Examining the Potential of Paper Cups as an Educational Constructive Toy

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Abstract

This paper explores the educational potential of paper cup construction as an affordable, stimulating activity. Play with simple, open-ended toys such as building blocks has been correlated with many learning benefits, including visual-spatial reasoning, mathematical and problem solving abilities, language acquisition, social development, and creativity. Paper cups can be used as a constructive toy, displaying the same educational characteristics as more traditional wooden blocks. Paper cups also exhibit some unique characteristics that set them apart from other commercially available constructive toys, demonstrating high potential as a pragmatic, affordable, educational activity. By extending block play access to low socioeconomic status (SES) environments, paper cup construction may counter income divides in young children's academic ability and achievement.

Keywords: education, constructive play, block play, low SES education

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In our increasingly technologically-oriented society, children are spending a growing amount of time consuming electronic media, which undermines school performance, peer relationships, creativity, and physical health (Campaign for Commercial-Free Childhood [CCFC], Alliance for Childhood, & Teachers Resisting Unhealthy Children's Entertainment [TRUCE], 2012; Borodroya & Leong, 2003). Low socioeconomic status (SES) environments are at particular risk of these effects since "children ages 0 to 8 from low-income families spend significantly more time with television and videos than their wealthier peers" (CCFC, Alliance for Childhood, & TRUCE, 2003, p. 9). The academic achievement gap is widening (Reardon, 2011), despite several federal education initiatives.

There is a growing acceptance that play with open-ended, stimulating toys has the potential to counteract these trends (Trawick-Smith, 2009); specifically, free play with constructive toys has been proposed as a tool for meeting educational standards and teaching critical science, technology, engineering, art, and mathematical (STEAM) skills (Drew et al., 2006; Lindeman & Anderson, 2015; Robbins, 2011). In addition to these learning benefits, paper cups show particular promise as a pragmatic, affordable construction toy for low SES households and learning centers.

Learning Benefits of Paper Cup Construction

According to a National Association for the Education of Young Children (NAEYC) presentation (Drew et al., 2006), "play with blocks and other open-ended resources can provide an ideal context for meeting curriculum standards and promoting young children's early literacy and oral language skills, logical reasoning and creative problem solving abilities, and social/

emotional competence" (p. 1). Research findings indicate that constructive toys such as building blocks facilitate the development of visual-spatial reasoning, mathematical and problem solving abilities, language acquisition, and social development, and creativity (Colker, 2008; Teyplo, Moss, & Stephenson, 2015). When paper cups are used as building blocks, they promote these learning benefits as well, as discussed further in this paper.

Visual-Spatial Reasoning

According to Mathewson (1999) and Ramadas (2009), visual-spatial reasoning plays a critical role in many STEAM disciplines (e.g., chemistry [Wu & Shah, 2004]). Because of their tactile and three-dimensional nature, constructive toys develop visual-spatial reasoning skills in young children, as well as improving visual-motor coordination. A study conducted by Caldera et al. (1999) identified a correlation between block play and spatial visualization abilities among preschoolers. The research of Casey et al. (2008) corroborated these results in a study of kindergartners, suggesting that constructive activities develop spatial reasoning and visual-motor coordination. Ferrara, Hirsh-Pasek, Newcombe, Golinkoff, and Lam (2011) found that visual-spatial learning outcomes were further enhanced when accompanied by spatial language during guided block play. Building with paper cups elicits the same visual-spatial thinking, especially when utilized in complex three-dimensional structures with multiple components.

Mathematical Ability and Problem Solving

Visual-spatial development is correlated with improved mathematical ability (Cheng & Mix, 2014). Since block play promotes visual-spatial skills, block play has also been correlated with mathematical ability (Verdine et al., 2013). Wolfgang, Stannard, and Jones (2009) demonstrated a positive correlation between preschool block play performance and later

mathematical achievement in middle and high school grade levels, indicating the significant impact that block play can have on early mathematical development.

In addition to indirectly improving mathematical ability by stimulating visual-spatial thinking, block play also inherently incorporates numerous mathematical and geometric concepts (Park, Chae, & Boyd, 2009). Paper cup construction is especially suitable for exploring shapes, symmetry, patterns, and dimension (such as in Figure 1). Furthermore, the concepts of circle and sphere packing, naturally manifest in the internal structures of paper cup towers, are foundational to many scientific concepts, such as crystal structures in solid-state physics.

Along with this mathematical development also comes increased critical thinking and problem solving abilities. According to Lindeman and Anderson (2015), the analysis and design involved in block play can develop critical STEAM concepts in children. The research of Keen (2011) further suggests that the tactile experiences of constructive play also facilitate problem solving development.

Language Acquisition

Christakis (2007) found that block play among middle- and low-income students from one-and-a-half to two-and-a-half years of age led to improved language development. Cohen and Uhry (2009) similarly found that "5-year-old preschool children use communication strategies and appropriate shared meaning in block play" (p. 302). Pickett (2009) extended these results by studying block play in a 1st-grade classroom, finding that it increased literacy behaviors after three weeks of exposure. According to Hanline, Milton, and Phelps (2009), the level of symbolic representation in preschoolers' block constructions is correlated with higher reading abilities in elementary years, suggesting that a storytelling context may improve language acquisition during

block play. Paper cups demonstrate the same characteristics as traditional wooden blocks in language acquisition capacities.

Social Development

In addition to developing individual abilities, block play "may provide young children with many opportunities and experiences that encourage social development" (Rogers, 1985, p. 245). While playing with blocks, students practice many critical social skills (Colker, L. J., 2008). Paper cups are especially well-suited to social development. When faced with a limited supply of paper cups, students learn about sharing. Students can take turns having a circular tower built around them so that they can knock it down from the inside (Figure 2). Refraining from knocking over another student's tower requires empathy and respect for the feelings of others, as well as significant self-regulation, which is correlated with improved cognitive and social development (Mischel, Shoda, & Rodriguez, 1989). Differences in self-regulation abilities are also correlated with the income-achievement gap (Evans & Rosenbaum, 2008), suggesting that this kind of play may help reduce the academic divide in low SES environments.

Creativity

In a Center for Childhood Creativity report, Hadani (2015) reported that "identifying and nurturing creative potential in the early years of childhood is crucial for raising the next generation of innovators whose mindset and problem solving skills will solve today's (and tomorrow's) greatest challenges" (p. 5). The same report described creativity as a composition of the following seven elements: (a) imagination and originality; (b) flexibility; (c) decision making; (d) communication and self-expression; (e) motivation; (f) collaboration; (g) action and

movement. Each of these components of creativity is particularly manifest in paper cup construction play, as discussed below.

Imagination and originality. In an interview with NAEYC regarding his research on the educational potential of different toys, Jeffrey Trawick-Smith reported the following:

> [O]ne trend that is emerging from our studies can serve as a guide to families as they choose toys: *Basic is better*. The highest-scoring toys so far have been quite simple: hardwood blocks, a set of wooden vehicles and road signs, and classic wooden construction toys. These toys are relatively open-ended, so children can use them in multiple ways. (NAEYC & Trawick-Smith, n.d., para. 3)

The simple, open-ended nature of paper cups makes them ideally suited to express a wide variety of creative ideas without presenting limiting biases (for example, see Figure 3).

Flexibility. Because paper cups are not associated with a particular genre, fixed purpose, or commercial brand, they do not automatically limit students' creativity to a confined space of possibilities. Jeffrey Trawick-Smith indicated that such flexibility also promotes stimulating social interactions, reporting that "[c]onstruction toys have done well overall in our studies due to the fact that they don't suggest any one use. They can be used in many different ways, so children tend to interact more and negotiate what they want to build" (as cited in Eastern Connecticut State University, 2012, p. 1). The open-ended nature of paper cups may also lead to improved language acquisition; simple, non-specific toys incite increased descriptive language from students, who are forced to explain the imaginary application in each new creative context (Borodrova & Leong, 2003).

Decision making. Unlike some constructive toys, which are accompanied by specific instructions for model building, paper cups are an open-ended medium, challenging students to make countless creative decisions while building structures. Original creation of this kind involves a combination of both divergent thinking to generate options, as well as convergent thinking to identify particularly promising solutions, promoting critical skills used in solving problems and evaluating ideas (Hadani, 2015).

Communication and self-expression. Playing with paper cups elicits communication and self-expression in several key ways. Students may describe their towers using spatial language or tell stories about their structures, promoting visual-spatial and language skills along the way (Casey et al., 2008; Hanline, Milton, & Phelps, 2009). In orchestrating a collaborative effort, students discuss responsibilities and strategies for building, promoting social skills. Creative self-expression is also exercised when students invent original structural ideas.

Motivation. Intrinsic motivation can be a significantly more powerful drive than extrinsic rewards (Lepper & Greene, 1973). Unstructured free play is an effective stimulant for autonomous drive, rewarding students with an empowering feeling of autonomy. Students' natural desire to push limits and explore extremes drives them to build ever more elaborate and expansive towers, asking questions like "if we stack all of the cups up, how tall will it be?" and "can we build this all the way to the ceiling?"

Paper cups may be more motivating than other traditional building blocks for two reasons. First, the affordability of paper cups allows for large collections to be easily amassed, allowing for larger and most elaborate ambitions to be realized before exhausting the supply of materials. Secondly, the composition of paper cups makes their constructions safe to demolish

enthusiastically without fear of damage to nearby people or objects. Indeed, for some students, a major motivation for building a structure is the ability to then dramatically destroy it.

Collaboration. Particularly large towers can be built more quickly with the help of other students. Ambitious projects also attract attention from others who want to contribute their efforts. This naturally leads students to collaborate to build large structures, such as turreted castles large enough to walk in and out of (Figure 4), or spiraling skyscrapers over six feet high (Figure 5). Students can also build different towers that coexist in a paper cup village, facilitating a dynamic building environment conducive to cooperative storytelling play.

Action and movement. Paper cup construction is inherently active in two major ways. First, building with paper cups requires practicing fine motor skills while carefully aligning cups in a tower or recollecting scattered cups into a stack. Second, carefully navigating an area with precarious towers or enthusiastically destroying a completed paper cup construction involves gross motor skills and proprioceptive awareness. Along with this physical connection comes a heightened awareness of kinetic and structural ideas as children explore forces, gravity, balance, and friction all at play in their constructions.

Educational Play Contexts with Paper Cups

Following are some specific scenarios of paper cup construction play demonstrating the learning activities associated with constructive block play:

- A student builds a racetrack with a pit stop and bleachers and then lets other students take turns racing their cars as fast as they can while trying not to knock over any cups.
- Before demolishing a tall tower, several students discuss possible strategies to shield nearby structures from incidental damage.

- After reading a book about ancient Egypt, a student designs a sarcophagus and then acts out a dramatic story about a mummy (Figure 6).
- A student builds a labyrinth out of paper cups and then asks others if they can solve it.
- After helping to collect scattered cups into a stack, a student patrols the room offering to share cups with those who need more for their constructions.
- A student patiently repairs a tower that repeatedly topples prematurely until the student identifies and corrects the root structural design failure, successfully completing the tower.
- Students build different structures and compare their stability by throwing paper cups at them and observing the number of impacts required to destroy each one.

These examples illustrate how paper cup construction incites high-quality educational play among students, developing both hard and soft skills. Moderate adult intervention to guide constructive play can enhance learning (Hadani, 2015; Ferrara et al., 2011), but care should be taken not to "overjustify" actions with external rewards, inhibiting students' natural drive (Lepper & Greene, 1973). This may be accomplished by interacting as a "naive" adult, asking probing questions and discovering concepts alongside children (Hadani, 2015; Tepylo, Moss, & Stephenson, 2015). Fostering a storytelling environment may also improve visual-spatial and language learning (Casey et al., 2008; Hanline, Milton, & Phelps, 2009).

Practical Advantages of Paper Cups as an Educational Toy

The educational benefits of paper cups have significant overlap with those of traditional wood building blocks. However, paper cups exhibit some unique advantages that set them apart from more familiar options. Some unique qualities of paper cups lead to high potential as an affordable, stimulating toy.

Safety

Paper cups are safer to play with than traditional building blocks. Their lightness and large surface area allows them to be dropped or thrown without concerns of damage. They have no sharp corners, choking hazards, or batteries. A folded rim even prevents paper cuts.

Efficiency

Paper cups can be stored extremely efficiently. Unlike solid blocks, which take up essentially the same amount of total volume when in use as in storage, paper cups can be stacked closely within each other for storage. As a result, the materials for a paper cup structure that fills a room can be packed neatly away into a volume of about one cubic foot. This makes paper cups a pragmatic solution for environments with limited storage availability.

Affordability

Compared to other simple building blocks available for commercial purchase, paper cups are an extremely affordable option. A competitive commercial unit price of wooden blocks (as of January 2016) is about twenty cents, while paper cups can be purchased at a unit price of just two cents. Certain paper cup designs are also durable enough to last for several years. Due to their affordability and convenience, large collections of paper cups can be acquired easily, fueling students' most ambitious constructions.

Conclusions and Recommendations

Paper cups, like other constructive toys, can be a tool to promote fundamental skills in children, including boosting mathematical achievement, fostering literacy development, improving social competence, and motivating creative and original thinking. In addition, they are safe, efficient, and affordable to purchase and use.

The low cost of paper cups also suggests particular relevance in low socioeconomic status (SES) environments. According to Verdine et al. (2013), at the age of three, low SES children already display a lag in block assembly abilities, presumably due in part to decreased block availability in low-income households and schools. Paper cups have the potential to significantly reduce this income division by providing affordable access to the early educational benefits of block play. The research of Campbell and Ramey (2008) suggests that such intervention would be most effective at early ages. Due to their pragmatic efficiency and affordability, paper cups may be an ideal tool to combat early income-related academic gaps.

Indeed, paper cups are already widely accessible; however, they are not commonly used as a construction toy, due simply to a general lack of awareness of their educational potential. Raising awareness among parents and educators is a requisite condition for fully exploiting the educational potential of paper cup construction.

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Figure 1. A paper cup structure demonstrating exploration of shapes, symmetry, and dimension. This structure includes tessellated triangles, pyramids, diamonds, and hexagons.

Figure 2. A circular tower built around a single child. These students are practicing cooperation and taking turns. (Faces are blurred for privacy.)

Figure 3. A creative tower structure involving multiple intersecting elements.

Figure 4. A paper cup castle. This construction was a product of over a dozen students' collaborative efforts. (Faces are blurred for privacy.)

Figure 5. A paper cup tower over six feet tall. Several students and one parent worked together to build this tower. (Faces are blurred for privacy.)

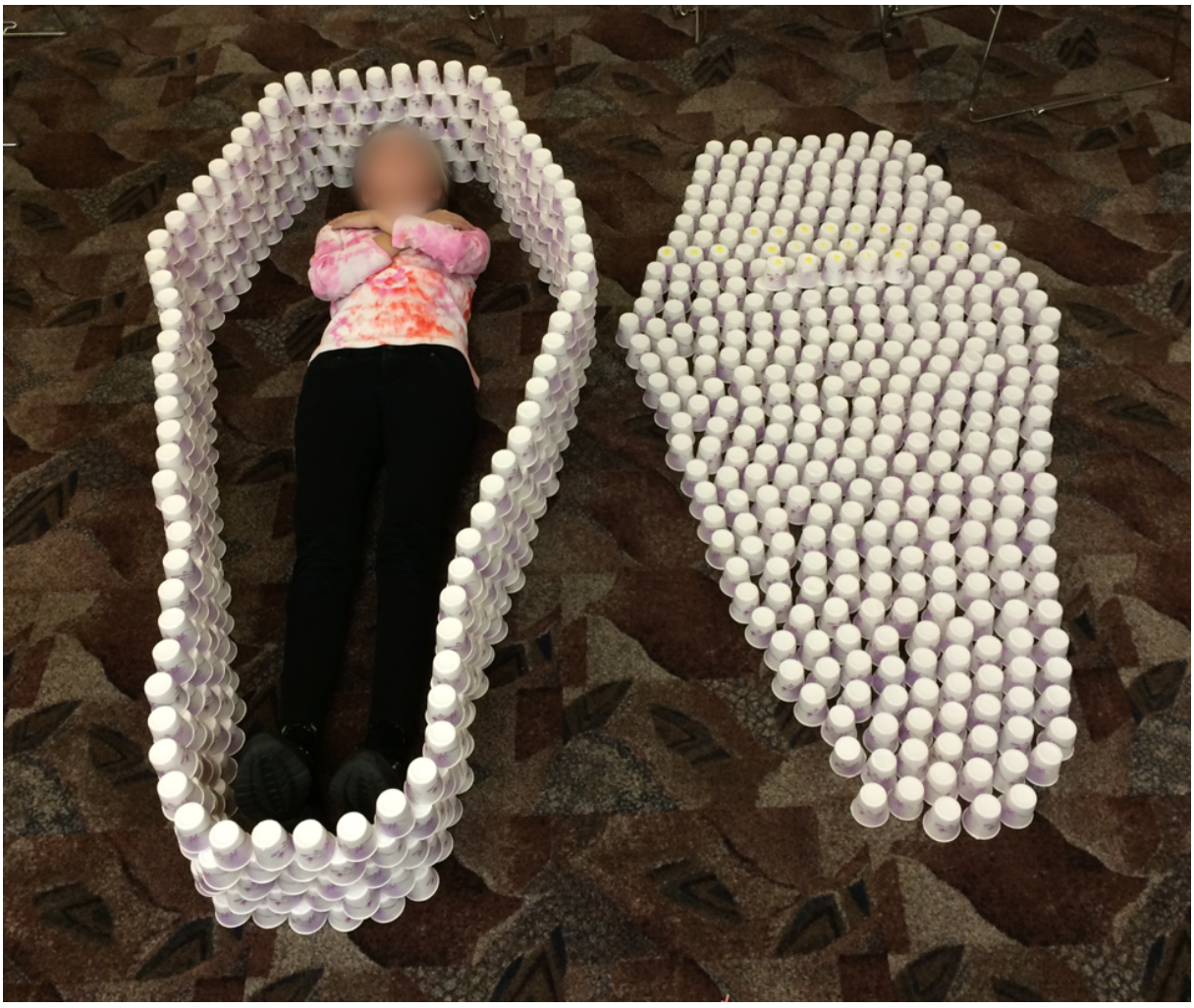

Figure 6. An Egyptian sarcophagus made of paper cups. The student designed this structure and then acted out a dramatic story about a mummy with friends. (Face is blurred for privacy.)