SciPlay Phase I:
Situating the Project in the Literature

Presented to SciPlay
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Pre-Phase I History and Report Overview

Every innovative project begins with a great idea, and SciPlay is no exception. Inspiration from the Klore gardens in Israel, an initiative of the Weitzman Institute, as well as the science playgrounds of the NY Hall of Science and other informal educational institutions led Sara Schupf, SciPlay Founder, to develop the following Mission Statement for SciPlay:

> *SciPlay was developed to engage more children in science by helping them make connections to science concepts and scientific habits of mind through play on outdoor playgrounds.*
>
> *SciPlay's goal is twofold:*

- *To inspire interest in science through play and activities on outdoor playgrounds*
- *To encourage teachers to view the playground as a resource for engaging students in science learning and sense-making*

Building from this Mission, SciPlay became associated with Mayor Bloomberg's PlaNYC and its goal of bringing green space within a ten-minute walking distance of every New Yorker, across all five boroughs. To accomplish this, PlaNYC aimed to convert existing real estate -- 290 public school yards -- into greened playgrounds and community parks. NYC public school administrators, teachers and students joined landscape architects, engineers, and municipal officers in the playground design process, which began in 2007. Each new playground takes approximately 1 ½ years from blueprint to blue ribbon ceremony. Once the renovations are complete, these spaces are opened to the public at 3:00 pm on weekdays, and during the day on weekends, giving communities access to their local school grounds for the first time ever.[1]

PlaNYC provided citywide energy focused on designing and building playgrounds, and Ms. Schupf connected with the Trust for Public Land and the Department of Parks and Recreation, the two main entities helping to design and install the playgrounds, to situate SciPlay in the center of the action. She commissioned a catalog of playground equipment designed to enhance connections to science concepts by a well-respected architectural firm, and the Trust for Public Land and Department of Parks helped deliver the catalog to schools. Released in fall 2008, the SciPlay catalog was not available to the first schools undergoing schoolyard renovations. However, Ms. Schupf believed that the there was more to the project that the equipment, and she invited prestigious educators, businesspeople and leaders in the non-profit sector to participate on a SciPlay Advisory Board, which convened for the first time in Summer 2008. The meeting was facilitated by newly-contracted SciPlay Project Manager Sarah Holloway, the former Director of Mouse, a high-growth and high-quality non-profit education organization founded in NYC. Together, participants at the meeting came up with useful and creative ideas to take the concept beyond the catalog, and several people opened

[1] More information about PlaNYC may be accessed here: http://www.nyc.gov/html/planyc2030/html/home/home.shtml

their own networks to leverage more support for SciPlay. It is not an exaggeration to say that SciPlay benefitted from a well-oiled public relations machine in NYC prior to its launch in schools.

Shortly after the meeting, it was decided that Phase I would involve a NYC school-based pilot program, during which the concepts identified in the Mission Statement would be tested. EduChange came on board at this juncture, mainly to act as educational liaison and content developer for the pilot schools. Six schools were chosen through an RFP process, to include preK-5, preK-8 and 6-8 schools across all five boroughs (with two in Brooklyn).

In order to inform the content development for the Phase I concept testing, we felt it was important to gather secondary educational research and recent statistics to inform the effort. Specifically, we sought to characterize the landscape in which SciPlay was launching. Ms. Schupf continued to reach out to almost 100 individuals in order to gain support for SciPlay, and shared with us any relevant comments. SciPlay resonated with different people in different ways. From these conversations, we took cues that guided us to a wide variety of entry points for our secondary research.

At this nascent stage of the project, Ms. Schupf felt strongly that we should consider all possible avenues that SciPlay ultimately could take, as well as the major concerns raised by the SciPlay Advisors. We took this early opportunity to follow some of the pathways to see whether any would intersect; we found that they did—and in profoundly rich ways. We also gained confidence that while identified obstacles were formidable, they may not be impossible to overcome. Though not our original intent, we also suggest why SciPlay is well-positioned for potentially widespread adoption and success.

Major theories and perspectives in the research literature guided the design of the framework for Phase I school activities and content development. In addition, we continually refined our framework and sought out additional research perspectives, in response to questions and input from teachers, collaborators and students. In creating this report, we surveyed existing research based on questions that arose and suggestions from collaborators and advisors. Therefore, this is not an exhaustive summary of literature related to science learning and play. Rather, we highlight pieces of research that have been important to our thinking, and we refer to large bodies of literature that help ground and situate SciPlay in its infancy.

This compilation has two main parts:

- *Part I: Serious Challenges Facing Time for Science & Time for Play*, which outlines the major obstacles to SciPlay implementation in schools

- *Part II: The SciPlay Opportunity: Connecting the Right Dots at the Right Time,* which joins science, play, learning and community playgrounds by exploring seemingly disparate fields, perspectives, issues and realities

These parts are further divided into subsections, each one guided by questions posed at the top of the section. The content that follows addresses the questions posed.

Part I: Serious Challenges Facing Time for Science & Time for Play

Guiding Questions:
How much school time currently is allocated to elementary science?
Will there be time for SciPlay?

This decision to pilot SciPlay in schools prompted us to consider probably the most pressing question for any in-school initiative: will teachers want to and be able to carve out time for SciPlay implementation? In the next two sections we examine the value that schools have recently placed on both in-school science instructional time and in-school play time at the elementary level.

The National Context: The Loss of Science Time in Elementary School

As a nation we have grown increasingly aware of the ramifications of the *No Child Left Behind* (NCLB) legislation put into place by the Bush administration during the 2001-2002 school year. The stated intention – providing accountability mechanisms designed to ensure that all students have access to core curriculum standards taught by "highly-qualified" teachers – has given rise to a culture of incessant testing at every level: national, state, local, and school site. This testing culture has shifted class time from instruction to test-prep, and has connoted "achievement" solely with improved test scores. Further, though NCLB was originally intended to address all core subject areas, English Language Arts (ELA) and math testing were rolled out first, effectively prioritizing those subjects to receive more than their subject-area counterparts of the most precious classroom commodity: instructional time. The pressure to demonstrate Annual Yearly Progress (AYP) on publicly accessible school report cards has motivated administrators to gear as many school programs as possible toward improving test scores in ELA and math. Thus, SciPlay is launching in the wake of lost instructional time for elementary science.

Just how much of a drain on science instructional time have elementary schools endured? A 2007 reported released by the National Center for Education Statistics summarizes changes in K-4 instructional time across subject areas, using Schools and Staffing Survey (SASS) data:

> Findings from this report show that combined teacher instructional hours in first through fourth-grade English, mathematics, social studies, and science increased between the 1987–88 and 2003–04 school years. This was due to individual increases in English and mathematics instruction. Over the same time period, instruction in science and social science saw an overall decrease. (p. 1)[2]

[2] The entire report may be accessed here: http://nces.ed.gov/pubs2007/2007305.pdf .

NYC public schools, the immediate context for SciPlay Phase I, has adopted a Citywide Scope and Sequence and identified appropriate curricular materials. However, each school controls delivery of its own science instruction, and enforcement is non-existent. We note the following about K-8 instructional time, based on NYC instructional time requirements: (NYC Department of Education, Division of Teaching and Learning, n.d.)

- ELA and math always bank more instructional time than do science and social studies. In K-2, the emphasis is most polarized: 300 minutes each for ELA and math per week vs. 135 minutes for science and social studies.

- The NY State Education Department requirements for instructional time in science do not go into effect until 7th and 8th grade, with 180 minutes per core subject (science, math, social studies, ELA) per week. This means that, in reality, time for social studies and science at the K-6 level is considered only in light of the accountability pressures in ELA and math.

- No specific time is allotted for technology instruction at the elementary level; it is to be integrated into all subject areas.[3]

As Grade 4 and Grade 8 state standardized science testing unfolds across the nation, elementary schools are stymied: they restructured time to meet ELA and math needs, but now there is no time left to add science back into the mix. Recognizing this situation, and for budgetary and political reasons, NY and other states are not currently considering science test scores "high stakes" (i.e., measured according to AYP).

Has the move to increased instructional time in ELA and Math led to higher achievement? Beyond that, has it led to more learning? Based on a review of instructional time alone, researchers don't think so, for at least two reasons that are relevant to our thinking about SciPlay:

- Extra time does not lead to increased learning if teachers do not effectively provide more rigorous activities and deeper exposure to content (Rangel, 2007).

- Miller and Almon's 2009 book *Crisis in the Kindergarten: Why Children Need to Play in School* reported that in an effort to prepare students for content-based tests, some schools have tried to use extra instructional time to push students beyond their developmental limits. The result? No increase in real learning and possible increases in real frustration, particularly for emerging readers.

International comparisons also show that despite an increase in instructional time for math, the United States is still being outperformed by its international counterparts. In a 2003 analysis of the results from 12 countries that participated in each of three mathematics tests spanning Grades 4, 8 and 10 (TIMSS-4, TIMSS-8 and PISA), The

[3] The NYC minimum requirements for instructional time in all subject areas, K-12, can be found here: http://schools.nycenet.edu/offices/teachlearn/Instructional_Time.pdf

American Institutes of Research named several findings based on these test results. The following quotation includes findings that are pertinent to this discussion:

- Overall U.S. performance was consistently low at all three [grade] levels.

- Each item of TIMSS-4 and TIMSS-8 was placed in one of four cognitive skills categories: knowing facts and procedures; using concepts; solving routine problems; and mathematical reasoning. For both TIMSS-4 and TIMSS-8, student performances were ranked on the least demanding cognitive skill, knowing facts and procedures, and on the most demanding skill, mathematical reasoning. On both cognitive skills at both grade levels, U.S. performance ranked in the bottom half of the distribution.

- For all three tests, countries that ranked below average on the least difficult [test] items also ranked below average on the most difficult items. Conversely, countries that ranked high on the least difficult items also ranked high on the most difficult items. All U.S. rankings were middle to low.

- U.S. elementary mathematics textbooks cover more topics at each grade level than do other nations. As a result, teachers rarely get beyond teaching mathematical procedures; they do not develop deep conceptual understandings of the topics and their applications.

- The U.S. curriculum has broad coverage of the content of TIMSS tests – 87 percent of the topics on TIMSS-4 and 98 percent of the topics on TIMSS-8. The other 11 nations cover (on average) 60 percent of the topics on TIMSS-4 and 75 percent of the topics on TIMSS-8.

- U.S. instructional time for mathematics is at the 12-nation average at grade 4 and somewhat above at grade 8. (American Institutes of Research, 2004, Findings section)[4]

Advocates of science education would be wise to take heed of these lessons learned. Increased instructional time may not lead to increased learning if the instruction is not structured for rigor and depth, and if it is not delivered in developmentally appropriate ways. Unfortunately, "rigor" is often equated with "what the older grades are doing" or with "more of the same," which actually is not an educationally sound way to define rigor—and apparently doesn't result in higher test scores, either. Pushing students to tackle abstract scientific or mathematical models before they are ready likely will do no good, even though it may make some adults feel like they are providing students with an opportunity for early advancement.

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[4] The entire report may be accessed here: http://mathforum.org/kb/servlet/JiveServlet/download/204-1421471-4962040-309376/RSS33b.doc**)**

Our own experiences in schools corroborate the research highlighted here: the loss of time for elementary science has effectively devalued science learning in schools. The recent establishment of the NYC scope and sequence for K-8 science and statewide testing is raising awareness for the need for science time again, and, in response, many elementary schools have purchased materials for teaching science, particularly for Grades 3-4, the testing-focused years. Unfortunately, the impetus for this increased attention is only coming from NCLB-related tests. It remains to be seen how schools will reconfigure schedules to “insert” even more time for science in a school day currently geared to meet AYP in ELA and math.

The National Context: The Loss of Play Time in Elementary School

Guiding Questions:
How much time currently is allocated to play in elementary schools?
Will there be time for SciPlay?

The other component of an in-school implementation of SciPlay is play on outdoor playgrounds. Either students need time to play during the school day—during recess, lunch, gym class—or teachers need to be able to take students outside to play during class time. In either case, time once again surfaced as an important factor to explore. Just as science and social studies have lost time during the school day, so too have physical education, the arts, lunch, recess and “free time” when students are most likely to engage in play (Center on Education Policy, 2008). In discussing children’s lack of exposure to a range of play experiences, Frost (2007) describes a “growing storm” now developing in education as a result of increased testing, standardization of playgrounds, the “dissolution of traditional spontaneous children’s play,” and poverty’s impact on children (p. 225). Regarding the standardization of playgrounds, we learned from PlaNYC that see-saws and swings will not be included as equipment in the City’s design process; safety and liability concerns overruled. Even among teachers who claim to value play as an important part of learning in early childhood, time for play is often missing in their classrooms (Ranz-Smith, 2007). It may also be the case that these same teachers fear student injuries, parent objections, or sending the wrong message to administrators about their degree of academic seriousness.

The following commentary laments the loss of play time in school:

> Why are the best and brightest of our children arriving at college feeling ‘burnt out’? Why are some preschools and kindergartens turning into intellectual hothouses with children struggling to master tasks that are inappropriate for their age? Why are desks and worksheets replacing blocks – in preschool? Why is play now often considered time unproductively spent? Simply put, our culture has

> taken a wrong turn. In its rush to create a generation of Einsteins, it has forgotten about the importance of play for children's development. (Play=Learning, 2005)

Paley (2004) cites school reform moves in the nineties that chipped away at time for in-school Kindergarten play:

> But we overlooked the villain in our midst. It turned out to be no so much the "academics" we were adding but the *time* we subtracted from the children's fantasy play that would begin to make the difference…Having not listened carefully enough to their play, we did not realize how much time was needed by children in order to create the scenery and develop the skills for their ever-changing dramas. We removed the element – time – that enabled play to be effective, then blamed the children when their play skills did not meet our expectations. (p.46)

One of the first questions we asked teachers in our pilot schools concerned time for play, and they confirmed these national statistics held true in NYC. In one school, teachers reported that due to budget cuts, a separate physical education class was eliminated and instead the classroom teacher was required to take students outside for 30 minutes *each week* for unstructured physical activity. Other schools noted that students spend time outdoors only during lunch for 20 minutes, since lunch times are staggered by grade level. Thus, the outdoor space is even off limits for gym classes during much of the school day. Indeed, there not only needs to be time in the school schedule allotted for outdoor play, but the space itself must be available at the time when teachers want access. Issues of time and space will need to be addressed by schools interested in making connections of any sort to playground experiences during the school day.

Is this a global phenomenon? Have our international counterparts reduced time for play in their classroom settings? It is interesting that Finland requires unstructured play periods for students under the age of eight, delays formal reading instruction until the same age, does not require teachers to administer standardized tests and—surprise—structures early learning years around play-based curricula (BBC News, 2007; WLIW, 2009). Finland also is a country celebrated for its students' strong performance on international assessments in science, math and reading, and its high rankings by organizations such as The World Economic Forum (2008) for the educational system as a whole[5]. We recognize the cultural, size and other major differences between Finland and the United States, but we find it interesting that more school-based play is not exactly turning Finnish students into academic laggards.

It appears that some top-scoring countries have earned their bragging rights without losing sight of the importance of play in school. In fact, while these studies do not make these exact correlations, we wonder whether countries like Finland enjoy academic success in part because of their emphasis on play and on developmentally correct instructional tactics. Conversely, the United States seems to be failing its students by

[5] The fact sheet may be accessed here: http://www.weforum.org/pdf/gcr08/Finland.pdf

pushing students to consume more curricular topics, to endure more “seat time” for ELA and math, and take more—many more—standardized assessments.

The Changing National Childhood Culture: 21st Century Play

Guiding Questions:
If US schools have essentially removed unstructured, outdoor play from school, does it exist elsewhere? In what forms?

If students are not playing in school, are they playing outside of school? Where, and with what? We hear many teachers and parents recall their own childhood days, when after-school time was spent outdoors in the local neighborhood, lending a hand at a relative’s place of work, or playing with friends of all ages (usually to include siblings they were tasked with watching)—all without the help of programs, classes and organized sports.

For those of us who work with children, it is evident that afterschool time is now arranged very differently. Children whose “achievement levels” are not up to par are forced or expected to participate in academic remediation programs. In families where both parents work, older children are required to provide care for younger siblings until they can get jobs themselves. Children whose parents have succumbed to the hypercompetitiveness of college admissions seemingly have every minute of every day scheduled for their children in some organized—and usually adult-led—activity.

Wenner (2009) describes statistical loss in time for free play:

> According to a paper published in 2005 in the *Archives of Pediatrics & Adolescent Medicine*, children’s free-play time dropped by a quarter between 1981 and 1997. Concerned about getting their kids into the right colleges, parents are sacrificing playtime for more structured activities. As early as preschool, youngsters’ after-school hours are now being filled with music lessons and sports—reducing time for the type of imaginative and rambunctious cavorting that fosters creativity and cooperation.

Structure and stress even seem to encompass moments where planned activities don’t exist. Judith Warner, in her New York Times bestseller *Perfect Madness: Motherhood in the Age of Anxiety*, describes how competition, guilt, a desire for control, the struggles of co-, shared and single parenting, a lack of quality daycare, increased living expenses, and several other factors plaguing middle- and upper-middle class parents have affected the ways that out-of-school time is experienced by the entire family:

> Have you noticed how hard it is these days to get together on the weekend with another family? First, you have to find a time slot free of kids' activities…Then you have to find a group activity that will please (or at least palliate) every member of the group. Indoors or out? Museum or not?...this one's husband doesn't like to leave home on Saturdays…and that one doesn't tolerate the playground. And then—the activity needs to have some *intellectual* quality. It needs to have some *athletic* component. (Otherwise the kids will be too crazy.) But it can't be *overstimulating* (the kids work so hard all week.) It has to be convenient, it has to be easy, it has to be over early, please, so everyone can be gotten home in time, fed in time, lulled into a cooperation-conducive mood in time so that the bedtime rituals can happen without Mom's going totally crazy. (p. 161-162)

When adults are in control of (indeed, obsessing over) every moment of a child's day, time for free play is often removed altogether. But at what cost? Dr. Roger Hart, a psychologist who conducted a 30-year longitudinal study of the factors influencing the transformation of childhood play, has gathered data from the same group of people: once as children in the 1970s and again more recently as parents. One difference he documents is a lack of independent thinking among children today as compared to thirty years ago:

> When he asked one child, for example, to name his "secret places" the child called to his mother for help identifying such a spot." That would have been inconceivable 30 years ago," he posits. "Then, most children I interviewed had places they went to that their parents had never been to." (Chamberlin, 2006, p. 64)

If children and adolescents are programmed into structured activities from dawn until dusk, do they have any "secret places" to which to escape and, well, play? Of course, children will always have their secret places, but the notion of "place" has changed significantly. For today's youth, the land of video games and the digital world remains "secret" even as they scroll screens and gyrate joysticks right in front of parents and teachers. The digital play space is still safe from most adults, who remain less technologically savvy and intuitive than young "connected natives," so-called by Warren Buckleitner, an educator, researcher, and founder of the *Children's Technology Review*.

"Pocket rockets," the name Buckleitner gives PDAs, are used to snap digital photos in one second and email them in the next, to convene ad hoc study groups, to listen to any musical title in stereo sound, to light a path through a dark hallway, and to receive a text from Dad signaling it's time to come to dinner (from downstairs). He also notes that the research on child development still is the driver of digital products for youth, such as Activision's Guitar Hero®, Nintendo DS® and Nintendo Wii®. Companies that have taken time to understand research behind biological and cognitive development, and have considered the ways young people actually play and learn, have been very successful at engaging children, sustaining their interest, and connecting them to their peers.[6]

While the increased exposure to all things digital has been named by some as a cause of child obesity and decreased physical activity, of diminished connection with the outdoor environment, and a distraction from school, it appears that by some accounts, the commercial producers of these products just may be the ones paying the closest attention to the drivers that most of us would consider “old-fashioned” attributes of childhood: playing, laughing, learning and making memories with friends and family.

As summarized in this section, it is evident that the time for science learning and for play simply does not exist, either in the SciPlay pilot schools, or during after-school time when it would compete against a plethora of other programs in which students are enrolled. In the next section, we consider why, amidst endemic and seemingly irreversible educational trends of accountability, SciPlay provides a breath of fresh air for which students and educators are gasping, both literally and figuratively.

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[6] The entire keynote address can be accessed here: http://www.mivu.org/symposium and a digest video can be found here: http://www.childrenssoftware.com/workshop.html

Part II: The SciPlay Opportunity: Connecting the Right Dots at the Right Time

Projects or organizations that are ultimately successful seem to do the right thing at the right time. While the substance of the project must be solid and compelling, other factors such as timing, audience readiness, and congruence with popular interests and concerns also are critical. Part II shows how seemingly disparate fields, ideas and perspectives are connected in support of SciPlay, and why these connections are likely to be well-received by interested audiences.

Connecting Play and Learning

> ***Guiding Question:***
> ***What do extant research bases tell us about the connections between play and learning?***

The fact is, the drive to play is natural. Children of all ages seek to engage in play whether it is scheduled during the school/work day or not. This may be one of the reasons why students pull out their cell phones during class or on a family trip to the relatives'; since adults have taken away their free play time, they must insert it whenever or wherever they can. Researchers from many different fields (beyond those mentioned here) have fed copious information into the academic archives in order to help us learn more about the role of play in our lives. Dr. Stuart Brown, founder of the National Institute for Play and author of the recent book *Play: How it shapes the brain, opens the imagination, and invigorates the soul*, has spent years working with other researchers to characterize the biological nature of play. In addition, he has convened a variety of scientists, physicians, psychologists, parents and others around these central questions: what is play, why do we do it, and what role does play have in our lives?

In the animal kingdom, "play is incredibly pervasive," Brown writes. And for those educators and parents who are reluctant to allow their children to play in unstructured ways, lest their progress toward the college/profession of their choice be slowed, Brown's findings may prompt them to think again:

> …one of the hallmarks of play is that it appears purposeless. But the pervasiveness of play throughout nature argues that the activity must have some purpose after all. Animals don't have much leeway for wasteful behaviors…Animals that play a lot quickly learn how to navigate their world and adapt to it. In short, they are smarter (p. 30-34)

Many young animals generate neural connections as a product of play. When play stops later in development, so too does brain growth. Humans follow the same play-cognition cycle as other animals, except that play can continue to develop neural connections throughout our lifetime. This means that time for play should not end in elementary school; people who find time for play throughout their lives may actually be the ones primed for career advancement and a better quality of life (Brown, 2009).

Learning theorists and founders of our understanding of cognitive development have weighed in on the connection between play and learning for over a century and have commented similarly to the animal behavioralists and neuroscientists. Play should not be considered merely an ingredient for brain growth, since it effectively pushes an individual to stretch beyond their otherwise demonstrated cognitive means. Vygotsky described play in this way: “In play a child is always above his average age, above his daily behavior; in play it is as though he were a head taller than himself” (1966, p. 16). As such, play is integral to the development of “higher mental functioning” (Fleer, 2009, p.6). Indeed, play is serious work.

The connection between play and learning is so poignant that entire educational theories and school models have been derived from the studies of this relationship. For example, observations of children’s play episodes and peer interactions, among other activities, have been documented to help form the basis of what educators call “constructivism**.”** While differences in approach and focus exist, While differences in approach and focus exist, the writings of Piaget (e.g., Piaget, 1975; 1972; 1962; see alsoGruber & Voneche (Eds.), 1995) and Vygotsky (e.g. Vygotsky, 1978; 1962), along with the work of John Dewey (e.g., Dewey, 1938; 1916; 1910), Jerome Bruner (e.g., 1974; 1966; 1960) and Ulrick Neisser (1967) combine to create a powerful foundation on which others have built. combine to create a powerful foundation on which others have built. This body of literature is relevant here in that it helps contextualize the kind of learning that people do when they play: build understandings via experience, alone and through social interaction, at developmentally appropriate levels. Further it helps inform the importance that learning theorists have placed on play since the early 1900’s.

The connections between play and learning across various fields of biology, child psychology, cognitive development, and educational theory are solid, but some readers may be suspicious of how these connections manifest in formal indoor institutions such as schools. In fact, there are well-renowned international models of early childhood education that rely on play as central to children’s learning. Piaget’s approach to play (1962) in which play is categorized in three stages (practice play, symbolic play, and games with rules), has been influential in the design of early childhood education in the United States (Wineberg & Chicquette, 2009). The Waldorf Model relies on the use of open-ended toys to foster fantasy play and reenactment play. By contrast, the Montessori Model, which extends past early childhood learning, draws on the learning from toys meant to teach a specific concept or skills – such as counting by tens. The Reggio Emilia Approach, specifically geared to preschool-age children, emphasizes the autonomy a child must have over his or her own learning, and as a result these programs emphasize exploratory play and interactions with the real world beyond the classroom. International studies of early childhood education, while not revealing "universal" traits of play, do demonstrate the importance of a range of play patterns around the world (Pramling-Samuelsson and Fleer, 2009).

Across the range of approaches to thinking about play and learning, there is absolutely a consensus about the importance of play for learning for all students. But can play support learning in older grades in school, even in our current standards-driven environment with curricula packed with facts and decontextualized direct instruction? "The evidence is compelling: play promotes learning, and guided play is a powerful teaching tool" (Golinkoff, *et al*, 2006, p. 10). Yes, play can be a part of the learning process for older students and their teachers in a number of ways:

- **Play may act as a precursor for direct instruction**: The teacher may teach concepts or skills to which students were exposed through play.

- **Play may act as a tool for processing direct instruction**: The students may play in response to a teacher-introduced concept, such as when students act with puppets the story from a book read by the teacher.

- **Children may learn through play**: Various patterns of play may serve as mechanisms for learning verbal and non-verbal social communication, trial and error, causal relationships, or materials/equipment selection

- **Teachers may learn and assess through observations of student play**: At present, external standards often shape how teachers design and understand children's play (Pramling-Samuelsson & Fleer, 2009)

Of particular interest to SciPlay Phase I, the pilot program in NYC public schools, Jerome Singer (2006) cites adults as central to the optimization of the play experience:

> For play to flourish as a truly enjoyable, cognitive, and socially adaptive human ability, it requires (to use Vygotsky's term) the scaffolding support of one or more concerned adults…many children from educationally or economically disadvantaged families may be especially at risk in sustaining effective utilization of their natural play tendencies. (p 253-254)

The connections between play and learning across extant research bases abound, and it is time for a new generation of educators to appreciate this legacy and foster 21st Century connections. Even today's data-driven educational audience is forced to agree that these data, when stacked against standardized test scores, prove superior on many indicators of educational quality such as intellectual rigor, developmental appropriateness, student-centeredness, active learning, and consistent progress across diverse types of students.

Connecting Play and Real-World Science

In the last section, we explored the many connections between play and learning, where the research base is solid and developed. As we move closer to the specific goals of SciPlay, there is less literature available to support directly the connections put forth in the SciPlay Mission Statement. Indeed, the NRC (2009) recommends that the field gather more information regarding the nature of informal science learning, particularly about the informal learning situated in places other than museums. Still, it is important to take cues from the available discussions and examples in order to understand whether connections between play and real-world science, which are critical for the success of SciPlay, is potentially viable. In the remaining sections of this report, we suggest specific connections that SciPlay can and should seek to bolster.

Guiding Question:
Are there connections between play and the authentic practice of science?

Perhaps the most famous and long-standing United States museum demonstrating the connections between science and play is San Francisco's Exploratorium, which is dedicated to engaging visitors in the self-discovery of scientific concepts. In describing the founder, staffers say of Dr. Frank Oppenheimer: "The qualities that made Frank so special are the same qualities that make the Exploratorium special: an insistence on excellence, a knack for finding new ways of looking at things, a lack of pretentiousness, and a respect for invention and play" (Exploratorium, n.d.). Museum curators and science educators worldwide (including us) have made pilgrimages to the Exploratorium to learn how the exhibit designers carefully and strategically make science fun, inviting, and unintimidating.

The Exploratorium exemplifies the ways in which the science-play relationship has already been concretized and, as described above, serves as a tribute to a celebrated scientist's approach to his work. In this section, we seek to provide more direct correlations between the qualities of play and the work of real-world research scientists.

While difficult to define play, Brown and others have tried to characterize it. Brown (2009) offers the following "Properties of Play:"

- Apparently purposeless (done for its own sake)
- Voluntary
- Inherent attraction
- Freedom from time
- Diminished consciousness of self
- Improvisational potential

- Continuation desire (p.17)

While we do not suggest that Brown's work is definitive, it provides a recent reference based on a variety of research bases aiming to understand the nature of play. In the table below, we summarize his annotated explanations of each property, and then correlate each with the qualities of activities of practicing scientists.

While we have not conducted research directly investigating the relationship between authentic science practice and the nature of play, the correlations below are suggested based on our ongoing collaborations and data collection efforts with The Rockefeller University over the past eight years. These collaborations have included: the close scrutiny of scientists' authentic behaviors and routines that are relevant to the assessment of inquiry skills in secondary science curricula; facilitated discussions among scientists and science teachers comparing authentic laboratory practices and school-based laboratory experiences; co-crafted conference presentations focused on differentiation and collaboration in research institutions and schools; and more.

The Rockefeller University functions much like a dynamic system of communities of practice, where researchers form ad hoc communities around central research questions. The questions, and the natural subjects of these queries, drive the research practitioners to leverage all relevant expertise just long enough to efficiently test hypotheses. Unlike more traditional academic institutions, where faculty have required duties and are assigned to departments, Rockefeller scientists are unfettered by departmental assignments or required faculty duties. And unlike these other institutions, Rockefeller is among the preeminent science research institutions in the world, boasting over twenty-three Nobel Laureates. The lack of formal, standardized boundaries, an emphasis on scientific freedom, and a deep respect for the natural world has made Rockefeller a pillar of innovation and discovery.

For these reasons, we felt it appropriate and informative to draw on both the formal and informal observations of scientists "in action" at Rockefeller over the past eight years. In 2002, as part of a formative evaluation of The Pre-College Science Outreach Program, directed by Dr. Bonnie Kaiser,[7] we conducted 37 interviews of Lab Heads, post-docs and graduate students. We sought to inform the Outreach Program's understandings of the aspects of a scientist's daily routines, as well as their motivations for and reflections on mentoring students and teachers in their labs. We returned to the interviews and filtered the data through the properties of play described by Brown (2009). The table of correlations below was informed by this review as well as other studies and examples from the field.

[7] Dr. Bonnie Kaiser also served as one of ten reviewers of the 2009 NRC Report that we cite in this paper.

Properties of Play (Brown 2009)	**Corresponding Characteristics of Authentic Science Practice**
Apparently purposeless (done for its own sake) – not done for practical value such as food or money	Basic scientific research is practiced largely for its own sake. That is, the natural world is observed in order so that we may understand how it works, and sometimes even why it works that way. There is no intrinsic monetary value associated with scientific discoveries, even though commercial interests feed off these discoveries to advance their business. Richard Feynman, the 1965 recipient of the Nobel Prize in Physics, explains this connection another way: …"I don't feel frightened by not knowing things, by being lost in the mysterious universe without having any purpose, which is the way it really is, as far as I can tell, possibly. It doesn't frighten me" (Feynman, n.d.) Just as some adults shunt play from their children's lives, people who do not understand the nature of scientific research are quick to label it "boring," "tedious," or "a waste of time."
Voluntary – not obligatory or required by duty	People are not required to become practicing scientists, or even to know much at all about the scientific enterprise. In fact, it seems that as the attentiveness to ELA and Math education has heightened, US schools have exposed students to science on a limited and voluntary basis. Not only do US students not need to learn science, they certainly are not expected to *become* scientists. When you add decreased exposure to a historical lack of access for certain segments of the population, the choice to be or not to be a scientist is not merely voluntary. Serendipity, luck, passion and persistence play roles as well.
Inherent attraction – it's fun, it makes you feel good.	Many practicing scientists have commented on the playfulness of their work, noting that playfulness brings them joy and professional satisfaction. One Rockefeller scientist noted of his student, "He was full of questions and joy" when he came to the lab each day (Rubin, 2002, p. 1). Brown himself interviewed Nobel laureate scientist Roger Guillemin and polio researcher Jonas Salk and "realized that what they were doing every day in the laboratory was playing. When Roger took me through his laboratory he was like a kid as he described his experiments. Here was the biggest, most expensive sandbox he had ever played with, all set up to let him discover wonderful new things. ..Their play was esoteric and difficult to understand for most people, but activity and the joy were the same as they would be for a

Properties of Play (Brown 2009)	**Corresponding Characteristics of Authentic Science Practice**
	kid in a sandbox" (p. 63-64).
Freedom from time - a loss of awareness of time's passage	When scientists make their observations they are acutely aware of the passage of time, no matter the increments. However, scientific experiments transcend normal "business hours" and, as such, make the work of scientists "free" from local community calendars. The experiment, their domain, dictates their activity—whether it's Tuesday at 3 am or Saturday afternoon at 1:30 pm. One Rockefeller scientist noted: "My student had her own keys and she was in here on Saturdays, Sundays, after school and holidays, doing what had to be done" (Rubin, 2002, p. 14). Sometimes scientists' playmates are their model systems, and the last time we checked, viruses and bioengineered mice cannot tell time, nor do they attend to its passage. Scientists must abide by nature's clocks instead of society's. Further, where international collaborations exist, time zones and datelines are crossed in order to share information in real time.
Diminished consciousness of self – a loss of awareness of how one looks or seems to others	To be a scientist one must be in awe of, and humbled by, the wonders of the natural world. More than merely disregarding one's appearance, a scientist is aware of how virtually untraceable a single human life is relative to the physical laws, evolutionary history, and dynamic systems that have stood the test of (geologic) time. More so than many other types of professionals, scientists must diminish their self-consciousness in order to understand the very subject matter of their work. We also considered this diminished consciousness in terms of the blurring of status and hierarchy during weekly lab meetings when high school students, graduate students, post-docs and Lab Heads come together to share results. The centrality of the science underscores democratic proceedings; it matters little who produces the results if they are reliable and useful in promoting the work of the lab (Rubin, 2002).
Improvisational potential – you never	The impression of science that most students hold is that answers already are known and are unchangeable, perhaps because that is what they often experience in classroom labs

Properties of Play (Brown 2009)	**Corresponding Characteristics of Authentic Science Practice**
know what is going to happen, a sense of chance or serendipity is accepted and welcomed	that demonstrate a phenomenon they just read about in their textbook. However, the scientific research that provides fodder for textbooks operates in quite the opposite fashion. Just as with a fun game or playground exploration, scientists never know what to expect. Results must be gathered carefully and reproduced reliably by others, but those results are not known to scientists *a priori*. In fact, many scientific discoveries have arisen from unexpected results that took a scientist in an unexpected direction, forcing him/her to improvise the original plan.
Continuation desire – the pleasure of the experience drives the desire to keep doing it	In 2002, researchers conducted a survey of epidemiologists across major institutes of public health in the USA to try to identify the factors contributing to a successful and long career. They found that "the top enabling factors were dedication to hard work and having an intrinsic curiosity and a sense of discovery" (p. 61). While hardly representative, we appreciate the hints at the intrinsic nature of job satisfaction for a scientist. In a more recent article, Stanford professor Stephen Quake explains: "Science at its most interesting is provocative, surprising, counter-intuitive and difficult to plan — and those are very difficult values to institutionalize in an organization or bureaucracy of any size" (2009, para. 9). The very intrinsic pleasure of conducting science—not the fame, fortune or recognition—seems to be both what drives scientists to keep researching and drives them crazy when the realities of grant funding and publishing set in. Replace these realities with a ringing school bell calling children at play in for high-stakes testing that will pronounce them "above, at or below grade level," and we gain a vision of how both science and play are driven by continuation desire that does not to fit into society's formal definitions of performance and achievement.

Connecting Practices: Science Education and Digital Gaming

Guiding Question:
Are there connections between 21st century play and best-practice science instruction?

If we accept that there is ample research substantiating the claim that play enhances learning, and if we entertain the idea that the properties of play bear resemblance to the activities of real-world scientists, then we must take the next step to explore play's potential relationship with science learning. As we have noted, science learning can inhabit formal and informal spaces, and this very tension was an early subject of discussion for the SciPlay team. Can connections to science learning based on playground play only be supported in informal settings and venues, such as after-school programs, family/neighborhood exchanges, camps, TV shows, and free play? Or can this type of learning connection be fostered by teachers inside the regular school day? Are both formal and informal settings viable?

Questions underscoring the tension between formal and informal are age-old. The debate goes far beyond a description of setting and into the realm of education philosophies. Dewey (1916) wrote:

> One of the weightiest problems with which the philosophy of education has to cope is the method of keeping a proper balance between the informal and the formal, the incidental and the intentional, modes of education. When the acquiring of information and of a technical intellectual skill do not influence the formation of a social disposition, ordinary vital experience fails to gain in meaning, while schooling, in so far, creates only "sharps" in learning — that is, egoistic specialists. (p.9)

While a discussion of competing educational theories is outside the scope of this piece, we point the reader to a nice summary by Bredo (1994) for further information, and relate this debate to considerations presented in the current NRC Report (2009) on Informal Science Learning. The National Science Foundation (NSF) requested this study, and is currently sponsoring grant competitions to encourage more research and information-gathering on the topic. Why this impetus for substantial financial support at this time? We note two central reasons offered by the NRC:

1) "This report echoes the need for greater coherence and integration of informal environments and K-12 functions and classrooms…while often complementary and sometimes overlapping with the goals of schools, the goals of informal environments are not identical to them…(p. 1-2)

2) "…there is no basis for targeted, systematic, and efficient knowledge accumulation, and it is difficult to leverage research to guide policy and practice" (p. 1-8)."

It appears that the NSF and NRC desire to create a framework for understanding how informal and formal science learning experiences relate, in an effort to have them coexist in optimal ways. Though not directly stated in the NRC report, we wonder if the following issues and situations also have pointed funders toward the expansion of practices and places relevant to teaching and learning science:

Formal school settings still fall short in providing students with truly inquiry-based science learning environments.

- **In many science classrooms across the United States, teachers are presenting science as a series of facts or truths that describe the way the world "really is.**" This current approach to formal science education contradicts not only the ways in which scientists practice and perceive of their experimental results, but it also runs counter to strategies for best-practice science promoted by national science and educational organizations such as AAAS (1993, 2009), NRC, NSF, NIH, NSTA, and others. These organizations and others have long advocated for inquiry—both as a teaching methodology as well as a repertoire of habits of mind and practices—to drive science education. Unfortunately, their advice has not been adopted on a widespread basis.

- **Current standardized state science tests and SAT II subject-based science tests include questions that largely require students to recall vocabulary terms and memorized relationships as presented in their (outdated) textbooks**. The tests measure students' capacities to interpret written questions posed using unfamiliar language and syntax and then select the best answer from 4-5 given choices. In order for students to "achieve" and post high test scores, teachers mirror their instruction accordingly by mimicking the idiom of the test in their own classroom. While performance-based science assessments exist, even as components of state tests, the questions posed are only those that can pass validity, reliability, bias and other requirements determined by pyschometricians and commercial test designers.

- **Inquiry-based instruction is difficult to employ effectively for teachers who have not learned in classrooms structured this way, and scientific habits of mind are difficult to identify, foster and assess.** Even when teachers use high-quality inquiry-based materials such as FOSS, which are being employed by many K-8 teachers in NYC, teachers unfamiliar or uncomfortable with the approach may skip or gloss over the moments designed to foster inquiry. And, particularly in the elementary setting, teachers may feel uneasy about not knowing answers to questions that students pose about the natural world.

Emerging research on digital play environments shows that well-designed, popular video games provide spaces for inquiry-based learning.

Many adults lament the fact that 21st century connected natives are continually glued to electronic devices, citing video games as a major culprit of rising childhood obesity and a decrease in physical activity. If this is true, then we adults are to blame. We have taken away every ounce of time for free, outdoor play; we have effectively grounded them from physical activity. Despite our best efforts to nurture the fully-remediated/high-achieving student, nature has won the battle. Children in the 21st century have found their "secret places" in spite of us.

The great news is this: *children have actually sought out the higher-order thinking skills and inquiry-based learning that schools and adult-led programs do not provide*. Gee (2005) explains why:

> Good video games incorporate good learning principles, principles supported by current research in Cognitive Science (Gee 2003, 2004). Why? If no one could learn these games, no one would buy them—and players will not accept easy, dumbed down, or short games. At a deeper level, however, challenge and learning are a large part of what makes good video games motivating and entertaining. Humans actually enjoy learning, though sometimes in school you wouldn't know that. (p. 3)

Gee goes on to draw a parallel between the practice of real scientists and the playing of video games:

> A science like biology is not a set of facts. In reality, it is a "game" certain types of people "play". These people engage in characteristic sorts of activities, use characteristic sorts of tools and language, and hold certain values; that is, they play by a certain set of "rules." They do biology. Of course, they learn, use, and retain lots and lots of facts—even produce them—but the facts come from and with the doing. Left out of the context of biology as activity, biological facts are trivia. (p.4)

Compare this to the guidelines given by AAAS (1993, 2009) for elementary science:

> …By gaining lots of experience doing science, becoming more sophisticated in conducting investigations, and explaining their findings, students will accumulate a set of concrete experiences on which they can draw to reflect on the process. At the same time, conclusions presented to students (in books and in class) about how scientists explain phenomena should gradually be augmented by information on how the science community arrived at those conclusions. Indeed, as students move through school, they should be encouraged to ask over and over, "How do we know that's true?" (Nature of Science section, para. 4)

It seems as though the very learning principles that have stymied educational practitioners in the classroom have fueled the ever-expanding digital gaming industry.

Principles of good games (Gee, 2005) correlate to STEM Habits of Mind.
From the statements above it is evident that understandings or conceptual knowledge, result from practice, from "playing the game," whatever the game may be. What kinds of activities are relevant to the practice of science, and are there corollaries to the playing of high-quality video games?

Science educators often talk about encouraging certain "habits of mind," and a report published by the NRC (Shavelson, 2002) helps describe this phrase:

> The culture of science fosters objectivity through enforcement of the rules of its "form of life"—such as the need for replicability, the unfettered flow of constructive critique, the desirability of blind refereeing—as well as through concerted efforts to train new scientists in certain habits of mind. By habits of mind, we mean things such as a dedication to the primacy of evidence, to minimizing and accounting for biases that might affect the research process, and to disciplined, creative, and open-minded thinking. These habits, together with the watchfulness of the community as a whole, result in a cadre of investigators who can engage differing perspectives and explanations in their work and consider alternative paradigms. (p.53)

Science educators have defined various STEM (Science/Technology/Engineering/Math) habits of mind. We often find them somewhat hidden inside the large state standards documents, but upon review of several sets of national and state science standards and the 21st Century skills (somewhat like habits of mind from the world of business), we have compiled a list for use in SciPlay content development. Since SciPlay Phase I will be implemented in NYC, we aligned our working list of STEM habits of mind closely to the "Inquiry & Process Skills" identified in the *Elementary Science Core Curriculum* (NYSED, n.d., p. 4). However, in some cases we interpreted their definitions more broadly to include ideas from other sources as well.

Our first table presented the properties of play and the practice of real-world science, comparing the pure and authentic characteristics of both. The table below compares the ways in which both the field of science education and the gaming industry strive to emulate pure science and pure play, respectively. High-quality (though largely elusive) school science curricula and high-quality video games strive to mimic and build on the natural, inquiry-based tendencies of their audiences. We posit that the intersection between science learning and play is paved by the STEM habits of mind, and we cite the emerging body of literature on learning in digital game environments in order to argue this point.

To keep this comparison focused, we refer solely to the work of James P. Gee, who is well regarded in the field of research on video games and learning. Katie Salen, SciPlay Advisor and Director of the Institute of Play, has collaborated with Gee. Annotations are included where appropriate in order to elucidate the connections we make:

STEM Habits of Mind	Activities of Gamers & Principles of Good Games
Acting Responsibly – avoiding reckless behavior, practicing safety; also considering larger purposes or other entities when acting	**Systems Thinking** (Gee, 2005) – "players need to think of how each action taken might impact on their future actions and the actions of the other players playing against them" (p. 9); in this way, players develop **effective social practices** (Shaffer, Squire, Halverson, & Gee, 2005, p. 106) that "follow certain norms and values" and cause them "to see the world, respond to the world, and act on the world in certain ways" (Gee, 2008, p.25).
Classifying - "arranging or distributing objects, events, or information representing objects or events in classes according to some method or system" (NYSED, n.d., p. 4)	**Smart Tools & Distributed Knowledge** (Gee, 2005) – information about playing the game is distributed among nonplayer characters and players. In a sense, certain kinds of information and skills are classified according to the role and purpose of the character. **Consolidation** (Gee 2005) also may be considered a product of a player's classification of new challenges as distinguished from those already routinized, or *consolidated*.
Collaborating – working with adults and peers toward a common goal; helping each other accomplish a task	**Effective Social Practices** and **Cross-functional Teams** – most high-quality games immerse the player in a world where players and nonplayer characters work together toward a common goal: **"**games bring players together, competitively and cooperatively, into the virtual world of the game and the social community of game players" (Shaffer, Squire, Halverson, & Gee, 2005, p. 106); in some multi-player games, different players bring different tools and skills to a single complex task or problem in order to solve it (Gee, 2005).
Collecting Data – data refer to any qualitative, sensory or quantitative data that inform the experience; the collection of these data may or may not be formally recorded	**Exploring** and **Thinking Laterally** (Gee, 2005) – Games "encourage players to explore thoroughly before moving on too fast, to think laterally and not just linearly, and to use such exploration and lateral thinking to reconceive one's goals from time to time" (p.10).

STEM Habits of Mind	Activities of Gamers & Principles of Good Games
Communicating – any statement, image, drawing, non-verbal gesture, verbalization or representation used for the purpose of sharing information	**Interaction** (Gee, 2005) – in games communication exists on a variety of levels—player to nonplayer characters, player to player (inside and outside the game environment), game to player, lead players to groups of players—as well as in a variety of forms—actions, decisions, data-gathering, feedback, etc. "…nothing happens until a player acts and makes decisions. Then the game reacts back, giving the player feedback and new problems. In a good game, words and deeds are all placed in the context of an interactive relationship between the player and the world" (p.6).
Comparing and Contrasting - "identifying similarities and differences between or among objects, events, data, systems, etc." (NYSED, n.d., p. 4)	**Systems Thinking** (Gee, 2005) – the influx of stimuli populating the screen at a given moment force players to compare entities and situations in order to make sense of them in ways that help players reach their goals or accomplish tasks. "Games encourage players to think about relationships, not isolated events, facts, and skills" (p.10). Further, players compare and contrast myriad experiences over time in order to generalize and even understand higher levels of abstraction (Gee, 2008, p. 30).
Designing & Inventing – any action or communication used to vary, build, reconstruct or reframe a previously utilized or manipulated representation	**Production** (Gee, 2005) – "Even at the simplest level, players co-design games by the actions they take and the decisions they make…Players help 'write' the worlds they live in" (p. 5-6).
Generalizing – "drawing general conclusions from particulars" (NYSED, n.d., p. 4)	**Generalizing** (Gee, 2008) – While school science courses often force-feed students scientific generalizations, they fail to educate students in the making of such generalizations—and then wonder why formula derivations escape even the best and brightest science and math students. In games, players have "ample opportunities to apply their previous experiences—as interpreted—to similar new situations, so they can 'debug' and improve their interpretations of these experiences, gradually generalizing them beyond specific contexts" (p.21).

STEM Habits of Mind	Activities of Gamers & Principles of Good Games
Identifying Variables – "recognizing the characteristics of objects or factors in events that are constant or change under different conditions" (NYSED, n.d., p. 4)	**Situated Meanings** & **Systems Thinking** (Gee, 2005) In games, players have the opportunity to isolate variables and see what they mean in different contexts and in relationship to other variables. This helps players come to define and recognize that variable and its properties when faced with a new situation or context. "As players move through different contexts—each containing similar but varied problems—this movement helps them to interpret and, eventually, generalize their experiences. They learn to generalize—but always with appropriate customization for specific different contexts—their skills, procedures, principles, choices, and uses of information" (Gee, 2008, p. 26).
Inferring – "drawing a conclusion based on prior experiences" (NYSED, n.d., p. 4)	See *Interpretation and Reflection* below.
Interpreting Data - "analyzing data that have been obtained and organized by determining apparent patterns or relationships in the data" (NYSED, n.d., p. 4)	**Interpretation** and **Reflection** (Gee, 2008) – Pattern recognition is key to mastering a player's own skills as well as understanding the skills set of opponents and allies within the game space. "…for experiences to be useful for future problem solving, they have to be interpreted. Interpreting experience means thinking—in action and after action—about how our goals relate to our reasoning in the situation. It means, as well, extracting lessons learned and anticipating when and where those lessons might be useful. "…games also encourage players to interpret their experiences in certain ways and to seek explanations for their errors and expectation failures" (p. 23).
Making Real-world Connections – relating the experience to authentic contexts: larger, local, or personal	**Models and Modeling** (Gee, 2008) – Some video games are simulations of real-world environments, with varying degrees of abstraction and fantasy. Players notice when simulated actions and environments do not seem to "work," when the modeling is weak. By contrast, the family of *Sims* games and *SecondLife* provide highly realistic, believable environments where avatars interact in ways recognizable to the average, un-game-educated person.

STEM Habits of Mind	Activities of Gamers & Principles of Good Games
Making Decisions – "identifying alternatives and choosing a course of action from among the alternatives after basing the judgment for the selection on justifiable reasons" (NYSED, n.d., p. 4)	**Risk-taking** and **Situated Meanings** (Gee, 2005) – In games, players are encouraged to take an action or make a decision and, when they fail, are invited to try again without too much penalty. Since failure is not a death sentence, players become more confident risk-takers once the game norms, systems, contexts, and/or environments become familiar.
Manipulating Materials – "handling or treating materials and equipment safely, skillfully, and effectively" (NYSED, n.d., p. 4)	**Character, tool and environmental manipulation** (Gee, 2004) – One of the universal aspects of games is their invitation to manipulate the accessible materials. Much as toddler explores through sensory manipulation, players explore via virtual manipulation: "…as a form, games encourage exploration, personalized meaning-making, individual expression, and playful experimentation with social boundaries" (p.16).
Measuring – "making quantitative observations by comparing to a conventional or nonconventional standard" (NYSED, n.d., p. 4)	**Measurements as Data** - Most games provide measurement data for players, for example, in dashboards of instruments. Players may not actively measure something within the game environment, but they do learn to use them as data and can include measures of competence, spatial orientation, air pressure, water levels or non-standard units that can be appreciated only through play. In games, students get experience with different kinds of measurements and measuring units.
Observing – "becoming aware of an object or event by using any of the senses (or extensions of the senses) to identify properties" (NYSED, n.d., p. 4)	**Observing** - Players observe through active manipulation (See *Character, tool and environmental manipulation* above). They also observe the outcomes of other players' and nonplayer characters' actions.
Organizing Data - data refer to any qualitative, sensory or quantitative data that inform the experience; the organization of these data may or may not be formally	**Organizing Data** - Outside the game environment, communities of players organize data about game experiences in the form of discussion forums, blogs, FAQs and shared screenshots of hallmark situations (Gee, 2008). Inside games, stats are logged and revealed as players request them: "Lots of

STEM Habits of Mind	Activities of Gamers & Principles of Good Games
charted, but the organizational system must at least be made evident in the way that interpretations are made.	games allow players to turn on and off a myriad of interface screens, which display charts, lists, and graphs depicting various aspects of game play, equipment, inventories, abilities, skills, histories, and accomplishments" (Gee, 2008, p.30)
Predicting & Hypothesizing – "making a forecast of future events or conditions expected to exist" (NYSED, n.d., p. 4); also basing ideas about outcomes on prior knowledge in order to make educated and informed guesses	**Well-ordered problems** (Gee, 2005) – "In good video games, the problems players face are ordered so that the earlier ones are well built to lead players to form hypotheses that work well for later, harder problems" (p.6). Unlike most school-based laboratory settings, video games provide ample experiences before prompting players to utilize their skills for the purpose of prediction or hypothesis-testing. In high-quality games, they are truly informed guesses.

One conclusion we draw from this comparison is that the activities of science students and game players are similar when both groups are immersed in an environment of guided inquiry. Best-practice science education helps foster inquiry skills and STEM habits of mind when teachers and curricula provide rich, student-centered experiences conducted in classrooms structured by norms and safety guidelines. High-quality games invite players into similarly rich, structured environments that are player-centered yet also provide parameters, rules and "smart tools" to scaffold and assist where necessary (Gee, 2005).

This is significant for SciPlay because play on playgrounds may exist as free, unstructured play but could benefit from teachers or other adults prompting the play in appropriate ways as well. This coincides with Singer's (2006) comment quoted earlier in this paper: "For play to flourish as a truly enjoyable, cognitive, and socially adaptive human ability, it requires (to use Vygotsky's term) the scaffolding support of one or more concerned adults…" (p. 253-254). It is important for SciPlay to balance the nature of digital play environments that appeal and are familiar to 21st century students, with the nature of playground play and its unique contexts. The next section explores why considering the playground as a context for learning is relevant and important.

Connecting Players and Places: Virtual and Real Playgrounds

> ***Guiding Question:***
> ***How can the playground serve as a resource for science learning?***

Gee and others make clear that one of the most powerful elements of high-quality games revolves around the community the game creates—both inside and outside the game environment. Video games provide a context and culture for a community of practice (the players), according to the concept of "situated learning." Applied to a wide variety of communities and seeded in constructivism, the growing body of research around situated cognition and situated learning (Lave & Wenger 1991; Kirschner & Whitson 1997; Brown *et al.,* 1989) emphasizes the ways learning occurs through social interactions and is connected to specific spaces and activities. Lave and Wegner (1991) have further defined what they call "legitimate peripheral participation," where new members of the community must become more actively engaged and participatory in order to legitimize their membership and become expert practitioners (i.e., players). In this situation, learning is usually unintentional rather than deliberate, where people learn knowledge and skills exhibited by other members of the community and, as such, learn in order to belong.[8]

Gee (2008) notes that good video games wield the powers of identity and community in order to situate the player in especially rich learning contexts:

> …players always learn in specific contexts. That is, they learn through specific embodied experiences in the virtual world…While they are richly detailed and specific, they are—in reality—not just any old contexts, but richly *designed problem spaces* containing problems that fall into a set of similar, but varied, challenges across the levels of the game. (p 25-26)

It is clear that the formation of a community of practice that is situated in a rich context for learning is not trivial. The personal and social meaning of the experience, as well as the nature of the learning that takes place, are the results of community co-construction. Buy-in is critical, but membership is ad hoc. Thus, every game yields a story unique to those players.

In many ways, virtual playgrounds seem to have taken their cues from outdoor playgrounds. Neighborhood playgrounds also house ad hoc communities of practice, where members on a given day may span ages and skill levels, and may include some of the same and some different members as the day before. Norms for play are communicated either verbally or nonverbally, and play ensues. The learning is derived

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[8] A nice introduction to the work of Lave and Wenger may be accessed here: http://www.infed.org/biblio/communities_of_practice.htm

from the play experience, and any content knowledge required is learned on an as-needed basis.

It seems as though the type of learning that appeals to 21st century connected natives also has a place on outdoor playgrounds, which may be novelties to urban NYC youth who will have access to safe, green spaces for the first time in their lives. And, both friends and foes of video games feel comfortable championing play on outdoor playgrounds; there is little dissension about the merits of outdoor play or outdoor learning. Those who see virtual playgrounds as thieves of physical activity and contributors to the childhood obesity problem are thrilled by the promise of greened outdoor playgrounds in NYC. And, both free play and guided or prompted play can exist at different times and in different situations without changing the nature of the space itself (i.e., it is unnecessary to shift to a new environment). Via PlaNYC, the 290 renovated playgrounds may be perfect places to situate learning, and popular interests and concerns make the timing perfect.

There is a growing recognition of the importance of outdoor experiences for learners. The No Child Left Inside Coalition (2009), for example, has responded to the changes instituted by NCLB mandates with initiatives "driven by the recognition that America's young people are growing increasingly disconnected from nature spending more time inside and not outside playing, exploring and learning." Coming from a similar set of concerns, the Trust for Public Land (TPL) is one of the organizations in New York City working to design playgrounds and open spaces as part of PlaNYC. Integral to TPL's initiative is the notion that young people should act as stewards for the sites around the city (2008). This idea of stewardship is significant because it involves young people and adults working together to plan the use and maintenance of their newly-fashioned outdoor spaces. Enter situated learning and communities of practice: by engaging with one another in new contexts like on playgrounds, people learn in new ways.

The "green" movement that has swept the country over the past few years also contributed positively to the aura of SciPlay. More than ever, people are concerned about our fragile environment, desire alternative energies, fear the depletion of the fresh water supply, and are conscious of sustainable farming practices that protect our food supply. President Obama's moves to engage the country in environmental science, research and development through his Re-Energyse intiative (The White House, 2009), coupled with his family's local statement on good nutrition and healthy food by planting a Victory Garden at the White House (Burros, 2009), send a clear message to the world about changing federal perspectives and policies. For both economic and socio-political reasons, people are more tethered to their local communities and want their children to care about each other as well as their local surroundings.

Other enlightened initiatives include making playground equipment and structures more accessible, thus making progress towards the expansion of playground communities of practice. Boundless Playgrounds (2009), leaders in inclusive playground communities and advisors to SciPlay, is making every child's participation legitimate:

> Through their common playground experiences, all children on a Boundless Playground gain the proven intellectual, physical and social developmental benefits of unstructured play. When children grow up playing and learning together, they develop a lifelong respect for, and appreciation of, individuals of all abilities.

It seems as though there a confluence of factors paving the way for successful community playgrounds. But can play communities situated on outdoor playgrounds engage in science learning, specifically? Phase I seeks to begin answering this question, though there is evidence to suggest that this connection is as natural as the surroundings provided by PlaNYC. Frost (2007) advocates for renewing our social and educational consciousness around outdoor play and its relationship to cognitive development:

> In failing to cultivate the inherent play tendencies of children in the outdoor world, we fail to plant the early seeds of passionate exploration, artistic vision, creative reflection, and good health. Childhood is the time when, and play-grounds and natural habitats are the special places where, the culture, arising from tradition, knowledge, and skills, is readily and rapidly assimilated into the growing brain and psyche. (p. 228)

In a larger sense, all cognitive development requires interaction with the world, and children are quick to become students of the natural world on outdoor playgrounds. In fact, there is evidence to suggest that urban children tend to have anthropocentric notions of the natural world and poor understandings of ecological relationships. PlaNYC will provide the green spaces to help address this critical issue. Beyond ecology, physical laws and properties describing the ways the world works are fodder for playground experiences. And, the STEM habits of mind are absolutely able to be fostered on playgrounds. Thus, inquiry-based play in a fun and stimulating natural environment *is* science learning. This AAAS (1993, 2009) suggestion coincides with these lines of thinking: “For students in the early grades, the emphasis should overwhelmingly be on gaining experience with natural and social phenomena and on enjoying science” (Nature of Science section, para. 4).

It seems that outdoor playgrounds can situate science learning nicely and, in the childhood memories of many adults, have a history of doing so. In order to prepare outdoor play and science learning for reentry into 21st century (as it seems to have been absent for many children), SciPlay would be wise to take heed of the learning frameworks and communities of practice fostered in high-quality digital games. However, we feel that communities of practice on newly-renovated NYC playgrounds can develop successfully in their own right.

Summary

This report was written to inform Phase I activities of the SciPlay Project taking place between February and June 2009. Phase I serves as a concept test of the SciPlay Mission Statement, to be carried out in six NYC pilot schools spanning grades K-8:

SciPlay was developed to engage more children in science by helping them make connections to science concepts and scientific habits of mind through play on outdoor playgrounds.

SciPlay's goal is twofold:

- *To inspire interest in science through play and activities on outdoor playgrounds*
- *To encourage teachers to view the playground as a resource for engaging students in science learning and sense-making*

In order to test whether teachers and students understood and valued this concept, and whether schools were viable settings for SciPlay implementation, it was important to develop prototype content to help transmit the SciPlay mission in tangible ways. With this report, we sought to situate SciPlay in the relevant literature in order to guide content development and the Spring 2009 activities with the pilot schools.

Compiling relevant research provided us with important information and helped us make useful connections that informed Phase I:

- Due to the accountability requirements of NCLB legislation, time for school science learning has been squeezed in order to prepare students for high-stakes testing in ELA and math. Science, particularly in grades K-5, has been effectively devalued.

- For the same accountability reasons, time for outdoor play has also diminished. Gym, recess, "free time" and even lunch have been cut short to accommodate longer instructional blocks for ELA and math. It appears that test-prep worksheets have replaced play-based learning, even in early grades.

- Interestingly, increased instructional time for ELA and math test prep have led to increased test scores in many schools, it has not resulted in heightened higher-order thinking and problem-solving skills. On these measures, our international counterparts far outweigh United States students. Further, those countries still believe in time for *both* inquiry-based science and play at the elementary level.

- 21st century play does exist, although a young person's time has been taken over by structured, adult-led activities—mandated either because the student is not performing "at grade level," or because the threat of competitive college admissions scares parents into the micromanagement of their child's resume-building.

- 21st century play exists whenever young connected natives can eek out some time to boot up their electronic devices: they play on virtual playgrounds that their parents and teachers are not savvy enough to supervise.

- The digital gaming industry has reminded educators and policymakers everywhere of something researchers have known for years: the drive to play is natural and, in the best examples, highly desirable. Play is a vehicle for cognitive and social development. It also plays a central role in both modern educational theory and formal models of early childhood education.

- In this paper, we showed that science itself could be characterized as play, as described by Brown (2009). Our experiences working with, observing, and interviewing scientists at The Rockefeller University, as well as allusions and examples from the field, combined to present some clear similarities and connections.

- We further demonstrated that players' activities and experiences in high-quality video games, as defined by Gee and his colleagues (Gee, 2003, 2004, 2005, 2008; (Shaffer, Squire, Halverson, & Gee, 2005), correspond closely to the STEM habits of mind advocated by major science education organizations as well as the NY State Education Department. Further, it appears that 21st century youth seek out complexly-designed, challenging, inquiry-based experiences to fill their little free time.

- The body of research describing situated learning and communities of practice resonate with the nature of outdoor play experiences. Based on their digital gaming experiences, students in 2009 are primed to engage in social networks situated in a common location with commonly shared norms and purposes. PlaNYC is providing 290 learning contexts, and SciPlay can provide opportunities for local communities of science practice.

- A confluence of factors at the international, national and local levels has created a landscape ripe for launching SciPlay. The green movement, President Obama's Re-Energyse initiative, the public outcry against a culture of school testing and loss of school play time, and the ever-present reminders of our nation's low international stature in the realm of STEM education are just a few of the factors uncovered in this report.

With the findings of this report in mind, SciPlay Phase I school-based activities commenced. Under separate cover, a collection of developed content, reflections, reports from the 2009 Phase I pilot schools is shared. For more information about SciPlay, please visit www.sciplay.org.

References

Alliance for Childhood. (2009). *Crisis in the kindergarten: Why children need to play in school.* College Park, MD: E. Miller & J. Almon.

American Institutes of Research. (2004). Report summary: 2003 TIMSS and PISA: Reassessing the results. Retrieved July 23, 2009, from Math Forum Website: http://mathforum.org/kb/servlet/JiveServlet/download/204-1421471-4962040-309376/RSS33b.doc

BBC News. (2007). Top of the class. Retrieved July 27, 2009, from BBC News Website: http://news.bbc.co.uk/2/hi/programmes/documentary_archive/6991288.stm.

Boundless Playgrounds. (2009). Playgrounds for everyone. Retrieved March 9, 2009, from Boundless Playgrounds Website: http://www.boundlessplaygrounds.org

Brown, J.S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher* 18(1), 32-42.

Brown, S. (2009). *Play: How it shapes the brain, opens the imagination, and invigorates the soul*. New York: Avery.

Brownson, R.C., Samet, J.M., & Thacker, S.B. (2002). Commentary: What contributes to a successful career in epidemiology in the United States? *American Journal of Epidemiology, 156*, 60-67.

Bruner, J. (1974). *Toward a theory of instruction*. Cambridge: Harvard University Press.

Bruner, J. (1966). *Studies in cognitive growth : A collaboration at the Center for Cognitive Studies*. New York: Wiley & Sons.

Bruner, J. (1960/1977). *The process of education.* Cambridge: Harvard University Press.

Buckleitner, W. (2009). Keynote Address. Disruptive innovation and the future of online learning conference. Retrieved July 27, 2009, from http://www.mivu.org/symposium/.

Burros, M. (2009, March 19). Obamas to plant vegetable garden at White House. *The New York Times*. Retrieved from http://www.nytimes.com/2009/03/20/dining/20garden.html

Center on Education Policy. (2008). Instructional time in elementary schools: A closer look at changes for individual subjects. Retrieved February 23, 2009, from Center on Education Policy Website: http://www.cep-dc.org/.

Chamberlin, J. (2006). Childhood revisited. *Monitor on Psychology*, *37*(3), 64.

Chesapeake Bay Foundation. (2009). About the No Child Left Inside Coalition. Retrieved February 27, 2009, from Chesapeake Bay Foundation Website: http://www.cbf.org/site/PageServer?pagename=act_sub_actioncenter_federal_nclb_coalition

Clements, R. L. & L. Fiorentino. (2004). *The child's right to play*. Santa Barbara: Greenwood Publishing.

Dewey, J. (1938). *Experience and education.* New York: The Macmillan Company.

Dewey, J. (1916) *Democracy and education.* New York: The Free Press.

Dewey, J. (1910). *How we think.* New York: D.C. Heath & Co.

Exploratorium. (n.d.). Dr. Frank Oppenheimer: A brief history. Retrieved July 24, 2009, from Exploratorium Website: http://www.exploratorium.edu/frank/bio/bio.html

Feynman, R. (n.d.). Retrieved July 24, 2009, from Feynman Online: http://www.feynmanonline.com/

Fleer, M. (2009). A cultural-historical perspective on play: Play as a leading activity across cultural communities. In I. Pramling-Samuelsson & M. Fleer (Eds.), *Play and learning in early childhood settings: International perspectives.* New York: Springer.

Fleer, M., *et al*. (2009). Play and learning in Australia. In I. Pramling-Samuelsson & M. Fleer (Eds.), *Play and learning in early childhood settings: International perspectives.* New York: Springer.

Frost, J.L. (2007). The changing culture of childhood: A perfect storm. *Childhood Education, 83*(4): 225-6.

Gee, J.P. (2008). Learning and games. In K. Salen (Ed.), *The ecology of games: Connecting youth, games, and learning*. The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning. Cambridge, MA: The MIT Press, 21–40. doi: 10.1162/dmal.9780262693646.021

Gee, J.P. (2005). Good learning and good games. Madison: University of Wisconsin-Madison. Retrieved July 3, 2009, from Academic ADL Co-Lab Website: http://www.academiccolab.org/pastarticles

Gee, J. P. (2004). *Situated Language and Learning: A Critique of Traditional Schooling*. London: Routledge.

Gee, J.P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave/Macmillan.

Golinkoff, R.M., *et al*. (2006). Why Play = Learning: A challenge for parents and educators. In Singer, D.G., *et al*. (Eds.) *Play=learning: How play motivates and enhances children's cognitive and social-emotional growth*. London: Oxford University Press.

Gruber, H. & Voneche, J. J. (Eds.). (1995). The essential Piaget. New York: Jason Aronson.

Kirschner, D & Whitson, JA. (1997). *Situated cognition: Social, semiotic, and psychological perspectives*. Lawrence Erlbaum.

Kirriemuir, J. & McFarlane, A. (2004). Literature Review in Games and Learning. Bristol: Futurelab.

Kuhn, D., Langer, J., Kohlberg, L., & Haan, N. S. (1977). The development of formal operations. in logical and moral judgment. Genetic *Psychology Monographs, 95,* 97-188.

Lave, J. & Wenger, E. (1991).*Situated learning: Legitimate peripheral participation*. London: Cambridge University Press.

National Center for Education Statistics. (2007). Changes in instructional hours in four subjects by public school teachers of grades 1 through 4. Retrieved July 23, 2009, from National Center for Education Statistics Website: http://nces.ed.gov/pubs2007/2007305.pdf

National Institute for Play. (2006). Play science – The patterns of play. Retrieved February 26, 2009, from National Institute for Play Website: http://www.nifplay.org/states_play.html

National Research Council. (2009). *Learning science in informal environments: People, places and pursuits*. Washington, DC: National Academies Press.

Neisser, U. (1967) *Cognitive psychology*. New York: Appleton-Century Crofts.

NYC Department of Education, Division of Teaching and Learning. (n.d.). K-12 Instructional Time. Retrieved July 27, 2009, from New York City Department of Education Website: http://schools.nycenet.edu/offices/teachlearn/Instructional_Time.pdf .

NYSED, Division of Curriculum, Instruction & Instructional Technology, (n.d.) Elementary science core curriculum, grades K-4. Retrieved March 1, 2009 from NYSED Website: http://www.emsc.nysed.gov/ciai/mst/pub/elecoresci.pdf

Paley, V.G. (2004) *A child's work: The importance of fantasy play*. Chicago: The University of Chicago Press.

Partnership for 21st Century Schools. (2009). Framework for 21st Century learning. Retrieved February 23, 2009, from The Partnership for 21st Century Schools Website: http://www.21stcenturyskills.org/documents/framework_flyer_updated_jan_09_final-1.pdf

Partnership for 21st Century Schools. (2008). Transition brief: Policy recommendations on preparing Americans for the global skills race. Retrieved February 23, 2009, from The Partnership for 21st Century Schools Website: http://www.21stcenturyskills.org/documents/p21_transition_paper_nov_24_2008.pdf

Pellegrini, A.D. (1990). Elementary school children's playground behavior: Implications for children's social-cognitive development. *Children's Environments Quarterly, 7*(2), 8-16.

Piaget, J. (1975/1990). *The child's conception of the world.* (J. Tomlinson & A. Tomlinson, Trans.) New York: Littlefield Adams.

Piaget, J. (1972). *The psychology of the child.* New York: Basic Books.

Piaget, J. (1962). *Play, dreams and imitation in childhood*. New York: Norton.

Play=Learning. (2005). A manifesto on the importance of play for children's development. Retrieved March 2, 2009, from Play = Learning Website: http://udel.edu/~roberta/play/manifesto.html

Pramling-Samuelsson, I. & M. Fleer. (2009). Commonalities and distinctions across countries. In I. Pramling-Samuelsson & M. Fleer (Eds.), *Play and learning in early childhood settings: International perspectives.* New York: Springer.

Rubin, C. (2002). Rockefeller mentor interview data: Selected quotations on various outreach program issues. New York: Pre-College Science Outreach Program at The Rockefeller University.

Quake, S. (2009). Guest column: Letting scientists off the leash. Retrieved July 25, 2009, from New York Times Blogs Website:

http://judson.blogs.nytimes.com/2009/02/10/guest-column-letting-scientists-off-the-leash/?pagemode=print

Rangel, E. (2007). Time to learn. *AERA Research Points 5*(2), 1-4.

Ranz-Smith, D.J. (2007). Teacher perception of play: In leaving no child behind are teachers leaving childhood behind? *Early Education & Development, 18* (2), 271.

Rao, N. & H. Li. (2009). "Eduplay": Beliefs and practices related to play and learning in Chinese kindergartens. In I. Pramling-Samuelsson & M. Fleer (Eds.), *Play and learning in early childhood settings: International perspectives.* New York: Springer.

Renner, J., Stafford, D., Lawson, A., McKinnon, J., Friot, E., & Kellogg, D. (1976). Research, teaching, and learning with the Piaget model. Norman, OK: University of Oklahoma Press.

Shavelson, R.J. & Towne, L. (Eds.). (2002). *Scientific research in education.* Washington, DC: National Research Council, Committee on Scientific Principles for Education Research.

Simons-Morton, B.G., *et al.* (1993). The Physical Activity of Fifth-Grade Students During Physical Education Class. *American Journal of Public Health, 83*(2), 262-4.

Shaffer, D.W., Squire, K., Halverson, R., & Gee, J.P. (2005). Video games and the future of learning. *Phi Delta Kappan,* 87(2), 104-111.

Singer, D.G., *et al*. (Eds.) (2006). *Play=learning: How play motivates and enhances children's cognitive and social-emotional growth*. London: Oxford University Press.

Singer, J. (2006). Epilogue: Learning to play and learning through play. In Singer, D.G., *et al*. (Eds.) *Play=learning: How play motivates and enhances children's cognitive and social-emotional growth*. London: Oxford University Press.

Trust for Public Land. (2008). About TPL: The Trust for Public Land. Retrieved March 9, 2009, from TPL: http://www.tpl.org/tier2_sa.cfm?folder_id=170

Vygotsky, L. (1978). *Mind in society: Development of higher psychological processes. Cambridge: Harvard University Press.*

Vygotsky, L. (1966). Play and its role in the mental development of the child. *Voprosy Psiknologii (12)*6, 62-76.

Vygotsky, L. (1962/1986). *Thought and language*. Boston: MIT Press.

Warner, J. (2005). *Perfect madness: Motherhood in the age of anxiety.* New York: Riverhead.

Wenner, M. (2005). The serious need for play. *Scientific American,* Feb. 2009*.* Retrieved from http://www.scientificamerican.com/article.cfm?id=the-serious-need-for-play&page=4

Wineberg, L. & L. Chicquette. (2009). Play and Learning in Wisconsin. In I. Pramling-Samuelsson & M. Fleer (Eds.), *Play and learning in early childhood settings: International perspectives.* New York: Springer.

The White House, Office of the Press Secretary. (2009, April 27) Fact sheet: A historic commitment to research and education. Retrieved from the United States Department of Energy Website: http://www.energy.gov/news2009/7347.htm

WLIW (producer). (2009). Globalization – Finland: What's the secret to its success? Retrieved July 27, 2009, from PBS Website: http://www.pbs.org/wnet/wherewestand/reports/globalization/finland-whats-the-secret-to-its-success/206/

World Economic Forum. (2008). The Global Competitiveness Report, 2008-2009 – Finland. Retrieved July 27, 2009, from WEF Website: http://www.weforum.org/pdf/gcr08/Finland.pdf

Zigler, E.F. & S.J. Bishop-Josef. (2006). The Cognitive Child vs. The Whole Child: Lessons from 40 Years of Head Start. In Singer, D.G., *et al*. (Eds.) *Play=learning: How play motivates and enhances children's cognitive and social-emotional growth*. London: Oxford University Press.

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