Playing Around in Science: How Self-Directed Inquiry Benefits the Whole Child

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Children of all ages who have the opportunities, time, and materials to explore science content in a self-directed manner will develop higher level understandings, and demonstrate more sophisticated approaches to science. A vast and growing body of research supports the academic benefits of self-directed or authentic scientific inquiry, which is defined as a line of questioning that belongs to the individual (Llewellyn, 2011; Akerson, Hanson, & Cullen, 2007; Cacciamani, 2010; Eick, Meadows, and Balkcom, 2005). Embedded within a child's distinctive ownership of the inquiry process is a highly beneficial, yet often overlooked aspect, and that is the child's choice to engage in play. Playing around in science presents children with opportunities to think creatively and divergently, to solve problems in innovative ways, and to develop a unique scientific identity. Llewellyn (2011) states that children learn about the world through exploration, "play, creativity, curiosity, and wonderment" (p. 63). Play in science extends far beyond promoting academic understandings. In fact, when a child engages in play activities while simultaneously undertaking inquiry processes, the child can also choose to participate in social/collaborative scientific endeavors. Furthermore, emotional development and connections can be made when children play around with science content. Also, since play activities typically involve movement, children are actively occupied in physical representations that can also make concepts concrete for better understanding. Play in science promotes comprehension, but it also provides opportunities for children to become socially, physically, emotionally, and even culturally involved. This article will discuss the benefits of play in science to the whole child as well as some of the obstacles that diminish or extinguish play behaviors and scientific exploration.

Definitions and Context

In order to unpack the benefits of play in science, some definitions and context are necessary. First, inquiry is a term that is heavily used in the literature, but can be poorly understood and not well manifested in the classroom (Stone, 2015). Different types of inquiry exist and form a spectrum of possibilities with the main distinction being ownership of the questions and processes (Llewellyn, 2011). When the teacher owns the scientific questions, processes, and outcomes, this is referred to as teacher-directed inquiry, and it forms one end of the spectrum. In teacher-directed inquiry activities, the emphasis is on standardization with students converging to a singular outcome, which was derived from a specific curriculum objective (Stone, 2015). Teacher-directed inquiry affords students little opportunity for creativity, divergence of thought or process, and has little to no capacity for play. On the other end of the spectrum, self-directed inquiry involves a line of questioning and developing processes, both of which belong to the individual student. The line of questioning is rooted solely in the interests and curiosity of the child, and is therefore highly intrinsically motivated. Self-directed inquiry allows students the freedom to explore, create, adapt, modify, and play with ideas because the child is the owner and stakeholder of the inquiry process.

Intertwined with self-directed inquiry is free play, which is a natural, inherent part of a child's interest-driven activities. The International Play Association (IPA) states that "the drive to play is innate," and that "play is self-chosen," involving "active choice and engagement" (IPA, 2014, p. 1). Play belongs to each individual child like self-directed inquiry. It is important for teachers and parents to know that an attempt to structure play in order to deliver a content objective is ill advised. Play must belong to the child, and the child must be free and unhindered by external constraints for the activity to still be considered play and not an academic task. Also, play is ubiquitous in human nature, as it is evident in all cultures, races, and genders. It is also important to note that play does not just belong in the realm of early childhood, but extends to children of all ages, including adults. Play is a process, much like science, which can take many forms including "bodily actions, social interactions and the development of symbolic thinking" (IPA, 2014).

Despite the numerous benefits, neither play nor self-directed inquiry are highly valued in the current school culture, which promotes a presumed efficiency model of education. This efficiency model is based on the manufacturing mindset and is constructed on the premise that standardization and high-stakes accountability will deliver predetermined content to the masses in the most timely, efficient manner. Play and self-directed inquiry are unique to the individual, are highly divergent, and require open time and resources that run counter to a school culture of compliance, standardization, and homogenization. However, the benefits of playing around in science, or any content area are clearly evident in the literature. Some of the many benefits are discussed in the following sections.

Benefits of Play in Science on the Whole Child

The advantages of play through self-directed inquiry are abundant, and are interconnected across academic, social, emotional, physical, and even cultural realms. For example, a child who is playing with magnets may be developing conceptual knowledge of the interaction between magnets or between magnets and metal objects. Through inquiry that is self-directed, the child may begin to ask questions and develop simplistic or even complex experiments to test ideas. The child may also ask or inspire others to join in a mutual scientific play endeavor where social interaction becomes a valuable element, and children co-construct their own scientific reality. The child or children will make use of movement, either repetitive (attracting magnets over and over) or non-repetitive (moving a metal object with a magnet under the table). Children may imagine that they themselves are magnets and can act out attraction and repulsion. The intrinsically motivated, choice-driven inquiry and play activities will help children develop strong emotional connections that are evident in their excitement and engaged passion for playing with the materials. In other words, children are having fun. It is a pleasurable experience, and one that will likely lead to deeper understanding (IPA, 2014). The children will often choose to repeat the experience if given the time and materials as well. Potentially, the child or children may connect the activity/content to a cultural experience or belief. To an uninformed teacher, a student engaged in these seemingly random, “disruptive,” and “off-task” behaviors is misbehaving and not learning. However, the internal and external processes, development, deep-level thinking, socialization, creativity and physical activity can be of the highest-level benefit to the whole child.

Academic Benefits

There are manifold academic benefits of play through scientific self-directed inquiry. Hamlin and Wisneski (2012) state, “play provides abundant opportunities for children to learn science concepts such as the diversity and interdependence of life, relationships between force and motion, and the structure of matter” (p. 82). Furthermore, play provides a “rich context” for children to explore the “process of scientific inquiry,” and has multiple modes for exploration including: functional or discovery play, symbolic play, and games with rules (Hamlin & Wisneski, 2012, p. 82-84). As part of a functional approach, which occurs through self-directed inquiry and play activities, Curren (2003) asserts children learn “through discovery and the largely spontaneous exercise of [their] own faculties, motivated and moved along from one topic to another by [their] own curiosity” (p. 236).

The National Science Teachers Association (2002) states, “Elementary school students learn science best when they are involved in first-hand exploration and investigation and inquiry/process skills are nurtured” (Elementary School Science, para. 3). Using the example of the child playing with magnets, he or she may discover the concepts of attraction or repulsion simply through his or her free reign of playing with the materials. After play events, teachers can guide and facilitate the attachment of terminology to the constructed conceptual framework already in place. However, teachers should not interfere with the play itself, as it provides a self-constructed experience in which the child makes use of his or her imagination, creativity, critical thinking, and capacity for thinking divergently to approach new and unfamiliar concepts. Therefore, a key benefit of allowing free play through self-directed inquiry includes building a child’s capacity to think beyond the parameters of a teacher-directed, boxed, inquiry event in which the questions, processes, and outcomes are predetermined. In other words, children become more adept at examining the world from multiple perspectives, and considering multiple possibilities to explain phenomena when they are given the freedom to explore through their own play.

The IPA (2014) states that play will help children discover and understand the world in which they live. Also, “play is the way humans develop efficient brains,” and by “playing [a child] enhances cortical connections and neural organization” (IPA, 2014, p. 2). When children become involved in choice-driven inquiry, they are actively using their minds to explore the endless possibilities of science.

Social Benefits

Social constructivism in science describes the nature of how human beings build scientific knowledge through various social experiences and activities. Fagan (2010) asserts scientific facts are socially constructed, as are the belief systems of scientists (whether true or false). Scientific knowledge is socially constructed, and therefore, when children embark upon inquiry/play endeavors that are of mutual interest, a co-construction of scientific “reality” takes place. For example, two children engaged in symbolic play pretend that they are astronauts. As their play progresses, their room might become their spaceship, and every day objects become their tools for conducting their experiments. The children mutually construct a play “reality” by building off of each other’s ideas and the entirety of their shared play experience becomes unique compared with what they might have done individually. Also, children will adopt new language and ideas from their peers. For example, as children are pretending to be astronauts, one might point to the window in the room and say, “let’s look out of the porthole to see if we can spot a planet.” The other child may never have heard of the word “porthole,” but may now associate the term with windows in spacecraft, and may begin using the word as well.

The NSTA (2002) posits children will value science best when they are given opportunities to interact with and share ideas with their peers. As they interact with each other, children will tend to improvise rather than following a set plan or script, and they will develop a high level of improvisational skill (Sawyer, 1997). Bergen (2002) found that as children play together, they will develop a high value pretense and that their involvement in such a pretense with others will aid in their socio-linguistic development. Also, children’s social play may help them avoid anxiety, depression, and loneliness (Rubin & Coplan, 1998). Ultimately, as children co-inquire and play around with ideas in science together, they will develop collaborative, socio-cultural, imaginative, co-

constructed realities from which they can approach content and better understand their world.

Emotional Benefits

The emotional benefits of play-based inquiry extend beyond “fun” and “pleasurable” (IPA, 2014). When referring to the affective domain, Stone and Glascott (1998) note that emotions in children’s science understanding are interconnected with the cognitive domain. So as children explore science content through self-directed inquiry and play, they are simultaneously thinking about and feeling the emotions of their exploration. Stone (2004) posits play in science is self-rewarding, intrinsically motivated, and personally satisfying because the play is owned and operated by the individual child.

Even though emotions are difficult to gauge or measure, the internal processes of play and self-directed inquiry can incorporate personal gratification, a sense of security and control, and pleasure. As children explore science individually or socially, they have chosen to pursue an activity for a reason, and typically the experience is interesting or pleasurable. For example, a child who is playing with oobleck (a non-Newtonian substance with differing physical properties) will create semi-solid shapes with the substance and then allow the material to revert back to a semi-liquid state. As the child is manipulating the substance, multiple, integrated, affective and cognitive processes are taking place. The child may be questioning why the substance behaves the way it does while also experiencing the satisfaction of controlling the substance according to his or her will (e.g. creating shapes or squishing the oobleck between fingers). As part of this process, play also helps children regulate emotions by moderating “primary emotions into more nuanced and subtle forms” (IPA, 2014).

Physical Benefits

The physical benefits of inquiry-based play are perhaps the most observable, as children move to manipulate, explore, or understand scientific concepts. The IPA (2014) states that play is a biological necessity as it contributes to healthy “muscular growth, physical health and well-being,” while also developing “flexibility, agility, balance, and coordination.” (p. 1). However, beyond the health benefits of simple or even complex movements, children can also develop understanding of concepts through their movements.

For example, if a child is attempting to understand the motion of the planets, he or she in collaboration with interested peers may actually act out planetary orbits. When the child engages in self-directed inquiry, bodily movement may help the child develop a more concrete understanding of the scientific concept.

Cultural Connections

Fleer and Pramling (2015) posit that it would be inappropriate to only focus on the conceptual development of science understanding without taking into account social processes and the cultural societies of children. Furthermore, scientific knowledge is "a cultural construction by society" and is "historically evolving" (Fleer & Pramling, 2015, p. 24). As children inquire and play around with ideas in science, they are connecting, relating, modifying, or adapting what they know and discover based upon their own socio-cultural experiences. Curiosity and inquiry are fashioned and directed by the characteristics of the child, including: race, gender, ethnicity, culture, religion and socio-economic status (Wong & Hodson, 2010). Play in science provides an opportunity for children to act out internally held beliefs or traditions in relation to their developing understanding of scientific concepts. For example, a child may ask the question, "why is the sky blue?" After some internal consideration, he or she may answer the question by saying, "I think God painted it blue." This response may show the child's internal belief system, or it may also show a socio-cultural construction that has been passed to the child through his or her family. In any case, play in science through self-directed inquiry presents a child with multiple opportunities to understand, strengthen, or even question their cultural experience and internally-held belief systems.

Obstacles or Barriers to Play and Inquiry

Many barriers exist that preclude children's self-directed inquiry and play experiences in science (Stone, 2015). As mentioned earlier, the dominant school culture values and expects compliance, standardization, and convergence. Not only are these aspects prioritized, but also time and materials in schools are regimented for efficiently delivering content to children. Zion and Mendelovici (2012) recommend moving away from what they call "instructionism." In other words, the curriculum is often predetermined and inflexible, leaving no room for child-centered practices. The standards are used as benchmarks to rank, order, and sort children, and the instruction is paced with timely coverage of material being of the highest priority. In such a rigid system, little time, materials, and opportunities are present for children to make use of divergent, self-directed inquiry and self-chosen play experiences. Some of the effects of this lack of play in science include students' reliance and dependence upon teachers to provide science content and answers (Stone, 2015). Also, students will be less likely to develop an individual and unique identity as a scientist. Finally, students will become accustomed to canned lessons with scripted procedures and given answers in science. They will not have a high capacity for thinking creatively and critically, and they may not be able to look for multiple possibilities when involved in inquiry processes.

As a part of the school culture that often dictates the types of tasks children do in class, teachers may not be aware of the valuable nature of play and self-directed inquiry. Furthermore, teachers may be uncomfortable giving up classroom time and materials for children to approach the content with their own curiosity intact, and with their own questions, play ideas, and explorations in mind. Teachers may fear that children are not learning. However, teacher-created obstacles such as fear or the devaluation of child-centered practices such as play can be overcome through professional development, research-based practices, and spreading awareness of the value of play and scientific self-directed inquiry.

Conclusions

Children will play regardless of their situation or circumstance, but to limit play and self-directed inquiry in schools based upon assumptions that children are not learning is unacceptable. Schools in Finland provide children with ample playtime, encourage scientific inquiry in its purest, most authentic forms, and limit the amount of "academic" homework as well as the time spent testing (Hancock, 2011). Teachers in Finland are respected and valued for their knowledge-base and are able to provide children with safe environments to learn at their own pace and through ownership of individual processes, like play. Unlike many schools in the United States, Finnish schools consistently demonstrate success due to their value for play and reduced standards/high-stakes accountability. In order to capitalize on the many benefits of playing around in science, it is important for teachers and parents to know and understand that play and self-directed inquiries provide a high level of cognitive, social, emotional, physical, and even cultural development. Play in science is a necessary and beneficial element of childhood, and it should be treated as such.

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