outside of the classroom situation.

Reducing the Variables

Since the study attempted to define how the learning space was being used by the participants, an attempt was made to keep the subjects the same across two environments, the classroom and the school garden. Classroom teachers were given a choice of 'high quality' lessons to teach. 'High quality' lessons in this context included components that required movement, California standards-based design, and promotion of concepts instead of memorization. Another effort to reduce variables was to ensure that classes followed their usual routines by having the usual teacher teach in their usual learning space, i.e., classroom teachers taught in the classroom and the garden teacher taught in the garden. In the study school, there was a separate garden teacher who taught lessons in the garden. She taught the same lesson in all three classes in the garden. In the classrooms, teachers taught their own classes.

Specific Lesson Selection

In order to compare student and teacher performance in the classroom and the garden, a math lesson about the same topic was chosen for each learning space. The goal was to see how successful the lesson could be in the different spaces. Lessons from Math in the Garden (White, Barrett, Kopp, Manoux, Johnson, & McCullough, 2006) and from the Alameda County Office of Education Math Development Center (Alameda County Office of Education Math Development Center, 2002) were presented to teachers and they chose *Inside Coordinate Grids* from Math in the Garden and *Classroom Coordinate Grid* from the Math Development Center. A math lesson on coordinate grids was chosen because students had some background in the concept, but had only experienced the topic conceptually. Although the garden and classroom lessons were not identical in approach (the classroom lesson required more complex student work), the goal of each was to take the students to a more practical level of understanding of coordinate grids. The classroom and garden lessons were also chosen to maximize the use of each space by the teachers.

Observable Features

In order to study the broad concept of learning spaces within a structure that could easily facilitate interventions and also capture the complexity of learning spaces, I created a methodology based on Gieryn's (2000) theory of place. As described in the second column of Figure 1, I collected data using both quantitative and qualitative methodologies as well as my own experience as an educator and administrator. Data was defined to collect observable features for each of the strands of place. For geographic space, the physical space was observed. For affordances or material resources, to understand what the space could promote or allow to happen, I observed what did happen. For the meaning of the space to people, I collected information about what spaces meant to people in the past and also their expectations. In this manner, I collected information about the elements of place to understand where interventions might take place in the future (affordances and geographic spaces) to mitigate performance issues in learning spaces (meaning of the space), as well as understanding what determined success in the learning spaces at the time of the study.

Data Collection

The next step in the process of discovering how learning spaces differ within the context of the theory of place was to link observable features with data collection techniques. For this purpose, the study collected data for each of the three theoretical strands of place:(a) the geographic space itself; (b) material resources of physicality; and (c) meaningfulness to the participants of the micro-setting.(See Figure 1.)

Strand 1: Investigating Geographic Spaces

Data for this strand included information about the physical learning spaces themselves. I collected five kinds of data to understand the geographic place: pictures of the spaces, maps drawn by the students, compare-and-contrast essays, and interviews to corroborate what was on the maps drawn by the students. Additionally, I measured the physical learning space. All students drew maps and legends, however, only the maps that could be corroborated by interviews were used in this first analysis of the data.

Table 1: Data collected about the geographic space.

Pictures/Video	Classroom	Garden
Baseline	Researcher	Researcher
Maps *Baseline*	Students	Students
Interviews – single *Corroborating*	Students	Students

Geographic spaces data. I took photos and videos of the learning spaces. Students drew maps and created legends for those maps. This information was considered the baseline information. Further corroborating data was collected from the students as part of the semi-

structured interviews.(See Appendix A.) In addition, more corroborating data was collected in written compare-and-contrast essays students created for this study.(See Appendix B.)

Figure 3: Garden learning space.

Figure 4**: Classroom learning space.**

Photos. Prior to each class, I took pictures of each learning space. I did this by standing in the center of the space and taking overlapping pictures of each space while turning in a 360º circle. I did this to get an overall perspective of the learning spaces.

Table 2: Map data collected about the geographic space.

Learning space	Session 1	Session 2
Garden	Map	Legend
Classroom	Map	Legend

Maps. The maps drawn by each student were collected over two sessions. By this process, I investigated what they used the spaces for and how they valued them without research influence or direction as advised by Seyer-Ochi (personal communication, April 28, 2009). Maps by novices conveyed the novices' meanings about the place (Low et al, 2005). The learning space mapping occurred in the space itself to create as direct a reference as possible (Lofland & Lofland, 1995).

During session one, each student drew a map of the particular learning space (classroom or garden) without prompting from the teacher or researcher. This was to allow for students to convey their perception of the space. In session two, students were then asked to name places on the map by creating a legend for liked, easy to learn, and other meaningful places for them. In order to facilitate this, students received copies of the maps they made in session one, and were asked to create legends that identified areas that they used, whether they liked the place and what they felt about the areas in the space (Appendix B). The students' feelings were very important because their thoughts and feelings indicate connection to place (Prohansky, et al., 1983) and perhaps implicit connections to the natural environment (Schultz & Tabinico, 2007).

Figure 5: Classroom map sample.

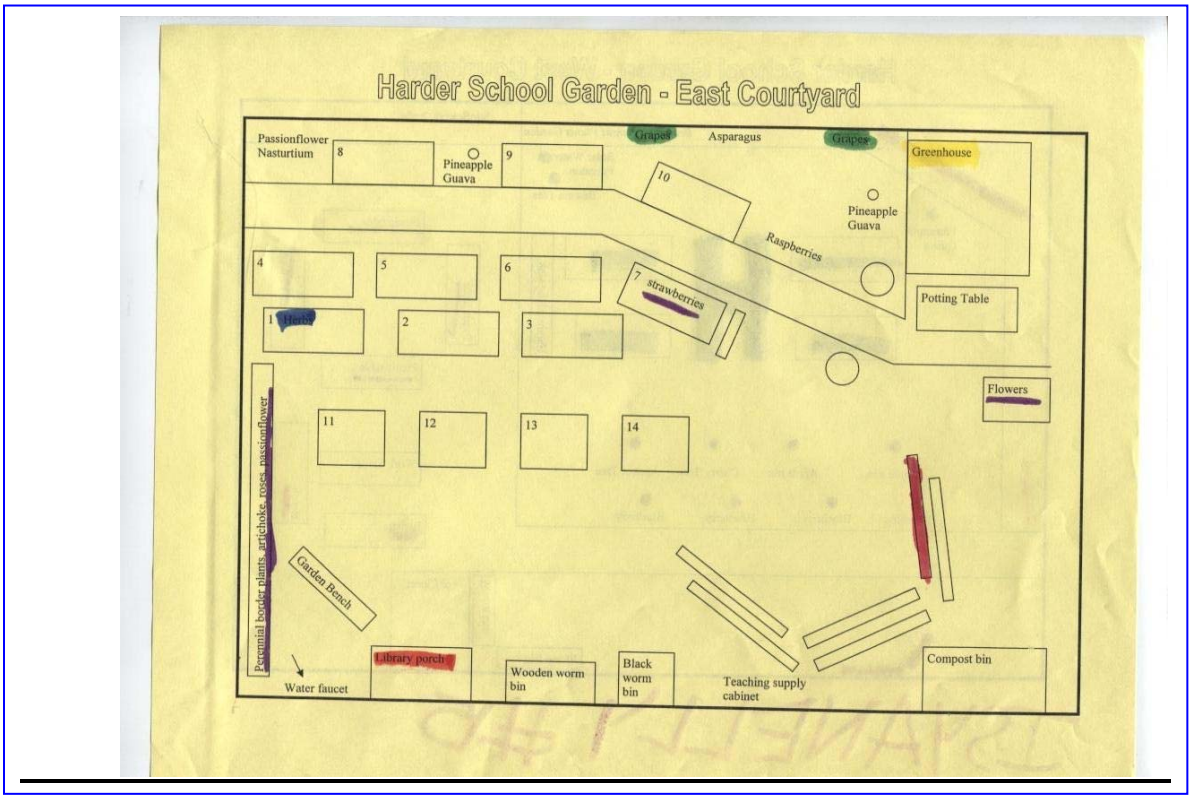

Figure 6**: Garden map sample.**

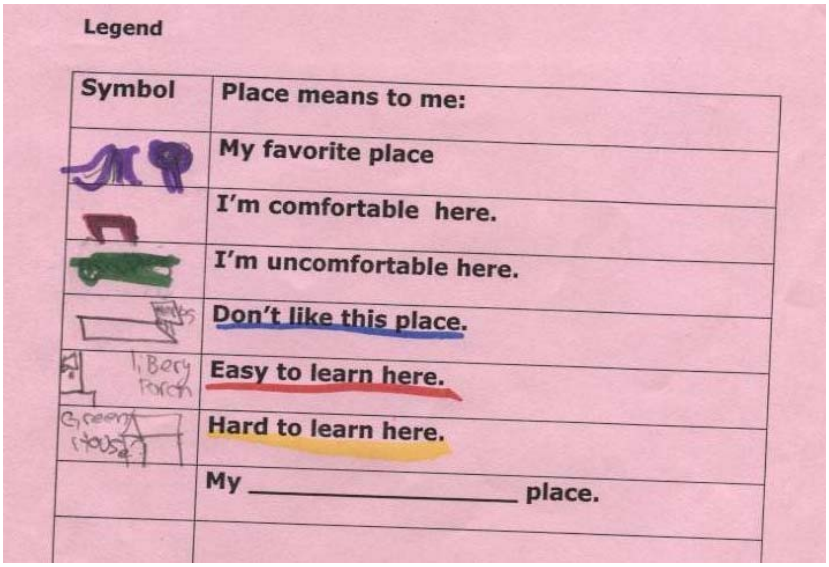

Figure 7: Garden legend sample.

This methodology of having students create legends for their maps was slightly problematic when it came to the garden. During data collection, it became clear that students could not draw maps of the garden. Rather they drew pictures of the garden. Consequently, at the second mapping session, maps of the garden created by the garden teacher were supplied to the students so they could identify the areas of the garden for their legends.

Interviews. Following the mapping, selected students (four from each class), their three classroom teachers and their garden teacher were interviewed to gather more information about the meaning and the material resources that they had identified on the maps or pictures. These helped verify the data and limited researcher speculation (Datnow & Yanazawa, 2004; Miles & Huberman, 1995).

B51695

Comparing and contrasting the Garden and classroom

I compare the garden and the classroom by the way how are they different and how are they the same.

The way they are the same is they have seats, a classroom, they write, have rules, learning, big, tables, sharing, working and safe.

The way they are different is the Garden is green, beautiful, nice, healthy, outside, quiet, harvest, taste, plants, observe, work and taste.

The other way the classroom is different is, being crowded, dirty, there's papers, noisy, stinky, clean, and fresh.

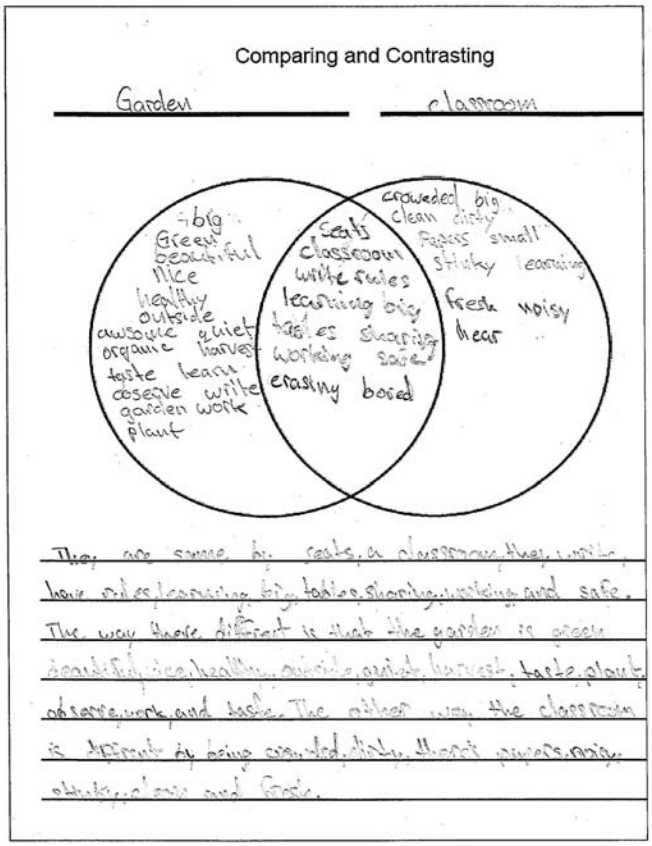

Figure 8: Compare and contrast sample.

Essays. After the mapping of the garden and classroom, students wrote about their perceptions of the garden and classroom (where they felt most comfortable, where they felt they could easily learn) through a guided journal writing experience. (See Appendix B.) They were given a Venn diagram to compare and contrast their experiences of learning in the school garden versus the classroom. Many of the students have a primary language other than English, so the writing activity was scaffolded to support the use of a variety of vocabulary. Scaffolding is a pedagogical technique that uses the knowledge that students have and builds their understanding (Vygotsky, 1978). Teachers led the class in a brainstorming activity designed to summon vocabulary to describe each learning space. Students were then asked to describe what they did in the respective learning spaces. Additionally, they were asked what was fun, interesting or boring. Teachers collected the compare-and-contrast graphic organizers, and I analyzed the data. Additionally, I interviewed ten percent of the students to corroborate the findings of the maps

(Datnow & Yanazawa, 2004; Miles & Huberman, 1995). Interview data was checked with the compare-and-contrast findings.

Strand 2: Investigating Material Resources – Opening up the Learning Spaces

The second strand, *material resources,* isolates what actually happens in a space from what is planned or expected to happen *(meaning*) and the affordances of that geographic physical space (*geographic spaces*). An affordance is a quality of an object, or an environment, that allows an individual to perform an action. Gathering data on this strand involved structuring the planned activity by choosing particular coordinate grid lessons to be taught in the classroom and garden settings, observing what happened during the lessons, and evaluating what the students learned in each setting.

Lesson planning. Prior to the taping of each lesson, classroom Teachers A, B, and C, together with the researcher, chose and reviewed the lesson. Teachers A, B, and C had attended a six week mathematics training that included content and pedagogical strategies; the lesson they taught was chosen from that course, the content of which was about coordinate grids. None of the classroom teachers had taught the lesson to students before the study. The coordinate grid lesson in the classroom created a coordinate grid with desks. Each desk was a point on the grid and students were identified as those points.

The researcher and Teacher G (garden teacher) chose a lesson for the garden about coordinate grids. The garden teacher had taught that lesson once before. The lesson used the garden as a coordinate grid and the students had to find points and subsequent 'treasure' at those points.

Videotaping to observe what happened. I videotaped the lessons in both the garden and the classrooms to observe what actually went on in the space and how the space was actually used. Videotaping allowed me to work with another researcher in the analysis phase of the study. There were three cameras in the garden and three in the classroom. One camera was stationary in the garden, and two were mobile. All cameras were stationary in the classrooms. There were technical difficulties with one of the cameras, but each lesson had at least two angles of video. Each lesson was about 50 minutes in length.

Two of the classes were videotaped in the garden and the classroom. The third class was not videotaped in either the school garden or the classroom because parental permission for videotaping could not be acquired for many of the students in the class; however permission was granted for audio taping the class. Limited field notes were gathered in all three classrooms.

Figure 9: Garden learning space practice segment.

Figure 10: Garden learning space practice segment.

Table 3: Data collection for material resources strand – observing what happened in each learning space.

	Garden lesson	*Classroom lesson*	*Academic mastery*
Class B	Video	Video	Pre/ post test
Class C	Video	Video	Pre/post test

Math tests. Students were given a pre– and post–test of six math questions (see Appendix D) related to the coordinate grid lessons taught in the study. In the garden lesson, the objective was for the students to identify points on the garden coordinate grid. In the classroom lesson, the objective was for students to understand how to find points on a coordinate grid after creating a T-table. The goal of collecting the testing information was to investigate if there was any relationship between the differences in the interactions in the school garden and classroom and academic attainment of math concepts.

Strand 3: Investigating Meaning - Prior Knowledge and Expectations

The final element of the triad of place is meanin*g*. The data collected was targeted to elicit prior experiences that students and teachers brought to the learning space. A semi-structured interview protocol merged place attachment and social networking questions (Manzo, 2005; Hawe & Ghali, 2008). The questions began with a broad frame to understand general feelings about places and moved to specific questions about the learning spaces of the classroom and school garden. All three classroom teachers, the garden teacher, and ten percent of the students were interviewed. Interviews lasted from 30 minutes to an hour and were conducted in the teachers' lunchroom for the teachers and in the garden teacher's workroom for the students. No other persons were present during the interviews except for the researcher and the interviewee. Interviews were recorded with digital recorders.

Table 4: Data collection to determine meaning of places to participants.

	Interviews	*Compare-and-Contrast Essay*
Students	X	X
Teachers	X	

Data Analysis

The purpose of data analysis was to answer the two main study questions:

(a) What are the similarities and differences between school gardens and classrooms with respect to instruction?

(b) Specifically, do gardens offer opportunities for better academic performance, both generally and with respect to individual students?

In order to analyze the data for all aspects of place (the geographic place itself, the meaning people bring to the place, and how what happens in the space is influenced by the place and the meanings), the study analyzed the data in three tiers. The three analysis tiers consisted of: (i) analysis within the strand, (ii) cross-strand analysis to determine additional codes and understandings, and finally, (iii) analysis beyond the strands investigating the data findings collectively to come to some conclusions about the differences between the learning spaces. I wrote memos during early analysis.

Initial codes for the qualitative data began as descriptive codes and then in the second and third iteration became inductive. I cross-analyzed data to provide a constant 'dialogue' (Miles & Huberman, 2008) and to ensure that I connected explanation to the data.

Table 5: Tiers for data analysis.

Tier	*Locus of analysis*	*Sequence of analysis*
Tier 1:	Within each strand of place (geographic space, material resources, meaning)	(a) Within the learning space (b) Across the learning space (classroom: garden
Tier 2	Across strands geographic space, material resources, meaning)	(a) Within the learning space (b) Across the learning space (classroom: garden
Tier 3	Beyond the strands	Interactive

Similar to the work of Datnow & Yanazowa (2004), this study used a variety of methods to enhance the validity of the data. I correlated audiotaped student interviews to the videotapes to discern patterns and themes within or across the particular instructional setting. I analyzed maps from Session G 1(a) and Session G 1(b) (see Appendix C) and coded for descriptive and inductive themes. I analyzed the audiotapes and videotapes for descriptive themes related to the particular strand in the particular learning space. In other words, I analyzed all the classroom geographic space data, and then all the school garden data. I then compared the maps, audio and videotapes to find common and outlier themes. I interviewed and videotaped teachers during the lesson to triangulate the ongoing findings(Datnow & Yanazawa, 2004; Miles & Huberman, 1995).

Analysis Within the Strands – Understanding Perceptions of Physical Place

In this first phase of analysis, I systematically investigated data collected for the geographic strand independently of material resources and meaning. Within the data collected for geographic space for instance, I analyzed maps, interviews and essays. I then grouped all the classroom maps and all garden maps and identified all the student places. After corroborating identified places with the student interviews, I then analyzed across the learning spaces, i.e., classroom or school garden, to see if there were any similarities or differences about the places identified.

Within strand 1: geographic spaces (map analysis). Analysis of geographic space was a three-tiered process. First, I reviewed maps within the place such as the school garden or classroom. I then analyzed maps with their legends to note any similarities. I created a cross-student case display for each learning space, one for the classroom and one for the school garden. I recorded information from the legends (such as what students liked, places within the space where it was easy to learn, and what were favorite places) onto an excel worksheet. Information collected from the maps informed descriptive coding by identifying places and activities such as favorite places or easy to learn places (see Appendix E). Corroborating this step, I recorded student and teacher interviews and then transcribed and entered them into the ATLAS data base. I then coded the transcripts with expected descriptive codes. I checked information and codes from the transcribed interviews with the map information for corroboration of information gained from review of the maps and legends. Student responses from the interviews were entered into the excel worksheet for cross-case analysis. After entering information, I compared the information from the classroom maps to information from the garden maps to analyze the similarities and differences and to investigate any new themes across the learning space cases (Tier 1, section (b); see Table 5). Since both learning spaces had the same expected descriptive codes, I analyzed the variations of the meanings by reviewing additional data from interviews and the compare-and-contrast essays. New analytic codes arose as the interviews were coded and recoded. Themes arose in this third step of the analysis.

Within strand 2: material resources- what actually happened in the learning space. I videotaped classroom and school garden lessons with three cameras. In the garden, one camera was stationary and at least one camera followed the students. Three cameras were stationary in the classroom in three corners of the room. The video segments were then downloaded onto Adobe Premiere 7, a video analysis software tool, to provide a continuous stream of information. The segments from the different cameras were placed in a single file for each lesson. After viewing the films, I realized that there were two segments to the garden lesson, a direct instruction section and a practice section, while the classroom lesson had only a direct instruction section. I separated the garden lesson into two parts: the initial direct instruction and the practice portion of the lesson. I did this to reduce the variables in the lesson execution and to avoid conflating the different kinds of instruction and the use of space during that instruction.

I used the Classroom Assessment Scoring System or CLASS (Pianta, Paro, & Hamre, 2008) analysis techniques for video analysis. This performance-oriented system has a validated scoring system for classroom performance elements. CLASS analysis consists of watching videos and using established valid codes to determine the quality of the teaching by teachers. Proven dimensions for student academic success are rated on a scale of one through seven. Each broad dimension, such as *positive climate*, is comprised of four elements, in this case relationships, positive affect, positive communication, and respect. Each one of the elements of positive climate has observable features identified for the observers. For instance, positive affect has smiling, laughter and enthusiasm as the observable features. CLASS codes then identify a

low, medium and high incidence of those features. For instance, for a low positive affect score, there is no or low display of positive affect by the teacher, meaning there was no or little smiling, laughter, and enthusiasm.

A graduate student trained in CLASS performance-based video analysis worked with me to code the videos based on consensus coding. We decided to code the direct instruction part of the garden lesson separately from the practice portion, giving us 6 segments of lessons to assess. We used published and valid CLASS codes, plus valid and unpublished codes from Ozer's project (Ozer, 2009). We individually coded each segment for a particular code.

In addition to the codes from CLASS and Ozer's (2009) youth development project, a new code was created to evaluate the use of space within the learning spaces (see Appendix F). The *use of space* code was equated with the validated CLASS codes and the Ozer codes to approximate a similar range of rating (see Appendix F). CLASS codes used were: *concept development, quality of feedback, group opportunities, student engagement,* and *positive school climate*. At the end of the viewing we created a table to describe the findings we made. (See Figure 13.) To further corroborate the lesson and link it to academic mastery, I analyzed the students' pre-test and post-test scores to identify differences in student test performance after the garden and classroom lessons (looking at shifts of standard deviation from the mean for lower-achieving students) and the kinds of misunderstandings and learning students took from the lessons based on the pre and post tests (see Figure 14).

Within strand 3: meaning of place - interview analysis. For the third component of analysis within the strand, I analyzed the interviews of the students and the teachers to understand the meanings and expectations they brought to the learning spaces. E-transcript transcribed the interview audiotapes and I entered the transcripts into ATLAS 9 software. I began the coding with expected descriptive codes from the prior map analyses. I initially coded for liked, disliked, favorite and not favorite places. Additional iterations of coding added analytic codes such as meaning of liked or disliked places.

After coding in ATLAS for each of the individual interviews, I printed out all the quotes of the individuals and grouped the codes onto large sheets of poster paper. On the first round, I grouped all of the quotes around descriptive codes with the learning space. For instance, I grouped best lessons in the garden with worst lessons in the garden, best lessons in the classroom with worst lessons in the classroom. After looking at the similarities and differences within those spaces, I compared across spaces, grouping best lesson in the garden with best lesson in the classroom and worst lesson in the garden with worst lesson in the classroom. I noted similarities and differences. Then I grouped all positive attribute quotes from the codes such as best/favorite/liked codes. Additionally, I investigated the meaning of learning for both students and teachers to determine if their ideas about the meaning of learning could influence their ability to learn in a certain learning space.

Across the Strands

This portion of the analysis was intended to determine further codes and understandings. Interviews corroborated the map data in geographic space strand. The math academic strand corroborated the affordance strand. Map data corroborated the meanings people attributed to places.

Beyond the Strands

After looking across the strands, I investigated data findings collectively to develop conclusions about similarities and differences of school garden and classroom learning spaces. I cross-examined findings from different strands, such as the meaning of places and the evidence from affordances, to determine what the space afforded or made available to the students. I did this to answer questions about equity. Did some students learn more in gardens? In order to answer this question, I synthesized what spaces meant to student and teacher with their actual performances (test scores or teaching activities) with respect to the learning spaces.

CHAPTER 4: RESULTS

Overview of Findings

The findings of this study were compiled through examination and analysis of multiple types of data to create a multidimensional understanding of the differences between teaching mathematics in school gardens and classrooms.

In general, there were differences observed between the garden and classroom spaces when looking at the videotapes of lessons in each space. Applying the CLASS coding to the videos showed that the school garden had higher scores for *positive climate*, *student engagement*, and *quality of feedback*. That was true even when comparing only the direct instruction portions of the classroom and garden lessons, with the garden direct instruction portion still scoring slightly higher than classroom direct instruction. The difference was much more pronounced when looking at the practice portion of the school garden lesson, which had the highest scores among all the lesson components.

Reviewers also coded the videotapes for a new *use of space* code developed specifically for this study. The new code had four original elements patterned after the CLASS coding design: geographic design of space, curriculum design, teacher use of space, and individual student use of space. The garden lesson scored highest on the new *use of space* codes, with the geographic design of the lesson allowing for maximum use of space and the most movement by teachers and students.

Analysis of the videotapes suggested a second potential new code based on bi-directionality. I observed that the classroom teacher who scored highest on the CLASS *concept development* code engaged her class in an interactive group call-and-response exercise intended to elicit student knowledge from prior related lessons. The garden lesson videotapes also showed a high level of bi-directional interaction between teacher and students, plus similar bi-directional interaction between individual students and between groups of students (students did coordinate grid practice in pairs). The high levels of bi-directional interaction corresponded with high scores on other categories of CLASS coding, suggesting that a new *bi-directional interaction* code could be a useful subject for further research

There were also observed differences in academic performance in the classroom and garden learning spaces. I investigated academic mastery in two ways, first examining trends in the larger student sample set and then investigating the actual work of students to ascertain their learning. In the larger sample set, I found that lower-performing students (scoring less than the median score on the pre-test) had the highest positive change in post-test scores across the garden and classroom learning spaces, with the largest positive change after the garden lesson. When comparing pre and post tests in the garden with those in the classroom, the average improvement for lower-performing students in the garden showed a higher deviation from the mean (about .7 of a standard deviation) than for lower-performing students in the classroom (about .4 of a standard deviation). This may indicate that the garden lesson was more effective in improving the performance of the lower-performing students.

These observed differences in academic performance between the two spaces were not reflected in reported student perceptions of learning more generally. In interviews, students did not report a different understanding of learning in the classroom compared to the garden. Generally, all the students considered learning to be something received, i.e., a transfer of

knowledge from the teacher to the student, or from the board to the classroom desk, rather than a more interactive process involving student participation. However, when asked specifically to identify easy-to-learn places, the students identified a far broader variety of learning spaces in the garden than in the classroom, indicating that gardens are providing more spaces for learning—and perhaps therefore more opportunities for learning—than the classroom setting.

Finally, there was at least some evidence that both teacher and student expectations about place and its relationship to learning contributed to the relative success of the garden as a learning space. Specifically, the garden teacher reported a very open perception of where and how learning occurs. Among the interviewed students, the only student who reported a perception that learning can occur outside the classroom also reported large gains on the pre and post tests in the garden.

These observations and formative findings suggest multiple areas for future research and development of strategies for improving student performance and equity in schools.

Research Question #1: What are the Similarities and Differences in School Gardens and Classrooms?

The first iteration of results was conducted by investigating data collected within a strand (geographic space, material resources and meaning) and then looking at corroborating data to verify the information. Within *geographic space*, students created maps, and then additional data from interviews and written essays corroborated the map data. Within *affordances*, two reviewers analyzed the videotapes to further investigate and corroborate findings. Within *meaning*, the interviews were analyzed and checked with the maps and written essays. After reviewing results that correspond to each strand of place, I corroborated data across strands. I identified patterns within and then across strands. Finally I synthesized the data to draw tentative conclusions about applied and research implications.

Research Sub-Question #1a: What are the Similarities and Differences in Student Perception of the Geographic Space?

The following section presents the geographical details of how classroom and garden spaces were different.

Descriptions of learning space: classroom. This classroom was a portable building of 30 ft. by 30 ft. (see Figures 4 & 11). These 'temporary' buildings were 20 years old. They had two windows of approximately 8 by 6 feet on opposites sides of the room and a single entrance led with a ramp. They overlooked a grassy area with tall trees at least 40 feet high. The classrooms had air conditioning units. They also had water available in a water fountain in the back of the room

Figure 11: Indoor classroom.

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Figure 12: School garden seating area.

Description of learning space: garden. The garden at this school was in two spaces on either side of a main open hallway. These lessons were taught on the side with the outdoor classroom seating area (see Figure 12). The school garden on this side was approximately 40 feet by 30 feet. It contained the seating area, the greenhouse, garden beds, and a variety of plants (see Figure 3 & 6). The playground bordered one side, hallways were on two sides, and four classrooms faced into the garden.

Table 6: Finding for geographic space codes based on student maps and interviews.

Code	*Classroom*	*School Garden*
Favorite places	Desk (7 out of 8)	Strawberries (5 out of 8)
	5 different places listed	21 different places listed.
	An average of 2 places listed per student. Note: 6 students only listed one.	An average of 5 places per student listed
Disliked spaces	Other desks (5 out of 8)	Worm bin (3 out of 8)
	8 different items listed	21 different places listed

Map findings: classroom. In the classroom, maps showed and interviews corroborated that students generally saw their desk as their favorite place. In addition, their favorite place corresponded to what they identified as a comfortable place and easy-to-learn place. Desk, board and the rug or carpet were most noted as comfortable places, with personal desk as the most comfortable, liked and easy-to-learn place in the classroom. One student indicated in the interview that the entire classroom was an easy-to-learn space.

Disliked and uncomfortable places in the classroom had more variety. Students identified the front of the room near the white board, the back of the room where students couldn't see, the rug (it was dirty), and the desks of other students who were identified by their peers as disruptive. These findings were corroborated by the interviews and the compare-and-contrast essays. Five out of seven students interviewed added an additional symbol to the legend that seemed generally positive. Furthermore, the interviews reported that in Classroom B, mice had been found at the sink area and the back of the room. Some students commented that this was the reason they disliked those places. In the essay graphics, students from classroom B noted that the classroom was dirty and smelly. In the compare-and-contrast essays from Classroom C, some students liked the classroom because it was quieter than the garden.

Map findings: garden. There was a much larger variety of places noted as comfortable and favorite on the garden versus classroom maps. Favorite places noted on the garden maps included discreet plants, planting structures and teaching benches. The variety of favorite places in the garden suggests that the students had high use of the space as they were more familiar with the spaces within the garden. Favorite places in the garden did not necessarily correlate to comfortable places. Students identified where they could sit as comfortable places. Four out of nine students interviewed marked teaching benches as an easy-to-learn place in the garden. One student marked the entire garden as easy to learn in. Some students found the garden peaceful and relaxing.

Disliked places in the garden had less variety than liked garden places. Most noted were the worm bins (because they were smelly) and the greenhouse (because it was too hot). This was corroborated in the student interviews and the compare-and-contrast essays. Two students also noted in the compare-and-contrast essays that they preferred the classroom to the garden because the classroom was cozy and the garden was too loud.

Research Sub-Question #1b: Are There Similarities and Differences in the Affordances of Classrooms and School Gardens?

The section below describes what actually happened in the learning spaces, how the lessons unfolded, and how the students interacted during the activities.

Description of classroom coordinate grid lesson. The classroom lessons were taught by Teachers B and C within their respective classes. Classroom A was not included in the analysis because most of the class did not receive permission to videotape the lesson. The lesson in classrooms B and C began with the creation of the coordinate grid in the classroom with the desks and students assigned to be an ordered pair. Teachers then stood at the front of the room asking questions and receiving answers. Teachers used call and response methods for total pupil

response at some points and asked for individual hands at other points. The lesson was 45 minutes long.

This lesson had a high level of complexity and was dependent on the students knowing how to add and subtract negative and positive numbers, plus put together a t-table and plot lines. During the lesson Teacher C confused some of the content by using incorrect vocabulary for some mathematical content. Teacher B did not confuse the content and contextualized the content of the lesson into the former knowledge of the students. Teacher B's class had the highest rating for concept development by the investigators.

Description of garden coordinate grid lesson. Each of the two classes (B and C) engaged in the same lesson in the garden, although at different times. The lesson was taught by the garden teacher (Teacher G). This lesson had two distinct parts: direct instruction and then group practice. The first part was direct instruction. Teacher G described how the garden had become the coordinate grid. She then explained through example how the students were going to find ordered pairs on the grid. She used three sets of students to model how to find the coordinate grid. The classroom teacher then assigned students into pairs. The direct instruction lasted approximately 15 minutes. The second part of the lesson involved students actually working in pairs to find the points on the coordinate grid in the garden and identify the object that was at that coordinate pair. This lasted approximately 30 minutes.

The garden lesson was less complex than the lesson taught by the teachers in the classroom because students were asked to search for coordinate grids, but not process that information in an equation or a t-table. Teacher G had a clear command of the content of the lesson in the garden.

Video analysis. I videoed the two classes during their respective math lessons in the school garden and classroom. Afterward I partitioned the lessons into direct instruction and practice in the classroom and school garden. Using the CLASS analysis process and codes (Pianta, Paro & Hamre, 2008), a graduate student trained in CLASS analysis and I reviewed each segment using consensus coding. Consensus coding means that the reviewers coded each video portion separately and then came to consensus about the scores of the code.

In the reviewer analysis(see Figure 13), *positive climate* was higher in the garden portion of the lesson than in the classroom portion, and highest in the practice portion. *Concept development* was highest in Teacher B's classroom; she engaged the students in many contextual references asking them to remember concepts that they had learned in earlier lessons. *Student engagement* and *quality of feedback* was highest in the garden practice session. *Group opportunities* were only evident in the garden practice portion of the lesson. This is because the only group opportunity (defined as where students had autonomous groups) offered by lesson design during all the lessons was during the practice portion of the lesson where students were finding coordinate grid points in the garden. The high presence of *positive climate* correlated to high *use of space, quality of feedback, group opportunities,* and *student engagement*.

The *use of space* code emerged during video analysis. As the reviewers watched the videos, it was clear that the teachers were using space within the learning spaces differently. It was also clear that the students were using space differently.

I developed a new code with four original elements that were patterned after the CLASS coding design: geographic design of space, curriculum design, teacher use of space, and individual student use of space. The first three elements were successfully consensus coded,

however, the last element raised questions for the reviewers and was not consequently reported as a reliable finding.

After constructing the code, reviewers coded the videos for *use of space*. *Use of space* codes were coded highest in the garden. Geographic design of the lesson allowed for maximum use of space and there was the most movement by teachers and students.

Cross cognitive opportunities were perceived to be about the same when the lessons were viewed as a whole, with both the garden and classroom settings at the middle of the coding scale. This perception led to the splitting of the garden and the classroom lessons into two parts. Even after the lessons were split, the code didn't seem to identify differences in the lessons for *cross-cognitive opportunities* because one of the classroom teachers seemed to have a medium cross cognitive code in spite of the fact that the students didn't engage with one another.

Later, when puzzling about and reviewing the class video for *high concept development* in Classroom B, I noticed that Teacher B responded bi-directionally with her students. She used a group call and response method, in which she asked a question and students responded as a group without requiring answers from single students chosen with their hands up. I then reviewed Classroom C with Teacher C, and Gardens B and C with Teacher G, and I found different levels of bi-directionality of interactions, not only with the teachers and students, but between students and students. The classrooms in general had bi-directionality of interaction between the teachers and students, but not between students. The garden had both bi–directionality of teachers with students and students with students. In addition, the garden had another level of bi-directionality of groups of students with other groups of students. Students also physically interacted with the garden, moving through it and noticing objects.

This bi-directionality code was not consensus coded and needs further definition and work to become a reliable factor. I explore the code further in the discussion and implications sections as a possible next step to exploring learning spaces.

	Class B	Class B	Class B	Class C	Class C	Class C
	Teacher B	Teacher G	Teacher G	Teacher C	Teacher G	Teacher G
	Classroom	Garden	Garden	Classroom	Garden	Garden
	Direct Instruction	Direct Instruction	Practice	Direct Instruction	Direct Instruction	Practice
CLASS CODES						
Positive climate	3	4.5	6	2.5	3.5	6
Concept development	5.5	3	4	4.5	2.5	4
Student engagement (secondary)	4.5	4	6.5	4	4	6
Quality of feedback	2	2	5	3	2	4.5
OZER CODES						
Group opportunities (OZER CODE 0, 1, or 2)	0	0	2	0	0	2
Quality of group work (OZER CODE 0 , 1, or 2)	n/a	n/a	2	n/a	n/a	2
USE OF SPACE CODES (Boynton)						
Geographic design	3	7	7	3	7	7
Potential for movement	3.5	4	7	3.5	4	7
Teacher use of space	2	4.5	7	3.5	5	6.5

Figure 13: CLASS video coding

Research Sub-Question #1c: Are there similarities and differences in student and teacher expectations and meaning for school gardens and classrooms?

In order to elicit participants' different understandings and expectations of meaning for the two learning spaces, I interviewed ten students and three classroom teachers to ask: (a) about place; (b) about their ideas about learning; (c) about relationships they had in and around the classroom; and (d) about their maps to corroborate data. I also asked open-ended questions allowing them to add anything they wanted. Interviewees were allowed to 'pass' on questions, so there are varying numbers of responses to the questions. (See Appendix A.)

Table 7: Synopsis of important and relaxing general place findings.

Participants	Important Places	Relaxing Places
Students	Grandfather's grave Park/Playground Library Country of family origin Family houses School/Classroom	Room/Family home Water park Under a tree Desk
Teachers	Family home Camp Summer home	My room /Boyfriend's Outdoors Summer home – outdoors on the lake

Students and teachers. In order to understand what was generally important to students and teachers, I asked broad questions about places. Students and teachers identified important places as those linked to important people, i.e., places where they were born, where they had relatives, and where their relatives died. For students and teachers it was clear that important places have to do with family relationships. Some students also noted that another important place to them was the playground. Two teachers referred to natural outdoor places as being important to them; one teacher confessed that she was 'an inside girl.'

Most students and two teachers identified their room at home as where they go to be alone and relax. Their room is where they felt safe, it was quiet and they could relax. One respondent identified nature or outdoor places as being where she would go to relax and be comfortable. Some students thought the school garden was a place where they could relax and find peace. The playground was identified as both a place to be alone and a place to be around others. Students and teachers described the living room or other communal area in their homes as where they go to be around others.

Overall, students and teachers felt important places were connected to family. Two teachers felt natural, outdoor places were important. Important places often coincided with relaxing places.

What learning means to the students. Students were asked to respond to the word 'learning'.. I did this to investigate whether students' ideas about learning were different from how I observed them learning in the different learning spaces. I thought that a dissonance in how they thought they learned and how learning spaces were constructed for them could provide information on how to construct better learning spaces. They responded generally with notions of being taught something new, that learning was connected to good education. Two out of ten students interviewed linked learning with an outcome:

- "To be smart, like, to have a good education, to pass, to have a better future." (Student 1)
- "To get taught stuff, so when we have like a job, it helps us get a job. I t shows us how - it teaches us how to keep our job...Like if you have a banking job, you can't keep on messing up or you'll quit, so then that's why they teach us math, so you'll learn more." (Student 2)

Learning to these students was being taught. Learning had to do with new subjects and review of old subjects.

- "...to being teached new stuff that you may not know, and going over stuff that you learned last year." (Student 3)
- "I can learn a lot of stuff from the teacher." (Student 4)

Overall, students perceived learning as a transfer of information, usually by the teacher to the student.

Where learning takes place. Only one out of eight students interviewed reported learning anywhere other than school or the classroom. That student responded that s/he learned best in people's houses. Generally, students believed that school is where they learn, the classroom is the setting where they learn, and their desk is where they learn the best.

What learning meant to teachers. Teachers had a broader sense of learning than the students. From a simple discovery of new things and gaining knowledge, as expressed by one teacher, to more elaborate answers for the other two teachers, learning had a broad definition.

- "Learning to me it means to gain knowledge whether it's about who you are as a person; whether it's context like textual information. Learning means to actively engage in the gaining of knowledge, so it could be how to learn how to ride a bike; it could be learning about who you are as a person so analyzing different things and gaining a deeper understanding of it, so it doesn't have to be anything new. It can be something that you already heard of or learned but you're gaining a deeper understanding of it…" (Teacher B)
- "Oh, there's a loaded one. Learning, I think for me personally learning feels like a lot of sort of solving mysteries and asking questions and sort of just an innate curiosity and trying to figure out whatever it is that is piquing my interest or somebody else's interest. Yeah, questions that open doors to more questions." (Teacher G)

The teachers' responses were in high contrast to student perceptions that learning was confined to the classroom and school desk, and it usually came from the teacher.

Where teachers learn. Teachers also learn in a different places. They did not refer to classrooms, but rather talked about many places.

- "I learn well in a lot of places." (Teacher G)
- "I learn best in setting that are interactive, that are not quiet. I would say interactive is the most important part of it. It has to be a place where you're talking and listening and participating." (Teacher C)

Previous experiences with lessons in school – students. Students connected to peers and teachers both positively and negatively and identified the classroom with academic subjects. When students talked about lessons they liked and disliked in the classroom and the garden, they spoke about their most well-liked / best situation using a variety of elements, including relationships, subjects, and lessons. But when they talked about their worst classroom/garden experience, they mostly spoke about teachers' and peers' 'meanness' or 'disruption'.

Table 8: Student likes and dislikes about classroom.

Liked about classroom	*Disliked about classroom*
Seeing Friends (3)	Peers (2)
Teacher (3)	Teacher (4)
Colorful(1)	Loud (3)
Math, science, reading (5)	Trashy (3)
Lesson (1)	Boring (1)
Scaffolding (1)	Too much work(1)

When students spoke about their liked classroom activities, they referred to subjects five times (math and science) rather than a particular lesson (once). They also spoke about their connection to the teacher three times. They referred to scaffolding where they were learning based on other learning.

- "I like sometimes when my teacher, like, teaches something, it reminds me of other things my other teacher taught me." (C5715732)

The respondents thinking about the worst lessons in the classroom referred to: a 'mean' teacher (4); subjects too hard or boring (2); and disruptive peers (2). Four students couldn't remember a worst lesson in the classroom and one couldn't remember a worst lesson in the garden. These responses coincided with what students disliked about the classroom. Additionally, students didn't like the messiness of the classroom and its loudness (3).

Table 9: Student likes and dislikes about garden.

Liked about garden	*Disliked about garden*
Teacher (3)	Bees (2)
Peaceful relaxing(2)	Bugs(2)

Colorful insects and flowers (3)	Compost bin (smelly)(2)
Fruits/vegetables /strawberries (6)	Boring (only plants to see)(1)
Tasting of fruits and vegetables(1)	Loud(1)
Fun (2)	No lessons worst (4)

When speaking about the garden, students referred to an actual lesson (coordinate grid, food chain, and tastings), not a subject. The same number of students referred to connecting to the teacher as in the classroom.

When students talked about what they liked in the garden, they talked mostly about the physical space and the fruits and vegetables growing. The colorful insects were referred to by one student. Fruits and vegetables growing (in particular strawberries which were in season and being harvested) were reported by a majority of students.

When students were talking about lessons they disliked in the school garden, half of the respondents (4) could not remember any lessons that were bad in the garden. The worst lessons in the garden were: not related to the garden (1); didn't have a tasting of a fruit or vegetable (1); had disruptive peers (1).

Research Question #2: Do Gardens Offer Opportunities for Better Academic Performance, Both Generally and with Respect to Individual Students?

When analyzing and coming to conclusions about this question, I looked to the general trends in the academic information from the pre and post tests. I first examined the average scores for the entire student population of approximately 58 students across the two classes (B and C). Looking at the absolute scores, students generally had higher average scores in the garden than in the classroom, both on pre and post tests. Looking at the more significant relative scores between the pre and post tests, students as a whole did not appear to show greater improvement after the garden lesson than after the classroom lesson. Neither the garden lesson nor the classroom produced substantial improvement in average student knowledge across the entire population.

I then took a closer look at the scores for the lower-performing students to investigate whether the school garden had a greater impact on their performance relative to the other students. When I examined the performance of students who scored below the median on the pre test, I found a higher average improvement on the post test than for the entire population of students. There were positive increases in both the classroom and the school garden as compared to other students.

Comparing that average improvement across the classroom and the garden, I also found a higher average improvement in the garden. Students with less than the median score on the garden pre test on average improved their performance on the garden post test by about .7 absolute points on a scoring scale of 0-6. With a standard deviation among the entire population of garden students equal to about 1, the average improvement for the lower-performing students was about .7 of a standard deviation above the mean for improvement among the entire population (where scores showed no meaningful change between pre and post tests).

Table 10: Garden performance change.

	All Students	***Students scoring <median on pre test***
Average change between pre and post test scores (on scale of 0-6)	-0.04	0.69
Standard deviation	1.01	
Population size	55	16
Average extra improvement (absolute points)		0.72
Average extra improvement (percenti of a standard deviation)		.72

Looking at the classroom scores, students with less than the median score on the classroom pre test on average improved their performance on the classroom post test by about .14 absolute points on the same scoring scale of 0-6. With a standard deviation among the entire population of classroom students equal to about 1.5, the average improvement for the lower-performing students was about .4 of a standard deviation above the mean change for the entire classroom population (where scores on average declined by about half a point).

Table 11: Classroom performance change.

	All Students	***Students scoring <median on pre test***
Average change between pre and post test scores (on scale of 0-6)	-0.48	0.14
Standard deviation	1.53	
	58	28

Population size	
Average extra improvement (absolute points)	0.63
Average extra improvement (fraction of a standard deviation)	.41

With respect to these lower-performing individual students, the garden lesson appears to have had the more positive gain from the mean than the classroom lesson (see Table 10 and 11). Students who began below the median score on the pre tests made significant positive gain in the post scores increasing 72 % of the standard deviation. Admittedly, the group of students studied was small. In addition, the relative improvement could have been the result of differences in teaching skill or due to the lower level of overall complexity of the garden lesson. But tentatively, there may be evidence that the garden as a learning space provided greater opportunities than the classroom for students who showed the least understanding on the pre test to show the most positive gain on the post test.

Detailed Findings from Pre and Post Math Comprehension Tests

After analyzing the larger set for general trends in the data, I investigated the smaller sample set of data from the students that were interviewed. I did this to corroborate the overall findings and to ascertain what students showed that they learned on their pre and post test scores. The test performance of the individual students interviewed reflected the overall performance of the group, with the lower-performing students showing the greatest gains on the post tests. The primary errors shown on the tests for the classroom lesson were transpositions of the x and y coordinates on the grids. Student made fewer mistakes in transposition of x and y coordinates after the garden lesson, perhaps suggesting that physical movement around the garden space improved their understanding. (See Figures 14 and 15.) I surmised this because students actually moved through a physical coordinate grid on the garden grounds and found coordinate points in the garden from the ordered pairs. This may have led them to find the correct points.

A Possible Explanation of the Success of the Garden as a Learning Space

I found some possible explanation for the observed differences between gardens and classrooms in the teacher and student interviews. I looked at two outlier cases, the teacher with the highest scores, and the student with highest gains in academic achievement. I did this across the strand: geographic space, affordances, and meaning. In the two most successful cases, one of teaching and one of learning, I found consistency in expectation, meaning, and performance.

Teacher G's meaning of learning and her place for best learning were consistent with high scores for student engagement, positive climate, use of space, and student gains in

knowledge. Her expectation was that the school garden was a good place to learn, she believed that you could learn anywhere, and that learning was active.

Teacher G had a very broad range of what learning meant to her. Learning was inquiry and not confined to one place. She felt the school garden was a great place to teach and learn. Evidence showed that her expectations (her meaning about learning and where learning happen) were consistent with high use of space, positive climate, and academic achievement of students. The garden teacher's expectations of where learning takes place matched her ideas of learning and she created a successful learning space.

I then looked at the outlier student who had gained the most from the school garden lesson. I found a weaker link between expectations of where learning can take place, her idea of learning, and her performance. Student 5 had a consistency between meaning and place where learning is best, and she made the greatest gain in understanding the math concept during the school garden lesson. She was the only student who indicated that she thought she could learn outside of school, in fact the only student interviewed who indicated she could learn outside of her desk. She replied that she thought that she could learn in people's houses. It is also possible that student expectations for learning could be linked to place.

Table 12: Results from academic mastery analysis – class B.

Student	*Pre Class*	*Post Class*	*Notes*	*Pre Garden*	*Post Garden*	*Notes*
B58241-2	0	1	Pre :4 transposed x and y, addition correct all positive #'s , but no line plotted pre,post: x and y transposed, subtracting numbers to negative # wrong, plotting transposed x and y, only correct -5.-5	3	4	pre: 3 x and y transposed , post: only 1 transposed
B51695-5	1	1	Pre: did not plot numbers, T table correct, no plot, 2 + # plotted correctly, identified x and y, but not neg[1]. Post: not plotting on right number spot and not identifying right number	2	5	Pre: transpose x,y Post: only 1 transpose x,y
B48943-13	5	3	Pre: did not plot numbers, T table correct Post: did not plot t table, t tale with subtraction, could not figure out what student did, y not neg	4	6	Pre: put 5 and -5 between 6 and 8 Post: correctly placed 5 twice
B50119-15	0	1	Pre: transpose 1, no attempt at rest (band) post: transpose numbers, didn't plot -#'s,mult[2] instead of add	3	6	Pre: no neg y's,transposed x and y? post: all correct
B 61608-30	3	2	Pre: y neg not identified , didn't plot coordinates; Post : neg y not identified	6	6	
	9	8		18	27	
B mean	1.8	1.6		3.6	5.4	

[1] Neg = negative
[2] Multi = multiplied

Table 13 Academic Mastery – class C

Student	*Pre Class*	*Post Class*	*Notes*	*Pre Garden*	*Post Garden*	*Notes*
C48937-7	3	1	Pre: transpose x and y, t table correct , but half way through plotting transposed x and y Post : transposed numbers, added 6 in t table instead of subtracting, didn't plot right	4	4	Pre : transpose x and y axis Post : did + y instead of neg, transposed x and y Post: didn't get - y; transposed x and y
C531931-9	6	6		6	6	
C49347-12	6	6		6	6	
C45624-17	2	0	Pre : +,+ correct, t table adding +2 correct, transposition of x and y, also unable to identify number on point Post: T table incorrect still adding 2, x and y transposed, unable to find correct number for point	0	1	Pre : transpose x and y axis Post : 2 not transposed but neg not correct in one and one not plotted right
C57517 - 32	6	6		5	6	Pre : neg of y instead of positive y
	23	19		21	23	
C mean	4.6	3.8		4.2	4.6	
Total mean	3.2	2.7		3.9	5	

Concluding Discussion

Creating or strengthening learning spaces in schools so that all students are successful can help eliminate the achievement gap. New learning spaces could be more equitable for students. The present study was conceptualized from a place methodology with the intent of capturing the complexity of place and developing recommendations for reform purposes. The present study adopted two research questions to explore learning spaces in schools: (a) What are the similarities and differences between school gardens and classrooms with respect to instruction? (b) Specifically, do gardens offer opportunities for better academic performance, both generally and with respect to individual students?

This research investigated these spaces within the strands of the physical space, what that space allowed the students and teachers to do, and what students and teachers expected to do in the space. The results indicate some of the similarities and differences in teaching and learning mathematics in school gardens and classrooms. They also suggest that some students could learn math better in school gardens, a conclusion which is supported by parallel findings in the video analysis regarding *positive climate, student engagement*, *quality of feedback*, and *use of space* in the garden setting.

As a final part of the investigation about place, a new code arose: *bi-directionality of interaction*. Bi-directional interaction is the interaction that occurs between people, in this case between teachers and students, students and students, and groups of students with groups of students. High bi-directionality of interactions seems to correspond to high use of space, positive climate, and group interaction. Higher bi-directionality also seems to correspond to higher student concept attainment in the math scores. High bi-directionality could be an observable feature of sense-making and sense-giving. These findings could inform our understandings of the potential for creating more equitable learning spaces.

CHAPTER 5: APPLIED IMPLICATIONS AND AREAS FOR FUTHER STUDY

Applied Implications

The findings of this study may have a number of implications for constructing equitable learning spaces for students and may indicate how to research those implications. This study possibly indicated that school gardens as learning spaces may allow some students to learn math more effectively. Gardens may afford a greater use of space and that greater use of space may engender higher student engagement. Additionally, students seemed to interact more with both teachers and other students in the school garden, possibly indicating a richer cognitive learning space.

Gardens may afford different opportunities for use of space. Bi-directionality of interaction in both learning spaces may increase understanding in some students. In the garden, video analysis results suggested that high use of space corresponded somehow to student engagement and positive climate. Using school gardens as instructional spaces may allow some students access to learning.

Also, analysis indicated that there could be an element in the use of space that may have allowed different levels or intensities of bi-directional interactions. Increasing the availability of bi-directional interactions in classrooms may increase student engagement and positive climate. Strategies to do this routinely could be incorporated into teacher spatial practices.

In addition, teacher expectations may influence their choices in using the space. We know that teacher expectations lead to successful student outcomes (Weinstein, 2002). It could be that teacher expectations of learning spaces contribute to how they use space and how they allow students to use space. By using school gardens as instructional spaces, teacher expectations of the use of space may change because they begin to see how the different learning spaces affect different students.

Finally, the best practices in school garden and classroom learning spaces could invite transference of successful practices from one learning space to the other. Academic rigor from the classroom could be used routinely in the school garden. School garden high use of space and increased bi-directionality could be used routinely in classrooms. Through this cross fertilization of best spatial practices, both learning spaces may offer more to students and teachers.

Research Implications

As researchers, it is important to determine both the impact of different learning spaces on teaching and learning, and conversely, how good pedagogical strategies impact the learning spaces. In addition, it is important to realize that there are mitigating factors outside of what happens in the classroom, including the expectations of students and teachers, that might affect student the success within learning spaces. By further studying learning spaces, it may be possible to: (a) understand more about how they work, (b) identify practices that increase the use of space and bi-directionality, and (c) validate those practices. Through this research, it may be possible to deepen understandings about

the influencing factors of learning spaces. Also, through further research, educators could better construct learning spaces that would be available to all students.

Understand How Learning Spaces Work

In future studies, variables need to be reduced even more to give a clearer idea about the contribution of use of space to the learning setting. In order to eliminate the confounding variables between the use of space and the contributions of the space itself. Do students have a natural environmental attachment to gardens? Another, factor not accounted for in this study was the different content knowledge by teachers. This could be accounted for in future studies by more teacher professional development in the math content area and subsequent verification of their knowledge.

Another variable that surfaced during analysis was the difference in complexity of the garden and classroom lesson plans. Although care was taken to match the lessons to the space in order to maximize the use of space, the classroom lesson depended on many more concepts to execute the objectives in the lesson. In analysis, it was clear that the students did not have mastery of those concepts. In the next study iteration, lessons need to be similar in complexity as well as good matches to space affordances.

In addition, the analysis of the math data indicates growth for lower achieving students. How do learning spaces work for the high performing students? Scores were lower for some successful students in the post tests than in the pre tests. Does a change in routine disrupt their thinking? Learning spaces seem to affect students differently Further, research to capture those differences could allow us to refine production of learning spaces.

Identify Practices that Increase the Use of Space and Bi-directionality

This study found that school gardens seemed to contribute to a high use of space. In the mathematics lesson students moved through the space and interacted with each other and the elements within the space. This practice of students interacting in multiple pairings could also be used in a classroom, constructing lessons that allow students to move and interact with one another within that space.

Validate Use of Space Practices Along with Connection to Academic Success

A larger study to validate the *use of space* codes in a variety of learning spaces would be paramount to the continued trajectory of this topic. Videotaping more classes and coding tapes to see if *use of space* continued to be valid across different groups of students and learning spaces could assist in the creation of new kinds of strategies for engaging students. Additionally, creating a bi-directionality of interaction study to explore this potential mechanism for connection may be fruitful for creating routine interventions to change the spatial practices of teachers.

Once the best *use of space* practices have been defined, the next step in reform could create routines to introduce those practices. The organizational management literature regarding change through the implementations of routines (Feldman, 2000), especially the literature specifically about schools and their routines (Coburn, 2001; Coburn & Russell, 2008; Sherer, J & Spillane, J., 2009), show a connection between routine and change of practice. Further, these studies show that agency (teacher's choice)

is paramount in change of practice. “Practice is transformed through agency, the choices that people make in the performance of an organizational routine over time.” (Sherer & Spillane, 2009, p. 23.) Further, through “the enactment of the routine,…teachers create change…. How they make sense of the routine and integrate it into their practice creates shifts in teaching and learning.” (Sherer & Spillane, 2009, p. 24.) By investigating teachers’ choices in how they use space and how those choices are made through routines around high use of space, interventions could be created and used to further identify how to produce learning spaces that are successful for all students.

Deepen Understanding of the Influencing Factors for Learning Spaces

From the qualitative data analysis, I found a possible correspondence between teacher expectations and practice in a learning space. The next step for research could investigate how the expectations about how to use learning spaces influence how teachers actually use learning spaces. Another factor may be district or site administrative policies. Those policies possibly influence teacher performance in learning spaces or even their choice of learning spaces. This could affect how they want to use the spaces and how they perceive they need to use the spaces to comply with administrative regulations or expectations.

Most students in the small sample perceived learning as receptive, that their understanding is given to them. Currently, theories of sense-making (Coburn, 2001) help explain teachers and districts as actors in the process of educational policy implementation, but how does sense-giving (Gioia & Chittipeddi, 1991) and sense-making work at the classroom level for different socioeconomic student groups? Overall, students perceived that learning was a transfer of information, usually from the teacher to the student. Would this finding change for students across different socioeconomic circumstances? Analyzing learning expectations across socioeconomic cases could create a baseline of information for creating routine interventions in schools. For instance, in lower socioeconomic schools study trips have disappeared because of economic factors and test preparation emphases. Is a study trip a learning space? Is it a learning space that informs students’ ideas of the locus of learning?

CONCLUSION

This exploratory study attempted to construct a methodology of learning spaces that would encompass the depth of the educational environment. I attempted to articulate the strands of learning spaces to identify the contributing factors for the construction of learning spaces. I then collected data on what I could observe and analyzed the data within and across the strands using Gieryn’s notion of place. Through the analysis, I found some indication that school gardens may afford a higher use of space. This higher use of space seems to coincide with positive climate and student engagement. I also found that school gardens may be effective learning spaces for lower-achieving students. However, there is much more to understand about learning spaces, both school gardens and classrooms. I hope that this beginning research will encourage teachers to use school gardens as another possible learning space for student success.

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APPENDIX A

Semi structures interview for Classroom Teachers, Garden-educators and students

Script introducing interview:

Welcome. This interview will help us find out what are good places for students to learn and teachers to teach. You are here because you want to be here, you can change your mind at any time.This will not affect your grades or anything else. If you don't want to answer any of the questions you can just say "pass" and we will move on to the next question.

General Place Questions:

- Tell me about some places that are especially important and meaningful to you.
- What are the places where you feel especially relaxed and comfortable? Why do you think that is?
- Where are the places that you like to go to be alone, to think or daydream? Why do you think that is?
- Where do you go to be around other people? Why do you go there?
- Are there places from your past that are important to you which you haven't been to lately but would like to go to again? Why are they important? Why do you want to go again?
- Refer to the special places that the students mentioned. Are any of these special places lost to you meaning you can't go there anymore? Why? How do you feel about that ?
- Are there any places that you still go to that were once special but have lost their meaning for you? Why is that?
- What does that phrase learning mean to you?
- Where do you best learn? Why?

Experience of the classroom.

- How do you feel about your classroom now?
- What do you like/dislike about it?
- How many times have you changed classrooms or schools since you started school?
- What was the best class in an inside classroom? Why?
- What was the worst class in an inside classroom ? Why?
- What do you like to do in class?
- Who do you know by name?
- Who do you know that you know a name of one of their family members?
- Who do you do talk to all the time?
- Who do you get advice from ?
- Who do you hang around with outside of school?

Experience of the school garden

- How do you feel about your school garden now?
- What do you like/dislike about it?
- How many times have you changed school gardens since you started school?
- What was the best class in a school garden ? Why?
- What was the worst class in a school garden ? Why?
- What do you like to do in class?
- Who do you know by name?
- Who do you know that you know a name of one of their family members?
- Who do you do talk to all the time?
- Who do you get advice from ?
- Who do you hang around with outside of school?

Past environmental experiences

- Are there particular school experiences that you've liked over the years?
- That happened in the classroom? the school garden? Anywhere else?
- When you think back to your younger years, what was the first learning space that was very important to you?

This instrument adapted from instruments included in:

Manzo, L. (2005) For better or worse: Exploring multiple dimensions of place meaning. *Journal of Environmental Psychology* 25, 67-86.

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APPENDIX B

Map Making/Journal entry writing protocol

This is a sample protocol for journal entry writing and map drawing with the students The final script will be determined by the classroom teacher and lead investigator. Data collected will be the maps, the journal entries, and the final essays. The maps and graphic organizers will be the main sources of information.

Sample:
Students will be asked to write a compare and contrast essay (English Language Arts Standard) something in the normal course of their education .
The topic : Learning in the garden and in the classroom.

After the subject lesson to be determined by teacher and lead investigator students will be asked to reflect on the lessons. The reflections will be done in each respective space.

Possible teacher script:
Session G1a
I want you to draw a map of the classroom (garden) on the first page of your journal.

Session G1b:
On that map I want you to mark 4 or 5 places.
1.) Places you learn the best.
2) Places you have a hard time learning.
3) Places you like the best.
4) Places where you feel uncomfortable
5) Other places you would like to point out on the map.

After map drawing :
Session G2a & G2b
On the next pages of your journal, I want you to answer why ?

Brainstorm with class on what could help or hinder the learning.
Write down the phrases and vocabulary.

1) Why do you think you learn well in that place?
2) Why do you think you have a hard time learning.
3) Why do you like that place the best?
4) Why do you feel uncomfortable?

Session G3a & G3b
Now we're going to draw a Venn diagram to compare and contrast learning (subject)__ in the garden and the classroom..

1) First I want you to describe what we did.
2) What did you think about the _____lesson we did here?
3) What was fun? What was interesting? What was boring?

APPENDIX C

Data Collection	S[3]	T[4]	C[5]	R[6]	Time
Presession: Goodenow Survey Whole class			X		30 -60 minutes
Maps : Session G1a[7] & G1b Maps in classrooms and school gardens Videotaping and audiotaping?			X		30- 60 minutes 1 class period
Maps : Session G2a & G2b Meaning of maps in classrooms and school gardens Videotaping and audiotaping?			X		30 – 60 minutes 1 class period
Preliminary descriptive codes				X	180 minutes per session
Researcher reviews the videotapes identifies interactions				X	30-60 minutes for each group for each period 5 groups = 5 hours for each class 15 hours for each lesson + additional 3 hours for creating video for students and teacher to observe
Researcher interviews teachers SessionT1[8]		X		X	3 teachers at 30 minutes
Researcher interviews students Session I1[9]	X			X	9 students at 30 minutes

[3] Student
[4] Teacher
[5] Class
[6] Researcher
[7] G1a is Group, Session 1 , place a (garden or classroom)
[8] T1 is Teacher session I
[9] I1 is individual student session 1

Data Collection : Compare and Contrast Journaling					
Session G3a & G3b describing the places After into at each site, students write about gardens and classrooms while in gardens and classrooms Video/audiotaping		X	X	X	Class 2 sessions of 60 minutes
Contrasting Session G4 Writing in a neutral place contrasting gardens and classrooms Video/audiotaping		X	X	X	60 minutes per class
Prepare video/audiotaping for teachers				X	180 minutes per class
Show teachers		X		X	60 minutes per teacher
Show students	X			X	30 minutes
Data Collection: Math					
Teacher session T2		X		X	1 60 minute session to go over math lesson
Session G5a & G5b Coordinate grid in the garden Audio and videotape			X	X	60 minutes per session
Researcher matches audio/videotapes and then views tapes and finds seeming interactions				X	180 minutes per session
Session T31		X		X	60 minutes per session
Session I3\	X			X	30 minutes per session

Collection of Place Data

	All Students		Single student case		Teacher case		Garden teacher case		Classrooms		Garden	
	P*	A**	P	A	P	A	P	A	P	A	P	A
Maps	60	85	6	12								
C and C	60		6	12								
Pre and Post tests	60		6	12					60	85	60	85
Video									2	2	2	2
Dual recordings									8		8	
Single interviews			6	12	3	3	1	1	11	16	11	16

* Projected data collection
** Actual data collected

MG Favorites places	MG Comfortable places	MG - Uncomfortable places	MG- Don't like this place	MG- Easy to learn	MG - hard to learn	MG - other symbols on legend
Strawberries, Flowers, Roses, Fruit trees, Picnic tables	Bench	Solar water fountain, Grapes	The H, and new beds	California Natives, gourds , water faucet,	Sunflowers and herbs, worm bin, tool closet, green house	
Fruit trees,Sunflowers herbs, work tables,passion flowers , graps, nasturtium,raspberries, strawberries	garden benches, garden bed 2,	-	-	-	benches (classroom)	relaxing places -pinabple guava tree, water faucet, picnic tables (5) , benches
Herbs, water faucet, strawberries	garden bench,teaching benches, grapes, raperries	NI	potting table, fruit trees, handwashing sink, solar water fountain, picknic tables, work table , bench, bench	NI	NI	My amazing place - NI
Pineapple guavea, passion flower , solar fountain, fruit trees, herbs garden bench	strawberries, apple trees, work tables	(mad) wormbin,compost bin	bed 11,worm bin, H	Fruit treas, picnic tables, solar fountain, flowers aparagus, library porch, garden bench, teaching benches	worm bin s	eating places solar water fountainteaching benches
Grapes, raspberries, strawberries, flowers, nasturtium,, beds 11,12 3, fruit trees	beds 8 and 9, teaching benches,fruit trees	worm bins, potting table, compost bin	green house, worm bin bed 1	banan tree, solar foundtain, water faucet (2), beds 2,10, path,	bed 4,13,62,3,	My garden place (flowers, plants)
Teaching benches,picnic tables	Native plants,strawberries	greenhouse, picnic table	tool closet, perennial border	teaching benches, benches on other side of garden	picnic tables	My bench place - native garden, teaching benches At the garden bench - garden bench, water faucets
raspberries, strawberries, apple, cherry, apricot, pluberry tree	Bed 1,pineapple guava, greenhouse	worm bins, potting table, compost bin	Bed 3, worm bin	teaching benches, bed 2	apple tree, pineapple guava	another favorite place - teaching benches, blueberry
Green house,califomia Natives, Solar foundtain	teaching benches, picnic tables, work tables, native plant garden	NA	NA	Line around the entire garden	NA	My awesome place - natvie gardens, H, Picnic tables, work tables, benches,garden bench, green house and teaching benches My quiet place - teaching benches , garden bench,picnic tables, native garden, solar water fountain , work tables, benchs
garden bench	garden bench	green house	greenhouse	teaching benches	greenhouse	My favorite place to hang out - picnic tables My best place to rest - benches by picnic table

Student ID	MC My favorite places	MC- Comfortable places	MC - Uncomfortable places	MC- Don't like this place	MC- Easy to learn	MC- hard to learn	MC - Other symbols (student generated)
B50119-15	My desk	My desk		Other students desk adjacent (F)	Other students desk adjacent (M)	Other students desk front of class (M)	
B51695-5	My desk	My desk		Teachers desk	-	-	
B61608-30		My desk	Carpet		Bookshelf	Closet	Excellent places - sink , windows
B48943-13	My desk , teachers desk, rug, neighboring cluster of desks	Rug	Front of room desk,	Front of room desk, side rear desk	Other student desk (M) Friend?	Front of room desk	My talking place - nothing identified
B58241-2	My desk, water fountain, Rug, board	Rug,cabinets at rear of classroom	Cabinet at front of classroom	Cabinet at side of class room	My desk	Board	Fun - my desk
C45624-17	The board	My desk	sink	sink	my desk	NI	my bord place left board
C48937-7	Front desk	Board	Desk in front of overhead	Back of room desk	front desk	second from the rear desk	-
C49347-12	My desk	My desk	Desk to the right	Board	TV	NA	My friend's desk
C53931	My desk	My desk	Line including first three rows of classroom excluding him	Line including first three rows of classroom excluding his desk	My desk, Suzies desk	Line including first three rows of classroom excluding his desk	My special place - my desk

APPENDIX E

Use of Space Codes (2)

Geographic Design of Place

Low - Flexibility

- Flexibility:Space designed for specific use. For instance, a lecture hall with fixed seats and desks that allow little movement with the furniture. In outside spaces, gardens designed with immovable beds or other features that are permanent such as fountains. In these spaces students would be assigned to seating.

Medium- Flexibility

- Flexibility Medium: Although there are some fixed structures there are ways to create stations within the space to allow some movement by the students throughout the room. That movement would allow students to move once they had finished an assigned task to another part of the room where they could work at a journal prompt station. In this situation students would have a home desk but sit in other desks throughout the day depending on task and curriculum. Different seating areas such as rugs for hearing stories, or reading lofts allow students and teachers to change their spaces from personal to public during the day.

High - Flexibility

- Flexibility: Space designed for flexible use. An example of this is open classrooms where one can create and change walls and tables. In gardens students could move from one area such as group seating to a station or a bed in order to change tasks. Students and teachers have access to public and private spaces or go to the bathroom. Students and teacher seem relaxed with the movements in the learning space.

Curriculum Design (lesson plan)

Low

- ***Curriculum designed for non movement or interaction***. Desks in the classroom are arranged so that it prevents or dissuades students from moving or talking. Students have all materials at desk and do not have to talk to or move from their seats.
- ***Fewer than 10% of students use space***. Lesson only has students moving to pass out papers or collect information from those seated.

Medium

- ***Curriculum designed for slight movement*** Students may be allowed to participate in talking to their neighbors such as during a think pair share segment or activity. Movement is constrained but allowed in order to reach understanding of the lesson.
- ***Some time in the lesson where students are allowed permission to move***. There are some segments where students are allowed to move. The movement may be to stand or move to a different area of the classroom where they are once again stationary or allowed to move in a directed manner.
- ***Limited space available for movement regardless of the total space***. As an example, students could move around their desks, but not around the classroom. The range of movement is about 3 feet the personal space of their desks. Students do not move through the public space.
- ***Limited movement adds to understanding of concept***. The teacher invites movement into the lesson to allow kinesthetic learners an opportunity to move. For instance, a geography lesson could use a floor map and movement to reinforce memory of the concept.
- ***About 30% of students use space***. Certain students no more than 10 are allowed to move through the space as directed by the teacher. These students are chosen randomly for reasons designed into the curriculum. They are allowed less prescribed movement.

High

- ***Movement is integrated into the lesson***. Students move with a purpose at some point in the lesson to either attain concept development or practice concepts. The movement seems to allow some students to understand the lesson or brings reinforcement of understanding for the majority of the students. For instance, a language lesson involving poetry could have hand movements or dance integrated into the recitation that assist with the memorization or delivery of the material.
- ***Total mobility around the learning space.*** Most of the space is available for movement even thought there are desks and chairs or as in an outdoor space benches, garden beds or fountains.
- ***Lesson provides opportunity to move more than 10 feet.*** Lesson instructs students to move through the space to discover, explore or practice some aspect of the concept.
- ***50% or more of students allowed and encouraged to use space***

Teacher Use of Space

Low

- ***Teacher primarily stationary, not moving from one part to another***. During lesson teacher sits or stands in one part of the room. The teacher sits at the overhead or stands at the board directing, lecturing or showing examples.

- ***Teacher proximity to less than 10% of class.*** Teacher often sits close to the same few students. These students could be very well behaved or could be those considered to need more attention because of behavioral matters.
- ***Few or missing physical gestures in explanations (hand movement s or head movements).*** Teacher delivery of information or materials is unaccompanied by gestures of either hand or head. Most of the time teacher is focused on the overhead and not the class. Little scanning of the class.
- ***Few or missing facial gestures in explanations.*** Teacher not animated or looking at class. If teacher is standing at the board they are facing the board and not turning to see or add gestures to the class.

Medium

- ***Teacher moves through 25% of the space.*** Teacher has a range of movement from the overhead to the board. The teacher walks back and forth in the front of the room.
- ***Teacher has a larger range of physical motion.*** Teacher moves in the front of the class from the overhead to the board in order to illustrate a point or develop a concept.
- ***Teacher proximal distance close to 1/3 of students.*** Teacher moves and is close to (even if momentarily) approximately 10 students (the first row or so)
- ***Physical gestures to punctuate explanations (hand movement s or head movements).*** Teacher uses gestures, nods or facial expressions to facilitate teacher and learning.
- ***Some affective facial gestures in explanations.*** Facial gestures are animated and convey meaning to class.

High

- ***Teacher uses moves through 50% of the space.*** Teacher moves throughout the space from the overhead to the board to the back of the class.
- ***Teacher moves constantly.*** As appropriate teacher moves throughout the space to demonstrate concepts .
- ***Teacher proximal to a large variety of students.*** Teacher movement allows physical proximity with a large variety of students in order to assist or communicate.
- ***Many physical gestures in explanations (hand movements or head movements) seemingly essential to the explanation.*** Teacher uses physical gestures or movements to explain concept. In garden lesson, teacher actually walked up and down the coordinate grid lines to demonstrate where points were.

- ***Many affective facial gestures (lots of smiling, eyebrows raised)*** Faces used to communicated to facilitate explanations and guide concept development.

Individual Student Use

Low

- ***Students don't use space.*** Students are not required by the lesson plan to use any space other than their desks.
- ***Some students using space not for lesson purposes (goofing off, poking prodding).*** These students are not involved with the lesson but actively pursuing other activities with students close to them.
- ***Less than 10% of students using space.*** A few students allowed to move through the space to distribute materials or demonstrate concepts.

Medium

- ***Students can move within the personal space maybe in and around their desks.*** Students standing and sitting within the three feet of their desks.
- ***Students using space are mostly focused, some not on task behavior.*** Most of the students are engaged in use of space for concept attainment, although some students are off task doing something that does not facilitate development concept. This movement seems to focus students and is not disruptive to others.
- ***At least 30% of students using / moving through space.*** At least 30 % of the students are allowed to stand or participate in the use of space.

High

- ***Students moving throughout the lesson.*** Students are using the space to assist in concept development or concept attainment.
- ***Students using space are focused , on task within the lesson objectives (not goofing off).*** Movement and conversation is focused on the lesson objectives, although the language maybe searching for meaning .
- ***Students using 75% of the space, moving through the public areas of the classroom/ space.*** Students move through the public parts of the classroom beyond their private space or desks. The movement is necessary for or adds to the concepts or objectives being developed in the learning space.

Student / Student Interaction in Space (Cross Cognitive opportunities / Grouping)
(These codes correspond to OZER group work codes and in order to identify how space is used during group work opportunities.)

Low/No

- ***Students are not allowed/ expected/ given the opportunities to pair or group***: Students are expected to act singly and do not interact with one another.

Medium

- ***Students are assigned partners/groups without flexibility or opportunity to interact outside of defined partners/groups*** Although there are students working together they are assigned partners by teachers and have no opportunity to work with other students.

High

- ***Students are allowed to form and reform partners or pairs of partners*** Although students have been assigned partners, they have informal pairings or conversations that allow them to work with other students or teachers to reach understanding about the concept at hand.
- ***Random or student defined partners or groups.*** Students self define their partnerships which allow them to understand the concept at hand.

Teacher/Student Interaction in Space (Cross cognitive Opportunities - Individual and Group)

Low

- ***Teacher distributes information and does not illicit response from students.*** Teacher hands out materials and does not generate interaction with students.
- ***Less than 10% of the time students ask questions .*** Students work on materials, few interact or ask questions of teacher. Teacher answers questions of students with hands up.

Medium

- ***Teacher interacts with whole class in a call /receive manner in order to assist in the understanding or developing of the concept.*** Teacher asks a question and expects students to answer by chorally responding or by calling out.
- ***Between 20 - 50% of the time students ask questions or respond to questions asked by teachers. concept.*** Most students participate in the asking and response. Students generate questions and responses to teacher interaction.

High

- ***Students have at will individual interactions with teachers in order to understand/develop a concept.*** Space is set up so teacher and students can interact on a one on one level that allows for multiple cross cognitive exchanges. Students can ask questions until they are clear on the concept.
- ***More than 50% of the time students have connected access to and are responded by a teacher.*** There is enough time and space for the teacher to answer or clarify concepts for the students needing assistance.