DESIGN FOR INCLUSION:

MULTIMODAL PEDAGOGIES IN THE NARRATIVE, PERFORMATIVE AND SIMULATED SPACES OF A DOC MCSTUFFINS EXHIBIT

Yanlin Chen

Submitted to the faculty of the University Graduate School
in partial fulfillment of the requirements
for the degree
Doctor of Philosophy
in the School of Education
Indiana University
May 2023

Accepted by the Graduate Faculty, Indiana University,
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy.

Doctoral Committee

Karen Wohlwend, Ph.D.

Sharon Daley, Ph.D.

Joshua Danish, Ph.D.

Jessica Nina Lester, Ph.D.

Adam Maltese, Ph.D.

December 1, 2022

Yanlin Chen

DESIGN FOR INCLUSION: MULTIMODAL PEDAGOGIES IN THE NARRATIVE, PERFORMATIVE AND SIMULATED SPACES OF A DOC MCSTUFFINS EXHIBIT

Studies in the current research paradigm follow a pattern of pre-exhibit activities, in-exhibit monitoring and post-exhibit test to evaluate learning and program effectiveness in museums. These efforts helped identify some important factors correlative to learning, but little is known about how exhibits are designed in a way that space, materials and instruction are organized as an integrated pedagogy. By examining knowledge production in-situ, in progress and in interaction at a Doc McStuffins exhibit in a children's museum, this study aims to find out how the exhibit is designed effectively as a pedagogical effort to engage children and parents and achieve its teaching objectives. In order to unpack the complex and dynamic pedagogy, I examine the three major components of the pedagogy separately for the convenience of analysis, namely, physical space organization, materiality (human-object interactivity), and differentiated instructions (parent-child and educator-visitor interaction), even though these components are organically interwoven together in practice. As a reconstruction of a toy hospital from children's favorite TV show, the Doc McStuffins exhibit organizes its pedagogies into narrative, performative and simulated spaces. This consistent and coherent arrangement of space, time and activities offers a backdrop of familiarity and fantasy that excites young children's imagination and offers them easy access to content learning. The study has discovered: (1) how the organization of physical space communicated to visitors the themes of the exhibit and impacted the ways in which parents and children interact with each other; (2) how materials and technologies are used for effective teaching and learning; and (3) and how parents and educators worked together to construct pedagogy in the form of differentiated instructions. These findings

can provide useful information for children's museums that are committed to creating a family-centered learning environment. They could also have widespread implications for classroom environment design and the design of community-based learning environments that involve a nexus of materials, space and a diverse population.

Key words: multimodality, pedagogy, space, interactivity, differentiated instruction.

Karen Wohlwend, Ph.D.

Sharon Daley, Ph.D.

Joshua Danish, Ph.D.

Jessica Nina Lester, Ph.D.

Adam Maltese, Ph.D.

Table of Contents

Transcription Notation

The following transcription symbols are used in this dissertation in an attempt to capture the sound of the talk as it was originally spoken.

word	Words in boldface indicate gestures and body movements that contemporaneously overlap the words, the transcription of which is put in double parentheses following the boldfaced words.
((*word*))	Italicized words within double parentheses are transcribers' comments or descriptions.
-	Dash indicates sudden stop of talk.
*	Asterisk mark indicates an instant that corresponds to a screenshot of which the figure number is labeled at the end of the comments.
(.)	Brief interval, usually between 0.08 and 0.2 seconds
(5)	Time (in absolute seconds) between end of a word and beginning of next.
=	End of one turn construction unit (TCU) and beginning of next begin with no gap/pause in between (sometimes a slight overlap if there is speaker change). Can also be used when TCU continues on new line in transcript.
[yeah]	Overlapping talk
[okay]	
wo::rd	Colon indicates prolonged vowel or consonant. One or two colons common, three or more colons only in extreme cases.
<u>w</u>ord	Underlining indicates emphasis. Placement indicates which syllable(s) are emphasized.

↑ word ↓ word	Marked shift in pitch, up (↑) or down (↓). Double arrows can be used with extreme pitch shifts.
.,_¿?	Markers of final pitch direction at TCU boundary: Final falling intonation (.) Slight rising intonation (,) Level/flat intonation (_) Medium (falling-)rising intonation (¿) (a dip and a rise) Sharp rising intonation (?)
WORD	Upper case indicates syllables or words louder than surrounding speech by the same speaker.
°word°	Degree sign indicates syllables or words distinctly quieter than surrounding speech by the same speaker.
word-	A dash indicates a cut-off.
>word<	Right/left carets indicate increased speaking rate (speeding up).
<word>	Left/right carets indicate decreased speaking rate (slowing down).
(??)	Unclear voices.

Chapter 1 Introduction

Back in 2014, when I first came to Indiana University and studied in the master's program of Arts Administration, I was surprised to find there was a type of museum called *children's museum*. I did a little bit of research and was even more surprised at the fact that people called this kind of interactive organization a museum. The kind of museums I had been familiar with all housed valuable collections for people to see. So, I was eager to learn more about this type of "non-museums" that called themselves museums.

The first children's museum was developed in 1964 by Michael Spock, the late director of Boston Children's Museum from 1962 to 1985. Believing that meaningful interaction with real objects, direct engagement and enjoyment was the best way to promote learning in a museum, he revolutionized the collection-based children's museum by replacing the glass-cased displays with exhibits and props that encouraged children to touch, handle and interact with materials. The first exhibit he developed, "What's Inside?" where children could see and explore the insides of ordinary objects, was wildly successful. It began with simple items for children to manipulate and grew to include a two-story climbing tower as well as a cross-section of a city street, which allowed children to crawl above and below the street through manholes and sewer pipes. He was also the first one to create exhibits especially for children under five by scaling exhibits to children's heights and capacities, appealing to all the senses for exploring and extending learning beyond books and instruction. Michael Spock's avant-garde style of learning caught on and children's museums have become the fastest-growing areas of the museum field since 1978.

Now there are more than 300 children's museums nationwide (not including institutions that call themselves science centers or discovery centers that cater to children) visited by millions of children each year[1]. They have been recognized as places that cultivate and enrich the soil of lifelong learning by providing children with interactive, hands-on and play-based learning opportunities. As a graduate student in arts administration, I learned how museums are managed in courses like marketing, financial management, fundraising, and so on. During the process, I realized that the success of a museum was not simply determined by its managerial strategies, but was closely related to the success of its educational programs or exhibits, which attracted more visitors and secured more members, which in turn became evidence to convince stakeholders of the unique value of the museum experience in encouraging children to explore knowledge and in fostering lifelong learning.

Designing a successful learning environment has been a major concern of children's museums (and indeed, of all museums). Once museums have assumed the role of an educational institution, designers began to realize that spaces, materials and people (e.g. designers, educators, parents) are all pedagogical resources to be coordinated to communicate educational intentions (Allen & Gutwill, 2009; Anderson et al., 2002; Bradburne, 1999; Carr et al., 2018; Degotardi, 2019; Falk et al., 2004; Henry, 2015; Moser, 2010; Sanford, 2010). Studies have highlighted both the psychological and sociocultural importance of such a learning environment. For example, the design of physical environment is important as it is linked to the ways in which people learn through psychological processes like cognitive fatigue, distraction, motivation, emotional affect, and anxiety, which are all at work during museum visits and affect how adults,

[1] The Children's Museum of Indianapolis, known as the world's largest children's museum, announced that more than 1.318 million visits were recorded in 2019, setting a new annual attendance record.

youth, and children learn in museum settings (Maxwell & Evans, 2002). Not only does the combination of structure, design and layout of the physical learning environment of the museum impact visitors' mental perception, but the designed learning spaces in museums are also worlds that are culturally different in terms of their values, goals, language, personnel, resources encountered and location. In such spaces, it is observed that learning professionals play an important role in assisting learners to negotiate the border-crossing between the communities of school culture, home culture and the sub-culture of the learning space itself (Peacock & Pratt, 2011). But there is a dearth of empirical research about how materials, spaces and humans work together to create an effective integrated pedagogy.

Museums have also been fully aware of the importance of parents in helping children to learn and advocated that design for learning should put a premium on inclusion of all family members, communication and collaboration between family members, and connection to personal experiences (Foutz & Emmons, 2017). However, parents' involvement in children's learning in museums has been primarily understood as parents' conversation with children, which received much attention (e.g., Leinhardt & Knutson, 2004; Leinhardt, Crowley & Knutson, 2002; Palmquist & Crowley, 2007; Haden, 2010). Little is known about parents' other ways of participation and how pedagogy can be designed in a way to increase parents' participation.

Another gap in the research landscape is young children's learning in museums (Hackett, Holmes & MacRae, 2020). Given the large numbers of visits reported by the Association of Children's Museums every year, studies about young children's (2-6-year-old) learning experiences in museums are paradoxically few and far between. Part of the reason for young children to be marginalized in the research landscape is that children's movement in museums

are “sticky data” that resist interpretation by the current research paradigms, as pointed out by MacRae and colleagues (2018): “Much of our ‘sticky data’ on young children in museums involves experiencing with the body, in ways that defy verbal explanation. When research works with conceptual models that can only account for what can be explained in words, other aspects of what takes place are usually disregarded (p.509).” What is problematic with these frameworks of learning and their construction of young children, is their inability to consider museum visiting as an embodied and emplaced experience and the vibrant materiality of the museum itself due to their emphasis on cognitive learning as evidenced through talk and behaviors (Hackett, et al., 2018). Similarly, Birch (2018) questioned the narrow view of museums that packages children as learners while ignoring children’s multisensory experiences at museum.

This study is an empirical exploration of these questions that remain to be answered. With a vision gained from wearable GoPro cameras, I literally focus on young children’s hands and their handling of objects to explore young children’s meaning-making through “hands-on” embodied and emplaced experience as they navigate a popular Doc McStuffins exhibit across time and space. The data for this study was collected at an exhibit[2] in a children’s museum in the US Midwest. The exhibit was modeled after the animated children’s television series, Doc McStuffins (https://en.wikipedia.org/wiki/Doc_ McStuffins), which aired on the Disney Channel and Disney Junior from 2012 to the present. The star of the series is a six-year-old African-American girl, Dottie “Doc” McStuffins, who communicates with and heals her stuffed animals and toys in a backyard playhouse-turned clinic. With Disney’s cooperation, the museum’s staff designed the exhibit to appeal to an anticipated audience of families with 2- to 6-year-olds. Child-sized pastel-colored plastic toys were used to mimic medical equipment in a doctor’s

[2] I use “exhibit” to refer to the whole design of the space and “exhibit element/interactive” to refer to the individual component of the exhibit following the museum protocol.

clinic, such as stethoscope, otoscope, inflatable blood pressure cuff, and so on, with the goal of inspiring the young visitors to engage with concepts of health and wellness through imaginative play. These hands-on interactives were distributed in four major medical-themed sections, namely, Emergency Room, Operating Room, Nursery and Pet Vet.

The purpose of this study is to find out how the Doc McStuffins exhibit is designed as a pedagogical effort to engage children and parents and effectively achieve its teaching objectives. I define museum pedagogy as a practice to communicate messages to visitors using a wide variety of resources ordered and arranged for the purpose of education. In order to unpack the complex and dynamic pedagogy in-situ and in progress, I separate the three major components of the pedagogy for the convenience of analysis, namely, physical space organization, materiality (human-object interactivity), and differentiated instructions (parent-child and educator-visitor interaction), even though these components are organically interwoven together in practice. I will situate my exploration of these components of the pedagogy respectively in the *narrative*, *performative* and *simulated* spaces of the exhibit (Dernie, 2006). David Dernie, an architect, categorized museum spaces into these three types according to the different ways in which artefacts are arranged and spaces are organized. Narrative space is a way of curating artefacts that structures the space coherently and consistently with a theme just like storytelling. Performative space is characterized by exhibits that offer hands-on interactive experiences to visitors. Simulated space is a characteristic of modern museums that often use a variety of technologies to create simulations for visitors to experience.

The Doc McStuffins exhibit is an integration of all these types of spaces. Borrowing the theme of toy hospital from the TV show of the same name, the exhibit organizes its pedagogy into narrative, performative and simulated spaces. I will study the organization of space for

pedagogical purposes in the narrative space (chapter 4), children's interaction with a toy Pet X-ray machine in the performative space (chapter 5), and the differentiated instructions through which educators and parents help children to learn in the simulated space (chapter 6).

Even though children's museums are not considered a traditional literacy space, current literacy pedagogy theories and empirical studies (chapter 2) have expanded the concept of literacy spaces far beyond the traditional school classroom. Through a multimodal analysis of the pedagogical nexus that involves space, materiality and bodies of the Doc McStuffins exhibit, this study answers the following research questions:

1. How are the physical spaces organized for pedagogical purposes?
2. How are materials and technologies used for effective teaching and learning?
3. How are multimodal resources employed to achieve effective differentiated instructions?

Chapter 2 Multimodal Pedagogies: Spaces, Materials and Bodies

The concept of multimodality entered the field of literacy in the mid-1990s with the advent of new forms of communication afforded by digital technologies. With digital texts, meanings are often constructed and interpreted through complex combinations of still and moving images, icons, words, screen layout, colors and sounds. Now multimodality has become an area of research in itself that studies how communication unfolds through the creation, development and functioning of texts by using more than one semiotic system. Even though much of the work in multimodality stems from Systemic Functional Linguistics (SFL) (Halliday, 1978; Halliday & Matthiessen, 2004), more analytical approaches were developed to systematize the relationship between semiotic realizations of various kinds and the social and cultural context in and by which meanings are produced. These approaches include social semiotics, conversation analysis, geosemiotics, multimodal (inter)action analysis, multimodal ethnography, and so on (Jewitt, Bezemer, & O'Halloran, 2016).

The revolutionary effects of digital technologies on communication have made it necessary for literacy scholars to reconceptualize literacy in terms of space, materiality and body. With the proliferation of digital technology, the traditional ways in which people participate in literacy events and practices have changed and the notion of situatedness (Street, 1984, 1995; Street & Street, 1991; Barton & Hamilton, 1998) in which literacies vary in and are always associated with specific domains or locations (e.g., home, community, school, etc.) was questioned (Leander & Sheehy, 2004; Burnett et al, 2014), due to the complication brought about by "the practices involving digital literacies, new media and multi-literacies where participants often occupy both real and virtual networks and rapid local-global movements are common

(Burnett et al, 2014, p.92).” The new collaborative and participatory literacy practices (Merchant, 2009, 2010), the production of multimodal texts in the digital age (Kress, 2003; Rowsell, 2013) and the production of identity and space by digital literacy practices (Burnett, 2011a, 2011b, 2014) all called for a re-examination of the ways in which the material dimension of experience (e.g., bodies, artefacts, walls, texts and screens) and the immaterial and embodied experience (e.g. associations, memories, feelings and imaginings) are interwoven in the meaning making across on- and offline contexts (Burnett et al, 2014; Burnett, 2015).

The awareness of the new literacy landscape has also made it imperative for educators to come up with new ways to prepare students for the multimodal, multilingual and multicultural world of communication. In the following sections, I will introduce two influential frameworks of multimodal pedagogy and the theories that informed them.

2.1 The Pedagogy of Multiliteracies

The social semiotic approach to multimodality is one of the earliest and most influential frameworks of multimodal communication. From a social semiotic perspective, communication is fundamentally sign making and interpretation and all signs are multimodal (Kress, 1997). Kress (2010) defined mode as “a socially shaped and culturally given semiotic resource for making meaning (p.79).” Examples of modes used in representation and communication include image, writing, layout, music, gesture, speech, 3D objects and so on. Each mode is characterized by its own constraints and affordances in the reach of representation determined by its materiality. What counts as modes is a matter of decision of the community in which the modes are historically, socially and culturally shaped based on the community’s representational needs. In making signs, people select forms in such a way that they best or aptly express their intended social meanings, specific to a particular culture. Signs, chosen by the deliberated action of the

designer to reflect his/her interests, are motivated. They are also rhetorical as they are created with an intent to persuade with all means possible those who are supposed to receive it (Kress, 2004).

One of the important tasks of social semiotics is to describe the potentials (affordances) and limitations (constraints) for meaning making which inhere in different modes. For that, it is essential to consider the materiality of modes. For example, "[s]peech uses the material of (human) sound; writing uses the material of graphic substance. There are things you can do with sound that you cannot do with graphic substance, either easily or at all; not even imitate all that successfully graphically" (Kress, 2004, p.112). To design is to make apt use of the affordances of each mode, based on an assessment of the environment in which communication takes place (Kress & van Leeuwen, 2001; Kress, 2010). During this process, special concern is given to the meaning making and the meaning resources which have been produced in any one society with the affordances of this material. Theoretically, the potential for the making of meaning with a certain material is infinite. However, any one society only ever uses some of these potentials. That is to say, only certain potentials will become modes in a community or social group as required at the moment of sign-making. A good example is sound. It is a material that can be shaped into speech, music, soundtrack; whistle-languages; drum-languages and so on. The relation of material and mode is anything but straightforward and this sets the goal for researchers of multimodal communication.

Based on the social semiotic concept of multimodality, the New London Group (1996) proposed a "Pedagogy of Multiliteracies". It has challenged the traditional monolingual and monocultural literacy pedagogy restricted to the practice of teaching and learning reading and writing in the standard national language. It was argued that listening, speaking, reading and

writing are all forms of designing and any semiotic activity is a dynamic process of designing with available resources to create patterns of meaning which involves three elements: "Available Designs, Designing, and The Redesigned" (p.74). Available Designs include grammars of various semiotic systems and order of discourse. Meaning making is therefore a creative application and combination of these conventions (Available Designs) in the active process of Designing that both transforms and reproduces these conventions (The Redesigned). In this way, Design is a metalanguage of multiliteracies the same way as grammar is the metalanguage of any language, the master of which is a demonstration of competence of that language. It is what students need to learn to be successful communicators in the new multimodal, multilingual and multicultural social realities in which they are and will be situated today and in the future.

2.2 The Pedagogy of Emergence

New materialism (e.g. Barad, 2003, 2007; Bennett, 2010; Coole & Frost, 2010; Alaimo & Hekman, 2008), sometimes referred to as sociomaterialism or material feminism, is concerned about the continuous and varied material exchanges of both living and nonliving entities through which knowledge and learning occurs, with a focus on the intersections of materiality, embodiment, and agency. It is new as against the Marxist view of materials. It also differs from the latter in terms of the human-non-human relationship. In Marxism, materials are natural resources in a world existing independently of human volition and subject to change under the dominating power of humans as the organizing force in their social and economic life. In contrast, new materialism conceptualizes matter as agentic and vibrant (Bennett, 2010) and displaces the human as the center of knowledge creation. All bodies, both living and non-living are considered as having agency involved in a conversation of meaning-making.

According to Barad (2007), the world is not out there waiting to be discovered by scientists but rather becomes lively through *intra-actions*—"mutual constitution of entangled agencies (p.33)" between persons, places and things. Agency is therefore understood as being enacted through relationships, rather than an intrinsic characteristic uniquely possessed by individuals alone. Human and non-human bodies become agentic only and always through dynamic, co-constitutive emergence. That is, both humans and objects are agentic in as much as they are capable of transforming each other. Bennett (2010) urges us to recognize the power of things or the "thing-power" -- "the curious ability of inanimate things to animate, to act, to produce effects dramatic and subtle" (p.6). For example, if we paid attention to the aliveness of matter, we wouldn't be so careless with our stuff. Alive doesn't mean good: garbage dumps are alive, and their toxins are always seeping into the earth and bubbling into the air. In this sense, they are "actants," a concept used to short-circuit the subject/object binary, which is "a source of action that can be either human or nonhuman; it is that which has efficacy, can *do* things, has sufficient coherence to make a difference, produce effects, alter the course of events." Its "competence is deduced from its performance rather than posited in advance of the action (p. viii)." What we usually call objects or contexts actually can impact us more than other humans: casinos keep the air a little cold to keep people awake, temples provoke awe and serenity in their architecture, music can provoke all kinds of feelings and happenings. These non-human forces have their own agency, and not just because of their "cultural significance." Their agency is really material, and it extends into our bodies and affects us.

Ontologically, new materialism foregrounded the forces, capacities and energies possessed by matter and challenged some of the deeply entrenched concepts like causality, motivation, agency and subjectivity. Pedagogically, it motivated researchers and educators to

think about how to devise new engaging learning environments and enact changes in the material configuration that can make a difference in the educational enterprise. Such a pedagogy, "the Pedagogy of Emergence", was proposed by Leander and Boldt (2013) as a critique of the Pedagogy of Multiliteracies. They problematized the pedagogy framework informed by the social semiotic theories: the reliance on "design grammars", an inheritance from Halliday's systemic functional grammar, to interpret and organize literacy productions.

> For the New London Group, the nature of creating things, bodies, and identities as artifacts or products was organized through design grammars. Central to our first concern is that the interest of the New London Group was not the difference between bodies and signs but instead expanding and smoothing out grammars in the service of comprehending 'the plurality of texts that circulate' in 'increasingly globalized societies' (p.24).

Instead, Leander and Boldt suggested that meaning making is not as intentional, rational and design-based as it was conceptualized in the "Pedagogy of Multiliteracies", which involves "a domestication that subtracts movement, indeterminacy, and emergent potential from the picture" (p.24). In critique of representationalism and text-centrism that characterized the pedagogy of multiliteracies, they proposed a new approach to literacy pedagogy as the Pedagogy of Emergence. Instead of seeing literacy activity as projected toward some textual end point, they suggested a view of literacy that focuses on the ongoing present, on the unexpected ways in which signs, objects and bodies are connected to produce not texts but affective intensities that are different from the rational control of meanings and forms, as opposed to the text-centric tradition.

The highlights of the Pedagogy of Emergence soon caught on and have become a new guideline for studies that followed. Studies from this approach are characterized by: (1) unintentionality of movements as a departure from Design; (2) the ongoing entanglement of bodies (humans and more-than-humans alike) that makes an unpredictable change and difference (becoming); (3) foregrounding materials as an active participant in becoming that incite movement and imagination, produce affects and intensities, as a result of literacy desiring; (4) featuring intra-action, in which materials are considered as having agency involved in a non-mediated causative meaning-making as differentiated from the human-to-human interaction mediated through language.

Despite their difference on whether meaning-making is intentionally designed or not, the two pedagogy frameworks have informed empirical studies that expanded our understanding of meaning making as a nexus of space, materials and bodies.

2.3 Space

According to Taylor and Phillips (2017), literacy places are twice-constructed—first by the sponsors who design them, and then by the persons who interpret and experience them. When the space is designed, the features in the space embody the meaning the designers intend to communicate. When such space is experienced and lived by its users, new social spaces are produced. This view of space creation and production represents the two major directions of research of space in early literacy, informed respectively by Scollon and Scollon's (2003) Geosemiotics and Lefevre's (1991) theory of social production of space. More recently, sociomaterial theory has also been adopted to study space. These perspectives direct our attention to an overlooked but important aspect in literacy teaching and learning and expand our understanding of literacy activities beyond classrooms.

2.3.1 Spaces that Articulate

Literacy spaces, as a product of design, are sites of circulating discourses that communicate meaning. Rainbird and Rowsell (2011) showed how families carved out special areas as "literacy nooks" to maximize children's literacy experiences. This practice was found to be closely related to parents' ideology of how to be good parents with respect to children's rearing and development. Similarly, when commercial organizations design online or hybrid spaces catering for preschool learning and development, they contextualize their promotional materials in a policy climate that foregrounds lifelong learning and school readiness. In this way, they assume an authoritative role as brokers of valuable childhood resources for parents who wish to lay successful foundations for their children's future success (Nixon, 2011).

In a study (Nichols, 2011) about local libraries' involvement in children's literacy development, it was discovered that children's spaces in all locations were characterized by design elements of curved shapes, bright colors and low furniture, as a deliberate attempt to counter the bounded system of compartmentation and hierarchy in traditional libraries with a sense of flow and connectedness. When design features index discourses of leisure, informality, flow and modernity, the space tends to be more inclusive. Whittingham (2019) also suggested that the establishment of a preschool center in a neighborhood of working-class residents communicated a discourse of commitment to the local community and urban rejuvenation. The center, together with other facilities, contributed to the social support network that constructed spaces of resilience, resistance and perseverance of families of color.

2.3.2 Spaces Produced and Transformed

Places are often designed for social events and activities, and this is especially true in education. Therefore, spaces are not fixed or abstracted. They can be produced, transformed and

augmented by activities. For example, when the classroom event is structured and routine, productions of space are also structured and routine. When classroom events are open-ended and child-directed, productions of space are less predictable across time and more responsive to student activity and interest (Whittingham, 2019). According to Levy (2008), classroom space can be augmented if children bring in various aspects of their home experiences, such as popular culture, television texts, computer technology and play to construct their own sophisticated and valuable reading experience. However, such constructions could be at risk of disruption by the demands of the school curriculum. For classrooms to be a "third space"—the space that mediates school and home, it was suggested that early literacy educators find ways to accommodate and utilize children's own constructions of reading in order to build confidence and initiate success in a modern generation of young readers. Flint (2018) found that children's responsive play, or children's playful responses to literature, is a socioculturally informed activity and a generative source of academic learning, allowing children to create in the classroom a new spaces. In such new dimensions of creation, they could make connections to texts through their knowledge and experiences to learn more about the stories, about themselves, about each other, and about the world they live in.

2.3.3 Space, Technology and Fluidity

The sociomaterial approach to space differs from the previous two approaches in its departure from the human-centered view of space as intentionally designed and produced by human activity. It features space as enacted and emergent in the entanglement of the human and more-than-human. This perspective is getting relevant to today's literacy spaces that are increasingly permeated by digital technologies. For example, Baroutsis (2018) studied how a teacher's pedagogy in a digital writing class is distributed all over the classroom in different

sections with different groups of students. The fluid differentiated pedagogies were personalized entanglements of materialities and spatialities that formed and reformed knowledge, enabling literacy space enacted in new ways through a combination of digital and mechanical text production technologies and collaborative writing, moving beyond the confines of the dated physical space and classroom design. Home literacy environment has also been re-engineered by the ubiquitous digital technologies from a stable and constrained space into a digitally networked space with porous boundaries (Flewitt & Clark, 2020). These networks enable even the youngest children (0-3-year-olds) to exercise agency, not through intentionality and design, but through the dynamics of networks interwoven with threads of human relationships that offer them fleeting opportunities to act, to intervene and to express meaning across diverse modes and media as they negotiate affectively intense relationships with distant others in a digitally mediated world. Seeing home literacy space through the lens of fluidity, even the most mundane living room turns into fluid networks of emergence, enactment and performance, where young children's literacy practices emerge as their engagement with digital technologies, parental ideology and domestic routines are reconfigured in the living-room assemblage (Poveda et al., 2020).

2.4 Materials

2.4.1 Vibrancy of Things

Thiel (2015) featured children's playing materials in a community clubhouse. For example, fabrics are found to have played crucial roles in children's superhero play. It serves as the actant that propels children's movement and play. It affords children the flexibility with which they create costumes of their own definition, by listening to and experiencing "the vitality of the fabric through their own intellectual lenses and creative theories (p.121)." The bodice, at

the same time, is a good example of being vibrant matter in terms of its ability to provoke affective energy. Upon seeing the bodice, Cedric, a boy who likes to design dresses, responded with excitement by jumping, shaking, laughing, and smiling. This bodily response can be read as a manifestation of the moment when matter is vibrant and this vibrancy is shared by or dispersed between the human and the material. As constituents of each other, they rely on one another to create a more powerful moment in which this affective energy cannot be contained but spills out of his body as "muchness" provoked by the presence of the dress form.

Central to the study made by Daniels (2019) is the hexagonal plastic spot tray, a commonly seen material configuration in Early Years classrooms in England, originally used by builders and construction workers to mix hardening materials such as concrete or plaster, but appropriated by teachers to arrange various materials for children to explore. It therefore served as a conceptual tool and a generative site for examining classroom assemblages. "As young children's moving bodies encounter the material conditions of carefully resourced and prepared continuous provision, the Early Years classroom becomes a hive of fluid, ongoing, rapidly changing and shifting activity (p.11)." It is at such a spot tray that a boy's patterned hand movements in an attempt to disentangle a puppet from the hessian strands were carefully observed and analyzed. The intentionality of the meaning of actions is questioned after the observation of this setting where children's ongoing exploratory movements and handling of the materials were found to be always deeply implicated and contingent within shifting material/spatial configurations.

Harwood and Collier (2017) highlighted sticks as a powerful agent in children's forest play: they are a catalyst for action, sounds movement and relations; something to be held, thrown, tugged, felt, smelt, thrashed, climbed, ridden, tripped over, hidden and so on. While

being acted on, the sticks act back upon the children's thinking, igniting their imagination with their infinite possibility of material affordances: a long thin Y-shaped stick is put between legs, aminated by guttural noises ‘‘grrrr’’, rotated in sweeping motions back and forth to serve as a garbage collecting truck; a small stick is effortlessly settled across laps to act like a seatbelt in children's superhero pretending play in a hollow amid the multiple trees that have conjoined and grown together as one; while another long thin stick held against a long-fallen log is considered a window to their "home", the small and intimate space under the trees. The sticks are revered and respected by the children. Children's story with the sticks is an illustration of how the variability and unpredictability of each of the entanglement of matter, relations and places produces new meaning and allows the "storying/ re-storying" of the relationship between matter and children.

Hill and O'Gorman (2020) reported a case of the power of mundane objects in a cultural center dedicated for young children. For example, in one program, children were invited to bring small objects from home, arranged them on light sensitive paper and left in direct sunlight during the summer heatwave on the roof garden to create "sun print" cyanotypes. In another program, participants were offered opportunities to connect known or expected processes with elements of newness in activities such as painting on turnip slices and cabbage leaves, making colored glues, using other kitchen cupboard materials and tools in new ways. It was observed that the material agency of food "is generated through aesthetic affect rather than consumption (p.66)". In these new encounters of playfulness that introduced the materials' possible "unknowns" and extended their possibilities beyond the potentially forbidden (as too precious, dirty or dangerous), it is possible to opens expectations beyond domesticated understandings of things restricted by prior human experience toward a wider and wilder experience of their capabilities.

2.4.2 Wordless Communication

Using a slow-motion video method to view filmed events in an inner-city nursery class, MacRae (2020) noticed the micro-responses of young children's bodies as they encountered the material and physical space. The focus of this study is the silent toy tussle among children. Even though sometimes the loud vocal toy tussles between two children invariably incurred adults' intervention, followed by instructions like "using words" and "share", these toy tussles took place far more frequently as quiet, unnoticed ongoing subtle hand movements through which disputes were tacitly settled. In these small tussling events, hands would flutter hesitantly as they reached towards toys held by other hands, and they grasped toys tighter or snatched at toys to declare possession while sensing other hands moving in their direction. Sometimes momentarily two hands tugged away from each other as they held the same toy, but they tendered toys, silently exchanged them and an agreement was reached. By looking closely at the slowed film of hands in motion, MacRae perceived an "involutionary" mode of attention that responds to movement through movement, which she calls "a sensed intelligence", an intelligence tentative by nature, not located in the person, but more affectively entangled with the world. She suggested thinking of hands as sense organs of thoughtful bodies to expand the view of listening and communication, as an ongoing responsiveness to the world. These micro-scale findings of the tactful and diplomatic movements as an effective and affective mode of communication problematizes the developmental view of language and morality for its essentializing intention and rationality as the higher order of intelligence and therefore as being.

Hackett and Somerville (2017) looked at two girls playing with mud at the river side. In one case, they mix water into mud to make it wet enough to make mud cakes and in another, they scoop mud and fling them into the river, pretending that it hit a mud monster swimming

when the water splashes, a continuation of a previous monster cave play story line. By a scrutiny of the mutually responsive relations between bodies, movement and sound, and their entanglement with time and space, the authors revealed how different ways of knowing and being in the world can be communicated and created. It is at the liminal space of the river that specific meaning is made possible. The very edge of the water (where large amounts of brown mud have been deposited by flood waters) attracts play and is the sole place of repeated visits when time and space collapse into one plane--"a flat ontology in which humans are decentred and everything exists on the same plane, in constant motion (p.374)". The authors suggested that an understanding of movement and sound as world-forming communicative practices, going beyond the traditional view of communication as speaking and writing, would allow the emergence of new forms of literacy and a new understanding of being and becoming.

2.4.3 Entanglement as Becoming

In their investigation of a multimodal writing workshop/studio in a second-grade classroom, Kuby, Rucker & Kirchhofer (2015) witnessed that when children interacting with materials, they were not always intentional and/or sure about what to do with materials and what they were creating in the moment. But if children were entrusted with materials, time and space, they were capable of negotiating and creating symbolic meaning out of the richness of materials in the making, as in the example of Elza's exploration of or conversation with the pink foam board in her effort to make it an addition to the previously made "mother bird": "The pink material essentially spoke to Elza. It was, in the moment of using her hands and knowledge of the mother bird that she created, that Elza decided this material would become pants. We witnessed this type of exploration with numerous children; over time, students did not plan how they would use materials before intra-action with them (p.408)."

Boldt and Leander's (2017) analyzed a case of father (Kevin)-son (Mike) Lego playing to illustrate how the human body is decentered by and entangled with materials to construct play narratives. With humans and non-humans serving as extensions for each other, the analysis of the play revealed that "agency and subjectivity are not limited to Mike or Kevin, their desires or embodiment or intentionality, but rather are dispersed across the changing, impersonal ecological field in which they are moving (p.415)." That is to say, the desire of individual actors alone does not determine the movement of the play: the materiality of the play may have shaped and suggested but never determined the unfolding events; texts in the form of improvised storylines may have structured and facilitated the play, but they broke apart in the face of the agencies of other materials. The possibilities in the play are kept open by the interplay of "undifferentiated desire--as energy--across human and non-humans, as they resonate, resist, intensify, hold stable, reconstitute and move one another" in emergent and evolving relations" (p.422). This flow of desire is a process of becoming that produces something new while still in relation to the old, during which it picks up materials (including human and/or non-human objects, actions and reactions) and energy, irrespective of repeated patterns (refrains that have the tendency to petrify the movement and exclude communication) but open to difference.

2.5 Body

2.5.1 Learning in Silence

From the sociocultural perspective, learning is associated with language that mediates interactions between teachers and learners. The multimodal perspective of communication, however, sees learning achieved through other modal choices in addition to speech (Bezemer & Kress, 2018). Multimodal analysis of children's "silent modes of communication" featuring various non-verbal embodied action modes (e.g. gaze, gesture, posture, movement, haptic) has

made visible young children's literacy learning process that had largely been overlooked in the verbocentric (Fueyo, 1991) paradigm. Researchers using this new analytic approach have revealed that children are nevertheless active young learners despite the lack of verbal means due to developmental restriction (Lancaster, 2001), unfamiliar learning environment (Flewitt, 2005a, 2005b, 2006), learning disability (Flewitt, Nind, & Payler, 2009) or institutional regulations (Mavers, 2015; Wohlwend et al, 2011).

Lancaster (2001) documented the process through which a 23-month-old girl, Anna, learned to "draw" cats from her father through her multifunctional gaze. By examining the bodily means of mediation used by Anna in her interaction with her father, Lancaster identified three functions of her gaze (analytic, interpersonal and expressive) and argued that gaze, far from being transparent, is a multiply constituted mode. Through analytic function, Anna uses gaze to interpret and construct the visual meaning between space and marks by designating her zigzags as "cats" in the identified section of space on the piece of paper. The small-scale retinal movement between her father's drawing and that of her own also allows Anna to bring back to her own work the quality of her father's marking action that representatively interests her. Gaze, in this respect, is motivated by the prior analytic interest of the looker and informed by the nature of the analytic tasks involved in the interpretive process. Therefore, gaze mediates the visual and spatial analysis that is central to the systematic organization of visual features to generate meaning. Meanwhile, Anna's analytic gaze is coordinated with the interpersonal function of gaze with which she draws, holds and directs attention and with the expressive function with which she persuades him to draw a cat for her and checks what he is doing after that. Multimodal analysis has made visible a wide range of embodied interpretive strategies used by Anne, who is too young to have access to the full range of linguistic resources. By describing the generation of

symbolic meaning as an embodied process, the study expanded our understanding of the very earliest stages of literacy and made the nature of young children's rational thinking accessible to description.

In a series of studies, Flewitt (2005a, 2005b, 2006) investigated how four 3-year-olds make and express meaning in the two different settings of home and playgroup. It is observed that children speak much less in playgroup than at home, partly because they are no longer supported by the shared understandings and support present in their homes, and partly because opportunities to talk are set by established playgroup activities with different communicative practices. Children's comparative absence of talk at pre-school implies neither a lack of talk at home nor a lack of learning and meaning making in pre-school. On the contrary, the silent modes of communication are found to be effective strategies for newcomers to fit in with the new educational setting which is strikingly different from their homes. When they are offered free-choice activities, children are more likely to choose those kinds of activities that match their own communication preferences. For example, the more confident children would spend a large percentage of their time in activity areas typically dominated by older boys who stake territorial claims, while quiet children tend to opt for activities where physical spaces are clearly defined by tables and chairs so that they could take part in an activity without interactions with peers or adults, or where interactions are made through the choice of silent modes of gaze, facial expressions and body movement. Newcomers also use imitative body movements as an efficient way to inveigle their way into these areas and to others' play. Such silent negotiation of access is generally more successful than talk.

Another case study (Flewitt, Nind, & Payler, 2009) enables us to see that even children with identified special educational needs and speech impairment are capable of learning if their

embodied actions are interpreted as meaningful and if their idiosyncratic modes of communication are valued rather than pathologized. The study reported the literacy experiences of a four-year-old girl, Mandy, across three different education settings: her home, a local playgroup and a special children's center. Mandy has Angelman syndrome and is identified with global learning and mobility difficulties. However, in the more inclusive ethos of the local playgroup where Mandy has never been referred to as delayed but as "just a little girl as individual as all the others", she is recognized as a symbolic being, able to express precise meanings albeit in non-linguistic and non-conventional modes. This recognition of the communicative competence of all children fosters her inclusion into the literate community, which in turn encourages her to participate in a web of interactive relationships and to negotiate her evolving identity as a learner and a social being.

In a picturebook sharing activity where speaking is usually constrained and bodily compliance is regulated, Mavers (2015) was concerned with how children express their understanding in ways beyond speech in such kind of learning environment. Her research shows that children's bodily movements that appear at first to be fidgeting or lack of attention turn out to be embodied modes of engagement. For about one-third of the time when the teacher read a story to the children, a girl, Amira, looked away, wriggled, waggled her hands, jiggled her legs and occasionally vocalized. However, a close examination of these sounds and movements in relation to what the teacher said and did and to the narratives of the story revealed that instead of "acting up", Amira "acted out" the narratives: when the teacher read "We can't go over it", she flicked her fingers upward on the "over"; she dropped and then raised her chin at the sound of "under" in "We can't go under it". Her movements during the process were numerous and varied, but certain patterns of signification can be discerned from her repetition. For example,

instances of putting her hands to her mouth were associated with anticipation, delight, and uncertainty to questions. This case illustrated how young Amira developed embodied knowledge by remaking meaning across modes.

Wohlwend and colleagues (2011) reported a case in which primary school-aged children successfully designed their online communication in a collective video game despite restrictions in an afterschool program. As it was required that children should play quietly with computers muted, the crucial audio resources (such as character speech, sound effects, and music) were inaccessible while the on-screen print directions were not helpful for lower-grade players. This created a barrier for children who wished to establish an online cooperation between players. However, the children overcame the difficulty and explored other means to achieve connectivity, for example, the layout of the webpage, off-line proximity and synchronization of gaze, mouse clicks and avatar movements. Even though some of their attempts failed, the improvisation they used to transcend the offline limitation to establish a cooperation made them creative and resilient designers of multimodal communicators.

2.5.2 Play as Action Text

In play, children design toys, animate props, act out narratives, play imagined characters, and create identities. Samuelson and Wohlwend (2015), seeing play through a semiotic lens, recognize that play is an embodied way of sign making and text production. As the meanings conveyed through young children's playing always involves materials and movement, a material- and action-oriented view of literacy is required to understand the unspoken social meanings of children's pretending and designing that characterize their play.

Young children are often observed to turn everyday objects into their toys, which is interpreted as sign making: "When a child treats a cardboard box as a pirate ship that is the

making of a sign, in which the material form (the box) is an apt medium for the expression of the meaning 'pirate ship', because what the child regards as the defining aspect of 'pirate ship' at that moment—its vessel-like qualities, 'containment', 'mobility', and so on, are sufficiently well expressed in the form (and the material) of the box" (Kress, 1997, pp.11-12). Wohlwend (2009a) captured an interesting case in which a girl improvised a make-believe telephone out a plastic carrot, held it against her ear and pretended to make a call when all the toy phones in the kindergarten were in use. A plastic carrot (or a banana) can provide more affordances in this case than, say, a plastic apple as it bears an iconic resemblance to a cell phone. These examples illustrate that the relation between the form (available materials) and meaning children assign to it is not arbitrary, but motivated. "Children emphasize certain modes or choose materials for their sensory qualities to make their signs more effectively represent their intended meanings and carry out their social purposes" (Wohlwend, 2009a, p.124).

Play not only involves the design of a prop or props that can mediate the expected pretending, but it also engages bodies in the corresponding physical actions that assign a new meaning to it/them. In the example above, we can see that the meaning of the plastic carrot was transformed into a cell phone when the girl was pretending to make a call. Although the iconic resemblance may suggest the possible improvisation, it is her following actions—holding it to her ear and pretending to chat—that allow a decisive interpretation of the meaning of the proxy, and therefore finalize the transformation. In another example (Wohlwend, 2009a), a boy has just made a flip phone out of a folded piece of paper with necessary details to signify its iconicity. "Additional phone features (receiver, compact size) were emphasized by adding play actions: he held the opened paper flat in the palm of his hand, raised his hand to his ear, talked into the paper for a few seconds, then snapped it shut with one hand, and tucked it into his pocket (p.125)."

These play actions with which young children create props, animate toys and pivot meanings are referred to as action texts (Wohlwend, 2013, 2017): “Action text describes the meanings that movements take on when children play as they act out a shared narrative: sometimes using talk to clarify the pretend meaning of a prop, but often also using actions and gestures to pretend alternative meanings for everyday objects” (Wohlwend, 2013, p.106). Action texts are also motivated: “it is through play that children foreground particular potential meanings of artifacts while backgrounding others, by adding physical play actions, talk, and sound effects that make one meaning more relevant (p.112).”

In play, children are not alone and free in their own imaginary worlds. They are inevitably situated in the real world of consumerism as a targeted demographic with toys designed for them. Now, with the advances in digital technologies, the concept of toys has also expanded to include the virtual worlds, online games and hybrid virtual and material artefacts (Marsh, 2010; Carrington, 2003, 2012; Rowsell & Pahl, 2007; Wohlwend et al., 2011). Despite the various media through which the toys are presented, they are considered texts of popular culture which is different from the traditional texts of childhood that allow children to live the world vicariously through their imagination. Instead, these texts of popular culture are pedagogic in the sense that they talk directly to children, construct what a childhood should be, set stereotypical social roles for girls and boys, and display available identities and lives (Carrington & Hodgetts, 2010; Black, Korobkova & Epler, 2014). What concerns the researchers of these popular texts the most is that these virtual worlds create for young children a “literacy-lite” learning environment, which is “static and controlled; a literacy that takes place online but does not reflect any of the powerful identity and community practices with text made possible via

Web 2.0…. There is no depth, no diversity and no dynamism" (Carrington, & Hodgetts, 2010, p.681).

Contrary to the bleak world of literacy-lite, observers of children's play always find another textual landscape of rich identity texts, as was first made manifest by Marsh (2005): "media-related performances of children were not used simply to replicate stereotypical, hegemonic versions of gendered identities, although of course this was a predominant feature. At times, children resisted the normalization process and presented contested and transgressive models of gendered practices" (p. 43). Wohlwend (2009b) suggested that we look at commercially produced toys as artifacts with "anticipated identities: identities that have been projected for consumers and that are sedimented by manufacturers' design practices and distribution processes" (p.59). By examining the myriad ways in which young girls in a kindergarten engaged Disney princess dolls to craft more agentic storylines and roles in their literacy practices, Wohlwend argued that literacy play is a process of productive consumption of these anticipated identities in toys and commercial media through which children both reproduce and revise these available identity texts based on their interests here and now informed by peer and classroom cultures, resulting in newly formed sedimented identities (Rowsell & Pahl, 2007). Similarly, boys with shared love of Disney princesses animated dolls to enact their favorite narratives and negotiated identity texts of the toys (Wohlwend, 2012). However, it was observed that even though the boys' playing with princess dolls challenged a social stereotype of gender that constructed girls as appropriate doll players, the masculine/feminine hierarchical relationships were still maintained by the boys' excluding of girls from their play and by the boys' appropriation of princess dolls with anticipated identities for enacting rough-and-tumble fighting scenes valued by other boys.

2.5.3 Embodied and Emplaced Knowing

Drawing on ethnographic data from ongoing research with toddlers and their families in museums, Hackett (2014, 2016) draws attention to the walking and running of young children as a key element of their multimodal communicative practices. What seemed to be random movements like walking and running of young children turned out to be communicative practices in an embodied, emplaced and experienced world. Their wayfaring not only enabled them to learn about layout, routes and material aspects of the museum, but also enabled them to attach meaning to particular locations and therefore led to the development of shared traditions. When the children walked and ran together in the museum, they created shared embodied ways of being in the space. This coming to know the place was reflected in how the children moved around the place on later visits, particularly through the development of and modification of embodied traditions in specific locations around the museum.

Bengochea, Sembiante, and Gort (2018) revealed how Anthony, a four-year-old emergent bilingual child accessed a variety of modes to participate in literate discourses in complex and varied ways in an early childhood dual language program. He could skillfully switch between two strikingly different configurations of the verbal (e.g. monolingual languaging versus translanguaging; varying sentence types), visual and actional modes (e.g. actual versus signified use of artefacts) in correspondence with his play purposes and collaborators. His multimodal versatility reflected his embodied and tacit knowledge of the existence of different subcultures, affinity groups and power relationships overlapping in the space.

2.6 Connection to Museum Pedagogy Study

Museums have not been considered a traditional literacy space. Both design for and research of children's leaning in museums have been heavily influenced by various strands of

developmental and psychological theories (Andre, Durksen & Volman, 2017) grouped under two dominating paradigms— the constructivist, and sociocultural paradigms (Crowley, Pierroux & Knutson, 2015). The study of children's meaning making in museums from a literacy perspective (e.g. Hackett, 2014, 2016; Hackett & Somerville, 2017) is a relatively recent phenomenon and these studies have been mainly concerned with individual visitor's experiences. Therefore, my study of museum pedagogy is still exploratory. It is the first time to see pedagogy as the organization of space, interactivity and interaction in the narrative, performative and simulative spaces of an exhibit. Nevertheless, I find myself empowered by the collective pioneering work of early literacy scholars that have evolved the notion of multimodality as it is related to space, materials and bodies. These insights, together with the theoretical and methodological visions gained from other approaches to multimodality, such as geosemiotics and conversation analysis, enabled me to approach the intimidating complexity of the learning environment of a museum.

Chapter 3 Methodology

From 2018 Fall to 2019 Spring, I had the opportunity to work as a research assistant in a project[3] that studied how young children learn STEM concepts through embodied literacies at a Doc McStuffins exhibit. This is when and where the study that cradled my dissertation began. In this chapter, I will describe the research context (Section 3.1), how the data was collected (Section 3.2), how I organized and understood the data (Section 3.3) and the analytical frameworks (Section 3.4) I am going to use to analyze and present my data that result in important findings in the following chapters.

3.1 Research Context

The site for this study was a Doc McStuffins exhibit in one of the largest children's museums in the Midwest. The exhibit was modelled after the Disney Junior's Peabody Award-winning *Doc McStuffins*, an animated television series about a six-year-old African American girl, Dottie "Doc" McStuffins, who communicates with and heals stuffed animals and broken toys in her backyard playhouse which she refers to as the Magical McStuffins Toy Hospital. Featuring the McStuffins Toy Hospital environment, according to the Exhibit Concept Overview[4], the exhibit was designed to immerse children and families in the Doc McStuffins universe of stories and characters and to offer families with 2- to 6-years-olds an opportunity to explore the hospital, assume doctor play roles, and help solve problems. Through imaginative play and hands-on activities, children learn important life-lessons about health and wellness.

The exhibit was composed of four major health-and-wellness themed sections, namely, Nursery, Pet Vet, Emergency Room (ER), and Operating Room (OR), with each section hosted

[3] The PIs for the project were Dr. Karen Wohlwend and Dr. Adam Maltese at the School of Education in Indiana University Bloomington.
4 Available at https://dktix1rrcd7mv.cloudfront.net/legacy/Documents/Exhibits/DocMcStuffinsOverview9-2016.pdf

by Lambie, Stuffy, Hallie and Doc McStuffins, the four main characters from the Doc McStuffins TV series, respectively (Figure 3.1).

- Nursery: Visitors are welcomed by a Lambie cutout at the entrance of this section. Families are invited to participate in activities that encourage the use of empathy and the practice of nurturing behavior to care for others. The designed interactives include Naptime Routine, Flicker Firefly Nightlights, Bath Time, Diaper Change and Feeding. Children are expected to learn how to keep babies healthy through the nurturing practices: tucking them into bed, singing lullabies, comforting them properly, feeding and cleaning them.
- Pet Vet: Pet Vet is a vet environment hosted by Stuffy that delivers messages about the special kinds of care and attention that pets need. Interactives include CAT Scan Check-up, Bath Time and Grooming, Toy recharge, Fish Tank Cleaning, Feed toy Fish, and Pet Shelters. Children are encouraged to learn to take care of their pets by feeding them properly, keeping them neat and clean, and taking them to the vet for a regular checkup.
- Emergency Room (ER): ER is hosted by Hallie, who appears in the space as a 2D graphic cutout. Children are invited by Hallie to assist with the treatment of toy patients with an array of toy medical instruments. Interactives include Check-up Station, Big Book of Booboos and Sewing Seams. White lab coats of different sizes are also offered for children to put on so that they can play doctors. Children are expected to learn ideas such as everyone needs regular checkups, doctors use different tools with special purposes to see if one is healthy and doctors keep records of patients to monitor their health.
- Operating Room (OR): OR is also hosted by Hallie. Interactives in OR include Scrub Sink, Toy Operation and Air Pump with Toy Operation as a major feature. The operation

table is designed in the shape of a lying toy dinosaur with its inside parts to be fixed. Children are to follow the step-by-step instructions given by Doc from the video screen above the table and conduct the “operation”. The design is trying to send out the message that sometimes doctors need to fix one of your inside parts to help you feel better.

In addition to the main interactive sections, there is a theater that plays the Doc McStuffins TV series and a classroom that serves as a pretend training school for hospital assistants.

Figure 3.1 The Four Interactive Sections of Doc McStuffins: The Exhibit

3.2 Collecting the Data

Strictly speaking, the data on which my research was based was collected before I began the study. As the data collection process was captured by the GoPro cameras, I can reconstruct the process as an integral part of method description. A total of 44 children in 40 families participated in the study. There were 27 girls and 17 boys ranging from one to eight (mean age: four years and one month). They were recruited at the entrance of the museum exhibit on a voluntary basis. Age-appropriate language was used in order to explain to the children why they were asked to wear a camera. Toddlers were told that the camera could help take pictures while they were playing and older children were explained that the camera could help find out what might interest them, how they played in the museum and how much they enjoyed the play. When parents were signing consent forms, child participants were assisted with the GoPro camera and very briefly interviewed for their age, gender, and to see if they had watched the television series.

Parents were informed that if their children feel uncomfortable wearing the camera, it was quite alright to stop participation at any time so that their experience would not be compromised by the awkwardness of wearing a camera. But every participating family was supportive and cooperative, and no children reported discomfort wearing the camera. Instead, sometimes when the participating children or other visitors asked about the camera, the parents being asked always explained in a way that deeply moved me. They would often explain to their children that it's cool to help collect information for scientific research and to other inquiring adults that this was for a research project conducted by Indiana University.

This data collection method produced the major data source for my study: videos. Children's visits averaged about 30 minutes in length. While wandering in the exhibit, children

wore chest-mounted GoPro cameras that recorded their handling of toys during play, their movements around the museum, their pretend conversation with toys as well as their talk with siblings, parents, or docents and other visitors in the museum. Three cameras malfunctioned for various reasons and one family dropped out a few minutes later, reducing the number of footages to 40, totaling about 20 hours of data. Other sources include:

- Interviews. The brief interviews for children's prior knowledge of the Doc McStuffins TV series were also captured by the GoPro cameras after they were attached to their wearers before the visits embarked. For younger children (2- to 3-year-olds), parents often answered or assisted them in answering, when the children did not respond in the first place. The set of questions include: How old are you? Are you a boy or girl? Do you know who that is (with the interviewer pointing at the Doc McStuffins' cut-out at the entrance)? Do you watch Doc McStuffins? A lot or just a little? Who's your favorite character?
- Photos of the exhibit. There are altogether seventy-five photos of the interactives, signages, and the environment.
- PDF files of the developers' ideas about the exhibit provided by the museum. These files specified visitor goals, developer's objectives, anticipated family interactions and exhibit interactives and environment.

3.3 Knowing the Data

3.3.1 Revisit the Field through First Person View

GoPro cameras provided me with a special view to revisit and reconstruct the field. They not only offered excellent video quality at a wide angle of view, but also reliably recorded clear audio sources such as children's dialogue with their parents, background music and speeches

made by docents nearby. Compared with the handheld cameras used by researchers to follow participants, GoPro cameras turned out to be less intrusive and therefore less likely to compromise visitor experience (Canton & Hackett, 2019; Burbank et al., 2018), as it was reported that an awareness of being observed can affect behavior in a number of ways (Merriam & Tisdell, 2015).

Always being attached to the participants in one way or another, GoPro cameras record images from precisely a new physical perspective, which has been established in the existing literature as a first-person perspective. Contrary to the claims that wearable technologies can offer more holistic and less researcher-centered biased perspective (Green, 2016; Burbank et al., 2018; Harwood & Collier, 2019), I sided with Pink (2013, 2015 a, b) who suggested considering first person perspective as a new form of digital visual and sensory ethnography with shifted researcher subjectivity and situatedness. This involves situating first person cameras as part of and emergent from "ethnographic places" (Pink, 2015a), acknowledging that we and cameras are part of an ongoing world of movement, and using the senses, affect and perception to understanding the ways that other people experience. Even though such kind of alignment may bring a new form of closeness into the research process, Pink maintained that "this would not bring the researcher closer to being able to achieve a view that is less biased," "but rather implicates the role of the researcher/research technologies in a rather different way, which means that the site, nature and quality of researcher-camera-participant intersubjectivity shifts, and this is one of the relationships that needs to be reflexively explored (Pink, 2015b, p.246)."

As a new form of digital visual and sensory ethnography, GoPro cameras produced videos that were methodologically meaningful and analytically supportive for me to understand children's multisensory experiences and the moment-by-moment construction of pedagogies

through embodied interactions. The bodiless constant-moving footage allowed a visual extension of my body into the flow of spaces, objects, noises, voices, music and people. This unique perspective enabled a view of children's intricate hand movements and how they handle the child-sized exhibit elements, which could be invisible without this technology (Figure 3.2a). This perspective was found to be especially illuminating when the exhibit elements were small and intricate. The angle of the camera also turned out to be particularly helpful when it came to face-to-face interactions. In this case of child-educator interaction (Figure 3.2b), the camera catches the facial expression, gazes, gestures that are in line with the educator's verbal expression and the child's hand movements, which provided abundant information for my detailed data analysis (see Chapter 6, Example 6.3).

a. b.

Figure 3.2 First-person view of interaction

Even though the knowing of the data was an ongoing process that continued well into my dissertation writing process, the preliminary effort to know the data can roughly be divided into three phases based on systematic observations, which I call general observation, organized observation and targeted observation. This observation system helped me construct an understanding of my data like a mind map composed of dots, lines and finally a dimension. When I was inspired by David Dernie's (2006) idea of narrative, performative and simulated

spaces that gave this dissertation a structure, I know instantly where to find data to flesh out the skeleton.

3.3.2 Phase One: General Observation

The first phase of my data processing was characterized by familiarization of the data by a general observation and reflection. During the first few weeks, I viewed every episode of video and took detailed notes about what each child does at each exhibit element. At the same time, I kept a research journal to document what I considered interesting and important moments from observation, such as an interesting remark a child makes, a problem a child learns to solve, a parent-child pretend play scenario, and so on. I also logged my reflections. This is an example from my journal (Figure 3.3):

9/11/2018
A 3-year-old boy (62m3) learned to deal with objects at the exhibit that involve different levels of technology design. If put into perspective in line with the difficulty level, these three incidences of material negotiation can provide great insights into the meaning of technologies in children's learning activities.

Location	*Technology in design*	*Boy's negotiation*	*Parent's assistance*
Fish feeding	*Wood, glass, overlapping slops, plastic balls*	*Insert the balls into the holes, examine the movements of the balls, wait till they drop, repeat the process several times. Results and feedback of his initiation of movements can be easily obtained.*	*No assistance*
Cribs & Firefly	*Electricity, circuits, switch, lights*	*Deeply engaged with the switch, flip it for multiply times, observe the change of lights*	*Father reading the instruction and explain: "so the red light means it's napping."*
OR	*Screen, computer programing, buttons, following three procedures*	*Difficult to figure out for the first two times, succeed in the third time, learned to follow the instructions to complete the "operation"*	*Both parents involvement*

Figure 3.3 A glimpse of my research journal

3.3.3 Phase Two: Organized Observation

After gaining a preliminary understanding of the data, I decided to make a more organized observation. I was interested in how children of different ages and gender were engaged differently, their preferences of certain locations or objects, and the way they deal with objects. Demographic and background information were extracted from the videos about children's age, gender, the duration of their visit, whom they were visiting together with, whether they could identify Doc McStuffins or not, whether and/or how they interact with the Pet-X ray machine. I used spreadsheets to organize this information (Figure 3.4). I organized the videos according to children's age and gender, made each child participant identifiable by a serial number that includes their age and gender, and assigned each of them a pseudonym.

						TV	Doc ID	checkup?	what?	Pet X?	Scan?	treat?
	Child ID	age	Sex	demographics								
1	83f1	1	f	F, M, C	slides; ball-feeding, climbing							
2	24f2	2	f	M; C	go potty; two babies	Y	Y	Y	doll	N	N	
3	31f2	2	f	GM; C	hungry girl who didn't enjoy herself	Y	Y	Y	parent	N	N	
4	74f2	2	f	M;GP; C; YS	Ouch! Oh! busy girl having a lot of fun					Y	N	
5	84f2	2	f	F;M; C	not interested in nursary; prefer balls					Y	N	
6	21m2	2	m	M; C	bandaid boy					N	N	
	2YO AVG											
7	111f3	3	f	M, C						Y	N	
8	21f3	3	f	M, GM, C, OS	doll checkup	Y	Y	Y	doll	Y	N	
9	61f3	3	f	M, GM,C, YS	All baby, bib, bottle; cry			N	No	Y	N	
10	62f3	3	f	M; C; YS		Y	Y	Y	doll, Whispers	N	N	

Figure 3.4 A portfolio of participants

Observation organized in this way enabled me to see developmental differences between children of different age groups and how these differences influence the ways in which they interact with exhibit elements. For example, almost no toddlers displayed any interest in the Pet X-ray machine and the Toy Operation. Even though these devices were more complicated in design, the operation of these devices limited the possibility of creative play. Play with these exhibit elements was lineal, prescribed and close-ended. On the contrary, the Fish Tank (with

balls, water buckets, faucet) and Fish Feeding were very popular with young children. These interactives offered reversibility, repetition, observable changes, and instant feedback to initiation of actions. The dolls and their accessories like bibs, blankets, milk bottles and clothes could always keep girls engaged. So were other objects like otoscopes, blood pressure measuring cuffs, and scissors. Children were busily and repetitively applying one object after another. These objects allowed them endless possibility for physical configuration and meaning negotiation. The five-year-old group can still be engaged by single objects like dolls, horses, puppies and brushes. But they all displayed a better communicative ability with exhibit elements that involved complex systems and multimodal interactive interfaces, like the Toy Operation and the Pet X-ray. Children of this age group were able to focus their attention on the visual and audio prompts made by the machine, follow the directions and find solutions accordingly.

This stage of observation enabled me to see the importance of an inclusive and age-appropriate pedagogy in children's museums, which is both necessary and challenging for museums as they serve the most diverse population in terms of developmental stages. The same exhibit elements can be interacted with in different ways by children of different age groups. Parent's mediation can also make a difference with respect to the degree of children's engagement and meaning negotiation. The understanding of children's behaviors based on these observations shaped my research focus on the construction of differentiated instruction that involves designers, parents and educators who can work together to meet the needs of children of different ages.

3.3.4 Phase Three: Targeted Observation

After the first two phases of more general observations, I wanted to target my observation to find out about how and how much children demonstrate their knowledge of medical check-up

and care giving as was expected by the design of the exhibit. Do they use the toy medical instruments for check-ups or for other self-created ways of tinkering? Do they play with the exhibit elements as expected or not? What are children's favorite places and what do they do there? How and how much do parents facilitate children's learning?

For the targeted observation, I designed three coding schemes with my video analysis software Studio Code (Figure 3.5).

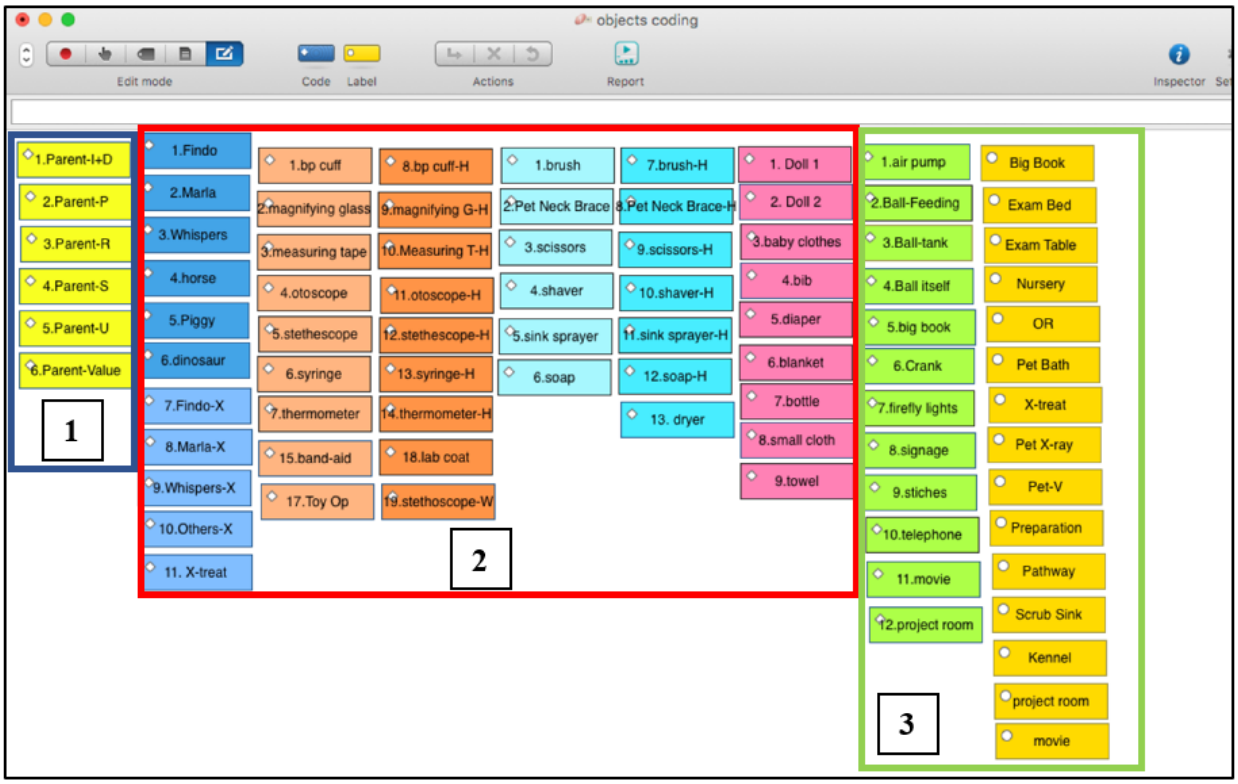


Figure 3.5 Coding scheme

The first scheme is composed of codes developed over time based on the previous observations of the different ways in which parents interact with children. The second scheme was used to see whether children use the toys as expected. For each type of toy instrument, e.g., an otoscope, I assign a pair of codes as "otoscope" and "otoscope-H", meaning "children use the otoscope for check-up" and "children use the otoscope for other purposes or just hold it". Similar

codes were assigned for the stuffed animals (by the name of Findo, Marla and Whispers) designed as the pet patients to be scanned in the Pet X-ray machine. If children use them for scanning, the code is, for example, “Findo-X”; if not, “Findo”. The third scheme was used to measure how long and how often children stay at one exhibit station or element to find out children’s favorite places.

Here is a sample of the coded timeline of a video episode (Figure 3.6):

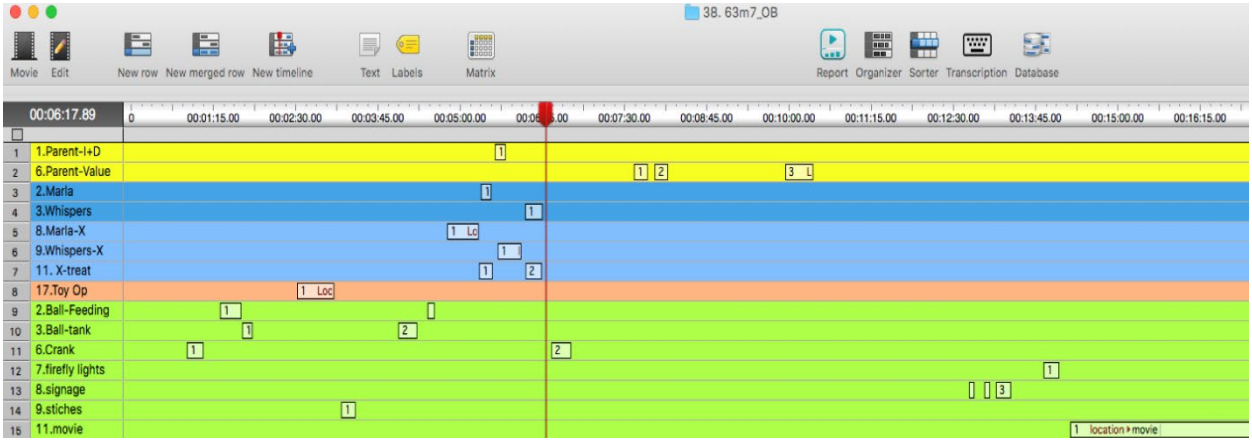


Figure 3.6 Coded timeline

From this sample, we can see that the child spends most of his time in the Pet Vet area, going around and briefly trying everything during the first five minutes. He scanned two “pet patients” (Marla and Whisper) as he plays with the Pet X-ray machine. But most of the time, he does nothing. This is typical for children six years old or older, who always go with younger siblings to the exhibit, but are less intrigued by the exhibit elements than younger children, as is shown by the coded timeline. From timelines like this, I get to know how visitors distribute their time, which exhibit section or element engages children the most, and what they do while they are visiting certain places. Are they engaged by objects or not (as the above sample shows)? These measurements are important for claims of the effectiveness of the design of the pedagogy as it involves space, materials, technologies and parent involvement. For example, children

spend much more time in areas like the Pet Vet and the Nursery than in other areas like the Theater, or the Operation Room, due to the material multiplicity available in the former areas. While parents may demonstrate different degrees of engagement in their children's activities in the self-directed learning areas, the synergy created by group instruction in the Feel-Better Training Center engaged both parents and children and therefore increased parents' involvement in their children's learning. Families that participated in the training program stayed longer at the exhibit than families that did not. Even though my study is not a quantitative one, the descriptive statistical information garnered by coding provided me with a solid basis for claims of pedagogy efficacy and a filtering mechanism for further qualitative analysis of, for example, the technology-mediated pedagogy (chapter 5).

3.4 Data Analyzing Approaches

As my data involves an array of multimodal texts, including spatial texts, visual texts, embodied human-object interactions and human-human interactions, I need to have corresponding multimodal data analytical tools at hand for different text types and different analytical purposes. I employed two major multimodal discourse analysis approaches, the social semiotic approach and the conversation analysis approach, each being widely used in studies of teaching and learning. I will use the social semiotic approach for spatial and visual texts analysis (primarily in chapter 4) and conversation analysis for embodied interaction analysis (in chapter 5 and chapter 6). I will elaborate on the two approaches and the sub-approaches under them which are relevant to my data analysis.

3.4.1 The Social Semiotic Approach

Unsatisfied with the monomodal language-centered paradigm of communication, Kress and van Leeuwen (2001) sketched a multimodal theory of communication in which

communication is conceptualized as practices of both representation and interaction to show that meaning is made through a multiplicity of different modes and media through four layers of practices: discourse, design, production and distribution. Discourses are defined as socially constructed forms of knowledge about aspects of reality that include the events constituting that reality and a set of related evaluations, purposes, interpretations and legitimations. When people are confronted with several alternative discourses with respect to a particular aspect of reality, they tend to use the one that is most appropriate to the interests of the communicative situation at hand. Designs are conceptualizations of the form of semiotic products and events through which discourses are formulated. Production involves the material articulation of semiotic products or events, which further adds meanings by the physical process of articulation and the physical qualities of the materials used. Distribution refers to the technical 're-coding' of semiotic products and events which were not believed to produce meaning. However, as Kress and van Leeuwen argued, in the age of digital media, the function of production and distribution become technically integrated to a much greater extent so that distribution technologies "begin to acquire a semiotic potential of their own (p.21)."

3.4.1.1 Spatial Texts Analysis

Seen through the lens of multimodal theory of communication, Doc McStuffins' exhibit is a meaning making process as a result of educational, managerial and sociocultural discourses, conceptualized by designers and materialized through production in the children's museum and later distributed throughout the nation as it travelled among different children's museums (even though the meaning added through distribution is not a concern of this study). In order to locate the discourses that inform this exhibit in the material place, I need an analytic approach that deals with the interactive dynamics of signs, people, actions and space. Geosemiotics (Scollon &

Scollon, 2003) is such an approach that analyzes semiotic systems among which humans take actions in the world. Any and all social actions take place at some intersection of these three elements: ***interaction order*** (the ways in which humans form social arrangements and produce social interactions among themselves), ***visual semiotics*** (the design, layout, and production of all the signs, picture, books, newspapers, posters and other images which are either being used by the interaction order or being ignored by them) and ***place semiotics*** (the built environment along with the 'natural' landscape within which the action takes place). These specific analytical perspectives allow a further unpack of what Kress and Van Leeuwen (2001) have envisioned in their multimodal theory of communication that in the meaning stratum of design, three things are designed simultaneously: "(1) a formulation of a discourse or combination of discourses, (2) a particular (inter)action, in which the discourse is embedded, and (3) a particular way of combining semiotic modes (p.21)". As a complicated "site of engagement" (Scollon, 2001), the Doc McStuffins Exhibit is a place where discourses converge. Geosemiotics also offers three principles to see through the dynamics of these discourses, namely, the principle of *indexicality*, *dialogicality* and *selection*.

To understand how people perceive designed spaces, I also adopt *spatial discourse analysis* (Ravelli & McMurtrie, 2016; Stenglin, 2004, 2008, 2009), in which the built environment, a synthesis of building, space, content, and users, is analyzed as *spatial text*. This strand of multimodal discourse analytical method aims at providing a critical analysis of the designed spaces in terms of how the multimodal resources that constitute the space combine to make meaningful texts. It is argued that like language, the spatial text has three meta-functional meaning potentials: the representational, interpersonal and organizational meaning. Representational meaning refers to "what something *is*, what it is *about*, what it is *for*…Choices

in representational meaning help build a sense of the world around us, what it consists of, and how users might participate in it" (Ravelli & McMurtrie, 2016, P.6). Interactive meaning refers to the kind of feelings a built environment creates for people: a place may feel overwhelming or inviting. Organizational meaning refers to the different meaning created by different ways to organize a spatial text.

3.4.1.2 Multimodality and Learning

The social semiotic approach to multimodality has been widely used in studies of learning activities. Bezemer and Kress (2016) expanded the social semiotic theory to learning analysis. They challenged the traditional conceptualization of learning as the linear transmission of knowledge, broadened the scope and effects of learning, and re-examined the taken-for-granted power relation in environments of learning and teaching. In this framework, learning is a more encompassing phenomenon that arises from every engagement with the (socially made) world than that in the school environment. Learning is reconceptualized as the outcome of *transformative engagement*—a term that highlights the creative and agentive aspects of learners/sign-makers, who are believed to be capable of selecting all the apt semiotic resources available to them that represent their interest and partiality.

A major concern of the social semiotic frame of learning is the demonstration of learning, or the relation between learning and sign making. "Each trace of semiotic work demonstrates learning: every sign and every sign complex is a sign of learning, regardless of whether and to what degree others—guides or instructors—are there to shape the learner's engagement (p.61)." The analytic focus of signs of learning is on modes that define engagement in and interpretation of learning. In the examination of learning, not only do we examine modes as an indication of engagement, but also trace meaning making as a result of the changes made in or between the

modes—transformation and transduction respectively, two terms created and defined by Kress (Kress, 2000, 2010, Kress & Van Leeuwen, 2001, Bezemer & Kress, 2016) to capture the essence of the semiotic change, or semiosis, a ceaseless and ongoing process that characterizes the modern communicational landscape where the re-articulation of meaning will invariably give rise to the change of representation. It is therefore necessary to distinguish two categories of semiotic change: "In one kind, change occurs within the same mode: we use the term 'transformation' for that. In the other kind, change occurs across modes, in a shift of semiotic material from one mode to another: we use the term 'transduction' for that (Bezemer & Kress, 2016, p.53)." These two terms are in turn put under a superordinate term "semiotic change" or "translation" (Kress, 2010, p.124). Investigating these semiotic changes is very important to the study of learning as all such changes, be it inter- or intra-modal, produce new meanings so that a new domain of learning is constructed. The social semiotic approach to learning has oriented our attention to the important roles played by semiotic resources and especially by semiotic transformation and transduction in meaning making and learning.

3.4.2 The Conversation Analysis Approach

For a closer examination of embodied human-human and human-machine interactions, I will use ethnomethodology/conversation analysis to understand how mutual understanding or intersubjectivity is achieved. Intersubjectivity as a major cornerstone of cognition in human interaction has witnessed a series of re-specifying efforts dated back to Garfinkel's (1967) challenge to the known-in-common social conventions or behavioral norms posited by the cognitivist trend of social sciences in an attempt to account for mutual intelligibility and social order. In the normative paradigm, a cognitive consensus built on an eternal invariant structure of rules that govern social actions is what maintains the stability of the social world. This cognitive

agreement is provided by the assumption that the actors share a system of culturally established symbols and meanings. Garfinkel turned this view upside down. Instead, he argued that every instance of meaningful action must be accounted for locally and specifically for its significance. Consequently, he recommended for social studies the processes through which particular, uniquely constituted circumstances are systematically interpreted so as to render meaning shared and action accountably rational.

Inspired by Garfinkel's ethnomethodological discussion of mutual intelligibility, Sacks and Schegloff, the founders of conversation analysis, highlighted implications for understanding cognition from conversational organization. As a departure from the then dominant cognitivist attempt to work out what entities and processes may underlie language as a prerequisite for mutual understanding, Sacks (1992a, b) focused on the practicality of talking and issues like how language can be learnable and understandable in interaction. It is argued that conversationalists make sense of each other through what is visible and/or hearable in interaction and talk is recipient-designed to coordinate understanding. Cognition (such as mind, thoughts, intentions and so on) are therefore relevant to, and involved in, interaction in terms of their current hearability in the interaction itself. Attention has been given to structural devices such as collaborative utterances that display a particular shared understanding and second storytelling that shows, rather than claims, an equivalent experience to the first story.

One of the central features about conversation highlighted by Schegloff (1991, 1992) is the way that the turn taking system of talk is fundamental to coordinating understanding. Challenging the cognitive science picture of shared knowledge as equivalent to two computing minds with the same memories, Schegloff developed a procedural sense of shared knowledge based on display of understanding managed in talk-in-interaction: "The defense of

intersubjectivity is interactional and sequential, coordinating the parties' activities in achieving a joint understanding of what is going on and how those events might have been incipiently misunderstood (1992, p.1338)." For example, there are structurally provided places (like the third turn repair place) where shared understanding can be defended in conversation, and there is no way for participants to check such understanding independently of those procedures.

3.4.2.1 Human-Machine Interaction

Suchman (1987) productively applied insights gained through research on face-to-face human interaction on human-machine interaction. Her seminal work illustrates how mutual intelligibility in human-machine communication is achieved by comparing the plan or the designing objective of an expert help system that guided users' operation of a copy machine and the situated actions of the users of the system in their efforts to accomplish certain copying task. Another comparison is also made between face-to-face interaction and human-machine interaction in terms of the access to semiotic resources. While humans can make use of a rich array of linguistic, nonverbal, and inferential resources in making their actions intelligible and sensible to each other, machines are designed only to respond to a fixed array of sensory inputs, mapped to a pre-determined set of procedures. It is this profound and persisting asymmetry caused by the disparity in their relative access to resources that limits the scope of interaction between people and machines.

This empirical study of human-machine interaction has two great analytical implications: First, it challenged the traditional cognitive psychology's conceptualization of goals and plans as pure pre-existing representational scheme constraining and structuring actions, favored, in her case, by the designers of "intelligent artifact." Second, it highlights the interactional nature of plans when they are involved in the moment-by-moment contingencies that constitute the

conditions of situated interaction and offers an alternative view of plans as resources for situated actions in a way that shopping list serves to help us do the grocery shopping, i.e., as something to be consulted to decide what to do next, what specific item to buy or to know when the shopping is done and so on. But a shopping list does not describe how to find the items, which aisles to go to get them or which brand is better. It simply prescribes the results of the shopping activity. Generally speaking, the work explored the relationship between plans and situated actions: Plans are efficient formulations of situated actions, while situated actions are processes by which efficient representations are brought into productive interaction with particular actions in particular environments (p.186-187).

3.4.2.2 Discursive Psychology and Cognition

Discursive psychology re-specified the traditional psychological constructs such as memory, attribution, cognition, beliefs, attitude and so on in terms of situated practices (Hepburn & Wiggins, 2005). The construct I am particularly concerned with in my analysis is cognition as shared knowledge or understanding. In a series of his works, Jonathan Potter (1998, 1999, 2000) argued that cognition should not be conceptualized as an absolute antithesis to an outward reality and as the putative inner entities and process that might be computing secretly within an actor. Instead, in discursive psychology, cognition should be treated as "something that is formulated, worked up, constituted, and oriented to by participants (1998, p.40)" in action, which renders interaction "the fundamental site for studying (a re-specified) cognition." This is because in the course of their practices, people produce versions of reality and of cognition that make their actions accountable. The re-oriented focus on interaction and practices leads to an inversion of the intellectual tradition in cognitive psychology, in which cognition and its stimulating

conditions (often described as the setting) are considered as a system, working together as the primary source for social activities--an epiphenomenon of cognition.

With cognition thus re-specified, the issue of shared knowledge and intersubjectivity are approached as features of discourse in Edwards (1997). A range of devices through which participants work up, imply, formulate, and counter what is jointly known have been explored. These include indexicality as a general feature of language, linguistic structures such as grammatical completions, and "given" and "new" information, formulations of what has been said as jointly known or consensual. The major analytic move in these efforts has been to treat them as participants concerns, where "participants define what counts as given, new, agreed, just so, contextual, contentious, or 'common knowledge' (p.137)." What is targeted in this re-specification endeavor is the psycholinguistic approach to shared knowledge and the communication model of talk, in which shared knowledge is treated as intersection of mental contents, or information that participants actually possess in common, existing objectively within their respective minds prior to or after talks; communication is therefore visualized as a kind of inter-mental transmission of those contents and information. However, as is pointed out by Edwards, this seemingly simple picture of communication is "bought at the expense of loading the explanatory burden onto a private and underlying life of the mind (p.138)." This means that in order to solve the problem of intersubjectivity, we will have to rely on a variety of hypotheses and presumptions on the putative mental states of speakers and listeners. It is suggested that this explanatory burden can be reduced by a re-orientation of our focus on talk as action rather than communication and on the organization of talk.

3.4.2.3 Interaction Analysis and Learning

Interaction Analysis outlined in Jordan and Henderson (1995) and Halls and Stevens (2015) was a productive development of ethnomethodological and conversation analytic techniques in studies of knowledge production. As a repudiation of the typical social scientific approach to knowledge analysis that relies on pre-existing criteria and categories to measure knowledge but remains indifferent to what count as knowledge to participants in interaction, these pioneering works proposed an alternative view of knowledge as demonstrably relevant not so much to researchers as to participants. This opens new ways to see crucial aspects of knowledge evaluation, that is, how knowledge is displayed can be determined by and dependent on the interactional context of its display.

As a seminal work that has brought Interaction Analysis to the attention of the learning research, Jordan and Henderson (1995) differentiated Interaction Analysis from other kinds of video-based analyses by defining it as "an interdisciplinary method for the empirical investigation of the interaction of human beings with each other and with objects in their environment (p.39)" with a goal "to identify regularities in the ways in which participants utilize the resources of the complex social and material world of actors and objects within which they operate (p.41)." Thus, interaction is committed to a view of knowledge and cognition as socially situated and distributed in the interactions among members of a particular community engaged with the material world. Another widely shared assumption on which interaction is established is that knowledge can be displayed and observable so that it can be accessible and sensible not only to participants in their mundane interaction but also to analysts observing such interaction captured as videotaped data. These notions of knowledge have methodological consequences: this new method to investigate learning has therefore shifted its attention from the mental

representations of knowledge to "the details of social interactions in time and space and, particularly, in the naturally occurring, everyday interactions among members of communities of practice (p.41)." In order to capture those naturally occurring daily interactions, video technology has been widely used in collecting data due to its ability to reconstruct the event, reduce researcher's subjective fallibility, allow for repeated and multi-perspective analytic attempts and make data accessible not only to researchers alone, but to the readers of the reports. Hall and Stevens (2015) reiterated the basic commitment of interaction analysis perspective as an analysis of knowledge "in use," "in action," or "in practice" and further suggested two principles for knowledge analysis: member relevance and consequentiality. That is, when doing analysis, researchers should avoid imposing extrinsic categories (e.g., teacher/student, expert/novice), on participants but instead demonstrate the procedural consequentiality of the enacted membership categories during moments of interaction.

3.4.3 The Configuration of Analytical Tools

These analytic perspectives have a great impact on how knowledge is defined, identified and analyzed in interaction. They offer a particularly useful lens to look at knowledge production in complex and dynamic learning environments like museums that are shaped by space, time, materials, people and activities. Table 3.1 is a summary of how the analytical tools, with their analytical focuses, are employed in my data analysis to unpack how different pedagogies of the McStuffins exhibit are constructed.

Analytical Tools	Analytical Focuses	Analytical Purposes
Geosemiotics Spatial Discourse Analysis	Visual semiotics Place semiotics Interaction order	How pedagogy is constructed through the organization of space.
Conversation Analysis Human-Machine Interaction	Embodied actions as turn taking	How pedagogy is constructed through interactive designs.
Conversation Analysis Discursive psychology Interaction Analysis	Configuration of semiotic resources in the conversation	How pedagogy is constructed through adult-child interaction.

Table 3.1 Analytical approaches and purposes

Chapter 4 Pedagogy in Narrative Space

This chapter studies the organization of physical space as pedagogy in the narrative space of the Doc McStuffins exhibit. I will further explain the concept of narrative space (section 4.1) and address the first research question: How are spaces organized for pedagogical purposes? The question will be answered by analyzing the visual semiotics (section 4.2), place semiotics (section 4.3) and interaction order (section 4.4) of the exhibit. How effectively the exhibit communicates its teaching objective can be observed by how parents and children interact with each other.

4.1 Narrative Space

According to exhibit designer David Dernie (2006), the effectiveness of an exhibition display depends first on the way it is structured. In this respect, exhibition making is similar to storytelling. An exhibition conceived as a narrative is considered to be an affective form of communication and learning the same way a good story captivates the audience. Narrative space design is a departure from the traditional encyclopedic display of artifacts according to types or rigorous chronological order. It is characterized by a structure that gives the presentation coherence and consistency. The spatial narrative is created by thematic grouping of artifacts in dialogue with each other from which emerges a spatial arrangement for the show. Strategic planning is very important in the narrative space design. It involves the invention of appropriate movement patterns and viewing lines that emphasize the thematic relationships that are important to the overall narrative. Like a text, a narrative space allows for a great deal of flexibility in terms of differences of emphasis, levels of intensity, and the overall rhythms of the visitor experience.

It is important for any exhibition that wants to attract and engage a wider audience than subject-matter insiders. The lack of a story framework in which to place a concept or idea can be a serious barrier to getting the visitor's attention and interest (Redmond-Jones, 2007). This is especially true in children's museums and science museums as well, as a narrative space creates a backdrop of familiarity for visitors to have an easy access to content learning (Allen, 2004).

The Doc McStuffins Exhibit is such a narrative space that draws upon the popular TV show to augment its physical space and provide the young visitors with a backdrop of familiarity. According to *New York Times*[5], "Doc McStuffins" quickly became one of the most popular children's TV shows, running for five seasons and viewed by millions of children aged 2 to 5 after its first release in 2012. In 2016, the first episode of Season 4 reached more than four million children. The show was nominated for several Daytime Emmy Awards and, in 2014, it won a Peabody Award for children's programming. The brief interview with the children at the entrance bears this out. The majority of children could identify Doc McStuffins' cutout when pointed at and if they could not verbalize it, their parents would do it for them.

In the following sections, I will use a combination of geosemiotic analysis (Scollon & Scollon, 2003) and spatial discourse analysis (Ravelli & McMurtrie, 2016; Stengling, 2004) to examine the *visual semiotic* and *place semiotic* resources with which the exhibit design communicates its pedagogical intentions. I will identify the meaning potentials (representational meaning, interpersonal meaning and organizational meaning) of the spatial texts with spatial discourse analysis. With an interaction order analysis, an analysis of how parents and children interact in such a space as an embodied way of demonstrating their perception of the meanings of

[5] https://www.nytimes.com/2021/06/20/us/chris-nee-doc-mcstuffins-ridley-jones.html

this space, I look at how effective the communication is between the designed space and the users it serves as a triangulation of the self-evident aspects of meaning analysis.

4.2 Visual Semiotic Analysis

4.2.1 A Keynote of Fun

The keynote of having fun is intertextually established at the entrance--a transitional space (Unwin, 2009) that allows visitor to negotiate the space between outside and inside and move from reality to fantasy. The first exhibit element that families can see is the "Backyard Clinic" (Figure 4.1) that constitutes the entrance to the exhibit.

Figure 4.1 Backyard Clinic (Left: front view; Right: back view)

As can be observed, the element is placed between two walls on which are painted white fences and green meadows surrounded by trees and bushes under a blue sky and floating clouds. Visitors can see the familiar backyard clinic with a 2D graphic cutout of Doc McStuffins beckoning at the door. They can also hear the "Doc McStuffins" theme song. These representational elements constitute a spatial text that makes intertextual references to the setting in the "Doc McStuffins" TV series. According to the Exhibit Concept Overview, it is intended for children to recognize the Doc McStuffins character and make a connection between this space and the backyard clinic from the ongoing television show.

As expected, most children come into the exhibit world through the slide. Not only does the slide serve as an entrance to the exhibit, but it is also believed to have developmental functions. Early designers for the Boston Children's Museums (Hansen et al., 1987) observed that slides could provide developmental practice of crawling, walking, climbing, exploring and taking turns. In addition to these functions, the slide is also symbolic, which means it connotes something beyond itself. Slides are usually an indispensable feature of a children's playground. Thus, by such a representational choice, designers are making an intertextual reference to a playground of fun and lightheartedness, which is believed to be conducive to learning. Based on years of observation and evaluation, Hansen and his colleagues suggested that a popular climbing structure installed in the lobby breaks the ice for first-time visitors and indicates dramatically that the museum is fun. They further reason that in designing children's museums as effective environments for learning, it is important for visitors to be able to relax and enjoy themselves: "if visitors are able to relax and enjoy themselves, they are capable of perceptions and insights related to our thematic concerns and materials that meet or exceed our goals" (p.10). The fun is further reinforced after children pass though the slide and into the "Toysponder Portal" where they would be showered with dotted purple and blue lights cast from above which create a mysterious and fictional atmosphere.

The representational meaning of the Backyard Clinic suggests having fun and it tries to send out a message of invitation to children. This is exactly how children respond to this design. They are often observed lingering in the toy house, or running in and out, playing with peers. In considering the interactional meanings for its users, it is interesting to note that this exhibit element helps minimize the institutional power at the entry to a great extent in terms of spatial design (Ravelli & McMurtrie, 2016). Exhibit halls usually have great height, which can create a

dominating effect for visitors, especially young children, while the backyard playhouse reconstructs the vertical plane by creating an intimate space for children when they choose to pass it either through the slide or the small front door. Beside the door stands a Doc McStuffins' cutout, about the height of a 5-year-old. This feature further positions the interactants (institution and users) at the same level on the vertical plane, creating a sense of equality. Organizationally, this entry piece provides introductory information that will help visitors acclimate themselves to the exhibit storyline and space. On the door of the playhouse (backyard clinic), a sign displays the message in Doc's voice: "*My toy friends need your help! Today I have to stay at my backyard clinic. Will you go to the McStuffinsville and help Lambie, Stuffy and Chilly at the Toy Hospital*?". The message and the Doc McStuffins cutout form a Speech Process (Kress & van Leewen, 2006) that establishes the exhibit premise and defines the visitor's role in the space.

4.2.2 Thematic Grouping

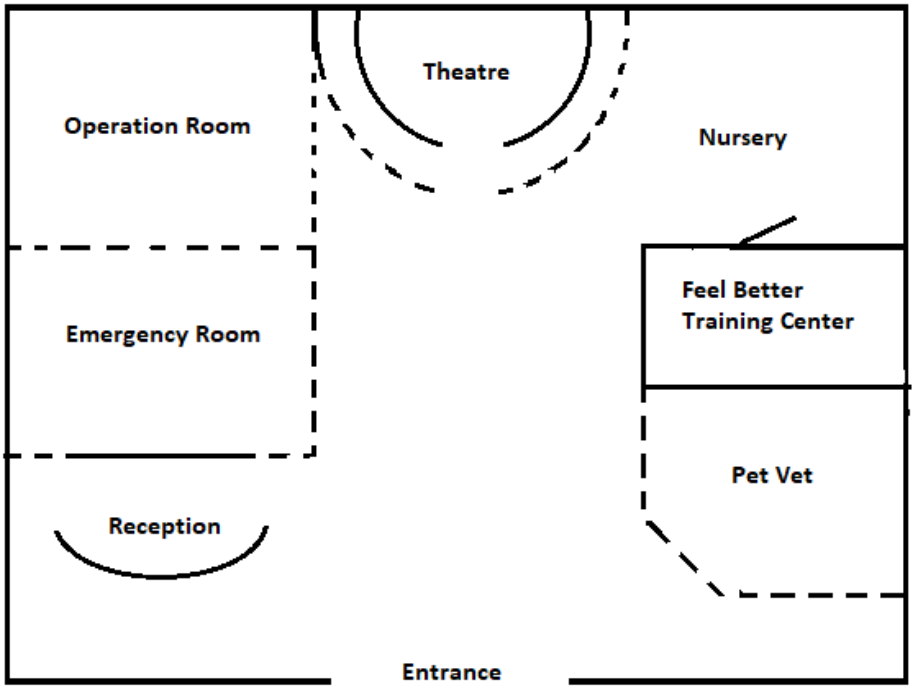
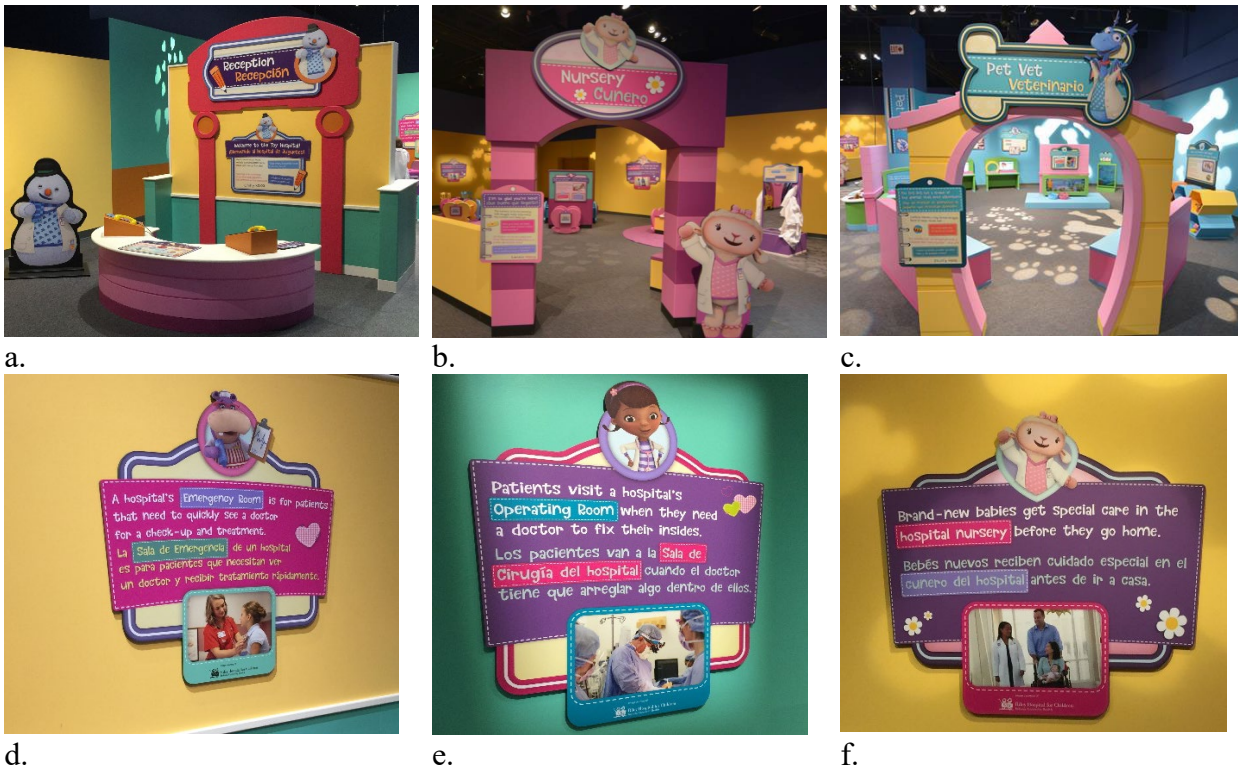


Figure 4.2 Floor map of the exhibit

The McStuffinsville toy hospital premise provides the thematic structure for the spatial organization of the exhibit. Notably, the five major characters in *Doc McStuffins*--Chilly, Hallie, Doc, Lambie and Stuffy are put in charge of the five hands-on sections organized clockwise in the space: Reception, Emergency Room (ER), Operation Room (OR), Nursery, and Pet Vet (Figure 4.2). This design ideal is represented by several features: A 2D graphic cutout of the character in charge is set at the entrance of the section or an image of the character is displayed on top of the arched doorway (Figure 4.3 a, b, c); A sign displays a message written in the voice of the representing character; An image of the character is displayed on top of the signage in the section with a message about what the section is for (Figure 4.3 d, e, f).



a. b. c.

d. e. f.

Figure 4.3 *Doc McStuffins* character cutouts and signages

For example, on the wall behind the reception desk, the sign displays the message from Chilly (Figure 4.3a):

Welcome to the Toy Hospital!

There are so many ways we help toys feel better here—

check-ups are my favorite.

Visit every hospital room to lend a hand.

Chilly XOXO

These signs are important here not because visitors would read it for information, but for other reasons. Organizationally, they form a uniform design feature that provides structural coherence for the whole exhibit, or a "visual rhyme" (Kress & Van Leeuwen, 2015, p.206)—a framing technique that creates connection by the common visual qualities, of two or more elements, for instance color. A good example of visual rhyme we often encounter is the templates of PowerPoint presentation, which generally remain constant across all slides, thus creating cohesion, while at the same time expressing the identity of the presenter or of the organization for which he or she works. Interactionally, the individual characters provide a rationale for the thematic grouping of exhibit elements for an intended pedagogical purpose. At the symbolic entrance of each section, the cartoon character and the message written in his/her voices constitute the speech process that addresses the visitors. For example, in the Exhibit Concept Overview, it is stated: "In this toy hospital nursery environment, visitors are welcomed by a message from Lambie. Lambie invites families to participate in activities that encourage the use of empathy and the practice of nurturing behaviors to care for others (p.3)."

In addition to the five hands-on sections, there are two other sections that serve the "training" purpose for the toy hospital: the Theatre and the Feel-Better Training Center. The narrative structure of the exhibit also provides a framework of pretend play to embed pedagogy and a storyline to initiate a teaching activity. In the theatre, a sign on the wall says:

Doctors-in-training learn by watching the best toy doctor in McStuffinsville! See Doc give check-ups, make diagnoses and give treatments to toy patients!

In the Training Center, a training session usually starts with the educator's opening speech to the families gathering there, assuming the role of a nurse (also dressed like a nurse) working for Doc McStuffins:

Good afternoon, everybody! How are you all today? I am really excited to see you all today. I have a really good job. My name is Rick (pseudonym). I work here at the McStuffins Toy Hospital, which means I have a super cool boss, Doc McStuffins. I was wondering how many of you out there know who Doc McStuffins is?

((raises his hand in the air))

There are a lot of you. I'm really excited. Could anyone tell me one thing Doc McStuffins does as part of her job?

((A child answers: "Help, help animals feel better."))

That is an outstanding answer. That's exactly right. Doctor McStuffins helps people feel better. She helps animals feel better. She helps toys feel better. One of the ways she does this is by giving them check-ups. Now you may have noticed that Doc McStuffins is not here right now at the hospital. She's out to help with more toys that aren't feeling well. She's asked me, the nurse, to help train new doctors by doing check-ups with them.

(Data source: video 28_24f5)

4.3 Place Semiotic Analysis

Separately, the six major sections of the exhibit are designed with different thematic emphasis and pedagogical functions. Put together, they constitute a consistent and coherent organization structure in reference to the visitor movement and interaction patterns suggested by

the design features like layout, pathway, and framing. In this section, I will analyze how the narrative pedagogy is spatialized through these design features to structure different functional areas of learning.

4.3.1 Layout and Pathway

In designing narrative spaces, Dernie (2006) suggests considering the visitors' movement as an important variant to determine the rhythm and intensity of the unfolding narrative like a text. This view is corroborated by Ravelli and McMurtrie (2016) in analysing the compositional meaning of a spatial text. They suggest that a spatial text can be viewed from above, as one might view an architect's floor plan. It might be looked at from the outside as if it was a two-dimensional shape, or it can be moved through to experience its three-dimensionality. In the case of the Doc McStuffins exhibit, if viewed as a floor plan (Figure 4.2), the exhibit is separated into two sides by a middle space. On the left are the ER and OR and on the right are the Nursery, the Training Center, and the Pet Vet. The Theater is at the end of the pass way. In terms of information value, the left side is perceived as Given as opposed to the right side as New in a left to right reading culture. If viewed according to the visiting order—front first and back later, the two front sections, ER and Pet Vet are supposed to be first visited and they assume the 'Before' value and the two inner sections, OR and Nursery would be 'After'. However, these two ways of interpreting the spatial text of the exhibition are not supported by the real visiting experience of the children. By examining children's routes over the exhibition, I noticed that no two children took the same 'reading path' in their visits, and there was no proof that the two front sections were always visited first as the point of departure. Instead, it was quite often for children to walk along the middle hallway for an overall inspection of all the sections on both sides before they decided to come into an area of their choice. Therefore, the four major hands-on sections are

designed in such a way that any one section could be accessed first and children do not have to experience one area before another. For this reason, there are no imposed Given/Before and New/After values when children explore the three-dimensionality of the spatial text of the exhibit.

4.3.2 Framing

The equal accessibility of the four sections is allowed by what seems to be a void in the center. It enables children to choose their favorite area to start with and allows children to leave the area and explore new areas of interest at their own wills, as all the four sections are designed with weak framing (see Figure 4.4a) that allows them to see the contents within all these sections from the center. Even though the center space does serve as a separation between the left and right sections, which can possibly be considered as a contrast of the two concepts 'health' and 'care', the center space assumes a more important meaning by allowing children to navigate freely among these sections. Therefore, the center space is more like a symbolic center that gives unity to the surrounding sections of different but related themes, conferring them semiotically identical status in terms of information values. This design feature connects the four sections and group them as free-choice family-group activity areas.

a. b. c.

Figure 4.4 Framing. (a. weaking framing between the hands-on sections; b. strong framing of the theatre; c. strong framing of the Training Center)

Compared to the equal and easy accessibility of the four sections, the accesses to the Theatre and the Training Center are more or less controlled. Even though children may choose any one of the four sections to start with, no children choose to go all the way down to the Theatre to start with. This is partly due to the position of the Theatre (far from the entrance) and partly due to its different framing. Both strong framing and weak framing are applied at the exhibit to create units of information or contents that are related to each other in different ways. Strong framing devices such as opaque walls and doors are used as a segregation for the Theater (Figure 4.4 b) and the Training Center (Figure 4.4 c). The Theater has two layers of walls that form a semicircle: an opaque inner wall painted purple and an outer glass wall with large pictures of the cartoon characters from the TV series. This is a strong framing that segregates the Theater from other parts of the exhibit as a distinct functional unit, where children can watch a video shown on a large screen. It is, however, less strong than the framing of the Training Center as it has an open access that allows visitors to come and go as they choose to. There is no control of the number of visitors in one time frame either. The same Doc McStuffins video clip is looped so that it makes no difference when a visitor starts to watch. The Training Center has the strongest framing of all the compositional sections of the exhibit. It has opaque walls on four sides and a door to control the access. Soon after the visitors (with pre-distributed tickets) are allowed to the space at the scheduled time on the daily activity timetable, the door is closed after them to ensure the organization of whole-group instructions within it.

4.3.3 Binding and Bonding

The strong framing, or segregation creates a solid impervious enclosure that makes possible the ongoing of the instructional activities inside the Training Center. However, an enclosure alone is not enough to realize the pedagogical purpose intended by the setting of such

an area. It takes another pair of analytic concepts, *Binding and Bonding*, for an interpretation of the validity of the Training Center, a simulated school in the center of a free-choice learning environment. Binding and Bonding are two analytic tools for interpersonal function of spatial text developed by Stenglin (2004, 2008, 2009). Binding is a semiotic principle that describes the ways in which differently proportioned spaces affect users' sense of (in)security. The value of Binding varies along a restricted to unrestricted continuum from extreme openness to extreme closure. The two extremes induce discomfort (claustrophobia and agoraphobia) while the middle zones produce security and safety, or freedom and possibilities. The materialization of Binding is concerned with two systems: *permeability* and *ambience*. Permeability identifies the fixed structural elements that create a space: the wall plane, the overhead plane and the floor plane. It is concerned with the degree to which a space can be sealed or penetrated by the elements, especially light and air. For example, while solid materials such as bricks, plaster or stones can occlude a space, other choices—large plates of glass can create diaphanous overhead openings, transparent walls and 'see through' floors (Stenglin, 2009). Ambience involves choices of color, light, texture and pattern that also play a very important part in making spaces feel more or less enclosed. These choices matter, for example, light colors, up lighting and shiny textures can considerably open up a space by making it feel more expansive; while darker hues, dim lighting and coarse textures can work together to make a space feel more firmly enclosed. These choices co-articulate with the choices for Permeability to construct relationships of (in)security with the occupants of a space.

Bonding complements Binding and is concerned with the communing potential of spaces. The basic function of Bonding is to align people into groups with shared dispositions. There are at least three tools that materialize Bonding in a space: *Bonding icons*, *Hybridization*, and

Symbolic Attributes. Bonding Icons are emblems or powerfully evocative symbols of social belonging. They usually have a rallying function that groups people around shared communal ideals, including (but not limited to) flags, logos, colors, memorabilia, songs, chants and even leaders. Hybridization means embedding a space within a space so that one space served many functions. By creating a multiplexing of spaces, Hybridization serves to recontextualize the values of one field to another, and in doing so, aligns people into a complex communality. Symbolic Attributes are objects that intertextually evoke other spaces/places with a privileging effect. They seem out of place in a particular text, or they evidently belong to the spatial text but have been displayed in such a way that they remind users of another space and/or time. Like Hybridization, Symbolic Attributes also serve to transfer values.

a. b.

Figure 4.5 Binding and Bonding. (a. the Training Center as a Bound space; b. the Training Center as a Bond space)

The Training Center is a Bound space (Figure 4.5 a), even though it does not have a ceiling plane. It is a rectangular space separated from the rest of the exhibit by four plank walls. The usual sense of security or safety is not as relevant here as the concept of Binding originally suggests. However, the enclosure created by the walls does secure a space for the whole-group activities to be conducted regularly without disturbance from the outside. Here the two systems--

permeability and ambience--through which Binding is materialized are important. Based on these principles, we can see that unlike other sections with glass or porous demarcations at the exhibit, the Training Center is completely impermeable. Glass is not a choice here to make a see-through wall as is employed in the Theater, where the goal is to invite as many visitors as possible to the inner part. There are two doors on the two opposite sides of the Training Center and visitors come in through one door and leave through the other. The walls are painted light purple, making the space look expansive from inside when illuminated by pure white lights from above. Projector lights that create vibrant projections of various patterns on the walls and floors in other sections are not a choice here, as the festive and fantastic ambience would be a distraction for young children given the teaching activities that are supposed to be conducted here. These design choices help create a horizontally Bound but a vertically Unbound instruction space where children's attention can be secured in the process and the activities be organized as planned without distractions.

The Center is also a bonded space with shared values. It opens 5 times a day for the whole-group pedagogical activities. Nine children and their families attended one of the activities and they stay at the center for an average of 20 minutes. For those children who participated in the activities, the time spent in the center takes up a large part of their total visiting time. Five minutes before each session, museum educators dressed like nurses would announce the opening of a session through a loudspeaker and distribute free tickets to visitors (Figure 4.5 b). The voice is so penetrating that visitors can hear it no matter where they stay at the exhibit. Parents usually regard this as an important occasion for children to learn and persuade their children to take part in the activity even though sometimes children prefer staying outside to "play" to "taking lessons inside", as if they can instinctively tell the difference. For

example, 5-year-old Connie insisted in vain that she wanted to "play" when she was asked by her mother to join in a training session. Sometimes parents of younger children would let their children decide whether to join or not, but phrase the training as "a show", which sounds a lot more attractive to children.

As can be seen, the educators with their augmented voice serve as a rallying force (Bonding Icons) that draws families from all over the exhibit from their individual engagement to this synergized activity of training where individual bodies group into a collective body of trainees/learners. The tickets are not supposed to be involved in a museum exhibit setting. They are usually associated with "shows" and give those who have them privileged access to something special. As a Symbolic Attribute, the ticket helps transfer the value of a theater or a theme park, something suggesting fun, to a learning place, making ticket-claiming special and appealing for young children. Most children would run to get the ticket at the announcement and they sometimes insist on keeping the tickets for the whole family before giving them back to the educator at the entrance when the "show" begins. The enclosure also creates a Hybridization of spaces in the exhibit, embedding a school in a playground by spatial segregation, temporal synergizing and group instruction. This is an articulation of the museum's pedagogical intent, and it agrees with parents' wishes for their children to learn something while playing. In this room, the values of all the stakeholders converge.

4.4 Interaction Order Analysis

According to Scollon and Scollon (2003), people read messages (visual semiotics and place semiotics) from the built environments they are situated in and behave accordingly. These perceptions also impact the ways in which they interact with each other (the interaction order). For example, a single individual in public places always keeps his/her attention on something to

read; people sitting at a large round table are likely to be engaged in a "with" order -- they tend to talk only to people next to them. In analyzing the visual semiotics and place semiotics of the exhibit, I focused on the meaning potentials of the designed space, e.g., what types of meaning (representational, interactional and organizational) are suggested by the exhibit elements. Now, an examination of how parents and children interact with each other can be a valid way to tell how effectively the physical environment is designed to communicate its meanings. Both visual semiotics and place semiotics of the exhibit have an impact on parent-child interaction.

4.4.1 Visual Semiotics and Interaction Order

Despite the playful atmosphere created by the visual spatial texts, parents tend to perceive the exhibit as a place of learning. Their perception is always demonstrated by the way they discipline their children, as this example shows:

Example 4.1

> *"Sit down! Sit, on the ground. This is not a running place."*
>
> *Seven-year-old **Mike**[6] was stopped by his mother and ordered to sit on the ground while he was running around in a Doc McStuffins' exhibit. Mike came to visit the museum with his two younger siblings. He spent about five minutes checking all around the exhibit and began to entertain himself by running from one section to another. Mike quietly sat there for about 3 minutes before his mother came back to talk to him.*
>
> *"Look at me. You may not be crazy. You need to walk, and do not run. OK? And you may look at any of the things you want to, but you may not be crazy. If you are too big for it then you need to help. You need to help a little kid. Annie and Mary may need your help. OK?"*

[6] All names are pseudonyms I assigned to each participant.

This released Mike and off he went to join his siblings.

(Data source: Video 38_63m7)

This is a good example that shows how parents perceive what this place is and what interaction order is expected from children in such places. This is a place for children to "look at any of the things you want to, but you may not be crazy." They are supposed to be *with* family members, and *with* siblings.

Parents are also often observed playing with their children, and taking the opportunity to teach, even though not all of them choose to do so. As the design is based on the grand narrative of a toy hospital, a familiar scene reconstructed by visual and spatial elements, especially, the omnipresent toy medical instruments, parents and children are often automatically engaged in the game of playing doctor, in which they talk about health and wellness related to and expected by the museum pedagogy. Here are some examples (P=parent; C=child):

Example 4.2

(A parent plays patient and a two-year-old plays doctor in Pet Vet.)

1	P:	How's my leg? Is it OK?
2	C:	No.
3	P:	Is my leg sick? What do I need to do with my leg?
4	C:	Hurts.
5	P:	It hurts? What do I need to do?
6	C:	To doctor.
7	P:	Oh, to a doctor. OK.
8	C:	((*picks up a syringe and gives the leg a shot*))
9	P:	Oh. It needs a shot. Ouch. But it makes it feel better.

(Data source: video 4_74f2)

Example 4.3

(The child is trying to measure the temperature of a doll with a thermometer, while the mother is watching her.)

1	C:	((*Holds a thermometer upside down while measuring the doll*))
2	P:	No. Try again. What do you do temperature?
3		((*pats child on the hand*))
4		What does mommy do your temperature?
5		Do you remember where mommy puts it?
6		(.)
7		Yeah. Under your arm.

(Data source: video 7_111f3)

Example 4.4

(Mother and child are staying at the reception desk.)

1	P:	((*Reading the floor map of the exhibit*)) We are at the reception.
2		So, you are a receptionist. You're gonna to help me find somebody.
3	C:	OK.
4	P:	Hello!
5	C:	Hello.
6	P:	I need some help.
7	C:	OK. How'd you spell your name?
8	P:	H, A, P, P,Y. (pseudonym)
9	C:	((*pretending to be typing on the telephone keyboard*))

10 P: OK. Will you help me find my pet lamb. She's really sick.

11 C: OK. Follow me.

(Data source: video 32_ 81f5)

Example 4.5

(The family are doing an assigned check-up exercise after a whole-group instruction in the Feel-Better Training Center. The mother plays patient and the child plays doctor.)

1 P: Can you check my heart? Which one do you use to check my heart?

2 C: ((*takes a stethoscope from the toolbox and perform the checkup*))

3 P: What does it say?

4 P: Right here, a little harder. ((*directs the child's hand to her chest*))

5 How is it? Good?

6 C: Good.

7 P: Is my heart healthy?

8 C: Yes. Healthy.

(Data source: video 31_32f5)

These examples of parent-child interaction show that the spatial texts of the designed environment successfully communicate to visitors by connotations, a type of representational meaning, which are "picked up by users, whose readings are influenced by their preconceived ideas, historical location, experience, knowledge, and familiarity of the textual referent" (Ravelli & McMurtrie, 2016, p. 29). Connotations are often variable and unfixed, and connected to intertextuality. The familiar and fantasy atmosphere created by the spatial texts of the exhibit allows parents and children to make easy connections to their prior experience of medical checkup when engaged in pretend play, which gives rise to various opportunities to teach. This is

evident in Example 4.2, in which the parent takes the opportunity emerging from playing doctor to lead the child to the right answer "to doctor" (line 6) with a repeated question "What do I need to do?" (line 5) when "the leg is sick" and in Example 4.3, in which the parent reminds the child of the family check-up practice of temperature taking as a correction to her "malpractice" of holding the toy thermometer upside down.

The exhibit also gives rise to opportunities for parents to create games and incorporate their teaching naturally into play. For example, in Example 4.4, the mother creates a game of "playing receptionist" in which she reads the map for the child and spells a name, creating a valuable letter recognition experience through play for the child, who also reads the connotation from one of the spatial texts at the reception, the telephone. She pretends to be logging information into a computer by typing on the keyboard of the toy telephone, connecting the current play with her digital literacy experience at home.

Example 4.5 makes a special case here in that it is a parent-child interaction in another setting. The interaction order is the same ("with"), but the context in which the interaction happens is different. This makes the way they interact, or the pedagogical action of the parent, different. Unlike previous cases in which parents just improvised a game or teaching opportunity, this case happened as part of the "Doctors-in-training" program (see more details in chapter 6) after a whole-group instruction made by a museum educator on how to use different medical instruments. It is more of a compulsory activity in which parents and children are assigned a project to do together. It is observed that the parent's pedagogical role has changed from a play mate into an "examiner", who takes the opportunity to assess what the child has learned after "a lesson". Another more detailed case of parents' facilitation in the project will be analyzed in chapter 6 in which a parent also tests the child the same way. This case is important

here as it is an indication of how different spatial connotations can influence people's behavior. In this case, even though the parent is involved in a pretend play, she reads the connotation of the spatial texts of a simulated classroom by associating them with a school context in which instruction and testing often happen one after another.

4.4.2 Place Semiotics and Interaction Order

In this section, I discuss how place semiotics impact parent-child interaction order. First, we can compare two models of pedagogy organization in the Training Center, as shown in Figure 4.6 and Figure 4.7, which I name as model A and model B respectively.

Figure 4.6 Parent-child interaction order model A

Even though both models are teacher-centered, the ways the audience are arranged are different. In model A, tables are arranged along the walls to vacate the middle part of the room for instruction. Both parents and children are seated on the ground but this way of seating automatically separates parents from children. Parents will have to sit in the margin or else they will block the view of children sitting behind (see Figure 4.6). In model B, the placement of tables and chairs suggests that parents and children stay together as a group. It is also observed that in these two models, children's behaviors are different. In model A, even though children all

sit quietly and stay put on the floor, only a few older children listen attentively to the educator's instruction and make responses when necessary. Younger children are more often than not engaged in their individual or private activities (see Figure 4.6, e.g. children in red circles). In model B, parents' involvement plays a very important role in maintaining children's attention. As can be seen from Figure 4.7 a, while older children often sit on their own, younger children are held by their parents and sit on their parents' laps. This arrangement often secures young children's attention during a long talk. This arrangement also encourages a synchronization of parents' and children's movements in a multimodal instruction in which the educator asks the audience to practice saying the word "ste-tho-scope" one syllable after another using hand-clapping to create a rhythm (see chapter 6 for further analysis). Parents often demonstrate to their children and urge them, especially young children, to practice together with the educator (Figure 4.7 b).

a.

b.

Figure 4.7 Parent-child interaction order model B

Another piece of evidence that supports the impact of place semiotics on parent-child interaction order is from the observation of parents' participation in the Training Center check-up project. This is an assignment left for children to finish after the educator's whole-group instruction as shown in Figure 4.6 and Figure 4.7 (see chapter 6 for detailed analysis). In such

projects, parents all facilitated children in the process and make sure that children complete the whole project as required by the Check-up Check List assigned to them (Figure 4.8). However, parents' involvement outside of the Training Center is varied and there is no fixed pattern in their engagement in children's learning. There are "helicopter" parents who accompany their children to every exhibit station they visit and take whatever opportunity they can exploit to teach their children. There are also "shepherd" parents who choose to keep a distance while keeping an eye on their children or taking photos of them. But it is in this "formal" classroom that parents have demonstrated the same effort to work with their children.

4.8 Parents' facilitation in assigned projects

Not only is the organization of space related to parent-child interaction, but it also has an important part in securing effective instruction design. I will further unpack this relation in chapter 6, where organizing for differentiation is to be discussed.

4.5 Discussion

This chapter discusses how the organization of physical space of the Doc McStuffins exhibit helps achieve its pedagogical purposes. Through an analysis of spatial texts of the exhibit, it is found that the design of space has achieved two pedagogical purposes related to the

other two components of the pedagogy: (1) it defined spaces for different types of instruction/interaction to meet the different needs of visitors; (2) it increased interactivity by creating a learning environment of familiarity and fantasy that suggested pretend play between parents and children and allowed them to be naturally engaged in interactive teaching and learning activities related to the theme of the exhibit.

In conclusion, we can see a relationship between space arrangement and framing, pedagogical purposes and interaction order, as summarized in Table 4.1 below:

Spaces	**Framing**	**Pedagogical purposes**	**Interaction order**
Training Center	Strong framing (with access control)	Whole-group instruction Family-group instruction	One-to-many One-to-one
Theater	Strong framing (without access control)	Whole-group activity (Observation)	No interaction
Reception, Pet Vet, Nursery, OR, ER	Weak framing	Free-choice individual or family group activity	One-to-one One-to-many No interaction

Table 4.1 Space organization and pedagogical purpose

The whole space is divided into three functional areas with different framing devices. The training center, with strict control of time and access, serves as an area for whole-group educational activities that include two interaction orders: one-to-many, through which an educator (sometimes two) instruct(s) a group of families, and one-to-one, through which a parent (parents) facilitate(s) a child in an assigned after-instruction project. This arrangement enabled a successful instructional effort to communicate the themes of the exhibit to as many audiences as

possible. It also increased parents' participation by assigning parents a role to play in the family-group activity.

The theater is supposed to be an area of demonstration and observation. It is functionally separated from the rest of the exhibit but allows free access. With video clips looped on a large screen and seats arranged facing it, this space does not suggest interaction, but for visitors to familiarize themselves with the discourse of Doc McStuffins if they happen to know little about it before.

The Reception, Pet Vet, Nursery and ER/OR are areas for free-choice or self-directed activities. They are symbolically demarcated and allow fluidity in movement. In these areas parent-child interaction orders are varied and family constitution differs from group to group. Some parents choose to be "helicopters" and some "shepherds", and there are some who stay in between. But based on the parent-child interactions that happened in these areas, we can see that parents tend to perceive the exhibit as a place of learning. It is observed that the learning space is designed in such a way that encourages parents to improvise games and incorporate their teaching naturally into the pretend play with their children. Parents are found to have been engaged in various teaching efforts: they build connections to prior experience, scaffold children in knowledge construction, provide demonstration and assessment. How and how much parents participate in children's learning is also found to be related to the learning environment design. For example, in the Training Center, parents all actively facilitate their children in the after-instruction project while in the free-choice areas, parents participation varies. These findings suggest that parents can be a powerful force in pedagogy construction and this could be useful information for museums committed to creating a family-engaging learning environment.

Chapter 5 Pedagogy in Performative Space

According to Dernie (2006), in a performative exhibition, visitors are invited to do things and the emphasis is placed on movement and action rather than static observation. Such kind of exhibition environment lends itself most immediately to projects in children's museum as it opens up the important relationship between learning and play: "As much as sophisticated playgrounds as museum interiors, the display devices ingeniously invite the children to move and interact in fun ways whilst learning important scientific principles. Physical interaction is key: they are spaces full of movement and expressive sounds that accompany the thrill of learning in this way" (p.46). Following this idea of space design, I examine interactivity as a form of pedagogy in the performative space of the Doc McStuffins' exhibit. Even though I adopt the broad sense of "interactivity" (Adams, Luke & Moussouri, 2004) that includes a wide range of semiotic arrangements involved in the design of space as interactive, I will focus on one particular exhibit element in this chapter: the tangible interactive/ interaction. The tangible interactive I will discuss is a toy pet X-ray machine. In the following sections, I will introduce the idea of tangible interaction (Section 5.1), analyze how children interact with the interactive (Section 5.2) and have a discussion of my findings and their implications (Section 5.3).

5.1 Multi-interface Design and Tangible Interaction

5.1.1 The Concept and Background

With the advances of technology, exhibits in children's museums (or museums in general) have become more and more sophisticated and expensive. With the democratization of computers since the late 1980s, educational technology has been closely associated with computers that rely solely on input devices such as mice, keyboards, and touchscreens. However, some researchers and educators began to realize the limitation of this single interface design in

that it overlooked the rich physical aspects of human interaction with the world. The criticism motivated designers to think beyond computing and incorporate technological innovations in mechanical, industrial, material, and electrical design, so that users can have a more natural, more embodied learning experience through tangible and full-body interfaces. Isii and Ullmer (1997) first coined the term "tangible", which was later defined by Horn (2018): "The term tangible refers to a variety of human-computer interaction techniques that move beyond computer screens and create opportunities for people to interact with digital systems using their bodies and physical artifacts (Horn, 2018, p.632)." Ever since the introduction of the notion of tangible interaction, it has caught on in the learning environment design community. One of the most natural uses of tangible and full-body design is in museums, a natural result of the emphasis on physical activity and movement enabled by large space, as Falk & Dierking (2000) stated that learning in museums is a whole-body experience.

Now tangible interactives are widely applied in museums and studies on tangible interaction have suggested that the incorporation of physical interface into computing design augments visitor experience by affording touching and manipulations, attracting more groups and therefore providing opportunities for people to talk and share. The combination of the physical, the digital and the social dimensions of a visit has been regarded as a special characteristic of the tangible interaction that provides visitors with unique experiences that cannot be afforded by the single-interface designs (Mueller, Agamanolis & Pickard, 2003; Marshall, 2007; Marshall, Cheng, & Luckin, 2010; Not & Petrelli, 2018). Usually, these studies were conducted by the designers/ developers of such projects with an interest in evaluating how successful and effective these projects are in terms of some measurable evaluation variables. The validity of evaluation was based on controlled experimental research designs that either compare

a tangible interactive with a single-interface interactive or compare the pre-exhibit visitor experience with that of the post-exhibit. Learning is assessed as part of the evaluation with a focus on how the tangible interactive projects help visitors understand the contents, concepts and themes intended by the exhibitions based on assessment tools like tests, interviews, questionnaires and surveys.

Even though the existing studies based on data from large numbers of visitors suggest that these new designs that combine computing with physicality played an important role in creating innovative learning environment for visitors, little is known about the in-situ interactive experience of visitors, as the assessment of the visitors' knowledge gain was mainly based on the recalling of past experience in the form of surveys and interviews. While much emphasis has been placed on the instrumental role of tangible interaction in helping visitors understand the intended contents and concepts, there is a lack of focus on the interaction itself as an embodied literacy experience. For example, the interactional problems that occur in the process of interaction with tangible designs have largely been ignored when physical artifacts, bodies and activities across space are incorporated into the design's ecosystem—problems that arise as a result of multiple interfaces.

By a close examination of children's moment-by-moment interactions with such a design at the Doc McStuffins exhibit, I attempt to explore the following questions:

1. What do children learn through this multimodal and embodied meaning making process? What has this to do with today's new literacy landscape?
2. How do the multimodal interfaces of the design help children make sense of both the actions of the design and their own actions? What can be improved in the design of the multi-interface interactive?

3. How do parents help young children to make sense of such a tangible design?

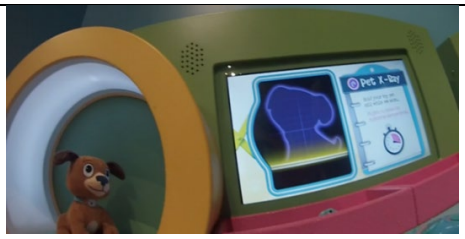
5.1.2 The "Pet X-ray" Interactive

The tangible interactive I focus on at Doc McStuffins exhibit is called "CAT Scanner Check-up", or the "Pet X-ray" (Figure 5.1).

Figure 5.1 "Pet X-ray"

The Exhibit Overview reveals that this exhibit element is to engage children in a three-procedure "check-up": scanning, diagnosing, and treating pet patients. Children are expected to learn the important concept of "diagnosis". The X-ray machine is composed of three interactive devices: a scanner, a screen and a speaker that work with three stuffed animals (Findo--a dog, Marla--a goat, and Whisper--a cat). Each animal has an RFID (Radio Frequency Identification) chip in it, detectable by the sensor embedded in the scanner if the stuffed animal is brought close enough to the sensor. Visitors are first reminded by a recorded voice (supposedly Doc McStuffins's voice) and a corresponding screen display to put the "toy pet" in the scanner. Once the scanner reads the chip, the machine is activated, displaying on the screen a scanning process with a "bling-bling" sound effect. It will then identify the troubled body parts of the scanned animal and give a "diagnosis", a fabricated disease name (e.g. Broken-leg-tosis, Sandi-nosi-tosis), as the Doc McStuffin character always does in the TV program. Right after the diagnosing

step, the machine recommends a corresponding treatment through a screen display and a voice-over (Table 5.1). Each toy animal is programmed to have two sets of diagnosis and treatment plan and each scanning will only trigger one of them randomly (for details see Appendix).

Design Steps		Screen display	Sound effects
1	Prompting		To get the check-up started, place your toy pet in the center of the scanner.
2	Scanning		(with “bling-bling” sound effect)
3	Diagnosing		The scan shows that there is a little stuffing separation inside Findo's leg. My diagnosis is Broken-leg-tosis.
4	Treating		Wrap Findo’s leg to give him support until the stuffing settles back again. You should also put a cone on his neck to prevent him from licking his leg before it gets better.

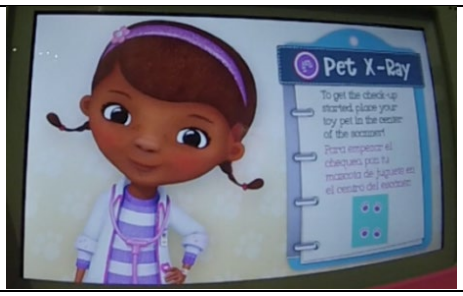
5	Feedback		Thank you for assisting Stuffy and me in the pet vet. You've been doing so much to make our toy pet feel better.

Table 5.1 The stepwise design of Pet X-ray

My observation of children's interaction with Pet X-ray is based on videos collected by the children who came to visit the exhibit interactive. The close-up first-person view captured by the GoPro cameras makes it possible to zoom in on children's intricate haptic movements in their contact with the Pet X-ray. Out of the 22 children (2-6-year-old) who stayed at the machine to play, only 14 successfully initiated the scanning process. Eight of them didn't demonstrate interest in scanning at all. With these 14 children, I documented each time they started a scanning process and saw whether they were able to follow through the following process. It was observed that these children made 39 scanning attempts altogether, followed by 21 times of observation of the monitor, followed finally by 6 times of treatment. If a successful interaction is defined by completing all the steps (scanning, diagnosing and treating) following the design plan[7], there was only a 15% success rate among all the attempts to scan, while in most cases, the attempts were frustrated by various kinds of difficulties that children faced in their interactions. This prompted me to take a closer look at the "unsuccessful" attempts as well as the parent-facilitated cases in which children articulated their perplexities, to explore what prevent children from following all the steps from initiation (attempts to scan) to treatment, what communications skills they demonstrate, and what they learn through this process.

[7] The museum that installed this exhibit has made an evaluation of the Pet X-ray exhibit element and this is the criterion they held to determine whether an interaction is successful or not.

5.2 Child-Machine Interaction

In this part, I explore how the toy Pet X-ray machine and children interact with each other through turn taking, which is achieved through "reading" each other's actions. Through the RFID technology, the machine reads its users' action as "scanning", which is taken by the machine as the right time for a next turn to activate an array of multimodal screen displays. By reading the machine's displays, children are expected to understand the machine's action as "diagnosis-treatment", an instruction that demands a next turn of action (to treat the pet animal) on the part of children. Similar to human-to-human interaction, human-machine interaction needs to be realized by a shared understanding (intersubjectivity) of what is the right action and when to take the right turn.

My analysis is also greatly informed by Suchman (1987), who productively applied insights gained through research on face-to-face human interaction on human-machine interaction. Her seminal work illustrates how mutual intelligibility in human-machine communication is achieved by a comparison of the plan or the designing objective of a machine and the situated actions of the users. A comparison is made between face-to-face interaction and human-machine interaction in terms of the access to semiotic resources. She pointed out that human-machine communication is *resource-limited*, if compared with human face-to-face interaction in which participants are able to mobilize a rich variety of semiotic resources to coordinate social actions and to monitor each other's action closely. Machines are designed only to respond to a fixed array of sensory inputs, mapped to a pre-determined set of procedures. As a result, when intersubjectivity is taken for granted in face-to-face interaction, it can be problematic in human-machine interaction as designers of machines must rely on limited

resources to predict the actions of the potential users and then design their instructions based on such predictions as a pre-existing plan.

5.2.1 Correctness of Action and Turn Transition

In the stepwise design plan as shown in Table 5.1, we can see that the only interface where a change of the state of machine can be triggered is the scanner. This turn-transition place is very crucial in deciding whether the whole check-up process will be activated or not. Suchman (1987) has observed that machine's recognition of turn-transition place is reactive and conditional, which means that there is a determinate relationship between certain actions by the user and the machine's transition to a next display and that the appearance of a next display is considered as a confirmation of the correctness and completion of the prior action. The importance of this transition place can best be illustrated by a breach of the predetermined plan, or to be more specific, a violation of the agreement about what should be considered as a correct action when it comes to scanning.

It is observed that in children's interaction with the Pet X-ray machine, it is quite often for them to put into the scanner various other kinds of toys at the exhibit than those prescribed by the design—the three chipped stuffed animals that can be detected by the sensory system of the machine. Example 5.1, 5.2, 5.3 capture three such cases in which the children, in response to the voice invitation, put something else into the scanner and failed to occasion a next turn as anticipated. These are cases in which the agreement of what is considered a correct action of scanning is breached and a determinate relationship between the users' action of scanning and the machine's transition to a next display of diagnosing is disrupted.

Example 5.1

(Five-year-old Brianna placed a plastic piggy bank into the scanner. X=toy pet X-ray machine; B=Brianna)

1 X: To get your check-up started, put your toy pet in the center of the scanner.

2 B: ((*Puts a plastic piggy bank into the scanner*))

3 (5.3)

4 ((*Removes the piggy bank from the scanner* and puts Whisper into the scanner))

5 X: ((*activated*))

(Data source: video 27-23f5)

Example 5.2

(Four-year-old Tulip came to the X-ray machine alone. There were no chipped toy animals to be seen. There was a doll on the counter and she put it in the scanner. T=Tulip)

1 X: To get your check-up started, put your toy pet in the center of the scanner.

2 T: ((*Picks up the doll and puts it in the scanner*))

3 ((*Turns to the screen and touches it for several times*))

4 ((*Plays with the doll while it is in the scanner, applying a shaver and a Band-Aid on it*))

5 X: To get your check-up started, put your toy pet in the center of the scanner.

6 T: ((*Reach out to the doll in the scanner*))

7 ((*Adjust the doll's position a little bit and gives it a pat*))

5 (3.9)

6 ((*Plays with the toys scattered on the counter*))

7 X: To get your check-up started, put your toy pet in the center of the scanner.

8 T: (6.6)

9 ((*Pick up a thermometer, puts it under the doll's arm*))

10 ((*Camera turns away from the X-ray machine*))

11 X: To get your check-up started, put your toy pet in the center of the scanner.

12 T: (6.6)

13 ((*Handles a thermometer and a Band-Aid*))

14 ((*Puts all tools into the box on the counter and leaves*))

(Data source: video 19-101f4)

Example 5.3

(Four-year-old Riley put a doll into the scanner. R=Riley)

1 X: To get your check-up started, put your toy pet in the center of the scanner.

2 R: ((*Puts a doll into the scanner*))

3 (2.4)

4 ((*Touches the doll with both hands*))

5 ((**Gives a quick touch to the mouth*)) (Figure 5.2, bottom arrow)

6 ((**Gives a quick touch to the circle*)) (Figure 5.2, middle arrow)

7 ((*Applies two* p*resses to the circle*))

8 ((*Gives a quick touch to the mouth*))

9 ((*Gives a quick touch to the circle*))

10 ((**Gives a quick touch to the small hole*)) (Figure 5.2, top arrow)

(Figure 5.2)

11 ((*Takes the doll out of the scanner*))

12 X: To get your check-up started, put your toy pet in the center of the scanner.

13 R: ((*Goes to another X-ray machine, picks up Findo, puts it on the scanner, waves it*

14 *up and down*))

15 (4.2)

16 X: The scan shows that there is a little stuffing separation inside Findo's leg. My

17 diagnosis is Broken-leg-tosis.

18 R: ((*Takes Findo out*))

19 X: Wrap Findo's leg to give him support while the stuffing settles back again. You

20 should also put a cone on his neck to prevent him from licking his leg before it gets

21 better.

22 R: I need to put a cast on him.

23 ((*Picks up a Band-aid from the counter*))

(Data source: video 17-74f4)

The miscommunication in these cases can be interpreted by analyzing the action structure of "put", which involves three components: an object to work on, the location as a destination of the object and a physical activity of "put". For the machine to recognize the action, the whole package of the action (the right object, the right place and the right physical activity) must be

delivered accurately as these elements combine to define the correctness of an anticipated action from the users. Another example (Example 5.4 below) shows that the "where" or the right place is also crucial in determining the correctness of the action.

Example 5.4

(Four-year-old Austin showed an interest in the Pet X-ray machine while he was playing nearby. Not knowing what to do, he asked his mother for help. M=mother; A=Austin)

1 A: How do you do the [X-rays?

2 M: [>I don't ↑know< =It says >to get your checkup started<

3 ↑place >your toy pet< in the center of the scanner.

4 Pick up the goat over ↑there,

5 A: ((*Pick up Marla from the floor*))

6 Where's the ↑sca:nnal.

7 ((*Holds Marla with both hands while standing in front of the machine*))

8 M: The scanner is over ↑here.

9 ((*****Points at the scanner***)) (see Figure 5.3)

(Figure 5.3)

10 A: ((*Places Marla into the scanner*))

(Data source: video 23-102m4)

In this case, unlike the previous ones in which the children are left to make sense of the machine and to solve problems by themselves, 4-year-old Austin got help from his mother. The parent-child interaction provides important information about the difficulties a child may confront when he first meets an unfamiliar exhibit and how a parent/caregiver can help a child to know what constitutes a correct action. At first, Austin shows an interest in the Pet X-ray machine but has a problem in how to use it (line 1). It's probably also the first time for his mother to see it ("I don't know") but she reads from the screen and repeats the instruction for the child. Then she begins to separate the overall instruction into small steps in which the different components of "put" are identified. By directing Austin to "pick up the goat over there" (line 4), she helps him to find the referent of "toy pet" and at the same time identifies the right object for "put". The next step is to find the right place to "put" and this is exactly what Austin is wondering about. By the wrong pronunciation "scannal" (line 6), we can tell that the word "scanner" is not the child's vocabulary and its referent is something he doesn't know. However, as the word "scanner" is embedded in the phrase "in the center of the scanner", it must be a place, hence the child's question "Where is the scannal?" instead of "What is a scannal?". By this question, Austin asks his mother to identifying the location for "put" while he is holding Marla (the object) and standing in front of the machine, not knowing where to put it. The mother answers the question and accompanies the verbal answer with a gesture of pointing from up-above to the bottom of the scanner (see Figure 5.3). In this way, she not only identifies the location but also demonstrates a trajectory for the action "put". With what, where and how clarified, all the action components have been successfully identified, which warrants the accuracy of the prescribed action and as expected, occasions a successful turn-transition.

We have seen how the responsiveness of the scanner is determined by the correctness of a prior action by the user because only actions recognizable by the machine can occasion a change in the machine's state, which in turn, ties the action to the requirements of the overarching plan of design. Therefore, the design plan has prescribed successful use of the machine by imposing requirements on the user. By interpreting requirements as intended by the designer, the user can expect to have successful use of the machine and this is a crucial link in the intersubjectivity chain of human-machine interaction.

5.2.2 Solicitation of An Expected Response

Cases in Examples 5.1, 5.2 and 5.3 demonstrate how children experienced interactional impasse in initiating the scanning process. It is therefore important to learn to understand the requirements for the correct action of scanning and solve this impasse. A close look at the children's reaction to the machine's irresponsiveness to their actions, we can observe that these children, as young as 4 and 5 years old, have demonstrated an ability to import certain expectations from human communication in the form of the turn-taking mechanism of conversation: namely, the relevance of each utterance is conditional on the last and if a previous action calls for a response, the next action will be a response. All children have taken a prescribed action of "putting their toy pet in the center of the scanner" as a response to the machine's request. The action they have taken is conditional on the previous turn by the machine. After that, there is an observable freezing of the movement (see Example 5.1, line 3, Example 5.2, line 5, 8,12 and Example 5.3, line 3, 15). By a close monitoring of the screen they have demonstrated their expectation of a next turn from the machine, as it has promised ("to get your check-up started"). When such a promise fails to be delivered in an expected turn, the children would take another turn to reinforce their expectation. The most illuminating case is

represented in Example 5.3 (line 4-10). After her action fails to bring about a change of the display as expected, 4-year-old Riley dealt a long series of touches to the screen (13.4 seconds). The places where she touches (see Figure 5.2) and the strength with which she touches are noteworthy here. In today's touch-screen technology environment, it is not difficult to see that the places touched (the mouth, the circle-shaped button and the small white spot) are all places where a voice or a change of the screen display is likely to be occasioned. When the two quick touches of the mouth and the circle fail to solicit anything, Riley applies two more prolonged hard presses to the circle, to see if it is because she didn't press it hard enough. When even these efforts fail, she gives another try of the mouth and the circle, and then the less likely place of the white spot up above before she finally gives up.

5.2.3 Repair of Action

After the failure to expect or elicit a response from the machine, the children who experienced such an impasse take the non-response as an indication to repair their previous actions. This attempt is based on an understanding of a new display on the machine's screen as implicit confirmation of the adequacy and correctness of a previous action. If the machine does not respond, there must be something wrong in their previous action that should be repaired. In Example 1, after a 5.3-second (line 3) waiting for a response from the screen, 5-year-old Brianna removes the piggy bank from the scanner and replaces it with Whispers, the right object that corrects her action and successfully occasions a turn-transition. It is the same case in Example 5.3, in which 4-year-old Riley finally decides to take her doll out of the scanner (line 11) after her repeated attempts to elicit a response from the screen fail. She then goes to another X-ray machine to have another try. It is interesting to note that she adds some actions to a single "putting" by moving Findo up and down (line 13-14) before the machine's next turn, the

scanning display, appears. Even though there is no evidence to show that additional shaking or waiving of the chipped toy animal is helpful in activating the machine, this seems to be a common practice among children who come to scan. These additional moves are significant to the analysis of children's understanding of the mechanism of the Pet X-ray machine, as an indication of children's attempts to make their actions more recognizable to the machine after they get to know how the scanner works.

Example 5.2 presents a more complicated case in which the machine not only does not make a response as anticipated, but also repeats the instruction again and again. How the child responds to such kind of machine behavior is of great interest. Suchman (1987) has in her work observed such an issue in which the repetition of instruction can cause ambiguity for users: "If the system's response is to repeat the instruction, the repetition implies that the user's previous action should be repeated (i.e. that the procedure is iterative) or that there is some trouble in the previous action that should be repaired (p.144)." In the case of Example 5.2, the machine repeats itself four times without being able to detect a correct action (caused by a wrong object). This loop is produced by an error in the child's action taken in response to the previous instruction. The child's response to the repeated instruction has demonstrated her understanding of such ambiguity between iteration and repair.

Unlike the children represented in Example 5.1 and 5.3, the child in this case (Example 5.2) doesn't have another chipped toy animal at hand to repair her action and she has no choice but give up scanning and plays with other toys (line 4, 6, 9, 13). At the first repetition of the instruction, she takes it as an iteration, that is to say, as an opportunity to a new trial. As the doll is already in place, she demonstrates her understanding of the instruction as a request to repeat her action by reaching out to the doll. At the same time, based on the previous failure, she adjusts

the position of the doll and makes sure this time it will be at the right place by a pat (line 7). This can be viewed as an action of repair even though it is not the right repair to fit the machine's sensory requirement. This trial proves to be a failed attempt for the child to make sense of the conditional relevance of the machine's next turn, which in turn serves as a basis to explain the child's not taking of any action further to repair her action at the following two repetitions of the instruction.

5.2.4 Mapping Actions In-situ

According to Suchman (1987), human-machine interaction can be traced back to human-human interaction in the sense that machines are all designed by humans under the presumption that they will be used by other humans capable of interpreting the same semiotic resources with which the designers use to code their instructions. In the designers' plan, actions are prescribed in the form of instructions for users to follow. It is expected that users can read instructions, interpret referents and descriptions and take corresponding actions whose effect is detectable by the machine, thereby triggering a transition to the next display or instruction. However, the design-user interaction through instruction coding and decoding actually involves two mapping processes: the designer's mapping of the world to words and the user's mapping of the words to the world. That is to say, in writing descriptions of actions, the designer will have to map the referents of the action in question (e.g. what to act on, where to act and how and when to act) to language, either in the mode of print or speech. Other visual modes may also be used to facilitate the mapping, like images displayed on a screen. At the user's end, he will have to map the prescribed action in the instruction to the referents as listed above in his situated environment. If the two worlds in the mapping processes happen to match with each other, the interaction may

go as anticipated and mutual intelligibility achieved. However, the designer's plan may sometimes go awry if the user's world is a different one than that of the designer.

This is the case of the Pet X-ray placed in the section of Pet Vet. The exhibit environment is far more complicated than what the designers' plan has anticipated. As I have observed and analyzed in Example 5.1, 5.2 and 5.3, one of the major reasons that accounted for unsuccessful initiations is the placement of indetectable objects into the scanner. In Example 5.4, four-year-old Austin expressed his bewilderment ("how do you do the X-ray") and articulated what it was that perplexed him (where is the "scannal"?). Obviously, scanner is a new word for him. These cases show that it is not as straightforward as it was assumed in the designer's plan to map the action described in "put your toy pet into the center of the scanner" into the real exhibit world in which children are situated. Both "toy pet" and "scanner" can be difficult for children to identify in reality when seeing a screen display (Figure 5.4) that does not provide necessary information.

Figure 5.4 A screen display that does not help

In the designer's plan, the "toy pet" simply refers to one of the three chipped toy animals in their context of designing and this is straightforward to them; but for children who come to the Pet X-ray, the "toy pet" can be anything scattered on the counter of the machine—dolls, a toy horse, a piggy bank, and indeed milk bottles and stethoscopes are sometimes put into the

scanner. These objects either distracted children from scanning or discouraged them from problem solving if there is no parent facilitation available (as in the example of 5.2).

Another difficulty for children in their interaction with the machine is to understand the treatment instructions. Treatment actions are difficult to map for two reasons: (1) the screen display does not provide useful visual clue to help children understand the long instructions full of unfamiliar terms and (2) the treatment plan always involves other exhibit elements across space. For example, the same screen display (Figure 5.5) is used for the treatment instructions for Findo, Marla and Whispers but does not offer relevant visual images to illustrate the treatment in question (also see Appendix):

For Findo: *Findo's nose needs cleaning. Bring him to the treatment counter and wipe his nose with a soft cloth.*

For Marla: *You need to massage the clump in the hoof and then wrap it up tight until her stuffing settles.*

For Whispers: *You need to gently wrap her tail up to hold it in place while it straightens out.*

Figure 5.5 A confusing treatment display for Findo, Whispers and Marla

In addition to the lack of useful multimodal illustration, the complex spatial engagement of these treatment plans is another difficulty that discourages children. The pet grooming area, pet shelters and treatment counters are relevant to the Pet X-ray as they are all involved in the treatment plans (Figure 5.6). Sometimes, children are asked to take their toy pet to the grooming area to give it a bath, to the Treatment Counter to wrap its leg or hoof, or to the Pet Shelters to feed it (see Appendix). It is observed that children often got lost on their way to find the Pet shelters or the grooming area when the exhibit area was crowded with visitors.

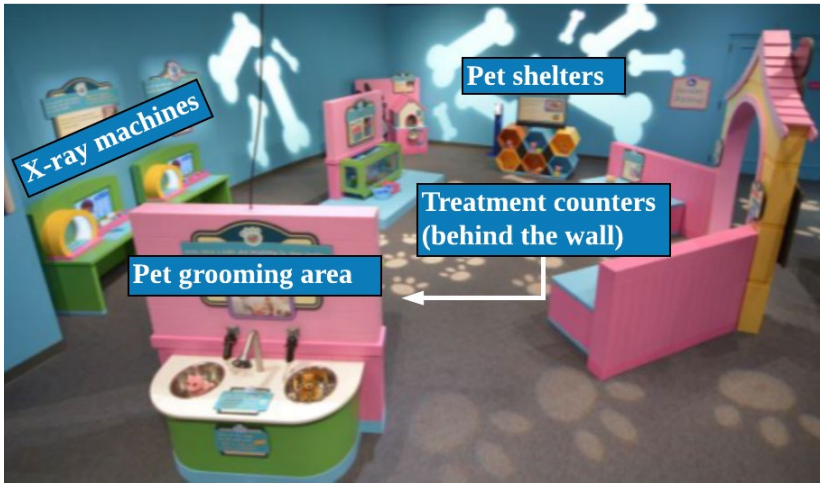


Figure 5.6 The complex spatial engagement of treatment plans

I will use two examples (Example 5.5 and 5.6 below) to show children's difficulties in mapping the actions prescribed by the treatment instruction given the complexity of the exhibit environment and how parents help them in translating the words into the worlds.

Example 5.5

(Five-year-old Eva and her mother were standing at the pet treatment counter near the X-ray machine. After the mother asks if Eva wants to play with the X-ray machine, they walked towards the machine. M=mother; E=Eva)

1 M: There's a scanner over there. want to do X-ray scanner?

2 E: ((*Holds Whispers in her hand*)) I want to (.) [to do.

3 M: [The X-ray scanner will tell you

4 what's wrong with it.

5 X: To get your checkup started place your toy pet in the center of the scanner.

6 M: Put it in the scanner alone↑ ((*Points at the scanner*))

7 E: ((*Puts Whisper in the scanner*))

8 M: OK? ( ) tell you what's >°gonna to happen°<

9 X: The scan shows that Whispers' tail is twisted on the side. My diagnosis is Twisti-

10 tail-tosis.

11 X: You need gently wrap her tail up to hold it in place while it straightens out.

12 M: So now Eva, you know what to do to fix it?

13 E: ((*Turns away from the screen display and takes Whispers from the scanner*))

14 Yeah (.) But HOW do we wrap the tail?

15 ((*Holds the cone against the tail while following her mother*))

16 Is this how we ↑wrap the tail ↑up?

17 (3.6)

18 How DO: we Actually wrap the tail up?

19 M: You °wanta° wrap the tail?

20 ((*Points at the pet exam table*)) There's more stuff over he:re (.)°if you want.°

(Data source: video 30-61f5)

In this example, the mother serves as an "interpreter of action" for the machine and provides supplementary information for her child to understand the "teaching objective" of the exhibit design. She successfully invites the child to "do the X-ray scanner" (line 1), and reveals

the purpose of the machine, to make *diagnosis*, in plain words: "The X-ray scanner will tell you what's wrong with it." (line 3-4). This summary of the machine's plan also helps the mapping of "it", an anaphora that refers to the "toy pet" (Whispers) the girl is holding in her hands. By further directing the child to "put it in the scanner alone" and by pointing at the scanner (line 6), the mother helps the child to map the action of "put". Then, by predicting the next action of the machine ("tell you what's gonna to happen" (line 8)), she has successfully directed her child's attention to the displays on the screen and the voice-over (line 9,10,11). Following these instructions, the mother makes a formulation (Edwards, 1997) of the assignment given by the Pet X-ray machine and recapitulates the treatment plan as "to fix it" (line 12). The formulation used here enables the parent to help the child to understand the machine's action (treatment) and achieve shared knowledge with the machine, which is agreed upon by the child ("Yeah" in line 14).

In order to fix the toy, a child needs to know how to map the action "wrap" into her immediate context. Eva displays her difficulty in fulfilling this task given by the machine: "But HOW do we do to wrap the tail up? (line 14)", and "How DO: we Actually wrap the tail up?" (line 18). According to the information structure (Halliday, 1967, 1970)--the "given" (the known) and the "new" (the unknown), what is given for her is the statement embedded in the question: "wrap the tail up", and what is new for her is the way in which the action "wrap" is performed, or more specifically, the tool with which the action is performed, as can be seen from the way she stresses the part she has difficulty with: "HOW", "DO" and "Actually" and the way she demonstrates the part she doesn't understand: holding a cone again the tail of the toy cat while asking her mother whether it is the right tool with which to do the wrapping (line 15-16). What she is trying to do is translate the verb "wrap" into a situated action in her context, the

exhibit. Again, according to the structure of the action verb “wrap”, it involves the identification of two objects in the real world —an object the action is performed on and an object with which the action is performed—to be able to map the action. The mother understands her child’s problem (line 19)—finding the right tool to wrap the tail, and tells her the likely place where she can find such tools by directing her attention to a table nearby (line 20).

Another example is worth examining here in Example 5.6, which is a continuation of Example 5.4.

Example 5.6

1	X:	The scanner shows that Marla has a clump of stuffing in her right front hoof. My
2		diagnosis is Hurt-hoofi-tosis.
3	X:	You need to massage the clump in the hoof and then wrap it up tight until her
4		stuffing settles.
5	X:	Thanks for assisting me in the Pet Vet. You’ve done so much to help our toy pets
6		feel better.
7	M:	It said stuffing for the ri:ght foot. Right here=
8		((*Holds Marla’s right front hoof with both hands*))
9		=so that you rub this
10		((*Rubs the hoof with right hand*))
11		and wrap it ↑up °they said° (.)
12		((*Picks up a small piece of cloth and wraps the hoof*))
13		like-Oh↑ here’s a band-aid for it.
14		((*Picks up a band-aid and wraps it around the leg*))
15		There you go.

This is a good example of how a parent helps her child understand the long and difficult instruction of treatment delivered by the machine. Previously (see Example 5.4), the mother helped the child index the "toy pet" and the "scanner", therefore successfully mapped the action of "put", which triggered the next turn of the machine as diagnosing followed by treating. After the machine's turn, the mother automatically takes the responsibility of translating for her child, using indirect speech devices like "It said" (line 7) and "they said" (line 11). Through a configuration of verbal actions, movements and objects, she helped mapping two actions described in the instruction ("massage the clump in the hoof" and "wrap it up") into the local contexts. In mapping the action of "massage", she first indexes the place where the action should happen (line 7-8) and then the way in which the action should take place (line 9-10). It is noteworthy that she replaced the verb "massage" originally used in the machine's instruction with her own word "rub", which is a more accessible expression for a young child, a diction probably based on her understanding of her own child through daily interactions. In demonstrating the action of "wrap", the mother finds the right tool to conduct the action, as suggested by the structure of the verb. A Band-Aid is apparently a more appropriate tool than a cloth as indicated by the mother's voice of amazement (Oh) (line 13). Like the mother in Example 5.5, the mother in this case provides valuable information for her child when the screen displays failed to do so. It is interesting to note that after his mother's demonstration, Austin seemed to understand the mechanism of the machine and started to experiment with different "toy pets" he could find.

5.3 Discussion

In this part, I discuss the three analytical questions I proposed earlier in this chapter based on a scrutiny of children's real-life interactions with the tangible interactive. I will first discuss

how and why these interactions matter to an understanding of children's communication skills and to literacy, and then the problems children experienced in their interaction and how parents helped children overcome these problems. Finally, I will discuss the implications for a better interactive design.

5.3.1 Technology-mediated Communication

For the machine to be successfully used as a mediation between two humans—the designer and a child, both parties will have to import some of the basic rules in the organization of face-to-face interaction, like turn-taking. However, unlike human-to-human interaction in which the participants can put each other under close monitoring moment by moment and make sense of each other through a large variety of semiotic resources and configurations, interaction between human and machine is restricted in its scope by an asymmetry in their relative access to these moment-by-moment contingencies that constitute the conditions of situated interaction. The intersubjectivity between human and machine will therefore have to be achieved as the machine presents itself as a pre-existing plan with user actions predicted and mapped into the plan as predetermined turn slots. This poses a strict requirement as to what counts as recognizable and thus acceptable actions for the machine restricted by its design technicality. In this special case, the Pet X-ray machine is designed with a sensor in the scanner to detect the three toy animals with chips built in them. As a result, an acceptable action whose effect will occasion a turn-transition into the next scanning display involves the identifying of the right object (one of the chipped toys), the right location (center of the scanner) and the right physical activity (put).

My observation of children's interactions with the X-ray machine revealed that even in the unsuccessful attempts children exhibited their ability to make sense of the special

requirements imposed by the X-ray machine as they understood the machine's next turn as an assessment of the adequacy and accuracy of their prior action. They displayed such understanding either through an attempt to solicit a response (for example, to touch the screen) from the machine as promised in its prior instruction, or through a repair of their prior action, for example, to go to another X-ray machine, to adjust the position of a wrong object, or to try another toy animal if available. This observation is important to an understanding of meaning making in an age when literacy and learning are becoming increasingly mediated by technological innovations. Kress and van Leeuwen (2001) pointed out that in the age of print literacy, distribution technologies were not intended to produce new meanings and were simply considered technical "re-coding" of semiotic products. However, in the age of digital media, "the functions of production and distribution become technically integrated to a much greater extent (p. 21)." If we look at the Pet X-ray machine in this way, we can see that the texts of the machine are all pre-programed in the designers' plan and the way these texts are distributed relies on an interactive structure that takes children's embodied action as a contingency. Children's body movements together with the objects (also as a form of text) will determine when, how, and which texts will be distributed. If children produce correct actions that meet the machine's requirement, the texts will be distributed responsively; if not, it will hold the distribution and urge a compliance. On the part of the children, they will have to learn that their bodily engagement with the machine can be meaningful in the sense that it will occasion the distribution of texts. They will not only have to learn to read the texts, but also have to act upon them and read the response from the machine as confirmation of their previous action. If the response is not punctually distributed as anticipated, they will have to learn to adjust their action accordingly. They learned to make meaning with, through and by their bodies. Given the

ubiquity of such kind of technology-mediated literacy practices in today's world in which even adults will have to confront intelligent but sometimes formidable machines everywhere, the learning opportunities and literacy experiences offered by such an interactive element at the exhibit is valuable as the interaction involves meaning making in a nexus of space, materials, bodies and movements enabled by technologies.

5.3.2 Parent-facilitated Interactions

In their interactions with the Pet X-ray machine, children have demonstrated difficulties in understanding the instructions for various reasons analyzed in the section above. A parent at present not only can provide immediate facilitation when needed, but also allows the child to utter his or her specific problems with operating the machine. For example, in Example 5.4, we get to know that at least one of the reasons that the child does not know how to do the X-ray is that he has no idea what a scanner is and where it is at the exhibit. In Example 5.5, the child has difficulty in mapping the action of "wrap" because she is not sure what tool to use to fulfil the action. In both cases children could not find necessary information from the displays of the screen and parents' help is the key to overcoming these problems and enables the child to understand how the interactive works.

Parents' facilitation can be categorized into three ways: (1) to formulate the intended action of the machine, as did the parent in Example 5.5 (e.g. "The X-ray scanner will tell you what's wrong with it." "tells you what's gonna to happen."); (2) to translate "machine"/adult language into children's language, e.g. from "diagnosis" to "tell you what's wrong"; from "massage" to "rub"; from a long sentence to short phrases like "It said stuffing for the right foot", "wrap it up they said"; (3) to map the words to the world, a practice that analyzes the semantic structure of verbs like "put", "rub" or "wrap" by indexing the elements of what, where

and how entailed by the verb, therefore materializes and localizes the abstract descriptions of actions in the designer's plan.

5.3.3 Multi-interface Interaction Design

The analysis of children's unsuccessful attempts and parent-facilitated interactions has important implications for the tangible interactive design that incorporates digital technologies, physical activities and materiality into a complex system, especially when the system is developed for young children. Usually the exhibit space where such an interactive is placed is much more dynamic and complex than what could be anticipated and then programed in the designer's plan. It is observed that when more interfaces are introduced and more activities and spaces are involved, more problems are likely to arise in the process of interaction. Given the complexity of such an environment, what seemed to be straightforward instructions like "put your toy pet in the center of the scanner" and "wrap her tail up" may be sources of confusion that frustrate children's experimentation (e.g. The child tried four times without any success before she finally gave up in Example 5.2).

The three ways in which parents helped children make sense of the Pet X-ray machine can offer useful information for developing a more effective interactive design. In designing for children, especially young children, it is important to consider whether the language will be accessible for them. What's more, if a voice-over is used, make sure that the speech is delivered at a moderate speed. Given the limitations on the machine's access to the basic interactional resources, Suchman (1987) suggests designers to counteract this problem by extending the access of the machine to the actions and circumstances of the user and compensating for the machine's lack of access to the user's situation with computationally available alternatives. One important computationally available alternative in this design is the screen, which could have

been used more effectively by providing useful and relevant visual clues for children to understand instructions. As can be seen from the analysis above, the screen displays for both the prompting and treating steps of the design did not provide relevant visual information to illustrate the corresponding instructions. The important multimodal interface was not fully exploited when confusion was most likely to occur. If the tangible interactives are supposed to be standing alone at an exhibit (Horn, 2018), it is important for designers not to assume but to take into consideration the complexity of the exhibit environment and provide as many "computationally available alternatives" as possible to clarify the teaching objective.

Chapter 6 Pedagogy in Simulated Space

The Doc McStuffins' exhibit is a simulated space, as the design of space is based on the premise of a make-believe toy hospital. With the toy medical instruments, children are often observed playing check-ups on toy animals and on their parents. The simulation suggests pretend play between parents and children, offering a natural opportunity for them to be engaged in talks related to the themes of the exhibit. In this chapter, I focus on how the museum takes advantage of the simulated space to organize for differentiated pedagogy, that is, for whole-group instruction, family-group activity, and one-to-one conference to achieve its teaching objective effectively.

In the analysis of the three ways of instruction, I focus on:

1. What multimodal pedagogical resources are employed in the organization of instructions?
2. How does the application of multimodal resources help teaching and learning?
3. How do multimodal instructions serve different pedagogical purposes?

I will introduce the "Doctors-in-Training" program in the Feel-better Training Center (section 6.1), followed by an examination of how an educator explains to families the check-up process (section 6.2) and how parents help children complete an assigned family-group project (section 6.3). I will also look at a case in which an educator "tutors" a child in a pretend play scenario (section 6.4).

6.1 "Doctors-in-Training"

The Feel-Better Training Center houses the "Doctors-in-training" program that includes whole-group instruction and family-group activity. It is a bound and bond space segregated from

the other exhibit areas by strong framing and control of access. These organizational devices are used to ensure the organization of teaching activities. Even though children of the target demographics have demonstrated more or less proficiency in using the toy check-up instruments in the free-choice sections, it is here in the enclosed space that all the children, with synchronized movements and structured exercises, learn the knowledge about the instruments.

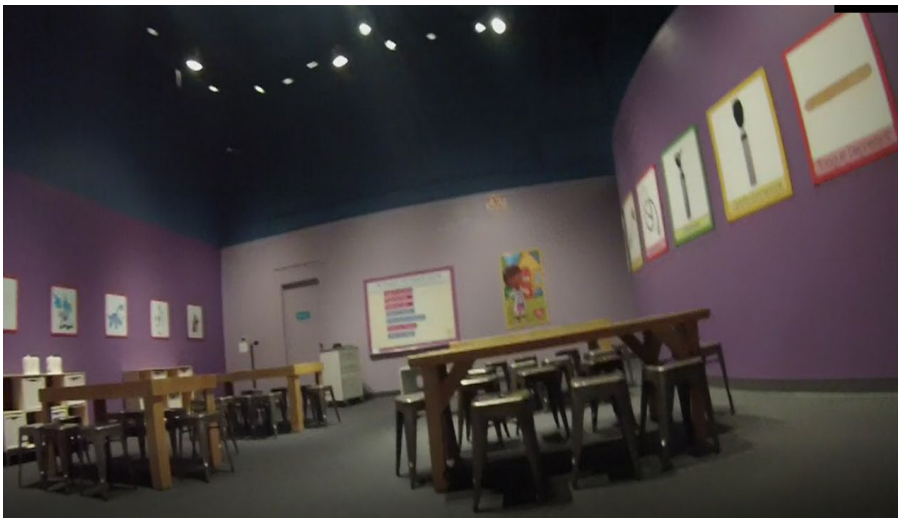
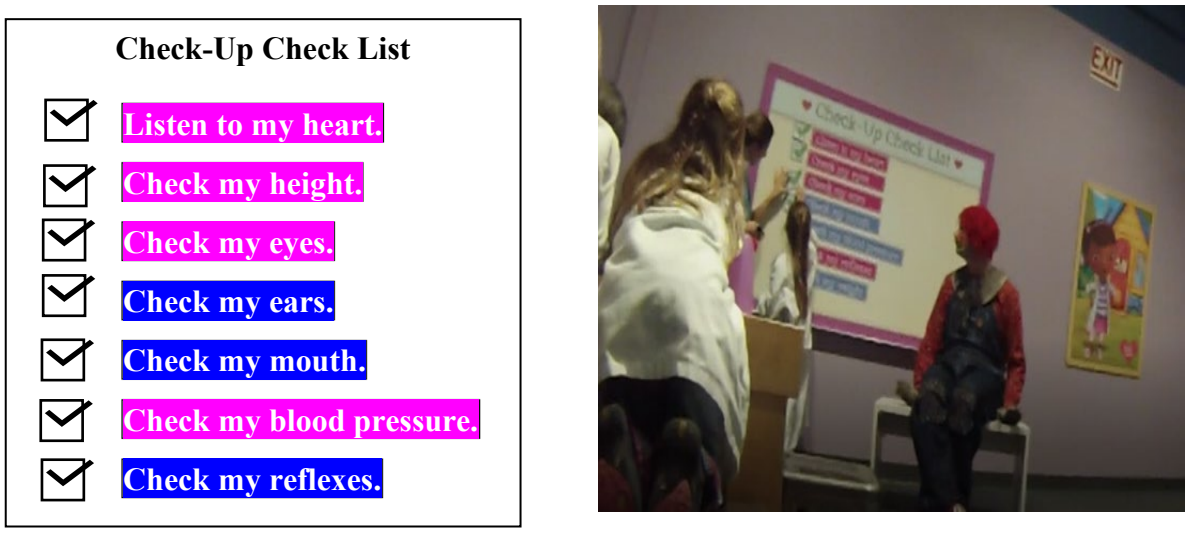


Figure 6.1 The Interior of the Feel-Better Training Center

This pedagogical intention is readily observable after visitors walk into the rectangular space (Figure 6.1). On the wall at the right side six pictures of enlarged instruments are displaced, with the name of each instrument printed under the image: *blood pressure cuff*, *knee reflex hammer*, *stethoscope*, *ophthalmoscope*, and *tongue depressor*. On the wall that faces the entrance is a white board, on which is attached the "Check-Up Check List" that plays an important role in structuring the group instructions made by museum educators (for an enlarged reconstruction, see Figure 6.2 a). At its right is a photo of Doc McStuffins in front of her backyard clinic, serving as a "Symbolic Attribute" (Kress & van Leeuwen, 2006, p.83) that connects the enclosed space with the theme of this exhibit. In the space of the room are evenly distributed four tables with stools around them. Children are told to be sitting with their families

as they enter. In some sessions, children and parents are required to sit on the floor when the educator is instructing (Figure 4.6), while the tables are set along the walls (Figure 4.8). In either case, the bodies are fixed to a certain place (to the ground or to the stool at the table), facing the educator. Like classroom instruction, here synchronized attention and movement is most desirable while random movements and individual activities are curbed.



a. b.

Figure 6.2 The Check-up check list (a. Check-up Check List on the white board; b. Children invited to put a check mark sticker beside the accomplished task)

The valuing of this special period of time is reflected in the distribution of time of the participating families and their staying patterns. The average time they spent at the Training Center is 18.5 minutes, and this accounts for an average of 56% of their total visiting time. Staying for an entire training session also enabled the family to stay at the exhibit for longer period of time than those who did not attend the training: While the average staying time of all the families at the exhibit is 20 minutes, families who participated in the training session stayed for an average of 34 minutes.

Two ways of organizing instruction can be observed from the footage collected by nine children who participated in the training activities. In one way, which I call “theatrical teaching”, one educator plays the role of a McStuffins Hospital nurse and the other, dressed like a rag doll, pretends to be coughing after an adventure in the garden (Figure 6.2 b). In doing check-ups on the “doll”, the “nurse” teaches how to use the medical instruments following the steps ordered by the Check-up Check List on the white board. One child is invited to join the nurse in each check-up step with the right tool from their assigned tool bag. After each step of the check-up, children are invited to put a magnetic checkmark sticker beside the task she/he has just accomplished (Figure 6.2 b). After all the check-up instruments are taught in this way, the educator leads the children into coming up with a diagnosis— “dirty-flush-osis”. The “doll” is prescribed to take a “shower” behind a curtain with sound effects imitating a shower and real bubbles flying into the air from behind the curtain. After a while, the “doll” walks out and declares that he feels much better. Finally, the children are given a “certificate” for their accomplishment of the training. In another way, which I call “plain teaching”, an educator would give instructions about how to do check-ups with one tool after another and put a check mark sticker beside the task bar on the check list each time a check-up is completed. After the instruction, each family is given a toolbox and a checklist to work on as was demonstrated by the educator.

In both ways, the checklist shapes and structures instructions. First, it breaks down the whole check-up process into clear-cut manageable tasks (e.g. “Listen to my heart.”; “Check my eyes.”) which enables the tools to be introduced one task at a time. It is interesting to note that the checklist on the white board is not monolithic. The task bar is magnetic and educators can group and order tasks in their own ways. What is equally important is the check mark stickers attached beside the task bar as an indication of an accomplishment of the previous step while

suggesting a continuation of the next step. Even though the task bars can be shuffled according to each educator's choice, once they are arranged on the white board, the list is fixed. It is the check mark stickers that create the progression of time, which integrate one moment upon another to orientate them towards a terminal. This is especially true for the theatrical teaching model in which young children are invited to the "stage" to put up the check mark sticker themselves. Putting up the sticker therefore means not only the accomplishment of a task but a reward. It usually sends children a message: "good job" (evaluation by the educator) and they can go back to their table, where their parents always welcome their return with a high-five.

In the Training Center, pedagogical activities are usually divided into two parts: educator demonstration/instruction and family-group exercise. I will discuss them separately in the following two sections.

6.2 Whole-group Instruction

In the instruction part, the efficiency of knowledge transmission is achieved by joined attention and synchronized movement during a time frame of about 15 minutes. The following example (Example 6.1) illustrates how the educator mobilizes available semiotic resources to secure children's attention and synchronize their movements so that all children can learn to do check-ups with tools one step after another following the guide of the check list.

After a brief introduction of himself as a "nurse" who works for Doc McStuffins and whose job is to train new doctors, the museum educator asks the children to recall their experiences in a doctor's office for a check-up. This naturally leads to his teaching objective:

> *We're going to have a lot of cool tools that you are going to do a check-up with. I want this to be fun. So, all the kids please raise your hands. Those who raised their hands get to be doctors and those who didn't get to be patients.*

Then he shows the check-up tool kit and a check-up list on a clipboard to the audience and assigns the task for parents and children to practice after the instruction.

Example 6.1

I'm going to show you how to use tools like a doctor would in a check-up. And Lambie is going to be our patient. **>You can see< I got a rea:lly big check-up check list right back here.** ((**aligns his finger movement with the edge of the checklist from top to bottom*)) (Figure 6.3 a) Let's start. I want everybody to try to learn some of the stuff. ((*turns around and faces the audience*)) **The first thing we are going to do** ((**points at the first task bar of the checklist on the white board*)) (Figure 6.3 b) is check Lambie's heartbeat. ((*walks forward toward the audience*)) It says listen to my heart. The first thing we're going to do is check Lambie's heartbeat. **So I'm going to use the tool doctors would use to help him or her listen to the patient's heart.** ((**raises a stethoscope high above in the air with his left hand and turns his torso in a semicircle to show the stethoscope*)) (Figure 6.3 c, d) **This is that tool.** ((*shakes the stethoscope*)) Has anybody ever heard of **a stethoscope before?** ((*gradually raises his right hand high above his head while keeping holding the stethoscope high in his left hand*)) (Figure 6.3 e)

Let's see. A couple of hands. ((*checks the audience for raised hands*))

It's kind of a funny word. Stethoscope.(.) Stethoscope.

((*hands down, holds the stethoscope in both hands*))

Well, we'd like to **do a little game** ((*quickly wears the stethoscope around his neck*)) when we are learning a new word.

I want to see if you can learn this word with me as quickly as we can. Here's how we practice saying this word. I want you to watch me do it and then we'll do this all together.

Ste ((**claps his hands once*)) (Figure 6.3 f)

Tho ((*claps his hands once*))

Scope ((*claps his hands once*))

Stethoscope ((*claps his hands once*))

Let's do it together.

((**Educator and the audience practice together*)) (Figure 6.3 g)

Very nice. Very nice. You all got that right.

Stethoscope is a funny word. **But it's really easy to use.**

((*takes the stethoscope down from his neck*))

All you need to do is to take the small ends and put them into your ears and then hold the end of the circle (.) and put it over your patient's heart.

And we're going to be listening for Lambie's heart.

*((*demonstrates the check-up on Lambie))* (Figure 6.3 h) Sounds OK to me.

So I'm going to give her a check mark over here at listen to my heart. ((*puts a check mark beside the task bar of "listen to my heart"*))

(Figure 6.3 i)

When all of you get your checklist like this you see up there, I want you to put a check mark in the box if your grownup is healthy.

(Data source: video 28-24f5)

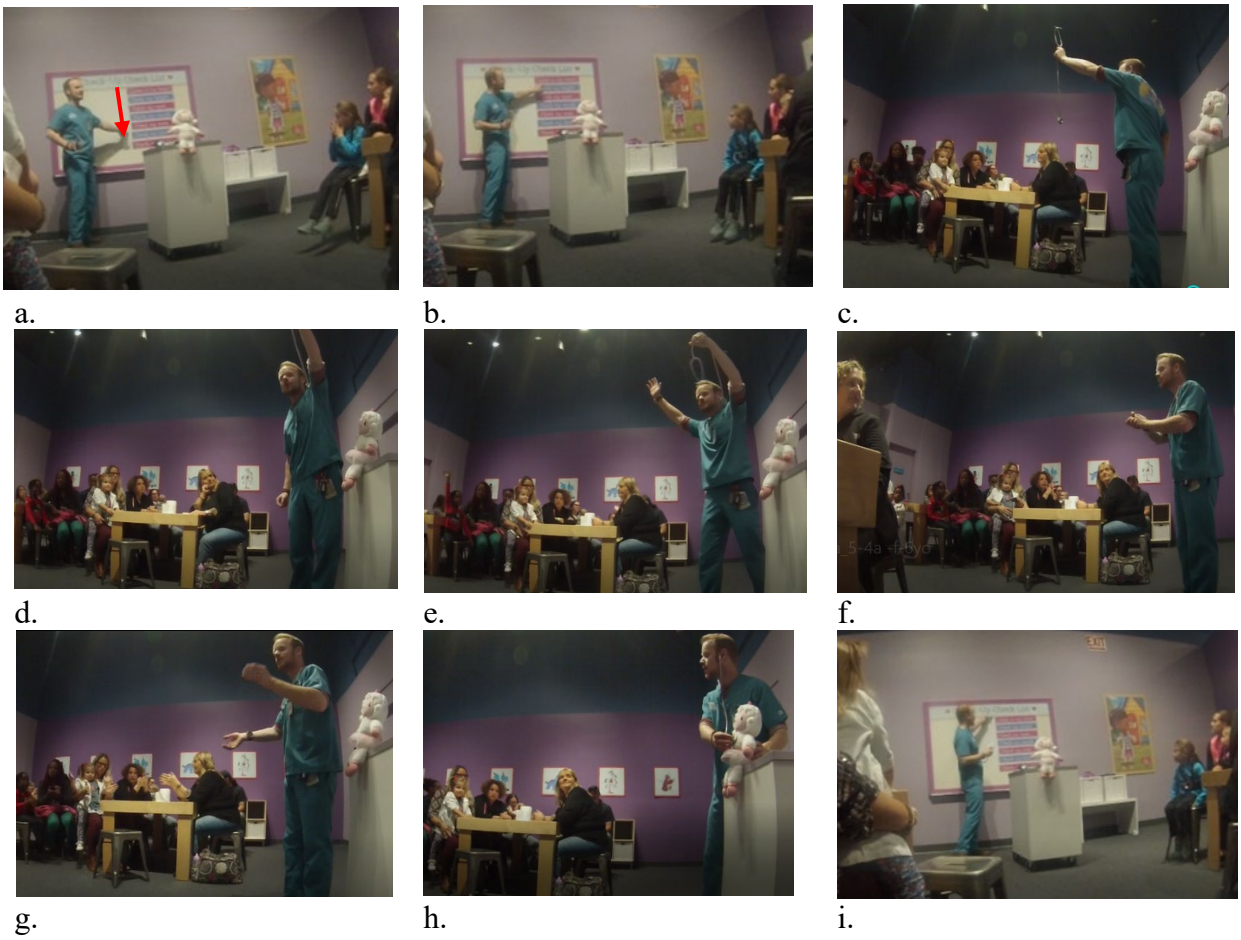


Figure 6.3 Whole-group Instruction

Even though this is a form of "plain teaching" as against what I called "theatrical teaching", the educator's use of rich embodied actions— voice, gestures, and movements in the

classroom—actions with pedagogical functions, produces a theatrical effect that successfully commands the attention of both adults and children. For the purpose of demonstration, he introduces "Lambie" (Doc McStuffins' aid), a stuffed animal, as a "patient" (line 02) and sets it on the desk in front of the white board. Before teaching how to use the tools, he introduces the check list on the white board, not only by his verbal action ("I got a really big check-up check list right back here"), but also by his gesture (line 03-05, Figure 6.3 a). His utterance, the elongated and stressed vowel in the word "really", accompanied by his gestural movement through which he carefully traces the check list top-down with his finger (suggesting "really big"), accentuates the importance of the check list, suggesting the steps into which their excise is going to be divided and the procedure to follow, because "I want everybody to try to learn some of the stuff" (line 06). Therefore, "the first thing we are going to do is check Lambie's heartbeat" (line 08-10, Figure 6.3 b), since this is listed as the first task: "it says listen to my heart" (line 11). In doing so, the educator cites the list as where to begin, establishing a structure to his instruction. This is an illustration of how the educator uses his embodied actions to incorporate the magnetic task bars, an important semiotic resource into his teaching practice. The establishment of order can have an impact on parents' facilitation in the family-group project that follows (Example 6.2).

After the order is established, the educator begins to teach the use of the first tool, a stethoscope, as is required by the check list to "listen to my heart". He attracts the attention of the audience by raising the tool high above the air and turns his upper body 90° for people at the other side to see (Figure 6.3 c, d). Then he shakes the tool in the air to reinforce his utterance "This is that tool." (line 17). The educator commands his audience's attention by asking a question— "Has anybody ever heard of a stethoscope before?". At the same time, he raises his

right hand while his left hand still holds the stethoscope high (Figure 6.3 e), in an attempt to elicit an embodied answer from the children—to raise their hands if their answer is "yes". This successfully secures the children's attention and a couple of them raise their hands to show they are familiar with the word (line 21). This legitimizes the necessity of learning to say the word as there are just "a couple of hands", and "It's kind of a funny word" (line 22). In teaching the name of the tool, the educator says the word twice and quickly wears the stethoscope around his neck so that his hands can be made ready for "a little game when we are learning a new word" (line 24-25). In order to learn this word "as quickly as we can", the educator asks the children to watch him do it first and practice together with him later. In demonstrating "how we practice saying this word" (line 27), the educator slowly utters the word, one syllable at a time, stressing the vowels, while at the same time clapping his hands once every time each syllable is uttered (line 30-32, Figure 6.3 f) before he finally says the word as a whole and claps his hands one more time (line 33). Following the educator's demand ("Let's do it together."), children and parents all actively join in the educator in the practice (line 35; Figure 6.3 g).

Compared to the difficult pronunciation of "the funny word", "it's really easy to use" (line 37). As he says so, the educator takes down the stethoscope from his neck and explains the different parts of the stethoscope and how to use it (line 39-41). This being said, he goes to the desk and applies the chestpiece to Lambie as he verbalizes the purpose of his action—"we're going to be listening to Lambie's heart" (line 42, Figure 6.3 h). By synchronizing his verbal and embodied actions, he successfully animates the function of the stethoscope. Since Lambie's heart "sounds OK", the educator goes back to the check list and "give her a check mark over here at listen to my heart"--putting a check mark beside the corresponding task bar (line 45, Figure 6.3i). As the children are going to be given a check list to guide their practice of check-up after the

instruction, the educator takes this opportunity to emphasize the importance of following the check list and concluding each step with a check mark (line 47-49).

This example shows how the museum educator effectively demonstrates the check-up process with one tool at a time. Through a configuration of multimodal communicative resources he successfully attracted both children's and adults' attention and engaged the families in synchronized actions of learning. The whole instruction lasted for about 20 minutes. The effectiveness of the embodied teaching of the educator is proved by the engaging effect it has on all the parents and children participating in the "training".

6.3 Family-group Activity

Five-year-old Connie visited the exhibit with her mother and grandma. She is the only child in her family group. The family participated in the training session as illustrated above. Despite her reluctance to come in the Training Center, Connie attentively listened to the educator's instruction and actively answered his questions. After the instruction, the educator gave her a tool kit, a pencil and a check list with a clipboard to write on. The task was for children to act like doctors and parents as patients in the check-up practice. Both Connie's mother and grandma helped her in the practice to make sure that she checked each corresponding box in the check list after the check-up procedure. The following example (Example 6.2) shows the process.

Example 6.2

(C=Connie; M=Mother; G=Grandma)

01 C: First (.) first thing we're gonna do to you_

02 ((*picks up an otoscope and holds it in her hands*))

03 I want to check >your ears, your eyes, your nose

04 [and your mouth.<

05 M: [OK. >The first thing we need to do is< check my

06 heart. <**Listen to my heart**.> ((*points to each of the word as she*

07 *reads from the check list*))

08 C: ((*takes hold of the stethoscope passed to her by her grandmother*))

09 G: **OK. I'll keep these close to you so that you know which**

10 **to take**. ((*moves the tools next to the clipboard*))

11 OK. So you can check your mother's heart.

12 C: ((*holds the chestpiece against her mother's chest for a few times*))

13 G: How was it.

14 C: It was great.

15 G: [Alright.

16 M: [Good. My heart is goo:d,

17 C: ((*picks up the pencil and checks the box*))

18 M: Now let's check my height.

((*Mother and child went to the stadiometer in the corner of the room and measured Mother's height; then they returned to their table*))

19 G: Did you check your mommy's height?

20 C: Yes.

21 G: **Here check?** ((*picks up the pencil and taps the corresponding box on the check*

22 *list with the point of the pencil*))

23 C: ((*checks the box*))

24 G: **Next is check my eyes**. ((*points to the task bar on the checklist*))

Which tool do you use to check your mommy's eyes.

C: ((*picks up a magnifying glass*))

M: Ni:ce (?)

C: ((*holds the magnifying against her mother's eyes*))

The eyes- your eyes are really great.

M: **Great**. ((*claps her hands*))

>**Now you get to check it up,**< ((*taps the checklist*))

C: ((*checks the box*))

M: Al<u>r</u>ight. So (.)**<u>che</u>ck <u>my</u> <u>mou</u>th**. ((*points to each word while reading*))

G: Do you remember which one (.) to use to check your

mouth?

C: ((*picks up a flashlight, having trouble with turning it on*))

M: Just click this, push it [down. **Look**. ((*points at the button*))

G: [push it down=What are you

gonna say. What- what do you need to say.

C: <u>A</u>h:

(4)

It's gr<u>ea</u>t.

M: Thanks.(2)[OK.

G: [OK. Check.

C: ((*checks the box*))

G: [Now it says

M: [wi:: <u>che</u>ck <u>my</u> <u>ears=</u>

48 G: =what do you use to check your mom's ear.

49 C: ((*picks up the otoscope*))

50 G: Don't put it in there

51 ((*movement unable to be seen*))

52 M: Ni:ce. What does it look like.

53 C: It looks good.

54 M: Here, check it up?

55 C: ((*puts down the otoscope and checks the box with the pencil*))

56 M: And check my- check my blood pressure.

57 C: ((*picks up the blood pressure cuff and wraps it around her mother's arm*))

58 (6)

59 M: Is it good?

60 C: It's goo:d,

61 M: Thank you, Connie. I feel so much healthier.

62 C: ((*checks the box*))

63 M: Last thing.

(Data source: video 28_24f5)

Following the educator's demonstration, Connie's caretakers make sure that her check-up process follows the exact order prescribed by the check-up check list. In maintaining the procedural progress of the practice, discourse markers such as OK, now, next, so, are used to establish a seriation of successive activities. For example, upon getting the fancy tool kit, Connie can't wait to apply them on her mother. She picks up an otoscope and declares to her mother the first thing she wants to do to her is "to check your ears, your eyes, your nose and your mouth" (line 1-4). Apparently, this could not practically be "the first thing" to do and her mother quickly

cuts her off in the middle of the lock, stock and barrel by a turn initiation discourse marker "OK" (Fung & Carter, 2007; Maschler & Schiffrin, 2015) followed by an utterance of accelerated speed ("The first thing we need to do is"), a strategy to take the turn from the other interactor or to prevent interruption (Schegloff, 2000). It is important to note that the OK used by the mother at this time is functionally different from other OKs in the conversation (line 09, 11, 43, 44), which mainly serve transitional functions, such as evaluation, recognition and agreement, even though structurally they all stay at the turn initiation positions. Here OK performs the action of interruption, a termination of Connie's disorientation ("check your eyes, your ears, you nose and mouth") and a demand of a new direction in the interaction. In this way, the mother reorients Connie's learning path and brings order to her pedagogy.

The different roles undertaken by Connie's caretakers are also important to note. While the mother acts "patient" and leads the practice by reading from the check list one task after another, the grandmother contributes to the process by undertaking a supporting role of a "tool manager" who makes sure that Connie uses the right instrument for the right check-up procedure. After Mother stops Connie from a messy initiation, she cites the check list as an authority to legitimize her intervention by reading out loud the task and pointing to each of the words she reads (line 6-7). The pattern of finger tracking while reading runs through the whole check-up practice and sometimes the grandma would also read for Connie if her mother is not available (line 18, 24, 33, 47, 56). Both caretakers pay special attention to urge Connie to check the box after the accomplishment of each task if she does not promptly do so herself (line 21-22, 31, 44, 54), until finally, Connie gets used to the pattern and automatically closes the task by checking the box without being reminded (line 62). Equally interesting is Connie's grandma's contribution to the process. She passes the stethoscope to Connie (line 8), implying this is the

tool for the task in question ("so you can check your mother's heart") (line 11). At the same time, she places the tools near Connie "so that you know which to take" (line 09-10). This creates opportunities for Grandma to assess Connie's knowledge she has just learned from "the training". In the rest of the practice, each time a new task is announced, she urges Connie to choose the right tool for the current procedure by a question (line 25, 34-35, 48). When Connie comes across a technical problem with the flashlight (line 36), both Mother and Grandma are eager to help (line 37, 38), but it is always the grandma who looks for details and makes a point of testing Connie's knowledge (line 38-39): Even in the middle of the power dispute (both caregivers are eager to give instructions--"push it down"), Grandma doesn't forget to remind Connie of a specific practice the educator taught in his demonstration of "checking my mouth"—say "Ah" to the patient to ask her to open her mouth. She quickly asks two questions right after her instruction "push it down" — "What are you gonna to say? What, what do you need to say?", in which the second question reinforces the first in intensity, changing from a suggestion to a demand, to elicit an immediate answer from Connie. Another example is when Connie chooses the otoscope to examine her mother's ears, Grandma warns her to not to put it too close to the ear (line 50).

This is a representative example of how parents urged children to accomplish the check-up assignment. Unlike parents who accompanied children in the self-directed areas, parents accompanying their children in the Training Center all participated in their children's learning activities. They played an important role in helping their children finish each task in an orderly manner and in recapitulating important instructions made by the educator. At the same time, both the mother's insistence on following the checklist order and the grandmother's assessment of

Connie's knowledge gain after the instruction are indications of the parents' attentiveness to the educator's instruction and also of the effectiveness of his embodied teaching.

6.4 One-to-One Conference

Besides the synchronized activities of training enclosed in the Training Center, sometimes museum educators would sit at a table with a basket of toy check-up instruments in the hallway of the exhibit and offer a one-to-one individualized instruction to children. In the following example (Example 6.3), a museum educator, dressed like a nurse with a stethoscope around her neck, is sitting at a table, with a stuffed monkey on her left side and a basket of check-up instruments at her right side. Seeing a girl (Ulla, a 5-year-old) approaching, she calls out to her to attract her attention. In the following interaction, the educator uses question structures, objects and gestures to help the child learn knowledge about the medical instruments through embodied experiences.

Example 6.3

(E=educator; U=Ulla; G=Ulla's grandma)

01 E: HELLO, DOCTOR? (2) Do you think you can help
02 me(.)**perform a check-up on this monkey**? ((**pushes the*
03 *monkey forward a little bit with both of her hands; gazes at Ulla who is*
04 *approaching*)) (Figure 6.4a)
05 **What tool would you like to start with.**((**drags the basket*
06 *in front of her and sets it between her and Ulla; gazes at the basket*))(Figure
07 6.4b)
08 U: ((*picks up a stethoscope from the basket and puts it on*))
09 E: **Ooh: >and what is ↑tha:t tool.<** ((*gazes at the stethoscope*))

10 U: Ah:(.) a stethoscope=

11 E: =A stethoscope. =And how do you use it.

12 U: Eh you put it on your ears and then you °just°—

13 ((**presses the chestpiece against the chest of the monkey*))(Figure 6.4c)

14 E: ((*Her gaze follows the chestpiece*))Oh:=and what do you hear?

15 U: En(.)her(.)heartbeat,

16 E: Her heartbeat?=What did it sound like.((**smiles at

17 *Ulla*))(Figure 6.4d)

18 U: ((*puts the stethoscope back in the basket*))It °sounds like° en

19 (.)beep beep_

20 E: Beep beep¿ Is that good?(.)Excellent.

21 E: **What are the other tools you'd like to use.**((Ulla *picks a*

22 *blood pressure cuff from the basket*))

23 U: ((**starts to wrap the cuff around the monkey's arm*)) (Figure 6.4e)

24 E: Ooh=What is this tool.

25 U: **Um.**((*takes up the bulb after wrapping*))

26 (4)

27 E: What do you think it does.

28 U: **Um.**((*keeps squeezing the bulb*))

29 (5)

30 G: What are you doing.

31 **What is it called?** ((**pinches twice the tube of the blood pressure*

32 *cuff*)) (Figure 6.4f)

33 (.)Do you have one of those?

34 U: Eh

35 (1)

36 P: °Blood pressure,°

37 U: Blood pressure.

38 E: A blood pressure cuff. I ↑see.

39 **So when you squeeze tha:t,** ((*holds the cuff with her right hand and*

40 *points at the bulb with her left index finger*)) (Figure 6.4g)

41 **what's happening to the dial.** ((*withdraws her left index finger*

42 *and points at the dial*)) (Figure 6.4h)

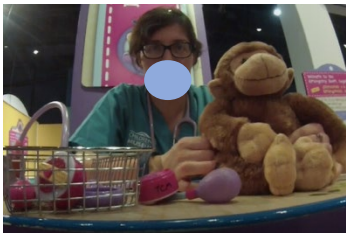
43 U: **It eh (.) spi:ns ¿** ((*points at the dial*)) (Figure 6.4i)

44 E: >It's spinning round and round. Isn't it.< We're

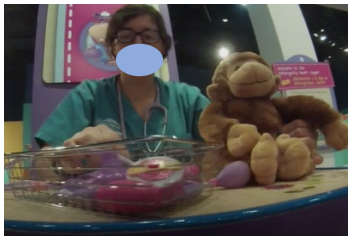
45 checking her blood pressure to see how much her heart

46 works.

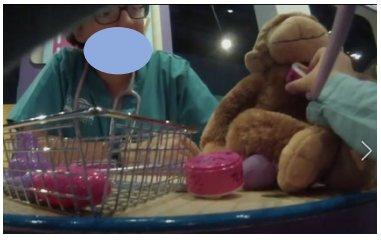
(Data source:20-92f4)



a.



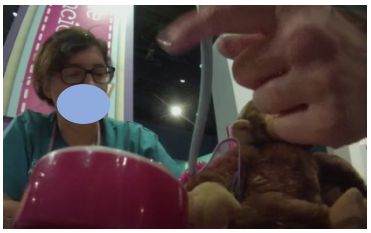
b.



c.

d.

e.



f.


g.


h.


i.

Figure 6.4 “Tutoring” in the hallway

This episode exemplifies how the educator makes use of a variety of multimodal communication strategies to provide scaffolding for the child in the individualized instruction. I will focus my analysis on how objects, conversation structures, and embodied actions are used to to help the child develop a conceptual understanding of the check-up instruments. Instruction in this case is more of a contingency than of a plan, which demands more sophisticated knowledge/training on the part of the teacher/educator to manage.

According to Vygotsky’s (1962) view of concept formation, “[t]he sensory material and the word are both indispensable parts of concept formation (p.52)”, and any method that separates the word from the perceptual material and operates on one or the other is a disregard of the complex structure of the total process. Despite the acknowledgment of the importance of the perceptual material, Vygotsky values the sign, or word as the basic means by which we direct our mental operations, control their course, and channel them toward the solution of the problem confronting us. As all the higher psychic functions are mediated processes, these functions incorporate the mediating sign in their structure as an indispensable and the central part of the total process. “In concept formation, that sign is the word, which at first plays the role of means in forming a concept and later becomes its symbol (p.56).” In a study of children’s development of geometric concepts, Hwang, Roth and Kim (2009) extended the Vygotskian mediating sign to the body. Their examples illustrate the two important roles the body plays in developing

concepts: First, the body is central to the living articulation of verbal thoughts. Second, the body is central to the real-life development of word-meaning. This helped us understand the relation of bodily-material experience and language in the development of conceptual understanding of the world.

The one-to-one instruction is different from the classroom-based whole-group instruction in that it does not seem to have a predetermined teaching plan as was articulated through the Check-up Checklist that established order and structure for the whole-group instruction. What to teach and how to teach is dependent on an immediate assessment of the child's current ability and knowledge level. Therefore, the instruction is individualized. The direct instruction model that assigns a teacher-student (trainer-trainee) relation to educator and children is now replaced by a more equal relationship of playing pals, as indicated by the way the educator addresses the child, Ulla (line 1), followed by an invitation to play doctor—"perform a check-up on this monkey" ("line 2). After successfully attracting Ulla's attention and seeing her approaching the table, the educator then drags the basket full of medical check-up tools in front of Ulla and asks her to choose one to start with (line 5-7). The combination of her bodily action and the corresponding verbal articulation serves to set the objective for this pedagogical activity--how to perform a check-up: the monkey pushed forward is a patient to be worked on and the tools to perform this task are to be chosen from the collection in the basket ("What tool would you like to start with", line 5). Conceptually, the basket dragged forward to a more salient position, together with the utterance "tool", establishes a category for the medical instruments. Pedagogically, instead of imposing an order as prescribed by the check list in the classroom setting, the child is encouraged to follow her own interest, indexing a more equal teacher-student relationship and suggesting an individualized interaction-based learning.

A noticeable conversation structure that the educator uses to help the child develop knowledge about the check-up instruments is the Initiation-Response-Feedback/Evaluation (IRF/E) structure typical in classroom teacher-student interactions (Sinclair & Coulthard, 1975; Mehan, 1979). In such a structure, the teacher's initiation, the student's response, and then the teacher's feedback makes up an exchange, or a bundle of turns that form a "triadic dialog" (Lemke, 1990). A turn can contain more than one move. For example, the teacher may take the third turn as a move of feedback and a move of further initiation. The feedback move can further be broken down into the acts of accept, evaluate or comment, where the teacher can take the turn as a chance of repair of student's answer or add more information. This structure is an effective tool of scaffolding in classroom teaching, through which teachers can elicit useful information about the students' learning to further plan their teaching.

In this episode, the educator skillfully uses the IRF structure to assess the child's knowledge as a basis for her future scaffolding. This pattern is observable in line 8-20 where the conversation between the educator and the child repeats itself as question, answer, acceptance and further question. After the question is answered, the educator always gives feedback either in the form of repetition of the child's answer (line 11, 16, 20), or (after a close observation of Ulla's operation of the chestpiece) in the form of "Oh" (line 14), a discourse marker that conveys a sense that something has just been noticed and acknowledged and the speaker has undergone a change of state (Heritage, 1984). These are acts of acceptance upon which a question of a higher order that demands advanced knowledge is followed based on the educator's observational assessment, such as "How do you use it?" (line 11), "and what do you hear?" (line 14), "What did it sound like?" (line 16). When the child fails to provide an answer to the question "what is this tool?" (line 24), the educator does not provide an answer to the question but shapes her

question according to her observation of Ulla's actions, which demonstrates her embodied knowledge of the blood pressure cuff despite her inability to verbalize its name (line 23, 25), and asks her to describe her own action: "What do you think it does?" (line 27).

During the conversation, this scaffolding strategy is mobilized to achieve the pedagogical purpose of helping the child develop conceptual understanding of check-up. This is achieved by (1) aligning the bodily experiences with the physical properties of these instruments and (2) eliciting verbalization of these bodily experiences. For example, after the educator secured a correct answer to the question 'what is that tool?' (line 9), she keeps assessing Ulla's knowledge about the stethoscope by asking 'And how do you use it' (line 11), which elicits a partial answer (line 12) and a series of embodied actions (line 13). This question activates the body in the sequential articulation or translation of the physical property and function of the stethoscope. In response to this question, Ulla first transcribes what she is doing with the earpieces as 'you put it on your ears' (line 12) and then her voice tapers off but still demonstrates her embodied knowing of the stethoscope by pressing the chestpiece on the chest of the stuffed monkey as the unfinished part of her talk. The educator further pushes for more bodily experiences of the instrument through the alignment of Ulla's auditory perception with the presupposed affordance of a stethoscope ("and what do you hear" (line 14), "What did it sound like?" (line 16)). Even though Ulla has finished her check-up with the stethoscope and put the stethoscope back into the basket, she is still involved in the response to the question asked by the educator ('beep beep' (line 19)), as the educator smiles at her, encouraging her to describe how the heartbeat sounds like. With a positive evaluation 'Excellent' (line 20), a full translation of the sensory-material experience of the stethoscope is accomplished.

The same structure is also applied to scaffold the understanding of the blood pressure cuff. In line 39-42, the educator asks Ulla: “So when you squeeze that, what’s happening to the dial.” When she utters “that” emphatically with an elongated “a”, she points at the bulb Ulla is holding (Figure 6.4 h), and points back at the dial wrapped around the monkey’s arm (Figure 6.4 i) as she utters ‘what’s happening to the dial’ (line 39). Her verbal action, augmented by the accompanying indexing actions, makes salient the causative relation between the bulb and the dial by aligning the child’s tactile and visual perceptions. After helping Ulla construct an understanding of the structural properties of a blood pressure cuff (“It spins”, line 43), the educator quickly offers a repetition as an act of acceptance (line 44) and takes the chance to add more information about what a blood pressure cuff is for (‘to see how much her heart works’ (line 45-46)).

Compared to the educator, Ulla’s grandma demonstrates less patience for scaffolding. After seeing Ulla unable to produce an answer to the educator’s question, the grandma joins in the conversation by asking three questions in a row to push for an answer. At first, she reformulates the educator’s questions in a more direct way: ‘What are you doing?’ and ‘What is it called?’ (line 30, 31). At the same time, her quick pinches of the tube (line 31-32), revealing her impatience for the delayed answer, together with the follow-up question— “Do you have one of those?” (line 33) constitutes an embodied reminder (Bietti & Castelló, 2013), an invoking of memory as an action of implying that Ulla should have known the name of the instrument since she owns one herself. While seeing Ulla unable to say the name, the grandma directly tells her the answer: “Blood pressure” (line 36).

This case captures a different role of parents in children’s museums learning. Research often shows that in the informal learning settings such as museums, public libraries or children’s

centers, when educators are present to deliver instructions, parents automatically consign themselves to the supportive role in instruction (Downey, Krantz & Skidmore, 2010; Nichols, 2011; Satta, 2015). However, in this case, Ulla's parent establishes herself as a legitimate, authoritative contributor to the conversation. This raises another question: What is the source of authority in such cases? The source of authority apparently does not come from the fact that the parent knows the answer to the question. It is the embodied reminder, which Wertsch and Rupert (1993) referred to as "mediated agency" that accounts for an authority shift in discourse. Thus, the parent's authority is established on her ability to mobilize Ulla's memory as a mediational means to help her out (an access the educator does not have) and, in a more important sense, on her alignment of this embodied reminder with her perception of the imperative of the current circumstance. This finding is also corroborated by the discursive action model of remembering (Edwards, Potter, & Middleton, 1992) in which memory is regarded far more than an underlying faculty founded upon linguistic representations, but as discursively situated and action-oriented in the contexts of their production. That is, memory is invoked to do something, to mediate discursive actions in such a way that it has agency. As parents often have shared memories with their children and therefore have a better understanding of their children's knowledge and performance, they demonstrate a tendency to appeal to children's memory for problem solving as a pedagogical action (also shown in Example 4.3).

6.5 Discussion

This chapter addresses the third research question: How are multimodal resources employed to achieve effective differentiated instructions? I have identified three ways of instruction employed at the exhibit as an effective component of pedagogy. If the whole-group instruction is a top-down instruction that delivers information efficiently to all children at the

same time in the room, the one-to-one instruction model is a bottom-up instruction whose effectiveness is based on the instructor's personal attention to and understanding of a child. In the middle is the family/small-group instruction. All these three instruction models are organized to meet the different needs of children at different ages at different times of the day. I will talk about how multimodal means help these instructions become effective and successful.

6.5.1 Embodied Teaching

Whole-group instruction is no doubt the most efficient way to organize pedagogy at a museum exhibit visited by a large number of visitors a day. It can pass information and deliver teaching objectives to quite a number of families at the same time. Despite its efficiency, it is difficult to use with young children as they have difficulty sitting and concentrating for periods of time. However, according to my observations of the ways in which whole-group instructions/activities are organized, this problem can be overcome by effective incorporation of multimodal resources in organizing pedagogical activities. The carefully designed "theatrical teaching" attracted both parents' and children's attention by inviting children to participate in the dramatical activities. While children were on the stage, their parents were often busy taking pictures for them. When children came back to their family groups, the parents often gave high-fives as positive feedback, thus encouraged children to participate in educational activities in spaces outside their familiar preschool environments.

As exemplified by a case I closely examined in Example 6.1, even "plain teaching" can also be effective if pedagogy is carefully structured and incorporated with rich multimodal resources, which can produce as theatrical an effect as the "theatrical teaching". It was observed that the educator successfully commands the attention of all the audience by his embodied teaching—taking full use of narratives, voice, large-scale body movements and props. His

effective teaching can also be observed by the engagement of parents (for example, Connie's mother and grandma), who passed down useful information emphasized by the educator's embodied pedagogical actions to their children in family-group activities. Embodied teaching has demonstrated more power in commanding audiences' attention than instructional method that mainly relies on verbal means, as can be seen from an example I presented in chapter 4 (Figure 4.6). It is also important to note that the organization of space can influence parent-child interaction and participation. When parents and children can be seated together at tables, parents are more likely to be automatically engaged in children's learning activities and this is especially helpful for young children as parents' engagement can help them concentrate and involved in pedagogical activities. This was evidenced by Example 6.1 too: after the educator demonstrated how to use hand clapping to create rhythm to help saying a difficult multi-syllable word, parents sitting close to their children, sometimes with young children siting on their laps, synchronized their movements with their children's to encourage their participation. This synergy is quite contagious and especially helpful for young children. This finding is also consistent with other findings made in language teaching (e.g. Smotrova, 2017), which suggest that teachers' employment of gesture as an instructional tool to help students identify syllables, word stress and the rhythm of speech is effective by enabling learners visualize and embody the intangible pronunciation phenomena.

The table-structured space also allows the educator to walk back and forth among the audience. Such movement across space with different paces is itself an effective indexing semiotic resource. For example, when he wanted to show a stethoscope to his audience he walked slowly toward them with the instrument raised high above the air and turned his upper body from side to side, enabling audiences at both sides to see it; when he finished

demonstrating, he quickly walked back to the white board, bring the audience's attention back to the Check-up Checklist.

Comparatively, a space without table-structuring tends to separate parents and children (Figure 4.6, repeated below as Figure 6.5) where young children often demonstrate less concentration than older children on the educator's instruction. This arrangement not only separates parents from children, but also draws a line between the educator and the audience, making it impossible for her to walk into the audience for more intensive communicative practices like the educator in Example 6.1 does. What is worth noticing is that while the educator is standing and the children are sitting on the floor, both the distance and angle created by such arrangement make it difficult for children to concentrate, as the position of children requires them to keep tilting their head.

Figure 6.5 A space without table-structuring

6.5.2 Effective Assessment

One of the important ways in which parents contribute to pedagogy construction is to provide effective assessment. This is widely observed in parent-child interaction, as I also mentioned in chapter 4. A closer examination reveals that parents are capable of providing

different types of assessment given the different pedagogical contexts. The type of assessment represented in Example 6.2 and another example in chapter 4 (Example 4.5) is more like a formative assessment which usually follows direct instruction to evaluate the teaching effect. Parents read the connotations from the spatial texts of the formal classroom setting and tend to associate their instructional role under such circumstance with a tester through intertexualization. They usually establish themselves as external examiners with typical questions like “Which tool to use to check up…?”, or “Do you remember which one to use to check up…?”.

While in the free-choice activity areas, assessment also happens when parents take the opportunity to teach/play with their children. I re-present the two examples from chapter 4 for assessment analysis here:

Example 4.2

(A parent plays patient and a two-year-old plays doctor in Pet Vet.)

1	P:	How’s my leg? Is it OK?
2	C:	No.
3	P:	Is my leg sick? What do I need to do with my leg?
4	C:	Hurts.
5	P:	It hurts? What do I need to do?
6	C:	To doctor.
7	P:	Oh, to a doctor. OK.
8	C:	((picks up a syringe and gives the leg a shot))
9	P:	Oh. It needs a shot. Ouch. But it makes it feel better.

(Data source: video 4_74f2)

Example 4.3

(The child is trying to measure the temperature of a doll with a thermometer, while the mother is watching her.)

1	C:	((Holds a thermometer upside down while measuring the doll))
2	P:	No. Try again. What do you do temperature?
3		((pats child on the hand))
4		What does mommy do your temperature?
5		Do you remember where mommy puts it?
6		(.)
7		Yeah. Under your arm.

(Data source: video 7_111f3)

In Example 4.2, the parent takes the pretend play opportunity to assess the child's knowledge about health care: "Is my leg sick? What do I need to do with my leg?" (line 3). After he gets a wrong answer ("It hurts"), he makes an effort to correct it by repeating the answer as a question ("It hurts?"), followed by a reiteration of his former question ("What do I need to do?") (line 5). It is so interesting to observe that the two-year-old even understands the parent's repetition of the question as a request for her to repair her answer ("To doctor" line 6). This answer is further accessed and approved ("Oh, to a doctor. OK." line 7). In example 4.3, the parent monitors the child's playing with a thermometer and offers an assessment based on her observation of the child's hand movement, by patting her hand for attention demanding (line 3) and then by reminding her of her home experience (line 4-6) until the child submits the right answer (inferred by the parent's reaction), which is finally approved ("Yeah. Under your arm." line 7). These assessment actions are closely interwoven with the parents efforts in scaffolding knowledge construction through which they also construct their identities as a play mate ("Ouch.

But it makes it feel better." Example 4.2, line 9) or a caregiver ("What does mummy do your temperature?" Example 4.3, line 7). These are practices of Dynamic Assessment (Lantolf & Poehner, 2014; Poehner, 2008, 2018; Poehner, Qin & Yu, 2019), well explored in language teaching, in which assessing and teaching are not taken as discrete activities but are believed to be closely related to each other to form a coherent pedagogical activity to promote learner development. My findings also show that parents can also be an effective pedagogy source with skills in assessment and scaffolding in response to different designed spatial texts.

6.5.3 Knowledge Construction

As demonstrated by Example 6.3, the one-on-one educator-child conference is an individualized instructional effort to meet the needs of children at times when there are no Doctor's in Training sessions. This form of instruction serves one child at a time, and it seems much less efficient than the whole-group instruction. However, this type of instruction creates for the child a unique opportunity to construct knowledge through translating embodied experiences into concepts. This process usually requires skills to configure a variety of multimodal resources in instruction, which also involves a close monitoring of the child's embodied knowledge as a form of dynamic assessment. This finding can be useful for early childhood/literacy education as young children's meaning making is largely non-verbal and can be overlooked. It can also be informative to parents who tend to feed children with an answer without bothering to encourage children to explore, construct and experiment for a while.

Chapter 7 Conclusion

In conclusion, I will talk about how the Doc McStuffins exhibit is an integrated pedagogy of space, materials and interaction, the implications and limitations of this research, and its significance in opening a different way to look at design and literacy.

7.1 An Integrated Pedagogy of Space, Materials and Interaction

This study examined the multimodal pedagogy design at a Doc McStuffins exhibit from three aspects: pedagogies in the narrative, performative and simulated spaces. I see all three types of space existing at the same time at the Doc McStuffins exhibit. For the purpose of analysis, I separate the spaces into three distinct chapters, each focusing on one aspect of the integrated pedagogy: with narrative pedagogy focusing on the physical organization of space, performative pedagogy on materiality, simulated pedagogy on differentiated instruction and activities. However, all these three pedagogical spaces are interwoven together. This consistent and coherent arrangement of space, materials and instructions offers a backdrop of familiarity and fantasy that excites young children's imagination and offers them easy access to content learning.

The physical organization of space, including both the floor plan and visuals on display, takes into consideration the type of materials and interactions that meet the special needs of certain types of pedagogical activity. For example, the bound and bonded space of the Training center houses tables and stools for family groups to take part in synchronized whole-group pedagogical activities, while the exhibit sections with weak framing suggest fluidity, free choice and individualized parent-child or educator-child interactions. The open access but strong-

framed Theater is for whole-group activity (viewing), but the activity does not necessarily have to be synchronized.

Even though the whole exhibit can be categorized as a performative space that encourages interaction, or hands-on experience, the performativity is both afforded and constrained by where, when, how, and with whom. In the free-choice hands-on sections of the exhibit, children's performativity is unconstrained and parents can choose to be a "helicopter" or a "shepherd". The high-tech interactives such as the Pet X-ray or the Toy Operation constrain performativity in a linear way, that is, there is only one way to interact with these exhibit elements. On the contrary, most of the low-tech simulated toys offer more flexibility and are more likely to give rise to pretend play between parents and children. The sections such as Pet Vet, Nursery, ER that feature such kind of materials and interactivity attracted more children and engaged children for longer period of time than other sections. These are the spaces where the most individualized learning happens. In the whole-group and family-group activities housed in the Training Center, the type of performativity is restricted, but the degree of performativity is increased: both parents and children are involved in the whole-group instruction and the following family-based project. Even though these activities are less individualized, the whole-group instructions, in which the museum educators often adopt various multimodal strategies to promote embodied teaching and learning, are effective and efficient in communicating to family groups the themes and major concepts of the exhibit in a matter of 15 to 20 minutes. This is also important to an exhibit that accommodates large numbers of visitors a day.

The simulated toy hospital environment offers a grand narrative for the museum to organize it differentiated teaching activities. These organizations are not independent from space and materials. In the "Doctors-in-Training" program, educators make use of various forms of

multimodality, such as drama and theatrical body language in the whole-group instructions that have engaged both parents and children. The table-structured space is also found to be more effective than non-structured space in facilitating parent-child interaction, therefore increasing parents' involvement in children's learning. In family-group interactions, the narrative of playing doctor gives both parents and children a role to play. The Check-up Checklist handed out to each family group provides parents and children with a structure to organize their project and creates a proceeding of time and a sense of success for children. In the one-to-one conference between an educator and a child, the educator used verbal skills and toy instruments to help the child to construct knowledge. The hallway is exploited to provide this individualized instruction for children when there are no "Doctors-in-Training" sessions available.

7.2 Design for Learning in Museums

Although multimodal analysis of literacy spaces has produced an established body of literature in literacy research, its application is paradoxically much less explored in the most multimodal and multisensorial learning spaces of museums. The multimodal analysis of space organization, (human-object) interactivity and (human-human) interaction in this study has produced findings meaningful for museums that wish to create programs that increase parents' involvement, incorporate effective instruction and design engaging interactive activities.

7.2.1 Parents' Participation

As findings of the study revealed, parents' participation can be influenced by the three aspects of pedagogy (space, materiality and interaction). While parents demonstrated different styles of caregiving for their children in the free-choice sections of the exhibit, they all took part in their children's learning in the enclosed space of the Feel-Better Training Center. Within the center, the more structured space that enabled parent-child interaction increases parents'

involvement than the non-structured space. Effective instruction is also a very important way to engage not only children but also parents. Parents who are engaged by the whole-group instructions are more likely to be intensely engaged in children's learning, such as helping them learn to sequentially manage a project, reminding them of important details, and assessing their knowledge. In this way, parents co-construct pedagogy by providing a valuable form of individualized instruction to their children. Materials help too. As was shown in Connie's family group case, the Check-up Check List gave Connie's mother an order to follow when guiding her child. The toy check-up instruments were also used by Connie's grandmother as tools of assessment to see if Connie knew what tool to choose for each check-up task. Simulation contributes to parents' participation too, as parents were assigned the role of patients to play in children's after-training exercise. This activity creates a one-to-one conference opportunity for parents and children. These findings can be useful for museums committed to creating family-centered programs.

7.2.2 Language and Differentiated Instruction

In studying all kinds of instructions, I also find that language played an important role in achieving differentiation to meet different needs. This role has been largely overlooked in the current research paradigms. Although conversation has been densely studied in the sociocultural framework, the method with which conversation is studied is problematic. Studies of parent-child conversation under this paradigm usually take a laboratory model of research design that relies on pre-exhibit activities, in-exhibit monitoring and (sometimes) post-exhibit test to validate the effectiveness of talks as instrument of learning (Benjamin, Haden & Wilkerson, 2010; Haden et al., 2014; Jant et al., 2014; Tõugu, Marcus, Haden & Uttal, 2017; Willard et al., 2019). Although these studies were conducted at an exhibit, the experience of participating families was

made to test the effectiveness of the pre-exhibit activities, sometimes called "experimental manipulation" or "facilitated educational program" (Haden et al., 2014) to promote family conversations and children's learning of concepts. In order to test the validity of conversation, both talks and knowledge were reduced into quantifiable viables, between which correlations were operationalized. For example, language was reduced into wh-questions and knowledge into memory. The more wh-questions a parent asked during the visit, the more likely a child would remember the contents of the exhibit (Benjamin et al., 2010; Jant et al., 2014; Willard et al., 2019). This universal method reduces data, extracted language from the complex pedagogical contexts in which it is used and oversimplified its roles in knowledge production, which is also oversimplified as retention of facts.

Through a naturalistic method of data collection and representation, I take a view of language as action-oriented, interactive, procedural, and situated. The multimodal analysis of instruction methods revealed that language is interwoven together with other modes of communication into a nexus of pedagogical efforts that involve space, materials and bodies. With different configurations of these semiotic resources, both parents and educators created effective differentiated instructions. In the whole-group instructions, the dramatic script is found to be very engaging. The "plain teaching" can be highly engaging too if the educator could skillfully support his verbal instruction with embodied actions, space making and teaching props, which also produced an effect of theatrical performance. It is also found that his creative use of hand clapping to visualize and embody rhythm in pronunciation is effective in engaging both parents and children (Example 6.1). In the one-to-one instruction, the educator's strategic use of conversation structures (IRE/F), objects and gestures helped the child translate her physical experience of objects into concepts. Her scaffolding strategy enabled the child to construct

knowledge based on her perception of the world (Example 6.3). In parent-child group work, parents are observed to use language to help children accomplish tasks, evaluate achievement and mobilize memory. These findings can provide educators and parents with empirical know-hows to conduct effective interaction with young children.

7.2.3 Engaging Interactivity

As a representative technology-mediated communication form, a tangible interactive, the Pet X-ray machine is examined in this study. Through an analysis of children's unsuccessful attempts and parent-facilitated interactions, the study identified problems with the multi-interface interactive design that incorporates digital technologies, physical activities and materiality into a complex system. Usually the exhibit space where such an interactive is placed is much more dynamic and complex than what could be anticipated and then programed in the designer's plan. Given the complexity of such an environment, what seemed to be straightforward instructions may be sources of confusion that frustrate children's experimentation. It is suggested that computationally available resources, in this case, the screen, be used more effectively by providing useful and relevant multimodal clues for children to understand verbal instructions.

It is also found that compared to the sophisticated designs like the Toy Operation and the Pet X-ray, simple toys are more attractive to children of all age groups. For example, the three toy animals designed as pet patients for the Pet X-ray, are carried everywhere and children created different ways to play with them other than their intended functions. Similarly, a popular toy horse is observed to be involved in an infinite composition with other toys. Even if children showed interest in figuring out those tech-rich designs, they soon left after they made sense of them. As a result, these stations are the least visited areas measured both by time and frequency. Children often choose to stay as long as possible in areas that allow them much tinkering,

combining, dissembling and animating. These findings could be helpful for children's museums to re-examine the idea of effective interactivity (Adams, Luke & Moussouri, 2004) as the development of interactivity can be very expensive (West, 2004).

7.3 Literacy-Rich Classroom Environments

Preparing a classroom's physical environment is often an overlooked aspect of pedagogy as teachers and curriculum developers tend to concentrate on the verbal or interpersonal factors while giving little attention to the spatial context in which teaching and learning occurs. However, as it was suggested by studies of classroom space (Baroutsis, 2018; Flint, 2018; Levy, 2008; Whittingham, 2019), the organization of physical space and the incorporation of technology, play, and interactive activities into pedagogy effectively produces and transforms literacy spaces. Appropriate design of physical space in a classroom, such as the arrangement of furniture, partition, the aesthetic quality of visual display, selection of artifacts, contributes to the effectiveness of pedagogy (McGee & Morrow, 2005). For example, rooms carefully structured into small spaces facilitate interactivity among peers and cooperative play, more than rooms with large open spaces (Reutzel& Cooter, 2009). The effectiveness of instruction is also coordinated by the arrangement of the environment (Weinstein & Mignano, 2003).

School classrooms, especially early-year classrooms, are more like museum exhibits than we think. In planning pedagogies to create a literacy-rich environment for children, educators can also take the three aspects of space organization into consideration. In terms of narrative space, the design of the room should accommodate and coherently organize whole-group activity area and various stations that engage children in productive literacy work. Stations can contain one or many activities for individuals or for group work. There could be literacy stations and interdisciplinary stations in a classroom to provide an integrated and interdisciplinary approach

to the development of literacy, based on a recognition of individual differences and levels of development. Like what Dernie (2006) said, a narrative space is like a story coherently and consistently structured to communicate a theme. The emphasis on literacy development in the early years can be demonstrated by an effort of the teacher to make the literacy center which includes the reading and writing areas an important part of the classroom. The center should be obvious, inviting, and comfortable, clearly defined and afford privacy as well. Such spatial discourse communicates to children "we value literacy".

In planning for contents in the stations, materials should be used to serve the achievement level and interests of children in a given grade. The literacy station can accommodate books of three or four reading levels about a variety of topics and in different genres. In stations designed for particular content areas, such as social studies, science, arts, dramatic play, etc., there should be materials specific to topics currently under study and storage places for relevant supplies and resources. Materials are designed and arranged in such a way that encourages manipulation and activity for children to use independently or in small groups. To label, display, store and update these materials are similar to the work of a curator.

Simulation can be a very important aspect in early literacy pedagogy. For preschoolers and kindergarteners, an environment that simulates home may help them achieve the transition from home life to school life. Even though long time whole-group instruction is considered inappropriate for preschoolers, story-book readings by teachers, singing songs, dance and short class discussions can be effectively organized if situated in a cozy living-room-like space. The literacy station can be a simulation of a library where children are allowed to check out books to take home and where it is comfortably furnished to encourage children to stay and relax with books. Visual semiotic resources such as posters and print can be used to celebrate reading and

increase literacy awareness. Activities can also be a very important source of simulation. For example, writing activity can be organized to simulate newspaper publishing with children pretending to be journalists. Dramatic-play activities, which have been proved by a large body of research as an effective literacy pedagogy, can also be a great source of simulation for content area learning. Children can be encouraged to create scripts based on themes being discussed in the content learning and act them out, which will not only enhance their literacy skills such as story production and comprehension, but also improve their ability to sequence and recall details.

7.4 Limitations

This study is mainly based on the data source collected by wearable cameras which proved to be a very efficient and unobtrusive way of data collection. The videos thus captured enabled researchers a first-person view of children's natural encounter and interaction with the material resources and learning environment of the exhibit. However, the method has its limitations too. First of all, children's age may be a factor in determining how much their hand movements can be captured. As younger children have shorter limbs, the chest-mounted cameras are often blocked when they stand close to an exhibit element taller than them. When taller children reach out to touch things high above them, these movements are not catchable either. This always happens when children try to touch the screen of the Pet X-ray machine. Another restriction imposed by this view of camera was keenly felt in my analysis of differentiated instructions. While the footage allowed me a clear view of children's face-to-face interaction with an individual educator in the one-to-one instructional practice, it offered a partial view of the whole-group instructional activities. The examples of educators' group instructions I used in my data analysis were fortunately obtained from videos taken by children who happened to be facing the educators. With the most intriguing form of whole-group activity—the "theatrical

teaching", I didn't get enough data to cover the whole instruction as only one or two children were invited to the "stage" at a time to have a participatory experience in the check-up of a "rag doll". As my research interest has gradually expanded from children's interactivity only to how the design of the exhibit worked as a pedagogy to enable such experiences, the single camera position in the original research design seemed to be a limitation on data source. These experiences are going to be informative for my future research designs.

7.5 Rethinking Design and Literacy

With a commitment to education, designers, assuming the responsibility to teach the public, are always concerned about whether their designs will be understood as intended for the anticipated educational objectives to be achieved (Allen, 2004; Allen & Gutwill, 2004). Whether visitors are able to make sense of these intentions is a determining factor in evaluating exhibit designs. For example, an exhibit was evaluated as successful if the thematic intentions were interpreted accordingly by visitors (Whitney & Associates, 2003) and unsuccessful in communicating its abstract theme if the intended theme was misidentified (Hein, 2003). Perry (2012) argued that what makes learning fun in museums is exactly visitors' ability to make sense of the exhibit designs, their working principles, functions and educational purposes. This view of design/program evaluation is still stuck in the validity model called "realism" (Fulcher, 2015) established by the work of Messick (1989) that claimed that a test is only valid if it tests what the designers claim it tests. This view of pedagogy design limited our view of museum experience (Birch, 2018; McRae, et al, 2018) and ignored the rich multisensory resources that not only enable children (and indeed all visitors) to make sense but also to make nonsense (Wohlwend et al., 2017). My analysis of children's "unsuccessful" attempts of the tangible multi-interface interactive (the Pet X-ray machine) revealed that what seemed to be nonsense-making is actually

children's embodied sense-making, which demonstrated children's ability to apply their interpersonal communicative proficiency to human-machine interaction. If we see children's meaning making beyond the sense-making framework, we can see how museum space could be a space that has the potential to produce infinite new forms of meaning, as was reported by Hackett (2015) that repeated visits to a local museum enabled children to develop a special kind of friendship shaped and reinforced by rituals of space-making communal activities.

The discussion about pedagogy design in museums is closely related to the current controversy in literacy pedagogy theories about whether meaning making is designed, rational and intentional or unintentional and emergent. The controversy over the role of design in pedagogy antagonized the two major frameworks of literacy: the social semiotic and the sociomaterialists approaches to literacy. Based on my empirical research and drawing upon Deleuze and Guattari's (1987) concept of assemblage, I will argue that making-sense and making-nonsense are both sides of design and they are indispensable to each other. Productive pedagogy designs are forms of sense-making that support the multiplication of "nonsense-making"—forms that produce more forms. An assemblage consists of two planes: the plane of organization and development and the plane of immanence, corresponding to what Deleuze and Guattari called *mental design* and *abstract design*. As mental design is a plane of organization and development of forms, it is the concept of design we traditionally take for granted and it is exactly the view of design from the social semiotic perspective. This plane of meaning making is indispensable in human life as meanings can be efficiently communicated through these predetermined forms (modes). However, it has its problems. It can construct powers of signifiance and subjectification and colonize our thoughts and constitutes an interiority of mind that naturalizes social practices and makes dominating powers imperceptible. This is why we

also need *becoming*, or *abstract design*--movement of deterritorialization that dissolves forms and sets free subjects, giving rise to the plane of immanence, as an escape from the dominating powers that normalize ideologies we take as absolute truth.

Mental design and abstract design are not a new dichotomy, but two tendencies of an assemblage that are inseparable to each other: Whenever an assemblage makes a move toward becoming, there is a tendency pulling it back toward stratification; whenever there is stratification, there are passes, or lines of flight, to escape stratification. Between these two interwoven tendencies, movement as the pure relations of speed and slowness, plays a crucial role in reducing the forms and functions to the minimum. Movement like this that dissolves forms is movement of deterritorialization as much as affects thus effectuated work for desubjectification. This perspective of the relation between movement and form offers us a new insight into the power of materiality: "There is a material proliferation that goes hand in hand with a dissolution of form (involution) but is at the same time accompanied by a continuous development of form" (Deleuze & Guattari, 1987, p.270). Therefore, becoming is the imperceptible movement of deterritorialization that dissolves predetermined forms but ends up creating new forms. It is the imperceptible abstract design (nonsense-making) in-between.

This view of design as an integrated combination of mental design and abstract design enables us to see the problems with both social semiotics and new materialism: the former sees only forms, the signified and the signifier as the two corresponding sides of a symbolic form; the latter sees only emergence and unpredictability without being able to see the sources (forms) from which the emergences emerge. Education cannot do without mental design, or symbolic forms. We design pedagogy for teaching purposes. We need to carefully engineer the learning environment for intervention, for better learning outcomes. We need to assess our designs to

evaluate their effectiveness. *What is problematic is not meaning-making by design, but the idea of design for signifiance and subjectification only*. What we should problematize is the established assessment literacy (Fulcher, 2015, 2020), the narrow view that a design is meaningful and successful so far as it conveys its intention, or its teaching objective, a view that reduces pedagogy design into forms of subjectification and signifiance. How can we design our pedagogies and instructions that do not subjectify and signify but encourage becoming? As designers and educators, we need what Deleuze and Guattari (1987) called "perceptual semiotics" (p.23), a flexible vision that enables us to see the middle, the plane of immanence, the imperceptible becoming between forms. The imperceptible is not intrinsically imperceptible, but instead, subjectively imperceptible, because our perception is always limited by certain thresholds and associated with our subjecthood. As subject to certain forms, we are unable or unwilling to see anything beyond that.

This view of design sheds a new light on the relation between movement and material power and between perception and knowledge creation. I would argue against the posthumanist proposal to decenter human in literacy research but suggest that we rethink what makes us human: not simply as beings of reason and intention capable of mental design, but also as becomings capable of molecular perceptions for individuation and transformation, that is, for abstract design as well. It is the desire for better and/or different perceptions that makes us human. This propels us to think deeper about what literacy is. It is the freeing of perception from its old threshold that enables us to be desubjectified and to escape the captivity of normalization and stratification. Only new perceptions will allow us to venture out of the interiority of our thought that normalizes and naturalizes domination, discrimination, inequity and indifference. Literacy, essentially, is a movement of deterritorialization: by reading, writing, listening, talking,

we learn from each other, learn from people of different cultures across space and time, to gain new perceptions. We constantly deterritorialize ourselves from old forms that shape our thresholds of perception in spite of the fact that we will be reterritorialized in a new form. It is this infinite and immanent transformation in-between that is what literacy is all about.

References

Adams, M., Luke, J., & Moussouri, T. (2004). Interactivity: Moving beyond terminology. *Curator: The Museum Journal, 47*(2), 155-170. https://doi.org/https://doi.org/10.1111/j.2151-6952.2004.tb00115.x

Alaimo, S. & Hekman, S. (Eds.). (2008). *Material Feminisms*. Indiana University Press.

Allen, S. (2004). Designs for learning: Studying science museum exhibits that do more than entertain. *Science Education, 88*(S1), S17-S33. https://doi.org/https://doi.org/10.1002/sce.20016

Allen, S., & Gutwill, J. (2004). Designing with multiple interactives: Five common pitfalls. *Curator: The Museum Journal, 47*(2), 199-212. https://doi.org/https://doi.org/10.1111/j.2151-6952.2004.tb00117.x

Allen, S., & Gutwill, J. P. (2009). Creating a program to deepen family inquiry at interactive science exhibits. *Curator: The Museum Journal, 52*(3), 289-306. https://doi.org/https://doi.org/10.1111/j.2151-6952.2009.tb00352.x

Anderson, D., Piscitelli, B., Weier, K., Everett, M., & Tayler, C. (2002). Children's museum experiences: Identifying powerful mediators of learning. *Curator: The Museum Journal, 45*(3), 213-231. https://doi.org/https://doi.org/10.1111/j.2151-6952.2002.tb00057.x

Andre, L., Durksen, T., & Volman, M. L. (2017). Museums as avenues of learning for children: A decade of research. *Learning Environments Research*, 20(1), 47–76. https://doi.org/10.1007/s10984-016-9222-9.

Barad, K. (2003). Posthumanist performativity: Toward an understanding of how matter comes to matter. *Signs: Journal of Women in Culture and Society, 28*(3), 801-831. https://doi.org/10.1086/345321

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.

Baroutsis, A. (2018). Sociomaterial assemblages, entanglements and text production: Mapping pedagogic practices using time-lapse photography. *Journal of Early Childhood Literacy, 20*(4), 732-754. https://doi.org/10.1177/1468798418784128

Barton, D., & Hamilton, M. (1998). *Local literacies: A study of reading and writing in one community.* Routledge.

Bengochea, A., Sembiante, S. F., & Gort, M. (2018). An emergent bilingual child's multimodal choices in sociodramatic play. *Journal of Early Childhood Literacy, 18*(1), 38-70. https://doi.org/10.1177/1468798417739081

Benjamin, N., Haden, C. A., & Wilkerson, E. (2010). Enhancing building, conversation, and learning through caregiver–child interactions in a children's museum. *Developmental Psychology, 46*(2), 502-515. https://doi.org/10.1037/a0017822

Bennett, J. (2010). *Vibrant matter: A political ecology of things*. Duke University Press.

Bezemer, J. & Kress, G. (2016). *Multimodality, learning, and communication: A social semiotic frame*. Routledge.

Bietti, L. M., & Castelló, F. G. (2013). Embodied reminders in family interactions: Multimodal collaboration in remembering activities. *Discourse Studies*, 15(6), 665-686.

Birch, J. (2018). Museum spaces and experiences for children – ambiguity and uncertainty in defining the space, the child and the experience. *Children's Geographies, 16*(5), 516-528. https://doi.org/10.1080/14733285.2018.1447088

Black, R.W., Korobkova, K., & Epler, A. (2014). Barbie Girls and Xtractaurs: Discourse and identity in virtual worlds for young children. *Journal of Early Childhood Literacy*, *14*(2), 265-285. doi:10.1177/1468798413494920

Boldt, G. M., & Leander, K. (2017). Becoming through 'the break': A post-human account of a child's play. *Journal of Early Childhood Literacy*, 17(3), 409-425. https://doi.org/10.1177/1468798417712104

Bradburne, J. (1999). Changing designership: The role of the designer in the informal learning environment. *Museum Management and Curatorship*, 18(2), 159-171.

Burbank, B., McGregor, D., & Wild, M. (2018). 'My special, my special thing, and my camera!' Using GoPro™ as a complementary research tool to investigate young children's museum experiences. *Museum & Society*, 16(3), 311-332. https://doi.org/10.29311/mas.v16i3.2792

Burnett, C. (2011a). The (im)materiality of educational space: Interactions between material, connected and textual dimensions of networked technology use in schools. *E-Learning and Digital Media*, 8(3): 214–227. https://doi.org/10.2304/elea.2011.8.3.214

Burnett, C. (2011b). Shifting and multiple spaces in classrooms: An argument for investigating learners' boundary-making around digital networked texts. *Journal of Literacy and Technology*, 12(3): 2–23. http://shura.shu.ac.uk/id/eprint/4139

Burnett, C. (2014). Investigating pupil's interactions around digital texts: A spatial perspective on the 'classroom-ness' of digital literacy practices in schools. *Educational Review*, 66(2): 192–209. https://doi.org/10.1080/00131911.2013.768959

Burnett, C. (2015). (Im)materializing literacies. In J. Rowsell & K. Pahl (Eds.). *The Routledge handbook of literacy studies* (pp. 489-503). Routledge.

Burnett, C., Merchant, G., Pahl, K., & Rowsell, J. (2014). The (im)materiality of literacy: the significance of subjectivity to new literacies research. *Discourse: Studies in the Cultural Politics of Education, 35*(1), 90-103. http://doi.org/10.1080/01596306.2012.739469

Burris, A. (2017). A child's-eye view: An examination of point-of-view camera use in four informal education settings. *Visitor Studies*, 20(2), 218-237. https://doi.org/10.1080/10645578.2017.1404352

Carr, M., Clarkin-Phillips, J., Soutar, B., Clayton, L., Wipaki, M., Wipaki-Hawkins, R., Cowie, B., & Gardner, S. (2018). Young children visiting museums: exhibits, children and teachers co-author the journey. *Children's Geographies, 16*(5), 558-570. https://doi.org/10.1080/14733285.2018.1480750

Carrington, V. (2003). 'I'm in a bad mood. Let's go shopping': Interactive dolls, consumer culture and a 'glocalized' model of literacy. *Journal of Early Childhood Literacy*, 3(1), 83-98.

Carrington, V. (2012). The contemporary Gothic: Literacy and childhood in unsettled times. *Journal of Early Childhood Literacy, 12*(3), 293-310. https://doi.org/10.1177/1468798411417373

Carrington, V., & Hodgetts, K. (2010). Literacy-lite in "BarbieGirls". *British Journal of Sociology of Education, 31*(6), 671-682. http://www.jstor.org/stable/25758491

Caton, L. & Hackett, A., (2019). Head mounted, chest mounted, tripod or roaming? In N. Kucirkova, J. Rowsell & G. Falloon (Eds.), *The Routledge handbook of learning with technology in early childhood* (pp. 362-376). Routledge.

Coole, D., & Frost, S. (2010). *New materialisms: Ontology, agency, politics*. Duke University Press.

Crowley, K., Pierroux, P., & Knutson, K. (2014). Informal learning in museums. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 461-478). Cambridge University Press.

Daniels, K. (2019). Notions of agency in early literacy classrooms: Assemblages and productive intersections. *Journal of Early Childhood Literacy*, 0(0), 1-22. http://doi.org/10.1177/1468798419866489

Degotardi, S., Johnston, K., Little, H., Colliver, Y., & Hadley, F. (2019). "This is a learning opportunity": How parent-child interactions and exhibit design foster the museum learning of prior-to-school aged children. *Visitor Studies, 22*(2), 171-191. https://doi.org/10.1080/10645578.2019.1664849

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus: Capitalism and schizophrenia* (B. Massumi, Trans.). University of Minnesota Press.

Dernie, D. (2006). *Exhibition Design*. W.W. Norton.

Downey, S., Krantz, A., & Skidmore, E. (2010). The parental role in children's museums. *Museums & Social Issues*, 5(1), 15-34. https://doi.org/10.1179/msi.2010.5.1.15

Edwards, D. (1997). *Discourse and cognition*. Sage Publications.

Edwards, D., Potter, J., & Middleton, D. (1992). Toward a discursive psychology of remembering. *The psychologist*, *5*(10), 441-446.

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. AltaMira Press.

Falk, J. H., Scott, C., Dierking, L., Rennie, L., & Jones, M. C. (2004). Interactives and visitor learning. *Curator: The Museum Journal*, 47(2), 171-198. https://doi.org/https://doi.org/10.1111/j.2151-6952.2004.tb00116.x

Flewitt, R. (2005a). Using multimodal analysis to unravel a silent child's learning. *Early Childhood Practice: The Journal for Multi-Professional Partnerships*, 7(2) pp. 5–16.

Flewitt, R. (2005b). Is every child's voice heard? Researching the different ways 3-year-old children communicate and make meaning at home and in a pre-school playgroup. *Early Years, 25*(3), 207-222. https://doi.org/10.1080/09575140500251558

Flewitt, R. (2006). Using video to investigate preschool classroom interaction: education research assumptions and methodological practices. *Visual Communication, 5*(1), 25-50. https://doi.org/10.1177/1470357206060917

Flewitt, R., & Clark, A. (2020). Porous boundaries: Reconceptualising the home literacy environment as a digitally networked space for 0-3-year-olds. *Journal of Early Childhood Literacy, 20*(3), 447-471. https://doi.org/10.1177/1468798420938116

Flewitt, R., Nind, M., & Payler, J. (2009). 'If she's left with books she'll just eat them': Considering inclusive multimodal literacy practices. *Journal of Early Childhood Literacy, 9*(2), 211-233. https://doi.org/10.1177/1468798409105587

Flint, T. K. (2018). Responsive play: Creating transformative classroom spaces through play as a reader response. *Journal of Early Childhood Literacy, 20*(2), 385-410. https://doi.org/10.1177/1468798418763991

Foutz, S., & Emmons, C. T. (2017). Application and adaptation of an institutional learning framework. *Journal of Museum Education*, 42(2), 179-189. doi:10.1080/10598650.2017.1306663

Fueyo, J. A. (1991). Reading "literate sensibilities": Resisting a verbocentric writing classroom. *Language Arts, 68*(8), 641-648.

Fulcher, G. (2015). *Re-examining language testing: A philosophical and social inquiry*. Routledge.

Fulcher, G. (2020). Operationalizing language assessment literacy. In D. Tsagari, (Ed.) *Language assessment literacy: From theory to practice* (pp. 8–28). Cambridge Scholars.

Fung, L., & Carter, R. (2007). Discourse markers and spoken English: Native and learner use in pedagogic settings. *Applied Linguistics, 28*(3), 410-439. https://doi.org/10.1093/applin/amm030

Garfinkel, H. (1967). *Studies in ethnomethodology*. Prentice-Hall.

Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics, 32*(10), 1489-1522. https://doi.org/https://doi.org/10.1016/S0378-2166(99)00096-X

Green, C. (2016). Sensory tours as a method for engaging children as active researchers: Exploring the use of wearable cameras in early childhood research. *International Journal of Early Childhood*, 48(3), 277-294. https://doi.org/10.1007/s13158-016-0173-1

Hackett, A. (2014). Zigging and zooming all over the place: Young children's meaning making and movement in the museum. *Journal of Early Childhood Literacy*, 14(1), 5-27. https://doi.org/10.1177/1468798412453730

Hackett, A. (2015). Children's embodied entanglement and production of space in a museum. In A. Hackett, L. Procter, & J. Seymour (Eds.), *Children's spatialities: Embodiment, emotion and agency* (pp. 75-92). Palgrave Macmillan.

Hackett, A. (2016). Young children as wayfarers: Learning about place by moving through It. *Children & Society*, 30(3), 169-179. https://doi.org/https://doi.org/10.1111/chso.12130

Hackett, A., & Somerville, M. (2017). Posthuman literacies: Young children moving in time, place and more-than-human worlds. *Journal of Early Childhood Literacy, 17*(3), 374-391. https://doi.org/10.1177/1468798417704031

Hackett, A., Holmes, R., MacRae, C., & Procter, L. (2018). Young children's museum geographies: spatial, material and bodily ways of knowing. *Children's Geographies, 16*(5), 481-488. https://doi.org/10.1080/14733285.2018.1497141

Hackett, Holmes, & MacRae (Eds.). (2020). *Working with young children in museums*. Routledge.

Haden, C. A. (2010). Talking about science in museums. *Child Development Perspectives*, 4(1), 62-67.

Haden, C. A., Jant, E. A., Hoffman, P. C., Marcus, M., Geddes, J. R., & Gaskins, S. (2014). Supporting family conversations and children's STEM learning in a children's museum. *Early Childhood Research Quarterly, 29*(3), 333-344. https://doi.org/https://doi.org/10.1016/j.ecresq.2014.04.004

Hall, R., & Stevens, R. (2015). Developing approaches to interaction analysis of knowledge in Use. In A. A. diSessa, M. Levin, & N. J. S. Brown (Eds.), *Knowledge and interaction: A synthetic agenda for the learning sciences*. New York, NY: Routledge.

Halliday, M. A. K. (1978). *Language as social semiotic : the social interpretation of language and meaning*. University Park Press.

Halliday, M. A. K., & Matthiessen, C. M. I. (2004). *An Introduction to Functional Grammar*. Routledge.

Hansen, S., Montagu, K., Gurian, E. H., Kamien, J., & Robinson, J. (1987). Learning in mixed crowds: Challenges for designers of children's museums exhibitions. *Children's*

Environments Quarterly, 4(1), 10-15. http://www.jstor.org.proxyiub.uits.iu.edu/stable/41514611

Harwood, D. & Collier, D. R., (2019). "Talk into my GoPro, I'm making a movie!": Using digital ethnographic methods to explore children's sociomaterial experiences. In N. Kucirkova, J. Rowsell & G. Falloon (Eds.), *The Routledge handbook of learning with technology in early childhood* (pp. 49-61). Routledge.

Harwood, D., & Collier, D. R. (2017). The matter of the stick: Storying/(re)storying children's literacies in the forest. *Journal of Early Childhood Literacy, 17*(3), 336-352. https://doi.org/10.1177/1468798417712340

Hein, G. E. (2003). *Final summary evaluation report for Traits of Life, a collection of life science exhibits*. Retrieved from https://www.informalscience.org/sites/default/files/report_82.pdf

Henry, D. (2015). Talking deeper about cultural difference: A digital interactive from Melbourne. *Curator: The Museum Journal, 58*(2), 209-222. https://doi.org/https://doi.org/10.1111/cura.12108

Hepburn, A., & Wiggins, S. (2005). Developments in discursive psychology. *Discourse & Society, 16*(5), 595-601. https://doi.org/10.1177/0957926505054937

Heritage, J. (1984). A change of state token and aspects of its sequential placement. In J. M. Atkinson & J. Heritage (Eds.). *Structures of Social Action:Studies in Conversation Analysis* (pp.299-345). Cambridge University Press

Hill, L., & O'Gorman, A. (2020). For the love of small stuff: Materializing theory in an early years artist residency. In A. Hackett, R. Holmes, & C. MacRae (Eds.), *Working with young children in museums*. Routledge.

Horn, M. S. (2018). Tangible Interaction and Cultural Forms: Supporting Learning in Informal Environments. *Journal of the Learning Sciences*, 27(4), 632-665. doi:10.1080/10508406.2018.1468259

Hwang, S., Roth, W.-M., & Kim, M. (2009). Development of mathematical concepts in children's learning geometry: a Vygotskian, body-centered approach. *Pedagogies: An International Journal, 5*(1), 72-85. https://doi.org/10.1080/15544800903406324

Ishii, H., & Ullmer, B. (1997, March). *Tangible bits: Towards seamless interfaces between people, bits, and atoms*. Paper presented at the SIGCHI Conference on Human Factors in Computing Systems (CHI'97), Atlanta, GA.

Jant, E. A., Haden, C. A., Uttal, D. H., & Babcock, E. (2014). Conversation and object manipulation influence children's learning in a museum. *Child Development, 85*(5), 2029-2045. https://doi.org/https://doi.org/10.1111/cdev.12252

Jewitt, C., Bezemer, J., & O'Halloran, K. (2016). *Introducing Multimodality* (1st ed.). Routledge. https://doi.org/10.4324/9781315638027

Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences*,4 (1), 39-103.

Kress, G. (1997). *Before writing: Rethinking the paths to literacy*. Routledge.

Kress, G. (2003). *Literacy in the new media age*. Routledge.

Kress, G. (2004). Reading images: Multimodality, representation and new media. *Information Design Journal*, 12(2), 110-119. https://doi.org/https://doi.org/10.1075/idjdd.12.2.03kre

Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication.* Routledge.

Kress, G., & van Leeuwen, T. (2001). *Multimodal discourse: The modes and media of contemporary communication.* Arnold Publishers.

Kress, G. & van Leeuwen, T. (2006). *Reading images: The grammar of visual design* (3rd ed.). Routledge.

Kuby, C. R., Rucker, T. G., & Kirchhofer, J. M. (2015). 'Go Be a Writer': Intra-activity with materials, time and space in literacy learning. *Journal of Early Childhood Literacy, 15*(3), 394-419. https://doi.org/10.1177/1468798414566702

Lancaster, L. (2001). Staring at the page: The functions of gaze in a young child's interpretation of symbolic forms. *Journal of Early Childhood Literacy, 1*(2), 131-152. https://doi.org/10.1177/14687984010012001

Lantolf, J. P.& Poehner, M. E., (2014). Sociocultural theory and the pedagogical imperative in L2 education: Vygotskian praxis and the research/practice divide. Routledge.

Leander, K., & Boldt, G. (2013). Rereading "A pedagogy of multiliteracies": Bodies, texts, and emergence. *Journal of Literacy Research, 45*(1), 22-46. http://doi.org/10.1177/1086296x12468587

Leander, K., & Sheehy, S. (Eds.). (2004). *Spatializing literacy research and practice*. Peter Lang.

Lefebvre, H. (1991). *The Production of Space*. (D. Nicholson-Smith, Trans.). Blackwell Publishing (originally published in 1974).

Leinhardt, G., & Knutson, K. (2004). *Listening in on museum conversations*. Alta Mira Press.

Leinhardt, G., Crowley, K., & Knutson, K. (Eds.). (2002). *Learning conversations in museums*. Erlbaum.

Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Ablex.

Levy, R. (2008). 'Third spaces' are interesting places: Applying 'third space theory' to nursery-aged children's constructions of themselves as readers. *Journal of Early Childhood Literacy*, 8(1), 43-66.

Luff, P., & Heath, C. (2015). Transcribing embodied action. In D. Tannen, H. E. Hamilton, & D. Schiffrin (Eds.), *The handbook of discourse analysis* (2nd ed.). John Wiley & Sons, Inc.

MacRae, C. (2020). Tactful hands and vibrant mattering in the sand tray. *Journal of Early Childhood Literacy, 20*(1), 90-110. https://doi.org/10.1177/1468798420901858

MacRae, C., Hackett, A., Holmes, R., & Jones, L. (2018). Vibrancy, repetition and movement: Posthuman theories for reconceptualising young children in museums. *Children's Geographies, 16*(5), 503-515. https://doi.org/10.1080/14733285.2017.1409884

Marsh, J. (2005). Ritual, performance, and identity construction: Young children's engagement with popular cultural and media texts. In J. Marsh (Ed.). *Popular culture, new media and digital literacy in early childhood* (pp.28-50). Routledge Falmer.

Marsh, J. (2010). Young children's play in online virtual worlds. *Journal of Early Childhood Research* 8(23): 23–39.

Marshall, P. (2007, February). *Do tangible interfaces enhance learning?* Paper presented at the 1st International Conference on Tangible and Embedded Interaction (TEI'07), Baton Rouge, LA.

Marshall, P., Cheng, P. C. H., & Luckin, R. (2010, January). *Tangibles in the balance: A discovery learning task with physical or graphical materials*. Paper presented at the fourth International Conference on Tangible, Embedded, and Embodied Interaction (TEI'10), Cambridge, MA.

Maschler, Y., & Schiffrin, D. (2015). Discourse markers: Language, meaning, and context. In D. Tannen, H. E. Hamilton, & D. Schiffrin (Eds.), *The handbook of discourse analysis* (pp. 189-221). https://doi.org/https://doi.org/10.1002/9781118584194.ch9

Mavers, D. (2015). Remaking meaning across modes in literacy studies. In J. Rowsell & K. Pahl (Eds.), *The Routledge handbook of literacy studies* (pp. 282-294). Routledge.

Maxwell, L. E., & Evans, G. W. (2002). Museums as learning settings: The importance of the physical environment. *Journal of Museum Education, 27*(1), 3-7.

McGee, L. M. & Morrow, L. M. (2005). *Teaching literacy in kindergarten*. The Guilford Press.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Harvard University Press.

Merchant, G. (2009). Web 2.0, new literacis and the idea of learning through participation. *English Teaching: Practice and Critique, 8*(3), 107-122.

Merchant, G. (2010). 3D virtual worlds as environments for literacy learning. *Educational Research, 52*(2), 135-150. http://doi.org/10.1080/00131881.2010.482739

Merriam, S. B. & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation.* John Wiley & Sons.

Messick, S. (1989). Validity. In R. L. Linn (Ed.) *Educational Measurement* (pp.13–103). National Council on Measurement in Education & American Council on Education.

Moser, S. (2010). The devil is in the detail: Museum displays and the creation of knowledge. *Museum Anthropology, 33*(1), 22-32. https://doi.org/https://doi.org/10.1111/j.1548-1379.2010.01072.x

Mueller, F., Agamanolis, S., & Picard, R. (2003). Exertion interfaces: Sports over a distance for social bonding and fun. In *Proceedings of CHI'03*, 561-568.

New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, *66*(1), 60-92.

Nichols, S. (2011). Young children's literacy in the activity space of the library: A geosemiotic investigation. *Journal of Early Childhood Literacy, 11*(2), 164-189. https://doi.org/10.1177/1468798411399275

Nixon, H. (2011). 'From bricks to clicks': Hybrid commercial spaces in the landscape of early literacy and learning. *Journal of Early Childhood Literacy, 11*(2), 114-140. https://doi.org/10.1177/1468798411401863

Not, E., & Petrelli, D. (2018). Blending customisation, context-awareness and adaptivity for personalised tangible interaction in cultural heritage. *International Journal of Human-Computer Studies*, 114, 3-19. https://doi.org/https://doi.org/10.1016/j.ijhcs.2018.01.001

Palmquist, S., & Crowley, K. (2007). From teachers to testers: How parents talk to novice and expert children in a natural history museum. *Science Education, 91*(5), 783–804. https://doi.org/10.1002/sce.20215

Peacock, A., & Pratt, N. (2011). How young people respond to learning spaces outside school: A sociocultural perspective. *Learning Environments Research, 14*(1), 11-24. https://doi.org/10.1007/s10984-011-9081-3

Perry, D. L. (2012). *What makes learning fun? : Principles for the design of intrinsically motivating museum exhibits*. AltaMira Press.

Pink, S. (2013). *Doing visual ethnography* (3rd ed.). Sage.

Pink, S. (2015a). *Doing sensory ethnography* (2nd ed.). Sage.

Pink, S. (2015b). Going forward through the world: Thinking theoretically about first person perspective digital ethnography. *Integrative Psychological & Behavioral Science*, 49(2), 239-252. https://doi.org/10.1007/s12124-014-9292-0

Poehner, M. E. (2008). *Dynamic assessment: A Vygotskian approach to understanding and promoting second language development*. Springer.

Poehner, M. E. (2018). Probing and provoking L2 development: the object of mediation in dynamic assessment and mediated development. In: Lantolf JP, Poehner ME, Swain M (Eds.) *The Routledge handbook of sociocultural theory and second language development* (pp 249–265). Routledge.

Poehner, M. E., Qin, T., & Yu, L. (2019). Dynamic assessment: Co-constructing the future with English language learners. In X. Gao (Ed.), *Second Handbook of English Language Teaching* (pp. 455-476). Springer International Publishing. https://doi.org/10.1007/978-3-030-02899-2_23

Potter, J. (1998). Cognition as context (Whose cognition?). *Research on Language and Social Interaction, 31*(1), 29-44. http://doi.org/10.1207/s15327973rlsi3101_2

Potter, J. (1999). Beyond cognitivism. *Research on Language and Social Interaction, 32*(1-2), 119-127. http://doi.org/10.1080/08351813.1999.9683615

Potter, J. (2000). Post-cognitive psychology. *Theory and Psychology*, 10, 31-37. https://doi.org/10.1177/0959354300010001596

Poveda, D., Matsumoto, M., Sundin, E., Sandberg, H., Aliagas, C., & Gillen, J. (2020). Space and practices: Engagement of children under 3 with tablets and televisions in homes in Spain, Sweden and England. *Journal of Early Childhood Literacy, 20*(3), 500-523. https://doi.org/10.1177/1468798420923715

Powell, S., & Somerville, M. (2020). Drumming in excess and chaos: Music, literacy and sustainability in early years learning. *Journal of Early Childhood Literacy, 20*(4), 839-861. https://doi.org/10.1177/1468798418792603

Rainbird, S., & Rowsell, J. (2011). 'Literacy nooks': Geosemiotics and domains of literacy in home spaces. *Journal of Early Childhood Literacy, 11*(2), 214-231. https://doi.org/10.1177/1468798411401865

Ravelli, L. J., & McMurtrie, R. J. (2016). *Multimodality in the built environment: Spatial discourse analysis*. Routledge.

Redmond-Jones, B. (2007). A Review of: "Exhibition Design". *Visitor Studies, 10*(2), 220-222. https://doi.org/10.1080/10645570701585418

Reutzel, D. R., & Cooter, R. B. (2009). *The essentials of teaching children to read: What every teacher should know!* (2nd ed.). Allyn and Bacon Publishing Company.

Rowsell, J. (2013). *Working with multimodality: Rethinking literacy in a digital age*. Routledge.

Rowsell, J., & Pahl, K. (2007). Sedimented identities in texts: Instances of practice. *Reading Research Quarterly, 42*(3), 388-404. https://doi.org/10.1598/rrq.42.3.3

Sacks, H. (1992a). *Lectures on Conversation* (vol. I, edited by G. Jefferson). Blackwell.

Sacks, H. (1992b). *Lectures on Conversation* (vol. II, edited by G. Jefferson). Blackwell.

Samuelson, B., & Wohlwend, K. (2015). Embodied signs. In P. Trifonas (Eds) *International Handbook of Semiotics* (pp. 565–572). New York: Springer,

Sanford, C. (2010). Evaluating family interactions to inform exhibit design: Comparing three different learning behaviors in a museum setting. *Visitor Studies, 13*(1), 67-89. https://doi.org/10.1080/10645571003618782

Satta, C. (2015). A proper place for a proper childhood? Children's spatiality in a play centre. In A. Hackett, L. Procter, & J. Seymour (Eds.), *Children's spatialities: Embodiment, emotion and agency* (pp. 178-197). Palgrave Macmillan.

Schegloff, E. (1991). Conversation analysis and socially shared cognition. In L. Resnick, J. Levine & S. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 150-171). American Psychological Association.

Schegloff, E. A. (1992). Repair after next turn: The last structurally provided defense of intersubjectivity in conversation. *American Journal of Sociology, 97*(5), 1295-1345. https://doi.org/10.1086/229903

Schegloff, E. A. (2000). Overlapping talk and the organization of turn-taking for conversation. *Language in Society*, 29(1), 1-63. https://doi.org/10.1017/S0047404500001019

Scollon, R. (2001). *Mediated discourse: The nexus of practice*. London, UK: Routledge.

Scollon, R., & Scollon, S. W. (2003). *Discourses in place: Language in the material world*. Routledge.

Sinclair, J., & Coulthard, M. (1975). *Towards an analysis of discourse: The English used by teachers and pupils*. Oxford University Press.

Smotrova, T. (2017). Making pronunciation visible: Gesture In teaching pronunciation. *TESOL Quarterly, 51*(1), 59-89. https://doi.org/https://doi.org/10.1002/tesq.276

Stenglin, M. K. (2004). *Packaging curiosities : towards a grammar of three-dimensional space* Sydney eScholarship. http://hdl.handle.net/2123/635

Stenglin, M. K. (2007). Making art accessible: opening up a whole new world. *Visual Communication, 6*(2), 202-213. https://doi.org/10.1177/1470357207077182

Stenglin, M. K. (2008). Binding: A resource for exploring interpersonal meaning in three-dimensional space. *Social Semiotics*, 18(4), 425-447.

Stenglin, M. K. (2009). Space odyssey: towards a social semiotic model of three-dimensional space. *Visual Communication, 8*(1), 35-64. https://doi.org/10.1177/1470357208099147

Street, B. V. & Street, J. (1991). The schooling of literacy. In D. Barton, & R. Ivanic (Eds.), *Writing in the community* (pp. 143-166). Sage.

Street, B. V. (1984). *Literacy in theory and practice*. Cambridge University Press.

Street, B. V. (1995). *Social literacies: Critical approaches to literary development*. Pearson Education Asia.

Suchman, L. (1987). *Plans and situated actions: The problem of human-machine communication*. Cambridge University Press.

Taylor, K. H., & Phillips, N. C. (2017). Place-making. In K. Peppler (Ed.), *Sage encyclopedia of out-of-school learning* (pp. 594-596). Sage.

Thiel, J. J. (2015). Vibrant Matter: The intra-active role of objects in the construction of young children's literacies. *Literacy Research: Theory, Method, and Practice, 64*(1), 112-131. https://doi.org/10.1177/2381336915617618

Tõugu, P., Marcus, M., Haden, C. A., & Uttal, D. H. (2017). Connecting play experiences and engineering learning in a children's museum. *Journal of Applied Developmental Psychology, 53*, 10-19. https://doi.org/https://doi.org/10.1016/j.appdev.2017.09.001

Unwin, S. (2009). *Analysing architecture* (3rd ed.). Routledge.

Weinstein, C. S., & Mignano, A. J. (2003). *Elementary classroom management: Lessons from research and practice*. McGraw-Hill.

Wertsch, J. V., & Rupert, L. J. (1993). The authority of cultural tools in a sociocultural approach to mediated agency. *Cognition and Instruction*, 11(3-4), 227-239. https://doi.org/10.1080/07370008.1993.9649022

West, R. M. (2004). The economics of interactivity. *Curator: The Museum Journal, 47*(2), 213-223. https://doi.org/https://doi.org/10.1111/j.2151-6952.2004.tb00118.x

Whitney, K., & Associates. (2003). *Seeing collection pre-post study final results*. Retrieved from https://www.exploratorium.edu/files/vre/pdf/SeeC3xbitIv_wb_01.pdf

Whittingham, C. E. (2019). Geosemiotics←→social geography: Preschool places and school(ed) spaces. *Journal of Literacy Research, 51*(1), 52-74. https://doi.org/10.1177/1086296x18820644

Willard, A. K., Busch, J. T. A., Cullum, K. A., Letourneau, S. M., Sobel, D. M., Callanan, M., & Legare, C. H. (2019). Explain This, Explore That: A Study of Parent–Child Interaction in a Children's Museum. *Child Development, 90*(5), e598-e617. https://doi.org/https://doi.org/10.1111/cdev.13232

Wohlwend, K. E. (2009a). Early adopters: Playing new literacies and pretending new technologies in print-centric classrooms. *Journal of Early Childhood Literacy, 9*(2), 117-140. https://doi.org/10.1177/1468798409105583

Wohlwend, K. E. (2009b). Damsels in discourse: Girls consuming and producing identity texts through Disney princess play. *Reading Research Quarterly, 44*(1), 57-83.

Wohlwend, K. E. (2012). 'Are you guys girls?': Boys, identity texts, and Disney princess play. *Journal of Early Childhood Literacy, 12*(1), 3-23. https://doi.org/10.1177/1468798411416787

Wohlwend, K. E. (2013). Playing Star Wars under the (teacher's) radar: Detecting kindergartners' action texts and embodied literacies. In V. Vasquez & J. Wood (Eds.), *Perspectives and provocations in early childhood education* (pp. 105-115). Information Age.

Wohlwend, K. E. (2017). The expression of multiliteracies and multimodalities in play. In F. Serafini & E. Gee (Eds.), *Remixing multiliteracies: Theory and practice from New London to New Times* (pp. 162-174). Teachers College Press.

Wohlwend, K. E., Peppler, K. A., Keune, A., & Thompson, N. (2017). Making sense and nonsense: Comparing mediated discourse and agential realist approaches to materiality in a preschool makerspace. *Journal of Early Childhood Literacy, 17*(3), 444-462. https://doi.org/10.1177/1468798417712066

Wohlwend, K. E., Vander Zanden, S., Husbye, N. E., & Kuby, C. R. (2011). Navigating discourses in place in the world of Webkinz. *Journal of Early Childhood Literacy,* 11(2), 141-163. https://doi.org/10.1177/1468798411401862

Appendix

Pet X-ray Screen Displays for each “pet patient”

(Each “pet patient” has two sets of diagnosis and treatment plans)

1. Plans for “Findo”

(1)

Steps	Screen display	Voice-over
Scanning		
Diagnosing		The scan shows that there is a little stuffing separation inside Findo's leg. My diagnosis is Broken-leg-tosis.
Treating		Wrap Findo’s leg to give him support while the stuffing settles back again. You should also put a cone on his neck to prevent him from licking his leg before it gets better.

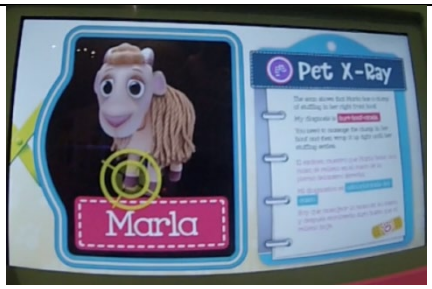
(2)

Steps	Screen Display	Voice-over
Scanning		

Diagnosing		The scan shows something in Findo's nose. It's sand. My diagnosis is Sandi-nosi-tosis.
Treating		Findo's nose needs cleaning. Bring him to the treatment counter and wipe his nose with a soft cloth.

2. Plans for "Marla"

(1)

Steps	Screen Display	Voice-over
Scanning		
Diagnosing		The scan shows that Marla has a clump of stuffing in her right front hoof. My diagnosis is Hurt-hoof-tosis.
Treating		You need to massage the clump in the hoof and then wrap it up tight until her stuffing settles.

(2)

Steps	Screen Display	Voice-over
Scanning		
Diagnosing		The scan shows that Marla's hair is all tangled.
Treating		Give Marla a good bath and brush in the grooming area, and he'll feel much more comfortable.

3. Plans for "Whispers"

(1)

Steps	Screen Display	Voice-over
Scanning		

Diagnosing		The scan shows that Whispers' tail is twisted on one side. My diagnosis is Twisti-tail-tosis.
Treating		You need to gently wrap her tail up to hold it in place while it straightens out.

(2)

Steps	Screen Display	Voice-over
Scanning		
Diagnosing		The scan shows that Whispers' heart is beating very fast. My diagnosis is Scary-kitti-atitis.
Treating		Whisper is very shy. You need to calm her down by putting her in a quiet, cozy pet shelter and feed her with water.

RESUME

Yanlin Chen
School of Education
Indiana University Bloomington
yanlchen@iu.edu

EDUCATION

Ph.D.	2023	Indiana University Bloomington, IN Literacy, Culture and Language Education Dissertation: *Design for Inclusion: Multimodal Pedagogies in the Narrative, Performative and Simulated Spaces of a Doc McStuffins Exhibit*
M.A.	2016	Indiana University Bloomington, IN Arts Administration
M.A.	2003	Central South University, Changsha, China Linguistics and Applied Linguistics
B.A.	1998	Central South University, Changsha, China English Language and Literature

LICENSURE

Higher Education Teaching License-Linguistics
Issued by the Ministry of Education of the People's Republic of China, Beijing Municipal Commission of Education (2004)

MAJOR EMPLOYMENT HISTORY

2006-2014	Senior Lecturer (tenured) Department of Graduate English, University of Science and Technology Beijing, China
2003-2006	Lecturer Department of Graduate English, University of Science and Technology Beijing, China

FELLOWSHIPS AND GRANTS

2021	Achasa Beechler Dissertation Proposal Fellowship ($1,800) School of Education, Indiana University Bloomington
2016	L. J. Fay Fellowship ($2,000)

School of Education, Indiana University Bloomington

2015 Dean's Council Scholarship ($2,000)
School of Public and Environmental Affairs, Indiana University Bloomington

AWARDS AND HONORS

2021 Travel Award
Department of Curriculum and Instruction, Indiana University Bloomington

2013 Teaching Excellence Award in the Fourth Instructional Design Competition
School of Foreign Studies, University of Science and Technology Beijing

2012 Graduate Course Teaching Award
Graduate School, University of Science and Technology Beijing

2010 Special Achievement Award in Teaching Research
University of Science and Technology Beijing

2010 Outstanding Faculty Award
School of Foreign Studies, University of Science and Technology Beijing

CERTIFICATION AND TRAINING

2021 Chinese Tester Training
The American Council on the Teaching of Foreign Languages (ACTFL)

2010 Teaching Chinese as a Second Language Teaching Proficiency Certificate
Beijing Language and Culture University, China

2009 Advanced Language Teaching Methodology Program Certificate of Completion
Latrobe University, Melbourne, Australia

PROFESSIONAL SOCIETIE MEMBERSHIPS

American Association for Applied Linguistics (AAAL)

American Council on the Teaching of Foreign Languages (ACTFL)

American Educational Research Association (AERA)

International Association of Chinese Linguistics (IACL)

International Association for Language Learning Technology (IALLT)

Literacy Research Association (LRA)

National Council for Teachers of English Assembly for Research (NCTEAR)

RECENT PRESENTATIONS

Chen, Y. (2021). *Making sense out of nonsense: An intra-active analysis of child-technology miscommunication.* Paper presented at the national conference of Literacy Research Association, Georgia, Atlanta, USA.

Chen, Y., Wohlwend, K. E., & Maltese, A. (2019). *When knowledge is assumed rather than shared: A critical analysis of children's interaction with a tangible design*. Paper co-presented at the Big10+ Maker Education and Computer Science Education Research Conference, Bloomington, Indiana.

Wohlwend, K. E., **Chen, Y**., & Maltese, A. (2019). *Toddlers tinkering with toys: Exploration and action texts in Doc McStuffins Museum Play.* Paper co-presented at the Reconceptualizing Early Childhood Literacies Conference, Manchester, UK.

Chen, Y. (2018). *A toddler's co-construction of Play-Based literacy moments at home: Objects, embodied action, and context*. Paper presented at the Working Conference on Discourse Analysis in Education Research, Columbus, Ohio.

SELECTED PUBLICATIONS

Wohlwend, K. E., **Chen, Y.**, & Maltese, A. (in press). Toddlers' tinkering with toys: Focusing Research on Actions and Assemblages, In M. Sakr & J. Osgood (Eds.). *Postdevelopmental approaches to childhood observation*. Bloomsbury.

Wohlwend, K., Parker Monger, J., & **Chen, Y.** (2022). Play and mental health. In J. N. Lester & M. O'Reilly (Eds.), *The Palgrave encyclopedia of critical perspectives on mental health* (pp. 1-9). Springer International Publishing. https://doi.org/10.1007/978-3-030-12852-4_94-1

Chen, Y., Monger, J. P., & Wohlwend, K. (2021). Book Review: Working with young children in museums: Weaving theory and practice. *Journal of Early Childhood Literacy,* 0(0), 1-5, https://doi.org/10.1177/14687984211057170

Bamanger, E., **Chen, Y**., Hoffman, G., Hwang, B.H., & Munyaneza, S. P. (2019). Conversation Analysis. In Samuelson, B. L., Frye, J. M. Hare, S. & Covington, M. (Eds.). *Short Guides in Education Research Methodologies* (pp. 14-28). IU Pressbooks. Retrieved from https://scholarworks.iu.edu/dspace/handle/2022/24429