THE EFFECT OF ORIENTATION

ON LEARNING EXPERIENCES IN SCIENCE CENTERS

by

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Submitted to the Graduate Faculty of the School of Education
Texas Christian University
in partial fulfillment of the requirements
for the degree of

Master of Education

December, 2006

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Thesis approved:

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Chapter 1

Introduction

In the latter half of the 19th century, European and American scientists wrested away from speculative philosophy the emerging field of psychology as a distinctive scientific study. In *The making of mind,* A. R. Luria (1979) described that turbulent period and the role in which he found himself. At that time, 'new psychology' embraced the scientific rigor of experimentation to study the mind. In the laboratory, elementary psychological phenomena yielded their secrets in precisely monitored and measured experiments. The mind's higher functions, however, stood aloof from the methods of this experimental scientific approach and could only be described in narratives derived from anthropological studies of cultural artifacts and folklore. In this historical context, the Russian Revolution broke out, opening with constitutional reform in 1905 and climaxing in 1917 with the violent Bolshevik overthrow of the Tsarist government. The political earthquake of the Russian Revolution triggered cultural changes immediately impacting disparate communities and populations throughout the Euro-Asian landmass that suddenly found themselves no longer in a Tsarist feudal world, but suddenly under the power of a novice government determined to retool the Russian world in the image of Marxist principles.

In the 1920's, Russian psychologists forged a unique three-fold approach to the study of mind, reflective of the philosophy that generated the Revolution:

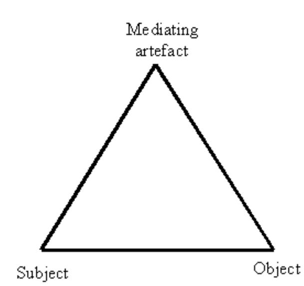
> First, there was increasing concern that Soviet psychology should be self-consciously Marxist. … Second, psychology must be a materialistic discipline; all psychologists were obliged to search for the material basis of mind. Third, psychology should have relevance to the building of a socialistic society. Lenin's

> exhortation that theory should be tested in practice was a matter of both economic and social urgency. (p. 12)

In 1924, Luria, newly vested in the Institute of Psychology of Moscow, met Lev Vygotsky at a conference in Leningrad. Vygotsky was invited to join the Institute, where he would collaborate until his death in 1934 with Luria and A. N. Leontiev. Under Vygotsky's direction, Luria and Leontiev undertook a "critical review of the history and current status of psychology in Russia and the rest of the world" with the aim "to create a new, comprehensive approach to human psychological processes" based on Marxist methods of analysis (p. 40). These methods steered Vygotsky to conclude that "the origins of higher forms of conscious behavior were to be found in the individual's social relations with the external world.… [Man] is not only a product of his environment, he is also an active agent in creating that environment" (p. 43). Experimental psychology at that time, however, reduced "complex psychological events to elementary mechanisms that could be studied in the laboratory by exact, experimental techniques. The 'sense' or 'meaning' of complex stimuli was pared away in order to neutralize the influence of experiences outside the laboratory which the experimenter could not control or properly evaluate" (p. 40). Vygotsky conceived a new approach that would address the socio-cultural context that nurtured the development of higher forms of conscious behavior in individuals. Luria, Leontiev, and Vygotsky set out to discover "the way natural processes such as physical maturation and sensory mechanisms become intertwined with culturally determined processes to produce the psychological functions of adults. … [They] needed, as it were, to step outside the organism to discover the *sources* of specifically human forms of psychological activity" (p. 43). Vygotsky's synthesis embraced this dynamic interaction between the person, the cultural environment, and the physical world.

Vygotsky called this new approach *instrumental*, *cultural*, or *historical* psychology, key features in the approach for the new psychology he proposed. *Instrumental* addressed the "mediated nature of complex psychological functions. Unlike basic reflexes, which can be characterized by a stimulus-response process, higher functions incorporate auxiliary stimuli, which are typically produced by the person himself" (p. 44). *Cultural* addressed the context in which psychological development is shaped. The individual encountered the world in "socially structured ways in which society organizes the kinds of tasks that the growing child faces and the kinds of tools, both mental and physical, that the young child is provided to master those tasks" (p. 44). *Historical* elaborated the *cultural* context of the new approach, on the basis that "the tools that man uses to master his environment and his own behavior … were invented and perfected in the long course of man's social history" (p. 44). In particular, cultural tools like language, writing, and mathematics "enormously expanded man's powers, making the wisdom of the past analyzable in the present and perfectible in the future" (pp. 44-45). Language not only carried within it "the generalized concepts that are the storehouse of human knowledge," but played a formative role in organizing thought itself (p. 44). Vygotsky conceived of psychological development as a process in which the person is shaped by a culture formed by the past, in which he lives now, and in which he will shape the future culture anew, as the Revolution did.

Figure 1.1. Mediated object.



From the moment of birth, children are in constant interaction with adults who actively seek to incorporate them into their culture and its historically accumulated store of meanings and ways of doing

> things. In the beginning, children's responses to the world are dominated by natural processes, namely those provided by their biological heritage. But through the constant intercession of adults, more complex, instrumental psychological processes begin to take shape. … Adults at this stage are external agents mediating the children's contact with the world. But as children grow older, the processes that were initially shared with adults come to be performed within the children themselves. That is, the mediated responding to the world becomes an intrapsychic process. It is through this interiorization of historically determined and culturally organized ways of operating on information that the social nature of people comes to be their psychological nature as well. (p. 45)

Vygotsky worked out a "Marxist science of mind" that, once conceived, had to be experimentally tested (Cole, 1979-1980, p. 4). Lacking tools, Vygotsky, Luria, and Leontiev had to create a methodology to study psychological development in this new way. Leontiev, who focused his research on the development of memory, formulated an approach that became the "central, methodological tool in all [their] studies, … the idea of using two sets of stimuli, one the primary set that has to be mastered and the other an auxiliary set that can serve as an instrument for mastering the primary set" (Luria, p. 47). Leontiev conceived an experiment in which children were tasked to remember a series of stimuli presented by the experimenter.

> At first the very young child, presented with clear reminders of a dozen or so common words, such as a picture of a sleigh to help him remember the word 'horse,' pays no attention at all to the reminders. Such a child might remember two, three, or four of the words, but not systematically and giving no evidence of engaging in any special activity to ensure the remembering. … [They] called this

> kind of behavior 'natural remembering,' since the stimulus seems to be remembered through a process of direct, *unmediated* impression. A little later, the child might begin to take note of the reminders, or 'auxiliary stimuli' as [they] called them. Although auxiliary stimuli sometimes helped the child, as often as not the reminder failed to remind him of the stimuli it was intended to evoke. … Still later the child could use such ready-made reminders quite efficiently, but the process of using auxiliary stimuli was still *external* to the child in the sense that the connections between stimuli to be remembered and reminders were given by the conventional meaning of words, that is, by the culture. Only somewhat later, at the age of nine or ten, did [they] begin to observe *internalized mediation*, when children began creating their own reminders so that virtually any auxiliary stimulus would be effective in aiding memory. (pp. 46-47)

Shaping the experiment in this way enabled Leontiev to observe the developmental process of the formation of memory, the field of the study, while observing the subject's interaction with external mediating stimuli. Initially unfruitful in helping the child remember the target word, the reminders' value changed as the child matured, sometimes more helpful, sometimes not. Eventually, the child formed the capacity to associate linguistically or culturally unrelated stimuli as effective memory triggers for target words, having internalized mediation as a tool for his use to master a task. In a controlled setting, Leontiev could study the dynamic interplay of cultural tools and the development of complex psychological functions in an individual.

In the 1930's, the Institute of Psychology of Moscow moved outside the controlled setting of the laboratory to the real-world setting of populations in cultural transition, with the aim of acquiring experimental data that could affirm the fundamental premises in Vygotsky's theoretical framework. In particular, Luria and Vygotsky sought out an experimental condition that could test Vygotsky's conclusion that "the origins of higher forms of conscious behavior were to be found in the individual's social relations with the external world … [in which] man is not only a product of his environment, he is also an active agent in creating that environment" (p. 43). They staged the experiment in Uzbekistan and Khirhizia, "where great discrepancies between cultural forms promised to maximize the possibility of detecting shifts in the basic forms, as well as in the content, of people's thinking" (p. 60). The former feudal culture of Uzbekistan encompassed, in its population, both a high culture in science and art comprised of the educated ruling class and a low culture comprised of illiterate, segregated peasants working the land. The Revolution dissolved the class structure that separated the disparate groups in the population and imposed profound cultural change. "Schools were set up in many villages, and new forms of technological, social, and economic activities were introduced. … Thus, [they] could observe both underdeveloped nonliterate groups living in villages and groups already involved in modern life who were experiencing the influences of the social realignment that was occurring" (p. 61). The study entailed naming and classification experiments which were revealing of the forms of thinking of the different groups in the study. For instance, when shown skeins of wool of various colors and asked to name the colors,

> … uneducated subjects, especially the women, many of whom were excellent weavers, used very few *categorical* color names. Instead, they labeled the colored pieces of wool by the names of similarly colored objects in their *environment* … 'the color of grass in the spring,' 'the color of mulberry leaves in the summer,' 'the color of young peas.' When these subjects were asked to group together different strings that were similarly colored, many refused outright,

> claiming that each string was distinct. Others ordered them into a continuous series of colors which increased in hue or saturation. This pattern of responding to the individual skeins of wool on a visually dominated, particularistic basis disappeared in our other experimental groups, whose responses were dominated by the *categorical* color names and who readily classified similar colors together. (p. 66)

Luria and Vygotsky observed a remarkable change in those people in the population who attended the collective schools set up by the Revolutionary government. As they "acquired some education … they readily made the transition to abstract thinking. New experiences and new ideas change the way people use language so that words become the principal agent of abstraction and generalization. Once people are educated, they make increasing use of categorization to express ideas about reality" (p. 73).

In this setting, in the real-world, Vygotsky began to see in adults the same distinctions between types of categories children used at different ages in the course of his developmental research at the Institute and in clinics. He had observed children in the early stages of development unable to categorize objects because they saw each object isolated from the others, not as a group of objects. At that stage, "words are not an organizing factor in the way he categorizes his experience" (p. 67). In the next stage, children began to categorize objects into groups based on a single attribute, such as color or shape; however, in the process of grouping objects by that attribute, the children would forget which attribute they were using to unify the group and mix up the objects in illogical groupings. "The determining factor in classifying objects into situational complexes … is called functional-graphic perception, or remembering of the *real life relations* among objects" (p. 67). Language played a critical role in forming how the children thought and how they could categorize objects in groups. “This way of grouping objects is not based on a word that allows one to single out a common attribute and denote a category that logically subsumes all the objects” (p. 67). Developmentally, Vygotsky discerned this stage of development, grouping objects by how they related to each other in actual situations, to be descriptive of the thinking of older preschool and elementary school children. He observed they no longer thought in this way, “on the basis of their immediate impressions,” when they reached adolescence; then, they could “categorize by assigning distinct attributes of objects. Each object is assigned to a specific category by relating it to an abstract concept” (pp. 67-68). What distinguished the Vygotskian framework from other psychology theory in Europe and America at the time was the context in which Vygotsky cast his observations of development. He described developmental stages in the context of the dynamic interaction between the individual, the culture in which he was reared, and the physical setting in which he lived.

> Categorical thinking is not just a reflection of individual experience but a shared experience that society can convey through its linguistic system. This reliance on society-wide criteria transforms functional-graphic thinking processes to a scheme of semantic and logical operations in which words become the principal tool for abstraction and generalization. (p. 68)

The Uzbekistan field study yielded real-world data to affirm the fundamental principles of Vygotsky’s theory. He concluded that “the modes of generalization which are typical of the thinking of people who live in a society where rudimentary practical functions dominate their activities differ from the generalization modes of formally educated individuals” (pp. 73-74). Vygotsky observed the movement from stage to stage of a complex psychological function – categorization - in adults in a culturally transitional population, not just in the maturational development of children. The adult population acquired a new way of thinking; they had acquired new tools – new language – and the outcome of the data confirmed that the "processes of abstraction and generalization are not invariant at all stages of socioeconomic and cultural development. Rather, such processes are themselves *products of the cultural environment*" (p. 74).

P. Ya. Gal'perin's Elaboration of Vygotsky's Theory of Mind

Vygotsky, Luria, and Leont'ev programmatically worked out a "Marxist science of mind" in the late 1920's; however, "only the barest empirical data supported it" (Cole, p. 4). The Kharkov school of developmental psychology, led by Leont'ev and staffed by Vygotsky's younger students, including P. Ya. Gal'perin, pursued a program of research founded on the seminal work of Vygotsky's sociocultural theory of mind. Gal'perin's research in the Kharkov school of developmental psychology elaborated that theory, focusing particularly on the concept of orientation and its role in thought. In an address at the Ukranian Republic Scientific Conference on Psychology and Pedagogy in 1941, Gal'perin (1979) articulated the problem of orientation in the context of thought and perception. He postulated the existence of two 'mental spheres' that working together comprises an individual's mind. One sphere is the "objective-conceptual sphere of consciousness," and the other is the "sphere of personality orientations" (p. 92). He described experiences in which a person encounters the world as coming to the person in two distinct forms, "as knowledge about something, and as a personal position from which we regard everything else" (p. 92). He illustrated this postulate with a pedagogical example:

> We have all heard … how a child perceives a story, that his understanding of the story is contingent not only on the content of the story but also on a position's being indicated from which the child can arrive at a proper understanding of the

> subject. Thus, even the very first stage of understanding demands an adequate orientation. … Ordinarily, the logical linking together of ideas facilitates the possibility of moving from one to another. But what is most important is to tie them to some personal position, for only then is some system created for comprehending the existence of some guiding factor, and only then do even ideas that are slightly connected with one another become accessible. (pp. 90-92)

In experiments conducted at the Kharkov school, Gal'perin articulated the concept of orientation as fundamental to learning, profoundly impacting the way a person processes experiences they encounter. He noted that, "by changing the method of upbringing and inculcating basic orientations in children**,** we are also altering the nature of their 'thinking'" (p. 86).

In *The quality of cultural tools and cognitive development: Gal'perin's perspective and its implications,* Arievitch and Stetsenko (1998) described Gal'perin's perspective as one grounded in Vygotskian theory.

> Instruction plays a key part in cognitive development by providing culturally evolved cognitive tools which, once internalized by the child, mediate and advance the child's cognitive functioning. Gal'perin further elaborated this approach arguing that it is the quality (specific character) of cognitive tools (such as concepts, criteria, and schemas) acquired by the child that to a large extent defines the specifics of cognitive development. (p. 69)

Gal'perin realized this model in a type of instruction he named systemic-theoretical. In it, students were provided with the means – cognitive tools - for conceptually based, theoretical generalization. That allowed them to orient themselves in a systemic way to the field of knowledge being studied. In this top-down pathway, students acquired "a general method to construct a concrete orientation basis to solve any specific problem in a given subject domain" (p. 77). Gal'perin experimented with systemic-theoretical instruction "aimed at teaching a variety of different subjects including mathematics, physics, language, and history," and to do so in a way that made it possible for children to acquire "not empirical but theoretical … concepts" (p. 79). Rather than introduce mathematics by teaching numbers as discrete objects – 'this is one, this is two …' – Gal'perin introduced the idea of measurement, since "all the basic types of numbers emerge as a result of measurement" (p. 80). Taught the importance of measurement in their everyday lives, they learned "to use measurement as an analytical tool to derive fundamental concepts in elementary mathematics" (p. 80). Given a cultural tool – measures - in the context of problem-solving, based on the historical genesis of discoveries in the subject field, students were oriented to look at mathematical problems from this perspective. The outcome of the experiment was "the formation of genuine mathematical concepts in children a whole age period earlier – in 6-year olds rather than in 10-12-year olds, when it usually occurs. … Even more importantly, however, was that the children's entire view of things had changed: the children came to understand that things cannot be judged by their visual properties alone" (p. 81). When confronted with mathematically-based experimental challenges, such as a conservation task, these students did not answer based on their visual perception of the fluid's apparent 'size,' instead insisting, "Let's first measure" (p. 81).

Arievitch and Stetsenko (1998) pointed out that in Gal'perin's perspective,

> … the central property that defines the developmental potential of certain types of instruction (and, therefore, their specific role in development) is the quality of cognitive tools that are provided to the child in the course of instruction to help the child to be oriented to the tasks' conditions and to perform the task

> adequately. … When the set of cognitive tools provided to the child is complete and based on theoretical concepts, instruction results in profound developmental progress. (p. 87)

Orientation, in this perspective, "makes learning inherently more meaningful and increasingly interesting to the child" (p. 86). Learning is so because it is not based on memorization and drill, but rather "on the intriguing process of discovering rational and meaningful connections between seemingly unrelated objects, phenomena, and events; and on making sense of what appears on the surface to be incoherent. Newly formed modes of thinking became part of children's everyday cognition" (p. 86).

Gal'perin's experiments, applying the concept of orientation to instruction in the systemic-theoretical model, were directed toward fields of knowledge – such as physics, mathematics, language arts – in which historical cultural tools had been developed and could be utilized in the preparatory, orienting stage of learning (Van der Veer, 2000). As he pointed out himself, the approach depended on coming to agreement that a "subject domain has essential characteristics" that can be identified in order to shape a top-down, theoretical orientation instead of a bottom-up, empirical orientation, and so it was "bound to specific subject domains" (pp. 100-101). The experiments' mode of engagement – materialism – derived from Gal'perin's presupposition that "intellectual operations originate in concrete, external actions" (p. 100). He "did not deny that children can learn things by reading, by imitation, and through listening to explanations, but he held that true, genuine, deep knowledge only comes about by acting upon the material, i.e. concrete world" (p. 101). Furthermore, in order to provide the conditions and cultural tools for the learner in the preparatory, orienting stage of learning, Gal'perin insisted on "the need for strictly guided exploration" by a teacher, so that students would not be left to "tackle a problem in their own inadequate ways. As a method of instruction, Gal'perin's perspective required extensive interaction between a competent adult, a teacher, and students exploring a subject domain, an interaction suited particularly for school settings.

As will be shown in the review of the science center settings and characteristics that make them distinct as environments in which learning experiences can occur, it would be impossible to directly implement a systemic-theoretical approach. Some elements of the approach, such as the presupposition that learners learn by doing, acting on concrete objects in a physical world, translate aptly. Other elements, such as an insistence on strictly guided, extensive exploration, do not suit the science center setting at all. This study intends to make the case that Gal'perin's concept of orientation, that is, that experiences come to a person in two distinct forms, "as knowledge about something, and as a personal position from which we regard everything else," can be a useful lens to explore learning experiences in science center settings (Gal'perin, 1979, p. 92). The concept of orientation is fundamental to learning, profoundly impacting the way a person processes experiences they encounter. Visitors to science center settings come to the experience with a mindset shaped by *orienting features* they have encountered in the course of their lives. This orientation, dependent on the quality of the cultural and cognitive tools that they have acquired, shapes their potential learning experience. While visiting a science center, they will engage in activities in which other factors - *orienting features* - specific to the museum environment come into play, further influencing the quality of the visitors' learning experience. Viewing those factors as orienting features within the concept of orientation provides a rationale and a tool with which to investigate the visitors' experience from arrival to departure.

History of the Science Center Setting

The first collection-based museums dedicated to the display of science and technology artifacts were founded in the 19th century in Paris and London. The Musee National des Techniques in Paris and the Science Museum in London spawned a museum model, the systematic museum that derived its educational theory from other cultural institutions, especially art museums and natural history museums (Salmi, 1993). Systematic museums relied on text-based media – in lectures, docent tours, and exhibit labels – to convey information to visitors. In 1903, the Deutsches Museum in Munich introduced the concept of hands-on interaction, inaugurating a subsequent generation of institutions that would become known as systematic-discovery museums. While still basing the visitor experience on viewing objects and reading text labels, they introduced visitor activity – self-selecting, self-directing, explorative, experimental, and hands-on interaction with objects – to engage museum-goers.

The Museum of Science and Industry in Chicago brought the systematic-discovery museum model to the United States. MOSI founder, Julius Rosenwild, established three goals for discovery museums:

1. The museum would give entertaining information about science and technology to ordinary people.
2. The museum would offer students, technical workers, and even scientists, excellent opportunities to expand and integrate their knowledge, through its new way of exhibiting phenomena.
3. For young people, the museum would be an inspiring and educational place to visit. (Salmi, p. 35)

In 1969, the Exploratorium in San Francisco and the Ontario Science Center in Toronto established the prototypical model for current science centers (Hein, 1990).

> There is very little curatorial presence on the staff of most modern science museums. The exceptions tend to be the science museums that grew out of collections gathered for World's Fairs. Many of these World's Fairs institutions still preserve and display their collections. Modern science centers founded in the wake of the Exploratorium and the Ontario Science Centre, however, have little or no artifacts of curatorial significance. These institutions tend to represent ideas rather than objects and are more likely to have a scientist or artist on staff than a curator. The objects on display in modern science centers tend to be purpose-built exhibits that display a particular scientific phenomenon. These exhibits often carry the name of the phenomenon they demonstrate: Critical Angle, Convection Current, Bernoulli Blower, or Water Waves. The object involved is only a means to an end: it exists primarily to demonstrate a phenomenon. (Bain and Ellenbogen, 2002, p. 155)

Distinctives of the Science Center Setting

Science centers present environments in which learning experiences can occur. The science center context, however, differs from school environments. In *Science museums as environments for learning,* Semper (1990) articulates that difference. "Museums offer learning opportunities that are difficult to replicate in a traditional school setting" (p. 2). Just what is going on in science centers has been challenging to define. Visitors' backgrounds are broadly divergent. Visitors make active decisions to come to science centers. They usually engage in the experiences there in groups. What they do while there is determined by their own interests and desires. Interactions are episodic.

Wertsch (2002) raises the issue of how difficult it is for science centers to assess and define learning experiences in such environments.

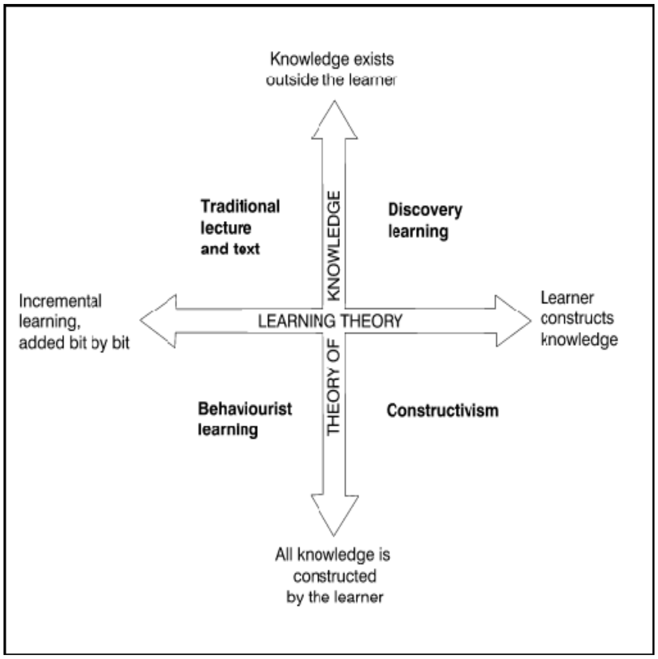
> One of the major problems facing museum professionals today is evaluation, especially evaluation of museums' impact on visitors. … On the one hand, we're called upon to assess the impact that museums have on visitors. … On the other hand, precisely what it is that we should be evaluating remains unclear. Should visitors be acquiring new information? Should they be developing new areas of curiosity? … Should visitors be engaging in some sort of identity project? Or is there something else that should be taken away from a museum visit? … When pressed to identify demonstrable educational results, for example, evaluators sometimes use off-the-shelf technology designed to assess outcomes of formal instruction, and in all too many cases the result is that museums are found not to be as good or as efficient at producing learning as instruction in standard school settings. Such findings suggest that students would be better off spending an additional hour or two in formal instruction than an entire day at the museum. (pp. 113-114)

Consequently, theorists and researchers in informal education disciplines have sought to formulate models of learning distinctive to the learning environment of science centers.

Models of Learning in Science Center Settings

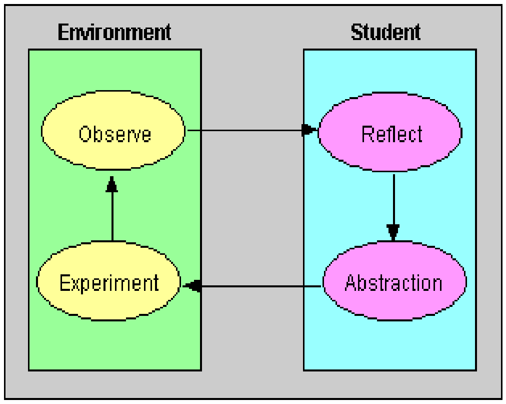
George Hein (1995), one of the seminal informal education theorists for science museums, organized a model of learning theory and theory of knowledge descriptive of the kinds of learning experience that occur in different kinds of museums. The matrix provided a structure in which to 'place' the various kinds of museums as they emerged over the past 200 years. The Musee National des Techniques in Paris (1799) and the Science Museum in London (1857) utilized theories of knowledge and learning in the systematic quadrant of the matrix, in which traditional lecture and text were mainstays for the learning experience. The Deutsches Museum in Munich (1903) shifted to the discovery quadrant of the matrix, emphasizing discovery learning. The Exploratorium in San Francisco and the Ontario Science Center in Toronto further shifted to the constructivism quadrant of the matrix.

Figure 1.2. Models of learning in science center settings.



Linda Black (1990) identified learning theorists whose influence had long-term impacts on museums, particularly Jerome Bruner, Jean Piaget, and Benjamin Bloom. Bruner elaborated discovery learning during the decades of the 1960's and 1970's, when science centers began to diverge from the systematic model into the discovery model. Piaget's influence was apparent in the development of interactive, hands-on exhibits, based on "his description of learning as an active exchange between the learner and the environment. … This theory is being applied when

Figure 1.3. Active exchange model.



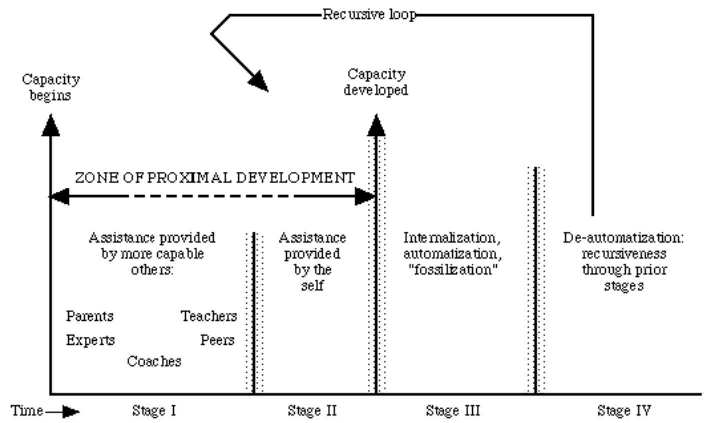
science learning environments involve various senses and motor skills, present real objects and apparatus, and provide opportunities for hands-on exploration of concrete and abstract concepts" (p. 23). Bloom's influence appeared in the application of his theory that "learning begins with acquiring knowledge, then proceeds through understanding, insight, and abstraction, to synthesis. He also maintained that the various stages of the thinking process … were enhanced when accompanied by emotional involvement, which he called affective learning. … [His theory] helped museum staff understand that it's a good idea for exhibits to both present knowledge and evoke emotion" (p. 24). In 1992, the Museum Impact and Evaluation Study was undertaken by a multi-museum collaborative to investigate distinctive aspects of visitor learning experiences in museum settings, in particular the roles of affect in the museum visit (Anderson and Roe, 1993). The report emphasized that it is "a little understood concept … that museums and science centers make real impressions on lifelong learning. … As the studies were conceived and executed, components of affect emerged and then were investigated. Among these were: value, curiosity, duty, motivations, interests, feelings, social interaction, control and attitudes" (p. 9). "The MIES project revealed a different viewpoint regarding how and why people learn in

Figure 1.4. Domains of learning.

museums. … We have come to regard people's personal feelings and socializing needs as prime movers" (p. 16).

At the time Black's article was published in 1990, Vygotsky's work was just becoming available, translated into English. On a first take, Black postulated that "many aspects of his research are pertinent to museums, especially his work on the roles of adults and peer guidance. Researchers in the United States are now using Vygotsky's work to develop models, such as one-on-adult guidance in problem-solving activities with children" (p. 24).

Figure 1.5. Zone of proximal development.

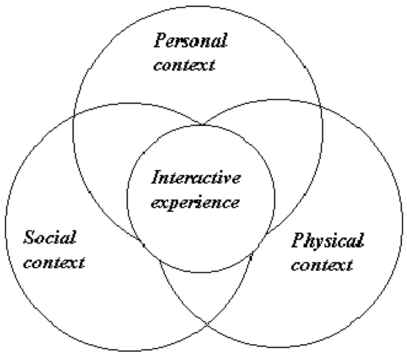


Several years later, Hein and Alexander (1998) placed Vygotskian theory on the right side of the axis of theories of learning in Hein's matrix.

> Sociocultural theories postulating that learning is a social activity, mediated not only by personal development but by language, culture, and context, also exemplifies the right end of the continuum. From this perspective, learning is primarily a social process: people learn through interaction with peers and, especially, with more knowledgeable members of a culture. Teachers do not impart information so much as provide appropriate means of access to the cultures of science, history, art, and other subjects. (p. 32)

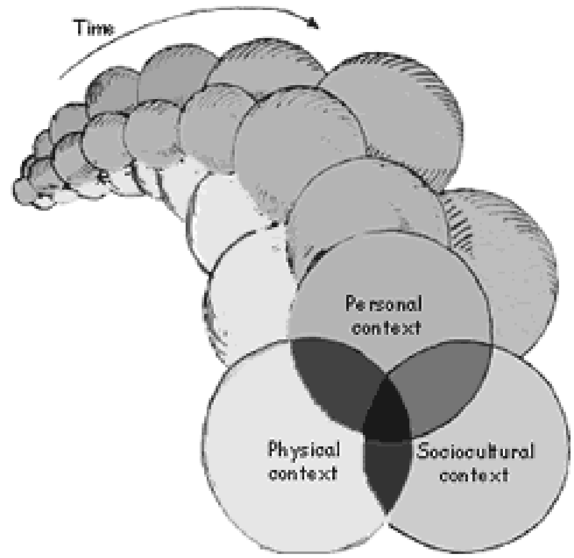
In 1992, based on extant museum research, Falk and Dierking proposed a model – the Interactive Experience Model - to describe and represent visitors' experience as interaction in

Figure 1.6. Interactive experience model.



three contexts: the physical context, the social context, and the personal context (Rennie and McClafferty, 2002). "The Interactive Experience Model emphasizes that the visit must be considered as a contextualized experience. … Thus research must investigate what it is about particular exhibits that promote the prolonged interaction that results in understanding" (p. 192). In 2000, Falk and Dierking (2000) elaborated the Interactive Experience Model in an updated framework they called the Contextual Model of Learning. The "three overlapping contexts contribute to and influence the interactions and experiences that children have with objects and the consequent learning and meaning-making – the personal context, the sociocultural context, and the physical context. Learning is the process/product of the interactions between these three contexts and is more descriptive than predictive" (Dierking, 2002, p. 5). The personal context encompasses everything that a person brings to the learning situation: interests, motivations, preferences for learning modalities, prior knowledge, and prior experience. "Four important lessons are at the heart of the personal context: (a) learning flows from appropriate motivational and emotional cues; (b) learning is facilitated by personal interest; (c) "new" knowledge is constructed from a foundation of prior experiences and knowledge; and (d) learning is expressed within appropriate contexts" (p. 5).

Figure 1.7. Contextual model of learning.



The sociocultural context addresses the shared experience of learning, both as an individual and as a group experience. “Knowledge … is a shared process, and learning and meaning-making take place within often delimited communities of learners. … Interestingly, not only is learning a sociocultural process in the here and now, but the historical and cultural modes of communicating ideas are also sociocultural in nature” (p. 6). Within the sociocultural context, there are two forms of mediation, one with the group and the other as facilitated by someone outside the group. Concerning the latter, “powerful socially mediated learning occurs with other people perceived to be knowledgeable, such as teachers, parents, and other facilitators. … Interactions with other people can either enhance or inhibit a child’s object-based learning experience. When skillful, the staff of a free-choice learning setting can significantly facilitate visitor learning” (p. 9). The physical context affirms that learning occurs within a physical reality, in contact with objects and experiences in the real world.

Paris and Hapgood (2002) discerned the significance of the sociocultural context and the physical context of informal learning environments (ILEs) as they impress and shape the visitor’s experience in their personal context:

> ILEs allow and promote enculturation of visitors into social practices. The objects in museums are selected as valued objects within a culture, whether they represent art, science, or history. … Likewise, experiences in ILEs are intended to enculturate visitors by eliciting senses of identity and participation with specific groups and values. The cultural participation afforded by schools and ILEs may be similar. … ILEs are venues that foster exploration and knowledge-seeking. Self-direction and self-regulation may be allowed in schools, but students are more often directed by others as they learn, whereas museum visitors often

> choose their own routes, pace, level of engagement, and social group as they explore exhibits. … ILEs are generally characterized as learning based on objects and experiences rather than text, perhaps the key distinction between traditional school and nontraditional learning. (p. 41)

Throughout this evolution of learning models and perspectives on learning experiences in science center settings, theorists and researchers have often echoed aspects of the theory that Vygotsky postulated a century before and that his student, Gal'perin, further elaborated in his perspective. The view of learning as an active exchange between the learner and the environment, the view of learning as a process and a product of the interactions between a person's personal-sociocultural-physical contexts, the view of learning in informal learning environments as based on objects and experiences rather than text, all of these views hearken to the emphasis of Gal'perin's presupposition that intellectual operations originate in concrete, external actions. The view of learning as a shared process not only in the here and now but in the perspective of historical and cultural modes being communicated in the museum experience, the view that objects in museums are selected as valued objects within a culture, the view that experiences in museums facilitate a person's enculturation by eliciting their participation with specific groups and values, all of these views recall Vygotsky's emphasis on the cultural and historical nature of psychology, the context in which psychological development is shaped. The very idea of a contextual model of learning in science center settings echoes Vygotsky's conception of psychological development as a dialectical process in which the person is shaped by a culture formed by the past, in which he lives now, and in which he will shape the future culture anew. Emphasis on mediation in the sociocultural context of the learning experience echoes Vygotsky's concept of psychology as an instrumental process in which adults first act as external agents who mediate the child's encounters with the world, a process that the child later interiorizes. The definition of personal context in the Contextual Model recognizes the contribution and influence of a person's interests, motivations, preferences for learning modalities, prior knowledge, and prior experience, all comprising the person's orientation as Gal'perin would ascribe in their acquisition of experiences, as knowledge about something and also as a personal position from which the person regards everything thereafter. In *Supporting science learning in museums,* Schauble, Gleason, Lehrer, Bartlett, Petrosino, Allen et al. (2002) articulate the case for viewing learning in a perspective apt for the experience in science center settings, while echoing the sense of Vygotsky's theory and Gal'perin's perspective:

> Although it is usually assumed that learning means cognitive or conceptual change, learning in the broad sense also includes outcomes like an expanded sense of aesthetic appreciation, the development of motivation and interest, the formation and refinement of critical standards, and the growth of personal identity. This sense of learning is consistent with sociocultural theory's focus on meaning-making in the broad sense, which emphasizes *social interaction* and *cultural symbols* and *tools* as crucibles for appropriating and adapting forms of knowledge, values and expression. (p. 425)

Using the Concept of Orientation to Explore Learning in Science Center Settings

Gal'perin argued that experiences come to a person, as knowledge *about something* and also as a *personal position* from which the person regards everything (Gal'perin, 1979, p. 92). In Gal'Perin's perspective, orientation is fundamental to learning, profoundly shaping the way a person processes new experiences they encounter.

Visitors to science centers come to the museum experience with an orientation given shape by an array of *orienting features* that they have previously encountered in the course of their lives. Their orientation - a position dependent on the quality of the cultural and cognitive tools that they have acquired in instruction, in life experiences, in their exposure to culture, its kind and sophistication – influences the quality and nature of learning experiences they may have during the museum visit. While visiting a science center, they will engage in activities during which other *orienting features* specific to the museum environment come into play, further influencing the quality of the visitors' learning experience.

A continuum of orienting features influences the quality of visitors' learning experiences in these settings. Museum educators and exhibit designers cannot change the visitors' personal context - their orientation - *prior* to the visit, but they can manipulate an array of orienting features in the physical and the sociocultural contexts of the museum itself .

Orienting Features and the Contextual Model of Learning

The Contextual Model of Learning describes learning as the process and the product of interactions between three contexts: personal, sociocultural, and physical (Dierking, 2002). The "three overlapping contexts contribute to and influence the interactions and experiences that children have with objects and the consequent learning and meaning-making" (p. 5). In the course of museum research projects, evaluations, and visitor studies, researchers have identified a variety of factors that influence the nature and quality of visitor experiences with objects in museum settings and with interactive exhibits. These factors may act as a continuum of orienting features shaping a person's perspective of the museum experience preceding, during, and after the visit.

The Personal Context and Orienting Features

The personal context encompasses everything that a person brings to the learning situation: interests, motivations, preferences for learning modalities, prior knowledge, and prior experience. "Four important lessons are at the heart of the personal context: (a) learning flows from appropriate motivational and emotional cues; (b) learning is facilitated by personal interest; (c) "new" knowledge is constructed from a foundation of prior experiences and knowledge; and (d) learning is expressed within appropriate contexts" (Dierking, 2002, p. 5).

In *Applying learning theory in the development of a museum learning environment*, Black (1990) addressed a flaw in the thinking of museum educators and exhibit designers in discovery-model museums, namely, that the idea of creating a museum in which visitors can enjoy discovery learning is predicated on the assumption that the visitors who come will know how to discover.

> Discovery learning has gradually been replaced by a revised concept, learning to discover. The revised theory distinguishes between experienced and inexperienced science learners. Successful self-directed learners have pre-existing knowledge and experience that they draw upon in their search for solutions. Inexperienced learners need to be provided both a variety of techniques for problem solving and instructions in how to proceed through each technique, if their learning outcome is to be successful. (p. 23)

A person's orientation, shaped in this aspect by cognitive tools usually acquired in instruction, determines the nature of how they will be able to interact in such an environment and the potential quality of those learning experiences. Borun (1994) reiterated the profound impact of prior experience, how it shapes visitors' ideas and ways of processing ideas. "Long before people are taught science, they develop their own ideas to explain how the world works. These 'naïve notions' are deeply rooted and widely shared. … There are indications that naïve notions are widespread among adults. Unless they have experiences that cause them to become aware of the flaws or limitations in their early explanations, people's naïve notions persist" (p. 1).

A person's orientation, shaped prior to visits to science center settings, defines the personal context (see Table 1.1). What were those experiences that shaped their affect, their motivation? That shaped their interests? That shaped how they think, that formed what they know? What values and attitudes in their family, their social community, their church community, their school community, formed their orientation? What activities did they enjoy, what hobbies did they choose, what work did they pursue? What cultural tools did they acquire in their instruction? What cognitive tools did they form? What do they know, and not know? Museum educators and exhibit/experience designers should be conscious of visitors' orientations. Otherwise, they may (and do) construct programs and experiences that do not 'speak' to visitors, as the visitors may not be able to 'hear' what is supposedly being said.

Table 1.1
Orienting Features in the Personal Context

Context	Temporal Frame	Orienting Features
Personal	Pre-visit/ post-visit	Attitudes and values in the family
		Attitudes and values in the social community
		Attitudes and values in the school community
		Attitudes and values in the church community
		Hobby experiences
		Vocational experiences
		Cultural tools (language, mathematics, etc.) orienting how to approach new experiences
		Cognitive skills orienting how to process new experiences
		Knowledge/schema formation

Now an 'elder statesman' in the field, Falk (2002) assessed the state of the state of informal education theory in a mature recollection capping decades of research in science centers. His reflections focused attention on the role of many orienting features in learners' experiences, not just those that occur within the museum, but especially those factors that orient visitors outside the museum context.

> When the search image has been appropriate, and the lens suitably selected, museums consistently emerge as extremely powerful learning institutions. In large measure, museums support successful learning experiences for the public in general, and children in particular, because they afford unprecedented opportunities to explore, observe, and sense a fairly limited set of contextually relevant, highly structured, concrete experiences: all within a socially and physically novel, but safe, environment. Equally, or perhaps most importantly, museums are also one of the few places left in our society where children can exercise a high degree of personal choice and control over their behavior and learning. In a museum, children normally get to choose what and when to have an experience. They get to choose what to look at, what to touch, what to climb on, and they are permitted a high degree of discretion over whom they might choose to have experiences with. However, choice and control, as well as novelty and safety, are all relative constructs. Hence, making sense of these important constructs, and how they affect the museum experience, requires examining them within the larger context of the child's entire life, not just during the 2 hours or so they happen to be within the museum. …
>
> As a group, today's investigators of museum learning largely reject the idea that investigations conducted in schools and laboratories readily transfer to the museum context. … However, like the generations of learning researchers before

> them, many investigators working within the museum context reveal an unspoken assumption that learning, or its larger relative "experience," can somehow be readily compartmentalized and captured, as if it were something with a discrete beginning and ending. These investigators operate with the tacit assumption that learning, no matter how it is variously defined, is something that functionally "happens" as a direct response to some unique interaction, event, or "stimulus" within the museum. In truth, learning is a continuous process, a state of becoming, rather than a unique product with distinct and totally quantifiable outcomes. I would assert that any effort to understand the visitor experience, let alone visitor learning, needs to be conceptualized within the larger context of individuals' lives … [and] must be conducted over a reasonably large framework of time and space … that includes the effects of experiences both inside and outside the museum, both prior and subsequent to the museum visit. (pp. x-xii)

The Physical Context and Orienting Features

The physical context encompasses everything that a person physically encounters before, during, and after visits to science centers (see Table 1.2). Learning occurs within physical reality, in *space* and *time*, in contact with objects and experience in the real world. Consequently, a person's orientation is profoundly shaped by their interaction with the physical context. In the course of museum research projects, evaluations, and visitor studies, researchers have identified numerous factors that influence the nature and quality of visitor experiences with objects in museum settings and with interactive exhibits in science center settings.

Setting: An Orienting Feature

In science centers, students on field trips typically comprise a large population of the visitors to the museum. Doing what can be done to make that field trip experience 'better' for them routinely occupies museum educators. To assess the impact of different approaches to prepare students for field trips, Bitgood (1994) set up three different pre-visit orientations: one preparing them for concepts and ideas they would encounter, another preparing them to use particular process skills during their visit, and a third simply providing information about the field trip. "Of the three groups, the trip agenda group demonstrated the most learning on an objective test of the program's concepts and ideas. It appears that previous knowledge of the *setting* and the day's *agenda* increases students' focus on the instructional experience (e.g. how to use a microscope), attitude change, and affective impact (curiosity, interest, satisfaction)" (p. 13). In this experiment, the simplest intervention – orienting students to the physical setting and the agenda for the day – yielded the greatest impact.

Location: An Orienting Feature

In 1992, a multi-museum collaborative undertook the Museum Impact and Evaluation Study to investigate distinctive aspects of visitor learning experiences in museum settings (Anderson and Roe, 1993). At the Franklin Institute in Philadelphia, one of the participating museums in the collaborative, researchers gave visitors photographs of the exhibits in the facility and invited them to sort the photos into categories of their own choosing. Researchers identified five schemas: "content, medium, location, presumed target audience and personal connections. … Classification by *location* was a surprise and adds to the reasons for ensuring that visitors are well-oriented to the location of exhibits and facilities in the building" (pp. 22-23).

Exhibition organization: An Orienting Feature

Schauble et al. (2002) observed that "the conceptual organization of most science museums is reflected in spatial organization. That is, a single exhibit is typically the locale for activities and demonstrations about a common scientific idea or related set of ideas" (p. 436). The researchers were studying ScienceWorks, a new exhibition at the Children's Museum of Indianapolis. For this 11,000 square foot exhibition, exhibit designers purposely diverged from this typical organizational approach and elected to embed "science content in everyday contexts and [to] distribute activities and illustrations about a concept across multiple locations" (p. 437). The organization of exhibit elements in an exhibition, in relation to each other and the whole, comprises a powerful orienting feature for the visitors' experience.

Exhibit Design: An Orienting Feature

Schauble et al. (2002) observed that the business of science centers and museums is to design exhibits. "Museums are contexts where designers give considerable explicit thought to assisting learning via symbol systems and tools, including built environments, texts, activity structures, even colors and traffic patterns" (p. 449). Elements of exhibit design provide a set of orienting features, consciously and purposely developed, to facilitate museum-goers' interaction with exhibits. Borun (1994) addressed the influence of exhibit design – in particular interactivity - on visitors' prior knowledge and 'naïve notions.'

> Unless they have experiences that cause them to become aware of the flaws or limitations in their early explanations, people's naïve notions persist. … The museum environment has great potential for changing visitors' misconceptions. The combination of *hands-on devices* and explanatory text can produce the 'aha' or breakthrough perception that opens people to new understandings. …

> Interviews with visitors indicate that a very high proportion of people who read the labels and *operate* the device understand what it is supposed to show. Moreover, many people clearly state that this is not what they expected and that they now have a new understanding of [the scientific concept demonstrated in the exhibit]. This is a very important finding for science museums. It tells us that *carefully constructed* and labeled devices can really teach. (p. 1-2)

Harvey (1995) conducted two studies of visitor interaction with exhibits at the Denver Museum of Natural History In particular, his studies looked at exhibit design features and their impact on visitors' experience. The studies identified particular design features – interactivity, multisensory stimulation, and dynamic displays – that especially influenced the experience, drawing visitors into interaction and arousing their level of attention.

Visitor Information Interface: An Orienting Feature

While addressing the influence of exhibit design on visitors' prior knowledge and 'naïve notions,' Borun (1994) pointedly emphasized the influence of the visitor information interface – often an explanatory or directive text label – and its particular role in 'notching up the interaction.' "The museum environment has great potential for changing visitors' misconceptions. The combination of hands-on devices and *explanatory text* can produce the 'aha' or breakthrough perception that opens people to new understandings" (p. 1). Likewise, Black (1990) pointedly emphasized the need for direction that visitors often have, a need usually answered in exhibit information interfaces. "Inexperienced learners need to be provided both a variety of techniques for problem solving and *instructions* in how to proceed through each technique, if their learning outcome is to be successful" (p. 23).

In a study at the British Museum of Natural History, McManus (1994) observed that 85% of visitors, “more than eight out of ten visitor groups, used the label texts when at exhibits” (p. 4). This evidence of the degree of usefulness of information interfaces affirms their value as an orienting feature in the physical context of the learning experience. McManus describes the interaction between visitors and label texts as a relationship between the visitor and the author of the label. “The closer the conversational relationship between the label writer and the visitor, the more likely it is that communication between the two will be successful” (p. 5). Few things do as much as information interfaces to orient visitors in their museum experiences.

Information interfaces can provide direction in ways to interact with an exhibit. They can provide explanations for the phenomenon being demonstrated by the exhibit. They can prompt sociocultural dynamics (in the third context of interactions, in the Contextual Model of Learning). In a study at the Children’s Museum of Indianapolis, Perry (1994) observed how the labels in an exhibit, The Color Connection, changed the experience for visitors.

> By composing the text at a low reading level (about fourth grade) … visitors could quickly see that they would be able to understand the exhibit. By observing visitors and what they did at the exhibit, we found that the majority engaged in some sort of explaining or teaching behavior with other members of their social group. … We wanted visitors to feel that they could come up to the exhibit and immediately and successfully interpret something about the exhibit to someone else. The labels specifically encouraged this: ‘Look up! Find the colored lights.’ ‘How many lights are there? There are three, a red, a blue, and a green.’ It should be noted that these labels were written for adults, not children. It’s usually the adults who read the labels; the children were having playing in the lights.

> Typically, adults accompanied by children are not trying to increase their own scientific literacy; they are looking for things they can tell their children to do, or to pay attention to. (p. 27)

Information interfaces can prompt experimentation that raises the learning level to a new height. Massey (1994) cited the case of an exhibit refinement that served to mediate the visitors' experience in powerful, new ways. While prototyping an exhibit, the designers realized that children saw it only as a play object, certainly not as the designers intended it to be seen, demonstrative of a scientific principle. In response, "we altered the exhibit by adding a computer programmed to produce a series of illustrations on the screen and verbal messages through an attached speaker. The messages provided suggestions for experimenting with the apparatus in a scientific way" (p. 9). With this additional orienting feature, an information interface,

> Children were much more likely to start a ball at the top of each cylinder at the same time and observe which reached the bottom first. They also performed novel experiments not suggested by the computer. Not only did children perform mini-experiments more often, they also talked about them more scientifically. For example, children were much more likely to predict which ball would 'win' and try to explain why. From these behaviors and comments we can infer that the children's understanding of the device had changed. (p. 9)

Observing the nature and quality of the learning experience that the children had with the revised exhibit, the designers concluded that

> … the computer enhancement seemed to help children organize their activity by providing cues about which behaviors were appropriate and their proper sequence

> (e.g. making a hypothesis, testing it, and then trying to explain the observed result). The prompts provided by the computer were open-ended, so that users would conduct their own explorations; however, the hints provided by the computer gave some guidance about how to structure these investigations. … In a sense, the children were led to take a step from the novice approach towards the expert model of scientific exploration. (pp. 9-10)

Table 1.2
Orienting Features in the Physical Context

Context	Temporal Frame	Orienting Features
Physical	Pre-visit	Orientation to the facility setting prior to the visit
	Visit	Setting of the facility in its geographic location
		Setting of exhibits in the facility
		Wayfinding/Maps, Symbol Systems to navigate the facility
		Spatial organization of the exhibits in an exhibition
		Design features in each exhibit: activity
		Exhibit design: interactivity/activity structures
		Design features in each exhibit: sensory stimulation
		Design features in each exhibit: dynamic display
		Design features in each exhibit: color
		Visitor information interfaces: text label
		Visitor information interfaces: graphic label
		Visitor information interfaces: monitor screen/computer program
		Visitor information interfaces: video loop

The Sociocultural Context and Orienting Features

The sociocultural context addresses the shared experience of learning. Within the sociocultural context, there are two forms of mediation, one within the group and the other facilitated by someone outside the group (see Table 1.3). Concerning the latter, “powerful socially mediated learning occurs with other people perceived to be knowledgeable, such as teachers, parents, and other facilitators. … Interactions with other people can either enhance or inhibit a child’s object-based learning experience. When skillful, the staff of a free-choice learning setting can significantly facilitate visitor learning” (Dierking, 2002, p. 9).

Schaubel et al. (2002) had previously noted that museums expend energy, resources, and money in a concentrated way to design and develop exhibits. "However, less thought has been spent on thinking about how to engineer the *role of people*, including parents, museum staff, and other visiting children. There is as yet no widely shared vision of professional practice in museums that includes the objective of gaining proficiency in diagnosing and capitalizing on knowledge about typical children's thinking (or the thinking of visitors of any age, for that matter)" (p. 449). Museums are coming face-to-face with the realization that, after 35 years of deploying the discovery museum model, many visitors who come to science centers leave with very little changed. Visitors typically adopt a "browse mode" (p. 425).

> Yet developing opportunities for deeper learning is no easy feat. Visitors – especially youngsters – may require assistance and support, both to identify these learning opportunities and to understand how to take advantage of them. Accordingly, there is growing interest in how to provide effective *assistance* of learning in museum, especially the kinds of learning that families and other visiting groups can provide for each other. (p. 426)

In the study at ScienceWorks in the Children's Museum of Indianapolis, staff was "adamant about the important of mediation. … Many of them claimed that effective mediation was the major factor responsible for tipping the gallery experience from unstructured play toward valuable learning experience" (pp. 440-441). Researchers noted that parents most often provided assistance to their children, to help them operate exhibits. "Staff emphasized talking to children or explaining how things work or asking provocative questions … Half the staff members volunteered that an effective way to spark learning is to pose a goal or challenge that can provide structure and direction to play that otherwise might become aimless" (p. 441). Mediation in the sociocultural context, whether by visitors within their own groups or by museum educators, is one of the most powerful orienting features that can be deployed in the museum experience, influencing "the interactions and experiences that children have with objects and the consequent learning and meaning-making" (Dierking, 2002, p. 5).

Table 1.3
Orienting Features in the Sociocultural Context

Context	Temporal Frame	Orienting Features
Sociocultural	Pre-Visit	Family members
		Adults in community settings
		Peers in community settings
	Visit	Adult mediators in family groups
		Peer mediators in family groups
		Staff mediators
		Educator mediators

In Gal'perin's perspective, orientation is fundamental to learning. It shapes the way a person processes new experiences. The quality and nature of learning experiences that visitors can have in a science center setting is directly influenced by orientation. While visiting a science center, they will engage in activities during which other *orienting features* specific to the museum environment come into play, further influencing the quality of the visitors' learning experience. The purpose of this study is to determine the effects of two kinds of orienting features added to an exhibit - the information interface and the museum educator - on visitors' learning experiences.

Chapter 2

RESEARCH METHODOLOGY AND PROCEDURE

Participants

The participants were a convenience sample of groups visiting the science center during the week of spring break, March, 2006. The sample included 102 groups participating in three conditions: 34 in the exhibit only condition, 37 in the exhibit+label condition, and 31 in the exhibit+label+educator condition. Visitor groups comprised of adults only or adults with children were included in the sample if they met the following criteria. Minimum size for adult only groups was two adults with a minimum age of 18; maximum size was four adults. Minimum size for adults with children groups was one adult with one child with a minimum age of five and a maximum age of 17; maximum size was two adults with four children. These two types of groups constituted a large segment of people who visit science centers, field trip groups comprising the other large segment. Group size was delimited to make it manageable to conduct observations in a public gallery space. Groups with children younger than five were excluded as adults in those groups spent more attention being reactive to their children's attention span and interests than to the impact of orienting features.

Procedure

To determine how the layering of orienting features in a science center setting impacted the quality of the visitor's learning experience, the public behavior of visitors in a science center setting was observed as they interacted with an exhibit demonstrating the Bernoulli principle. Participants were observed in three different conditions: (1) exhibit only, (2) exhibit with an added visitor information interface, in this case a label, and (3) exhibit with an information interface and an educator to facilitate the visitors' experience.

Exhibit only.

During the second and third days in the nine-day spring break week of the experiment, all visitors to the Bernoulli table experienced the exhibit with no visitor information interfaces and without mediation by an educator. This condition provided baseline information for the two other conditions.

Exhibit with Information Interface

In the fourth and fifth days, all visitors to the exhibit experienced the same exhibit as on the second and third days, with the added orienting feature of an information interface, in this case a graphic-text label suggesting what to do and describing what the exhibit demonstrated. Because the interface was a physical element of the exhibit, this orienting feature was a component of exhibit design in the physical context of the Continuum model; however, it was also a feature of mediation in the sociocultural context, in the sense that interfaces constitute a ‘conversation in absentia’ between participants and exhibit designers.

Exhibit with Information Interface and Educator Mediation

In the fifth, sixth, seventh, and ninth days, the exhibit and informational interface was retained and an educator was added, representing an orienting feature of mediation in the sociocultural context of the continuum model.

Instruments

Museum visitor studies have determined that the depth of visitor engagement can be inferred from dwell time, the number and kinds of behaviors shown by them during the experience, and self-reports of their own perception of the experience. Instruments were developed for use to measure these qualities (see Appendix A).

Interrater reliabilities were determined for independent ratings from 10 cases prior to data collection. Pearson's r = .93, 80% agreement measuring dwell time (+/- 5 seconds), 80% agreement identifying behavior categories. The author of this study collected the data for dwell time and indicator behaviors.

Dwell Time

Dwell time was measured when one member of a group engaged the exhibit, label, or educator for five seconds, "a 5-second cutoff … [being] fairly common in time-based behavioral studies" (Sandifer, 2003, p. 125). Dwell time stopped when the last member of the group disengaged from the exhibit. Total dwell time was calculated in seconds by subtracting the difference.

Number of Indicator Behaviors

Another measure of the quality of visitor engagement was the number of indicator behaviors manifested by participants in the course of their dwell time. Four behaviors identified by prior research as indicators of learning activity in informal learning environments were used for this measure: *doing*, *watching*, *talking*, and *coaching*. Doing was defined as a behavior manifested by a member of the group when they physically interacted with the exhibit. Watching was defined as a member of the group passively observing other members of the group doing the activity. Talking was defined as conversation between members of the group about the exhibit, seeking direction or guidance about it, asking questions about it, or discussing its conceptual content. Coaching was defined as a member of the group directing another member of the group to experiment with the exhibit. A category of indicator behaviors was checked on the observation instrument when any member of the group manifested that behavior.

Kinds of Indicator Behaviors

In addition to counting the number of indicator behaviors shown by participant groups, the *kinds* of behaviors were noted as indicators of depth of engagement. Doing and watching were baseline activities, whereas talking and coaching implied a more deeply engaged experience.

Self-Reporting

To obtain insight into participants' perception of the quality of their experience, adults in groups were asked to rate statements in exit surveys. The exit surveys were created on the basis of components of affect identified in the Museum Impact and Evaluation Study (1993). The MIES sought to "understand nuances in visitors' learning behaviors and how learning interacts with affective relationships" (Anderson, p. 8). Statements were crafted around the components of value, curiosity, and feelings.

Facilitator Recordings

For observations in the exhibit+label+educator condition, the educator facilitating the interaction also recorded comments about their mediation with each group. The educator was asked to record 'impressions and recollections.'

Chapter 3

RESULTS

102 groups were observed during the nine-day observation period. Data were analyzed for dwell time, number and kinds of indicator behaviors, and self-reported perception of the exhibit experience across the three conditions.

Dwell Time

To determine visitor interest in each of the conditions, dwell time was analyzed in a one way ANOVA across the three conditions. Mean dwell time in the exhibit only condition was 133.76 seconds, 191.46 seconds in the exhibit+label condition, and 226.77 seconds in the exhibit+label+educator condition (see Table 3.1).

Table 3.1
Dwell Time Means and Standard Deviations

	N	Mean	Std. Deviation
Condition exhibit only	34	133.76	101.393
Condition exhibit+label	37	191.46	131.307
Condition exhibit+label+educator	31	226.77	90.062

The one-way ANOVA (see Table 3.2) yielded an overall significant effect, $F_{(2,99)} = 5.9$, $p < .01$. Mean dwell time did increase with the addition of orienting features across the three conditions.

Table 3.2
Dwell Time ANOVA

	SS	*df*	*MS*	*F*	*p*
Between groups	144469.1	2	72234.558	5.943	.004
Within Groups	1203287	99	12154.411		
Total	1347756	101			

Comparisons were made using Gabriel's post hoc test, indicating that the exhibit+label+educator condition was significant ($p < .004$, see Appendix B). Dwell time increased when an educator was added to the exhibit.

Number and Kinds of Indicator Behaviors

To determine the depth of visitor experience, indicator behaviors were observed across the three exhibit conditions. Indicator behaviors were analyzed initially for number (1 – 4) to determine whether the number of behaviors increased in response to changing conditions. This analysis revealed a significant association between the type of condition and the number of indicator behaviors that manifested ($X^2_{(4)} = 22.61$, $p < .001$, see Appendix C).

Indicator behaviors were then analyzed for kinds to determine whether participants manifested behaviors indicative of deeper engagement (talking, coaching) in addition to baseline interactive behaviors (doing, watching). This analysis revealed a significant association between the type of condition and the kinds of behaviors that were demonstrated by participants across those conditions ($X^2_{(4)} = 23.54$, $p < .001$, see Appendix D).

In both analyses, for number and kinds of indicator behaviors, participants exposed to an exhibit condition with two orienting features - the label and educator added to the exhibit - were 13.6 times more likely to demonstrate four indicator behaviors than a participant exposed to an exhibit only condition. They were 4.3 times more likely to do so than someone exposed to an exhibit condition with one orienting feature, the label with the exhibit. By the same ratio, participants were 13.6 times more likely to demonstrate kinds of behaviors indicative of deeper engagement (talking and coaching) than someone exposed to the exhibit only condition, and 4.3 times more likely than someone exposed to an exhibit condition with only one orienting feature. The important thing in this finding was that there was a difference in observable behaviors resulting not just from layering a number of orienting features on the exhibit, but from adding particular types of orienting features, in this case the educator.

Self-reporting

To determine visitor perception of their experience, participants' ratings were collected in responses to statements using a five-point Likert scale (strong disagreement and strong agreement). Factor analysis was used to aggregate responses.

Of the ten variables in the survey, seven were retained for factor analysis after reliability tests of the subscale measures indicated that removing the three variables with lowest communality values would markedly improve reliability (see Tables 3.3 and 3.4).

Table 3.3
Communalities of initial ten variables

	Initial	Extraction
It was fun to watch people play at the table	1.0	.626
I enjoyed playing with the exhibit	1.0	.826
I found the exhibit appealing	1.0	.302
I was sure what to do at the exhibit	1.0	.436
It was worthwhile to spend my time at this exhibit	1.0	.727
I would recommend this exhibit to other people I know	1.0	.557
I tried different ways of playing with the exhibit	1.0	.630
I discovered something new while playing with the exhibit	1.0	.353
I learned something about science from this exhibit	1.0	.305
I am sure what the exhibit was trying to demonstrate	1.0	.468

Table 3.4
Means and Standard Deviations of seven remaining variables

	N	Mean	Std. Deviation
It was fun to watch people play at the table	216	4.60	.734
I enjoyed playing with the exhibit	216	4.81	.570
I was sure what to do at the exhibit	216	4.37	1.053
It was worthwhile to spend my time at this exhibit	216	4.67	.702
I would recommend this exhibit to other people I know	216	4.47	1.208
I tried different ways of playing with the exhibit	216	4.68	.726

I am sure what the exhibit was trying to demonstrate	216	4.62	.902

Analyses revealed two underlying scales in the survey suggesting sub-components of the participants' experience (see Appendix E). Four variables loaded in factor one (see Appendix F). They suggested a common theme related to feelings. Reliability of the subscale measure was .85 (see Appendix G).

Three variables loaded in factor two. They suggested a common theme related to the participants' comfortableness with the exhibit. Reliability of the subscale measure was .60 (see Appendix H). The three values of Cronbach's Alpha-If-Item-Deleted were less than the overall alpha of .601; deleting any of the three variables would not substantially affect reliability.

Results of a repeated measures ANOVA for the first factor (feelings) indicated there were significant differences across the conditions, $F_{(3,219)} = 8.80$, $p < .001$ (see Table 3.5).

Table 3.5
Repeated measures ANOVA for factor one

ANOVA

		Sum of Squares	df	Mean Square	F	Sig
Between People		284.927	219	1.301		
Within People	Between Items	4.982	3	1.661	8.797	.000
	Residual	124.018	657	.189		
	Total	129.000	660	.195		
Total		413.927	879	.471		

Grand Mean = 4.69

Results of a repeated measures ANOVA for the second factor (comfortableness) also indicated significant differences across the conditions, $F_{(2,222)} = 4.15$, $p < .02$ (see Table 3.6).

Table 3.6
Repeated measures ANOVA for factor two

ANOVA

		Sum of Squares	df	Mean Square	F	Sig
Between People		416.475	222	1.876		
Within People	Between Items	6.209	2	3.105	4.146	.016
	Residual	332.457	444	.749		
	Total	338.667	446	.759		
Total		755.142	668	1.130		

Grand Mean = 4.49

Facilitator Recordings

Audio recordings by educators in the third condition were transcribed and assessed to identify any emergent themes related to orienting features that could enrich the information gathered by the observation instrument and the exit surveys.

Of 31 recordings, the facilitator described participants' interactions with the orienting feature of the exhibit's design for interactivity in 15 recordings. These descriptions commonly capture the playfulness that the exhibit encouraged in them:

> *Appears the thing that he liked best was the balls hovering, but he took and put one of the traffic cones inside of a larger plastic cylinder and then put the large ball on there, discovered that whenever you put the large ball on the traffic cone it blocks off the air enough it makes the cone float.*

Two recordings specifically identified the orienting feature of the label as a useful tool in the group's social interaction at the exhibit:

> *The mom was very patient with the little girl and told her to come over and read the signs; she would actually learn a new word and something about science. Then she explained it to her.*

Three recordings described the facilitator's role in encouraging participants to extend their experience with two other thematically-related exhibits in the gallery:

We talked about it for just a minute. They were successful at getting them into the plate after a few tries. Then they came over to the Bernoulli Table and had a lot of fun.

Of particular interest, five recordings described prior experiences participants had with the scientific concept, acquired previous to their museum visit:

Dad knew what the Bernoulli was before we ever talked about it.

The father said he had demonstrated to the kids how the Bernoulli worked the other day with a hair dryer and a ping pong ball at home.

The mom knew about Bernoulli and about airplanes and how they work.

She was also very well aware of what the Bernoulli was, how an airplane worked.

Then she told me that she had tried this at science class at school, that [inaudible] a ping pong ball go up into a flow of air, and she was very excited that we had this particular experiment.

Summary of Results

In all measures of visitor interaction – dwell time, complexity of behaviors, and self-reported perception of the exhibit experience - analyses of data supported the hypothesis that orienting features would impact the visitors' experience in measurable ways. Dwell time increased when an educator was added to the exhibit. For both the number and kinds of indicator behaviors, participants exposed to an exhibit condition with two orienting features - the label and educator added to the exhibit - were more likely to demonstrate four indicator behaviors (increased number) and those kinds of behaviors indicative of deeper engagement (talking and coaching) than a participant exposed to the exhibit only condition. Factor analysis aggregated self-reporting responses into two factors, the first suggesting a common theme related to positive feelings experienced during the activity and the second suggesting a common theme related to their comfortableness with the exhibit. Both factors showed significant differences across the exhibit conditions. The majority of facilitator recordings highlighted the playful delight shown by participants as they were encouraged to experiment by the exhibit’s physical design for interactivity, while other recordings underscored the use of labels as orienting features in groups’ social interaction at the exhibit and the facilitator’s role in encouraging participants to extend their experience with other exhibits.

Chapter 4

DISCUSSION

The quality of learning experiences in museum settings is dependent on an array of factors, some antecedent to the visit to the center, others influencing visitors during the visit. They come with a mindset shaped by a continuum of orienting features. They engage in activities at science centers, where another set of orienting features specific to the museum environment come into play, further influencing the quality of the visitors' learning experience. Educators and exhibit designers in museums cannot change the visitors' personal context - their orientation prior to the visit - but they can manipulate an array of orienting features in the physical and sociocultural contexts of the museum itself. The approach of this study – viewing elements in the physical, sociocultural, and personal contexts of the Contextual Model of Learning as orienting features – provides a rationale and a tool with which to explore the visitors' experience.

Dwell Time

Visitors in science museums self-direct their choice of activities and the length of time they elect to spend at each activity. In this research, dwell time provided one indicator of visitors' interest in the exhibit experience. If the added features (label and educator) served as Gal'perin would have predicted, to orient the learner and enhance their experience, we would expect dwell time to increase. That is what happened. Surprisingly, only the addition of the educator in the third condition had this effect. The addition of the label did not. As suggested by the anecdotal recordings made by the facilitators, very few visitors in the sample noticed the four labels on the exhibit, most being drawn into direct engagement by the exhibit's 'invitation to play.' Thus, the label – as one form of an information interface – may not really serve as an orienting feature in this highly interactive kind of exhibit, or at least not sufficiently to enhance dwell time.

Indicator Behaviors

The behaviors of doing, watching, talking, and coaching were identified through prior research (Anderson, 1993, Borun, 1997, and Jones, 2003) as indicators of learning activity in informal learning environments. At the 2003 ASTC (Association of Science-Technology Centers) conference, Johanna Jones, a senior associate of the museum evaluation agency, Randi Korn & Associates Inc., discussed indicator behaviors in the session, "Let's dwell on it: three perspectives on exhibits that foster high dwell time." Whereas dwell time provided an indicator of visitor interest and attention in an exhibit experience, it did not address issues related to the quality of the learning experience. The presence of these indicator behaviors helps us to "understand visitors' affective and cognitive experiences" (Jones, 2003, p. 5).

The observation instrument also drew upon the results of the 1996-1998 PISEC (Philadelphia-Camden Informal Science Education Collaborative) Family Learning Project conducted at the Franklin Institute Science Museum, the Academy of Natural Sciences, the New Jersey State Aquarium at Camden, and the Philadelphia Zoo. The PISEC Project sought to elicit evidence that 'enhanced exhibits' produced measurable increases in active family learning. The first phase was guided by the "recognition that learning is often a group experience. Museum-based family learning was defined as an exchange of knowledge and associations in response to an exhibit" (Borun, 1997, p. 1). This phase, completed in 1996, established "behavioral indicators for family science learning" (Borun et al., 1996). "Behaviors that were found to be statistically related to learning levels … were identified as performance indicators" (Borun, 1997, p. 2). They included: asking questions, answering questions, commenting on or explaining the exhibit, reading the text silently, reading the text aloud. "When families are engaged in these behaviors, we can infer that learning is taking place" (Borun et al., 1996).

If the label and/or the educator served as orienting features, we would expect to find an increase in the number of indicator behaviors. We found that a participant exposed to an exhibit condition with two orienting features (label and educator added to the exhibit) was 13.68 times more likely to demonstrate four indicator behaviors than a participant exposed to an exhibit only condition, and 4.3 times more likely than someone exposed to a condition with one orienting feature (label added to the exhibit).

Not only would we expect to see an increase in number, but also an increase in kinds of behaviors indicative of deeper engagement (talking and coaching). Again, we found that a participant interacting in a condition with two orienting features (label and educator) was 13.64 times more likely to demonstrate complex doing-watching-talking-coaching behaviors than a participant exposed to the exhibit only condition, and 4.29 times more likely than someone exposed to a condition with one orienting feature (label). Conditions with added orienting features influenced both the number of behaviors that participants showed and the kinds of behaviors, supporting the test hypothesis. This was especially true when the exhibit included an educator in addition to a label. Unfortunately, we did not test for the condition of adding only the educator without a label in the exhibit condition; that should be studied to isolate the impact of each of those orienting features.

<u>Self-Reporting</u>

Surveys were used to determine visitors' self-reported perception of their experience. Information derived from self-reporting surveys provided a richer body of data with which to interpret the impact of orienting features on visitors' experiences. The surveys were based on the Museum Impact and Evaluation Study (1993). In that study, "components of affect emerged and were then investigated. Among these were: value, curiosity, duty, motivations, interests, feelings, social interaction, control, and attitudes" (Anderson, p. 9). Statements in this survey were crafted around three of those components of affect: value, curiosity, and feelings.

The variables in the first factor suggested a common theme related to feelings that participants experienced in their activity, including enjoyment in doing or watching, satisfaction with the value they perceived in devoting time to the activity, and playfulness, the encouragement they felt to experiment divergently with the exhibit. Affectively, participants perceived their experience on a scale of responses ranging from positive feelings about the experience to negative feelings. There was measurable movement toward positive feelings with the addition of orienting features in the exhibit conditions.

The variables in the second factor suggested a common theme related to the participants' comfortableness with the exhibit (the ease to which the experience put them), including the degree to which they felt invited to enter into the experience because they were comfortable with what the exhibit was trying to demonstrate and what they were to do with it, and the degree to which they were satisfied with that invitation, prompting them to commend it to other people they knew. There was measurable movement toward comfortableness in the exhibit experience with the addition of orienting features.

The two factors aggregated from self-reports may highlight the powerful role these components of affect play in the visitors' personal context as they engage in learning experiences at the museum. Science centers are generally considered to be educational institutions, but the form in which learning takes place there is distinct from the form of learning in formal school settings.

> Although it is usually assumed that learning means cognitive or conceptual change, learning in the broad sense also includes outcomes like an expanded

> sense of aesthetic appreciation, the development of motivation and interest, the formation and refinement of critical standards, and the growth of personal identity. (Schauble et al., 2002, p. 425)

These factors suggest that the affective nature of the *process* of learning in these settings is more important to participants than cognitive outcomes. They also suggest that the sociocultural context of the experience is vital to participants in informal settings, a dynamic that the Museum Impact and Evaluation Study (1993) explored in trying to understand “nuances in visitors’ learning behaviors and how learning interacts with affective relationships” (Anderson, 1993, p. 8). Just what influences those components of affect has been the subject of this study. As we have seen in dwell time and indicator behavior results, the quality of the visitors’ learning experience has been influenced more positively by the addition of an educator to the exhibit than by the addition of the label. Evidently, the information interface – serving in the role of a virtual conversation between exhibit designer and visitor – has not had as profound an influence as the presence of a mediator in this kind of exhibit experience. As Bitgood (1994) noted in the study of field trip pre-visit orientations, it is sometimes the simplest intervention – in that case orienting students to the physical setting and the agenda for the day – that yielded the greatest impact, making their field trip experience better by increasing their focus “on the instructional experience, … attitude change, and affective impact (curiosity, interest, satisfaction)” (p. 13). In this study, the simplest intervention has been the presence of an educator.

Because there have been many research studies on exhibit labels and visitor learning, the efficacy of the information interface as a tool to direct visitors’ interaction, to highlight conceptual content, or to stimulate reflection cannot be doubted. However, in the context of this study – specifically looking at design, labels, and facilitators as orienting features in a continuum of shaping influences on the visitors' learning experience – the educator emerged as a more powerful influence affecting how long visitors spend at an exhibit, how many and what kinds of indicator behaviors they show, and their perception of the quality of that experience.

Facilitator Recordings

Two educators participated in the exhibit+label+educator condition. They were members of a two-year project supported by the Meadows Foundation. The purpose of the project was to place highly experienced educators, whose purpose was to facilitate visitors' interactions with exhibits, in the public galleries of the science center. One educator had 19 years experience teaching in the public school district, 11 years experience in informal museum education; the other educator had 37 years experience teaching in the public school district, 25 years experience in museum education.

Of the 31 audio taped comments made by educators after each interaction in the third condition, 15 described what participants did with the exhibit, sketching a picture of how the exhibit's design for interactivity encouraged playfulness by inviting them into an enjoyable experience.

Only two comments mentioned that participants purposely used the label. In these instances, educators remarked how exceptional those cases were in contrast to the number of other observations about the effect of the exhibit's design for interactivity. In both instances, the educator's belief was that the information interface was used to "learn a new word and something about science."

In the course of conversations with participants, educators commented in five cases on prior experience clearly shaping the groups' interactions. In four of the prior experience cases, an adult in the group knew something about the scientific concept and its application before their visit to the science center. They drew upon that experience as they talked with and coached their children during the interaction. In one of the prior experience cases, a teenager evinced considerable enthusiasm to be able to relate the museum exhibit to a school experiment in which she had recently participated. She was excited to discover something in the museum with which she was already familiar. In all five of these cases, prior experience enabled the participants to be comfortable with the exhibit, confident in their ability to interact with it and competent to communicate to others in their group. For them, the interaction became a 'teachable moment.'

In the 19th and 20th centuries, systematic museums relied on labels to describe displayed objects in order to communicate the intent of the exhibition to visitors. During the latter half of the 20th century, however, discovery and constructivist influences clearly shifted visitor behaviors and expectations in interactive science centers. The participants in this study preferred experiential play over reading labels.

Outcomes Inform Exhibit Development

Gal'perin's perspective emphasized the role of orientation in the development of mind. Experiences come to a person as knowledge *about something* and also as a *personal position* from which the person regards everything (Gal'perin, 1979, p. 92). Visitors come to museums with an orientation already shaped by an array of *orienting features.* While visiting, they engage in activities in which other *orienting features* at the museum come into play, further influencing the nature and quality of their learning experience.

Understanding the impact of orienting features specific to the museum setting (in this case, the baseline feature of interactive design, information interfaces such as labels, and the role of educators) should be a necessary requisite to inform the work of museum exhibit designers and educators as they develop exhibitions and interactive experiences. As Black (1990) noted, it has been a flaw in the thinking of museum educators and exhibit designers in discovery model museums to predicate the development of exhibits on the idea that visitors who come will know how to discover.

> Discovery learning has gradually been replaced by a revised concept, learning to discover. The revised theory distinguishes between experienced and inexperienced science learners. Successful self-directed learners have pre-existing knowledge and experience that they draw upon in their search for solutions. Inexperienced learners need to be provided both a variety of techniques for problem solving and instructions in how to proceed through each technique, if their learning is to be successful. (p. 23)

There is no single approach in designing an exhibit that demonstrates a scientific concept. There is an array of approaches. Choosing an appropriate approach is dependent on the orientation of the people who will comprise the intended audience. Clearly, it is vital to keep in mind what *they* bring to the experience. It is also vital to employ those orienting features in the museum that are most apt to successfully impact their interactions with exhibits. As shown in this study's outcomes, the value of the educator as a mediator of experiences – the cornerstone of Vygotskian interactions – cannot be overestimated.

Implications for Further Study

This study was conducted during a nine-day period, spring break, in a public science museum. It focused on visitor interactions with a single exhibit, an air-powered Bernoulli table. Two orienting features were layered on the exhibit across three conditions: (1) exhibit only, (2) a set of four labels placed on the table, and (3) an educator added to the exhibit with a label on it. Different participant groups were observed in each condition as convenience samples throughout the week. Alternative approaches to these studies could further clarify the impact of orienting features.

A companion study which isolates rather than layers orienting features, introducing only a single feature for each condition, would be a logical complement to this study. That would provide insight into the impact of each discreet orienting feature. Variations of each orienting feature should be explored. What might be the impact of a graphic label rather than a text label? A screen rather than a label? An interactive screen rather than a passive one? A novice facilitator rather than a screen? An experienced facilitator rather than a novice? A seasoned educator rather than a pedagogically naïve facilitator?

Methodologically, it would be of interest to create a study utilizing a single population of groups. Introducing successive conditions (exhibit, then exhibit+label, then exhibit+label+educator) to the same population in the course of a single exhibit experience, followed by interviews to solicit their perception of how those layered features affected them, could further clarify how additional features influenced their experience. Every participant group would then experience the same continuum of conditions.

This study focused on an interactive exhibit at a hands-on science center. Further study should focus on object-display exhibits with varying degrees of interactivity. Do some orienting features better serve different kinds of exhibits? The nature of object-display experiences differs from hands-on explorations as more specific outcomes are intended in the former than the latter, hands-on exhibits usually promoting divergent outcomes. What may be the impact of the array of possible design features, information interface features, and educators with that form of museum exhibit? Might we then find the role of the information interface more influential than it played in this study?

Appendix A

Observation Instrument for Dwell Time and Indicator Behaviors
Observation One, Group No. ____ (1-40)

Date: ____________________

Level of crowding	Day of visit	Time of visit	Group composition
☐ Low ☐ Moderate ☐ High	☐ Weekday ☐ Weekend	☐ Morning ☐ Afternoon	☐ Adult/adults ☐ Adult/children

Exhibit	Start time	Stop time	Total time	Behaviors
Bernoulli Table				☐ Do ☐ Watch ☐ Talk ☐ Coach

Exhibit	Start time	Stop time	Total time	
Bernoulli Table				
		Group Member No.	**Adult/Child**	**Behaviors**
		1	☐ Adult ☐ Child	☐ Do ☐ Watch ☐ Talk ☐ Coach
		2	☐ Adult ☐ Child	☐ Do ☐ Watch ☐ Talk ☐ Coach
		3	☐ Adult ☐ Child	☐ Do ☐ Watch ☐ Talk ☐ Coach
		4	☐ Adult ☐ Child	☐ Do ☐ Watch ☐ Talk ☐ Coach
		5	☐ Adult ☐ Child	☐ Do ☐ Watch ☐ Talk ☐ Coach
		6	☐ Adult ☐ Child	☐ Do ☐ Watch ☐ Talk ☐ Coach

Self-report instrument for exit survey

SURVEY

Observation No. 1
Group No. ____________ (1-40)
Group Member No. _____ (1-6)
Date: ________________

Rate your response to each statement ✓

Education: ☐High school ☐College student ☐Bachelor degree (or equivalent)
☐Masters degree (or equivalent) ☐Doctorate (or equivalent)

Statement	Rating				
	Strongly disagree	Somewhat disagree	Neutral response	Somewhat agree	Strongly agree
It was fun to watch people play at the table.					
I would **not** recommend this exhibit to other people I know.					
I tried different ways of playing with the exhibit.					
I found the exhibit **un**appealing.					
I learned something new about science from this exhibit.					
I was **un**sure what to do at the exhibit.					
I did **not** discover anything new while playing with the exhibit.					
It was worthwhile to spend my time at this exhibit.					
I enjoyed playing with the exhibit.					
I am **not** sure what the exhibit was trying to demonstrate.					

Appendix B

Post hoc multiple comparisons test for Dwell Time

Multiple Comparisons

Dependent Variable: Dependent variable

	(I) Independent variable	(J) Independent variable	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Gabriel	Condition One - Orienting Feature Design	Condition Two - Orienting Feature Design-VII Label	-57.695	26.191	.087	-121.25	5.87
		Condition Three - Orienting Feature Design-VII Label-Educator	-93.009*	27.378	.003	-159.45	-26.57
	Condition Two - Orienting Feature Design-VII Label	Condition One - Orienting Feature Design	57.695	26.191	.087	-5.87	121.25
		Condition Three - Orienting Feature Design-VII Label-Educator	-35.315	26.844	.468	-100.41	29.78
	Condition Three - Orienting Feature Design-VII Label-Educator	Condition One - Orienting Feature Design	93.009*	27.378	.003	26.57	159.45
		Condition Two - Orienting Feature Design-VII Label	35.315	26.844	.468	-29.78	100.41
Games-Howell	Condition One - Orienting Feature Design	Condition Two - Orienting Feature Design-VII Label	-57.695	27.719	.101	-124.13	8.74
		Condition Three - Orienting Feature Design-VII Label-Educator	-93.009*	23.749	.001	-150.02	-36.00
	Condition Two - Orienting Feature Design-VII Label	Condition One - Orienting Feature Design	57.695	27.719	.101	-8.74	124.13
		Condition Three - Orienting Feature Design-VII Label-Educator	-35.315	26.975	.395	-100.05	29.42
	Condition Three - Orienting Feature Design-VII Label-Educator	Condition One - Orienting Feature Design	93.009*	23.749	.001	36.00	150.02
		Condition Two - Orienting Feature Design-VII Label	35.315	26.975	.395	-29.42	100.05

*. The mean difference is significant at the .05 level.

Appendix C

Chi-Square test for number of indicator behaviors

	Value	df	Sig.
Pearson Chi-Square	22.61	4	.000

Number of Indicator Behaviors * Condition Crosstabulation

			Condition			
			Condition One - Design	Condition Two - Design-VII Label	Condition Three - Design-VII Label-Educator	Total
Number of Indicator Behaviors	2 IB	Count	11	6	2	19
		Expected Count	6.3	6.9	5.8	19.0
		% within Number of Indicator Behaviors	57.9%	31.6%	10.5%	100.0%
		% within Condition	32.4%	16.2%	6.5%	18.6%
		% of Total	10.8%	5.9%	2.0%	18.6%
	3 IB	Count	19	20	9	48
		Expected Count	16.0	17.4	14.6	48.0
		% within Number of Indicator Behaviors	39.6%	41.7%	18.8%	100.0%
		% within Condition	55.9%	54.1%	29.0%	47.1%
		% of Total	18.6%	19.6%	8.8%	47.1%
	4 IB	Count	4	11	20	35
		Expected Count	11.7	12.7	10.6	35.0
		% within Number of Indicator Behaviors	11.4%	31.4%	57.1%	100.0%
		% within Condition	11.8%	29.7%	64.5%	34.3%
		% of Total	3.9%	10.8%	19.6%	34.3%
Total		Count	34	37	31	102
		Expected Count	34.0	37.0	31.0	102.0
		% within Number of Indicator Behaviors	33.3%	36.3%	30.4%	100.0%
		% within Condition	100.0%	100.0%	100.0%	100.0%
		% of Total	33.3%	36.3%	30.4%	100.0%

Appendix D

Chi-Square test for kinds of indicator behaviors

	Value	df	Sig.
Pearson Chi-Square	23.54	4	.000

Category of Indicator Behaviors * Condition Crosstabulation

			Condition			Total
			Condition One - Design	Condition Two - Design-VII Label	Condition Three - Design-VII Label-Educator	
Category of Indicator Behaviors	Do and Watch	Count	12	6	2	20
		Expected Count	6.7	7.3	6.1	20.0
		% within Category of Indicator Behaviors	60.0%	30.0%	10.0%	100.0%
		% within Condition	35.3%	16.2%	6.5%	19.6%
		% of Total	11.8%	5.9%	2.0%	19.6%
	Do Watch and Talk or Coach	Count	18	20	9	47
		Expected Count	15.7	17.0	14.3	47.0
		% within Category of Indicator Behaviors	38.3%	42.6%	19.1%	100.0%
		% within Condition	52.9%	54.1%	29.0%	46.1%
		% of Total	17.6%	19.6%	8.8%	46.1%
	Do Watch Talk and Coach	Count	4	11	20	35
		Expected Count	11.7	12.7	10.6	35.0
		% within Category of Indicator Behaviors	11.4%	31.4%	57.1%	100.0%
		% within Condition	11.8%	29.7%	64.5%	34.3%
		% of Total	3.9%	10.8%	19.6%	34.3%
Total		Count	34	37	31	102
		Expected Count	34.0	37.0	31.0	102.0
		% within Category of Indicator Behaviors	33.3%	36.3%	30.4%	100.0%
		% within Condition	100.0%	100.0%	100.0%	100.0%
		% of Total	33.3%	36.3%	30.4%	100.0%

Appendix E

Self-reporting: two underlying scales suggesting sub-components

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.562	50.888	50.888	3.562	50.888	50.888	2.775	39.643	39.643
2	1.027	14.664	65.552	1.027	14.664	65.552	1.814	25.910	65.552
3	.727	10.386	75.939						
4	.602	8.603	84.542						
5	.484	6.921	91.463						
6	.396	5.662	97.124						
7	.201	2.876	100.000						

Extraction Method: Principal Component Analysis.

Appendix F

Self-reporting: two factors

Rotated Component Matrix[a]

	Component	
	1	2
LiketoPlay	.866	
Worthwhile	.818	
WaystoPlay	.805	
FuntoWatch	.765	
Recommend		.790
SureWhattoDemo		.734
SureWhattoDo		.660

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Appendix G

Self-reporting: reliability of variables in factor one

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.855	.864	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
LiketoPlay	13.95	3.203	.831	.709	.775
Worthwhile	14.09	2.987	.718	.584	.806
WaystoPlay	14.08	2.998	.676	.517	.826
FuntoWatch	14.16	3.087	.608	.386	.856

Appendix H

Self-reporting: reliability of variables in factor two

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.601	.609	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Recommend	9.00	2.482	.437	.202	.470
SureWhattoDemo	8.85	3.355	.446	.202	.469
SureWhattoDo	9.08	3.165	.369	.137	.559

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Personal Background	Paul Alan Vinson Born August 31, 1950, Houston, Texas Son of William Hubert and Marilyn Ruth Vinson Married Mary Vinson March, 1989 Three children
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ABSTRACT

THE EFFECT OF ORIENTATION
ON LEARNING EXPERIENCES IN SCIENCE CENTERS

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This study explores the effect of orientation on the quality of visitors' learning experiences. Orientation, elaborated by P. Ya. Gal'perin, originates in Lev Vygotsky's instrumental psychology and informs Falk and Dierking's Contextual Model of Learning. This study's approach – viewing elements in physical, sociocultural, and personal contexts as orienting features – provides a rationale and tool to explore museum learning. In this study visitors interact with a Bernoulli exhibit to which orienting features – a visitor information interface and a museum educator – are added. Depth of visitor engagement can be inferred from dwell time, number and kinds of indicator behaviors, and self-reported perception of their experience. Understanding the impact of orienting features should be a requisite to inform the work of museum exhibit designers and educators.