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Creative by Nature: Investigating the Impact of Nature Preschools on Young Children's Creative Thinking

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ABSTRACT

Creative thinking is valuable and necessary in society today and in the development of solutions to environmental issues. Fostering creative thinking skills and environmental values should begin early in life. The purpose of this study was to investigate the influence that a nature preschool experience has on the development of creative thinking in young children. The *Thinking Creatively in Action and Movement* (TCAM) instrument was used to assess creative thinking through measuring children's fluency, originality, and imagination scores at four nature preschools and one non-nature preschool. Results indicate that nature preschooler's creative thinking scores increased significantly from pretest to posttest measures. Results further suggest variation in influence on creative thinking across the nature preschool sites.

Keywords: young children, creativity, creative thinking, nature, nature preschools

Creative thinking, which is defined as thinking that is novel and produces ideas of value (Sternberg & Lubart, 1996), is a crucial skill in society today. It plays a key role in everyday cleverness, arts and science advancement, business innovation, social interactions, and public policy (Moran, 2010). Creative thinkers are active learners who can find and solve problems, recognize patterns, combine information in new ways, challenge assumptions, make decisions, and seek new ideas (Healy, 2004). Creative thinking is needed to develop, refine, communicate, and execute ideas; it is needed for being open to new perspectives, demonstrating originality, understanding real-world limits, and viewing failure as an opportunity (Greenhill, 2015). The development of these skills is particularly valuable in early childhood, as they are foundational skills upon which young children learn (Banning & Sullivan, 2011). Furthermore, creative thinking has significant implications for the natural environment. Creative thinking will be integral in resolving climate change, biodiversity loss, resource depletion, and other pressing environmental issues of our time (Csikszentmihalyi & Wolfe, 2014). Individuals who care about and place a high value on the environment may be more likely to act for the environment and invest their time and energy into developing creative solutions to environmental issues. Because early childhood has been shown to be a critical period for developing lifelong environmental values (Ewert, Place, & Sibthorp, 2005; Iozzi, 1989; Samuelsson & Kaga, 2008), the field of environmental education has much to gain from the development of effective approaches to fostering creative thinking and instilling environmental values in children as early as possible.

Even though creative thinking is valuable and necessary for both individuals and society, there is growing concern that early childhood learning settings do not provide young children with opportunities to develop creative thinking (Beghetto, Kaufman, Hegarty, Hammond, & Wilcox-Herzog, 2012). This is often because early childhood educators feel pressured to focus purely on academic skills to meet the expectation that children enter kindergarten with specific academic knowledge (Beghetto et al., 2012). In fact, a recent study found that relative to students in 1998, kindergarten teachers today are far more likely to expect children to enter kindergarten with academic skills, provide teacher-directed instruction, use workbooks, and administer standardized tests (Bassok, Latham, & Rorem, 2016). Those teachers were also far less likely to utilize learning centers (Bassok et al., 2016). Additionally, early childhood learning environments today often restrict creativity by requiring young children to find a single correct answer, discouraging alternative solutions, taking away outdoor free playtime, and providing constant, adult-directed learning experiences (Gray, 2016). These changes in kindergarten and preschool experiences have profound effects on the creative thinking abilities of young children.

For instance, a recent study had some startling findings regarding creative thinking scores in children. The study found that creative thinking changes with age in the following manner: young children's creative thinking steadily increases until third grade, then it levels off and begins to decrease until about high school, when increases are again observed (Kim, 2011). This aligns with a conventional stage model of creativity that suggests creative thinking levels correlate with a child's ability to understand societal conventions (Runco, 2014). However, the study also found creative thinking scores have been decreasing significantly since 1990 in children across all ages, even when considering conventional stage differences among age groups, with the greatest decrease indicated in kindergarten through third grade (Kim, 2011). The authors suggest this decrease may be due to increased focus on academic success and too many structured activities at the expense of unstructured, free play time (Kim, 2011). This indicates that there is a need to renew efforts to foster creative thinking in young children.

Nature preschool programs may offer a solution to help reverse this trend. Nature preschools are preschools that "use nature themes and daily nature explorations as the central organizing concept of their program," are "equally committed to both high standards of developmentally appropriate early childhood education and the best practices of environmental education," and "support dual aims for children: meeting child development goals and acquiring conservation values" (Finch & Bailie, 2016, p. 92). Nature is an ideal environment for developmentally appropriate learning across all domains, and nature play opportunities at nature preschools allow children to solve problems, be curious, and play creatively (Banning & Sullivan, 2011). Nature play is child-initiated and child-directed play that happens when "children play in and *with* nature" (Erickson & Ernst, 2011). Nature play can provide children with plenty of space, time, variety, and loose parts to invent endless play scenarios that contribute to the development of creative thinking skills that will persist throughout life (Banning & Sullivan, 2011). Nature play is also beneficial in early childhood from an environmental education standpoint because repeated positive experiences in nature foster the development of lifelong environmental values and ethics (Ewert et al., 2005; Iozzi, 1989; Samuelsson & Kaga, 2008).

In response to the need for creative solutions to the environmental issues of our time, research is needed to determine strategies that will best support creative thinking at all ages. This research is essential at the early childhood level, as the insights gained can help educators provide experiences that support the development of creative thinking skills children can draw upon when faced with real-world issues later in life. In light of the potential for nature play to foster creative thinking in young children, the purpose of this study was to explore the influence of nature preschool on the development of creative thinking in young children. The quantitative research methods used in this study sought to answer the following research questions:

(1) Did nature preschoolers' creative thinking significantly increase from the beginning of the school year to the end? Was a similar growth pattern seen in children who attended a non-nature preschool?

(2) Was there variation between nature preschool programs in terms of their influence on creative thinking?

This study is significant because it sought to find an empirical link between nature preschool participation and the development of creative thinking. Research that can demonstrate a significant link between a nature preschool experience and creative thinking development can lend strength to a growing body of evidence indicating important life skills, including creative thinking, can be fostered through immersive nature play experiences. Furthermore, research such as this can provide early childhood educators with a deeper rationale for stepping back from academically focused instruction and providing more play-based learning opportunities.

REVIEW OF LITERATURE

Creative Thinking: A Multidimensional Construct

Creative thinking is defined as the thought process associated with developing novel and useful ideas (Sternberg & Lubart, 1996). Creative thinking can refer to any part of the creative thought process including generating, analyzing, refining, or even rejecting ideas (Healy, 2004). Furthermore, creative thinking is a multidimensional construct (Clapham, 2011). The idea that creativity is a multidimensional construct was first presented in Guilford's 1956 Structure of Intellect (SOI) model, which classified mental abilities by "operation performed, content used to perform the operation, and the type of product produced" (Clapham, 2011, p. 459). The SOI model emphasized that intellect is made up of several factors including cognition, memory, divergent thinking (the process of generating multiple responses to a problem), convergent thinking (the process of choosing a single correct response for a problem), and evaluation (Guilford, 1956). Guilford (1956) further suggested divergent thinking was the factor most associated with creative thinking. Recent research supports the idea that creative thinking and divergent thinking are related by indicating divergent thinking ability is a meaningful predictor of future creativity (Kim, 2006; Runco & Acar, 2012).

Divergent thinking can be further broken down into the subdimensions of fluency, flexibility, elaboration, and originality (Clapham, 2011; Guilford, 1956). Fluency is the ability to quickly produce many ideas that are relevant and adhere to specified requirements (Clapham, 2011; Guilford, 1957). This means when problem is at hand, a person who has a high fluency can develop many solutions to solve the problem rapidly. Fluency stresses the number of ideas generated over the quality of the ideas generated (Clapham, 2011; Guilford, 1957). Flexibility is described as the number of categories produced to solve a given problem (Clapham, 2011), or the ability to discard familiar ideas into order to develop new or unfamiliar ideas (Guilford, 1950, 1957). Elaboration refers to the ability to build upon and improve an idea (Clapham, 2011). Originality refers to a person's ability to develop unique ideas that have purpose and meaning in a particular situation (Feist, 2010; Runco & Jaeger, 2012). Originality is particularly important for creative thinking because ideas must be original if they are to be considered creative (Runco & Jaeger, 2012; Sternberg & Lubart, 1996).

Imagination is also a dimension of creative thinking. Imagination was not included in Guilford's SOI model, but imagination was included in early childhood assessments of creativity, such as the Creativity Assessment Packet (Williams, 1980, as cited in Lemons, 2011), the Khatena–Torrance Creative Perceptions Inventory (Khatena & Torrance, 1976, as cited in Lemons, 2011), and the TCAM (Torrance, 1981b). Imagination refers to the ability to develop mental representations of things, concepts, or ideas that are not immediately present to the senses (Markman et. al., 2009, as cited in Forgeard & Kaufman, 2016). Imagination allows a person to move beyond the current moment in time or place and plan for the future, create a new world, or consider alternatives (Taylor, 2011). Furthermore, the ability to imagine what it is like to be another animal or person promotes development of empathy, which is a desirable trait in children as well as adults (Torrance, 1981a; R. Wilson, 2014).

Natural Progression of Creativity Development

Maslow (1971) proposed two distinct varieties of creativeness: primary creativeness and secondary creativeness. Primary creativeness arises from the unconscious mind and is "a universal and common kind of thing" (Maslow, 1971, p. 80), while secondary creativeness involves hard work and training to help a person complete a creative endeavor (Maslow, 1971). This is important to understanding the natural progression of creativity development in children because the idea of primary creativeness indicates that all children have the potential to be creative, and secondary creativeness suggests that creative abilities can be developed over time (Maslow, 1971; Runco, 2014).

The four C model of creativity, which divides creativity into categories based on the magnitude of creativity, suggests a path for the development of creativity over time (Kaufman & Beghetto, 2009; Kozbelt, Beghetto, & Runco, 2010). These creative magnitudes are referred to as little-c, mini-c, Pro-c, and Big-C creativity (Kaufman & Beghetto, 2009). Mini-c and little-c creativity are lower magnitude forms of creative expression that can be achieved by anyone (Beghetto et al., 2012). Mini-c creativity refers to transformative learning and includes the process of constructing personal knowledge to understand new concepts (Kaufman & Beghetto, 2009). The theory of personal creativity suggests mini-c creativity may not be considered creative by others, but for the individual who constructed personal knowledge, it is both novel and significant (Runco, 2003). This indicates that young children who rarely, if ever, produce ideas or products that would be considered creative by the standards of society are indeed creative (Runco, 2003). Little-c is the next level of creativity and involves everyday innovations that would be considered creative by anyone (Kaufman & Beghetto, 2009). Pro-c and Big-C creativity are higher, professional levels of creative accomplishment that can be achieved over time through hard work and commitment (Beghetto et al., 2012; Kaufman & Beghetto, 2009).

The conventional stage model can be used to explain how a child's creative growth typically occurs (Runco, 2014). In this context, conventions are considered normative or typical behaviors in society such as laws, fads, or fashions (Runco, 2014). Children are typically in the preconventional stage throughout early childhood as they are unaware of conventions and are therefore unable to conform to them (Runco, 2014). This unconventionality often manifests as creativity. As children approach middle childhood, they enter the conventional stage as they begin to understand societal conventions place a high value on conventions, which can inhibit self-expression and creativity (Runco, 2014). In fact, there is evidence that approximately 50 percent of children experience a "slump" in their creative thinking during the conventional stage (Runco, 2014; Torrance, 1967). Finally, children enter the postconventional stage during adolescence when they are aware of conventions, but also understand that they can choose which conventions to follow (Runco, 2014). The opens the door for creativity. Evidence suggests children who were strong creative thinkers in early childhood and slumped during the conventional stage tended to regain their creative thinking abilities as they transitioned into the postconventional stage (Runco, 2014). This emphasizes the importance of fostering creative thinking skills gained early in life because those skills can persist and resurface when children become postconventional thinkers.

Fostering the Development of Creative Thinking

In the context of creative thinking development in young children, mini-c and little-c creativity are particularly relevant. Mini-c creativity should be the primary emphasis in early childhood education because play is central at this level of creativity (Beghetto et al., 2012). Young children learn about themselves and the world through play, and a notable amount of what young children learn during play cannot be taught (Wilson, 2008). Play provides opportunities for early learning and development across all domains (Wilson, 2008), and the most beneficial play is both self-initiated and child-directed (Banning & Sullivan, 2011). Mini-c creativity can be readily included and fostered in early childhood programs by providing opportunities for self-directed play as children will naturally construct knowledge through such play experiences (Beghetto et al., 2012). Further, when children pretend during their play several creative thought processes occur including divergent thinking, flexibility, problem solving, perspective taking, and more (Russ, 2014). Early childhood education should also include a moderate focus on little-c creativity, which can be developed through the inclusion of domain-specific skills while also providing time for play and exploration in that domain (Beghetto et al., 2012). By focusing efforts on developing mini-c and little-c creativity, educators can encourage the skills needed for lifelong creative thinking abilities (Beghetto et al., 2012).

Furthermore, brain-based learning research from the field of neuroscience also has important implications for fostering creative thinking. This research indicates early experiences that are reinforced will persist into adulthood, and those that are not reinforced will not persist (McCain, Mustard, & Shanker, 2007; Shore, 1997). Thus, a child's experiences have a strong influence on their development. Furthermore, highly creative brains have more complex and highly-connected neural circuits than less creative brains, which contributes to a creative thinker's ability to readily generate ideas (Feist, 2010). This information offers an example of how early childhood experiences that reinforce creative thinking can contribute to the persistence of those pathways later. Thus, children who are consistently exposed to situations that require creative thinking will develop brains that are wired in manners that allow creative thinking to occur more readily. Early childhood educators can foster creative thinking by providing these novel experiences through play opportunities because play is a primary way to stimulate and reinforce neural connections in the brain (McCain et al., 2007).

Educators can also foster creative thinking growth by creating a non-judgmental space for young children to generate novel ideas (Alkhudhair, 2015). Open-ended and child-directed play opportunities provide the setting young children need to practice generating novel ideas as they engage in activities of personal interest (Banning & Sullivan, 2011). Craft (2008) found that student collaboration and providing opportunities for children to construct their own knowledge can also foster creative thinking in children. Again, play can foster that collaboration and knowledge construction (Banning & Sullivan, 2011). Research also indicates that educators can promote creative thinking development through open-ended questioning, allowing experimentation and mistakes, encouraging imagination and play, demonstrating critical thinking, and accepting unconventional answers (Alkhudhair, 2015).

These strategies for fostering creative thinking are strongly aligned with teaching strategies and methods that are widely used in the field of environmental education, particularly in early childhood environmental education. As such, early childhood environmental education has the potential to play an important role in fostering the development of creative thinking in young children. Many qualities of nature make it a developmentally appropriate environment for children to play and learn. Nature is ever changing, engages all of the senses, and allows for full body movement (Banning & Sullivan, 2011). Nature also provides unstructured, child-directed play opportunities, a plethora of loose parts, and experiences that allow young children to develop and learn across domains and meet early learning indicators including imagination, creativity, problem-solving, and flexibility (Banning & Sullivan, 2011; Wilson, 2008). These features of nature suggest that early childhood programs that embrace nature play should help foster the development of creative thinking in young children because there are ample opportunities each day for exposure to constructive learning and new situations that reinforce brain pathways. This idea is supported by a recent study that found creativity development at a preschool program that spent daily time in a natural outdoor classroom was supported by four factors: predictability of learning spaces, amount of time and consistency of time, open-ended materials, and a caring adult (Kiewra & Veselack, 2016).

Nature preschools regularly incorporate nature play into their daily routines in their efforts to integrate best practices in both early childhood education and environmental education (Bailie, 2016). Such regular nature play opportunities make nature preschools an ideal early childhood learning setting to promote and foster creative thinking development for several reasons. Nature preschool programs tend to follow emergent curricula that allows their children to follow their own interests throughout the year (Bailie, 2012). These child-directed learning experiences at nature preschools provide children with time needed to develop creative thinking abilities as they explore, play, and experiment with their natural surroundings (Banning & Sullivan, 2011). Further, children at nature preschools must think creatively to find new ways to use the same nature play area as it changes with the seasons and weather throughout the year. Similarly, seasonal changes provide new and different natural loose parts such as dry leaves, seeds, or snow that require children to think of new creative ways to play in and with nature. Nature play at nature preschools can also promote cooperative play among children (Banning & Sullivan, 2011). This cooperative play can often take the form of creative problem solving as children develop, share, and test multiple ways to solve a problem like moving heavy log or climbing a steep hill (Banning & Sullivan, 2011; Craft, 2008). As such, nature preschools, with their emphasis on nature play, offer ideal settings for fostering creative thinking in young children, thereby reversing the current trend of decreasing creative thinking levels.

METHODOLOGY

Participants

Participants in this study included children ages three to six who attended four nature preschools in Minnesota. In addition, participants included one class of children who attended a non-nature preschool program located on a university campus, administered through the university, and within the same geographic region as the nature preschools. All enrolled preschool children were invited to participate. There were 19 children from nature preschool A, 13 children from nature preschool B, 17 children from nature preschool C, and 26 children from nature preschool D who participated in this study. There were 11 children from the non-nature preschool who also participated in this study.

Design

This study was carried out using a nonequivalent pretest posttest control-group design. This quasi-experimental design was necessary because the participants could not be randomly assigned to treatment or baseline groups (Creswell, 2014). While ideally there would have been multiple non-nature preschool sites included for relatively equal number of participants in the treatment and control group, the study utilized only one baseline site because early childhood educators and parents are often hesitant to allow young children to participate in research, particularly when it is not directly beneficial. Thus, the study proceeded with the unequal group sizes. This difference (n = 75 versus n = 11) prompted an analysis that focused on growth in the nature preschool participants, using the non-nature preschool participants as a baseline group or reference group, as opposed to an actual control group.

Treatment

The treatment for this study was participation at a nature preschool during the 2016-2017 school year. There was a baseline, non-nature preschool group included in this study to serve as a reference or comparison for what typical creative thinking growth looks like over the course of the school year. The university-administered preschool was selected because the program has an experienced and stable teacher, is rooted in developmentally appropriate processes, and is connected to the university's education and early childhood education departments and consequently open to participation in university-affiliated research. This was a mixed-age preschool program where the guiding philosophy stressed that children learn best through child-directed play and that play supports and enhances cognitive, social, emotional and physical development. In order to provide children with opportunities to direct their own play the classroom environment, materials, and curriculum are driven by the interests of the children. These characteristics that the university-administered, non-nature preschool could be considered high-quality and can therefore serve as a baseline showing how children in a high-quality preschool classroom are expected to grow in their creative thinking over the course of the schoolyear. For this reason, and due to being demographically similar to the participating nature preschools, the university-administered preschool seemed appropriate for providing participants for the baseline or reference group. All of the participating preschools were in existence prior to the study, and the preschool programming and operations continued on throughout the study as they would normally proceed in the absence of a study being conducted.

The nature preschools and the non-nature preschool in this study offered several different schedules for families to choose from including half day, all day, partial week, and full week options. In this context, half day means that children attended preschool for a half day in either the morning or afternoon, while all day means the children attended preschool both in the morning and afternoon. In partial week programs children attended preschool either two or three days per week, and in full week programs the children attended preschool four or five days per week. The preschools also had varied amounts of time spent outdoors, learning spaces, and guiding philosophies (see Table 1, next page).

Instrument

Divergent thinking tests are among the most commonly utilized measures of creativity, and numerous divergent thinking tests have been developed in efforts to measure levels of creative thinking in individuals. Divergent thinking tests emphasize searching for as many novel solutions to problems as possible in an effort to measure divergent thinking dimensions and thus extrapolate creative thinking levels (Lemons, 2011). This study utilized a divergent thinking test called *Thinking Creatively in Action and Movement* (TCAM), an established and intact instrument designed for use with three-to-eight year old children who are often better at expressing themselves through movement than verbally (Torrance, 1981a, 1981b). The TCAM accepts both kinesthetic and verbal responses to four activities that measure fluency, originality, and imagination, which are dimensions of creativity relevant to a young child's life and are developmentally appropriate (Torrance, 1981a). In this operational context, fluency is number of ideas generated, originality is production of unique ideas, and imagination is one's ability to take on a new role (Torrance, 1981a). TCAM activities were administered according to a provided protocol and are summarized as follows (Torrance, 1981a):

- "How Many Ways" asks participants to think of different ways to move from one side of the room to the other and is scored for fluency and originality.
- "Can You Move Like?" asks participants to take on six different roles, which are scored for imagination on a Likert scale ranging from "no movement" to "excellent, like the thing."
- "What Other Ways?" asks participants to think of as many ways as possible to place a paper cup in a waste basket and is scored for fluency and originality.
- "What Can You Do with a Paper Cup?" asks participants to think of as many ways as possible to play with a paper cup and is scored for fluency and originality.

The TCAM has an overall test-retest reliability coefficient of 0.84 and the individual activities have coefficients of 0.71, 0.79, 0.67, and 0.58, respectively (Torrance, 1981a). The TCAM has a published interscorer reliability level greater than 0.90 (Torrance, 1981a). TCAM scores do not indicate a relationship with intelligence, cooperation, race, sex, previous school attendance, and socioeconomic status; the scores are associated with learning experiences expected to produce creative growth, a creativity curriculum, and problem-solving sociodrama (Torrance, 1981a). Reisman, Floyd, and Torrance (1981) found that creative thinking abilities assessed by the TCAM predicted cognitive performance that involve divergent thought.

Table 1
Nature preschool characteristics

Preschool	All or Half Day	Full or Partial Week	Approximate Daily Time Spent Outdoors	Learning Spaces	Guiding Philosophy
Nature preschool A	All day	Partial	4+ hours	Indoor classroom, outdoor classroom, nature playscape, and access to a minimally-managed, 30-acre forest	Help children build community, create a lifelong love of play, foster a sense of self, and develop a connection with nature
Nature preschool B	All day	Full and partial	4 hours	Indoor classroom, nature playscape, and access to maintained hiking trail and unmaintained, forested public natural areas	Provide opportunities for nature play, self-regulation, and early learning
Nature preschool C	Half day	Partial	2 hours	Indoor classroom, barnyard with farm animals, nature playscape, and trails leading to several different natural habitats	Foster child-directed learning, considers the outdoor learning space a second educator, and encourages learning through nature play and exploration
Nature preschool D	All day	Partial	3+ hours	Indoor classroom, nature playscape, and access to nature center and public forested parkland	Develop connections to nature and whole child growth through education, play, and exploration
Non-nature preschool (baseline)	All day	Partial	Varies; typically less than 30-60 minutes	Classroom and fenced outdoor playground with plastic play structures and open space	Provide high-quality, nurturing care and learning opportunities

Data Collection Procedure

Prior to administration of the pretest, IRB approval was obtained and consent forms were given to guardians of children at the five participating preschools. Only children whose guardians consented to their participation were given the option to participate in the TCAM pretest and posttest. Researchers asked these children if they would like to participate before beginning the pretests and posttests and proceeded with data collection only if the child was willing to participate. If the child chose to stop in the middle of a pretest or posttest, it was noted and the child was allowed to stop and return to the group and activities underway.

Data was collected using results from the TCAM pretest and posttest. The pretest was administered by two researchers in September 2016, and posttests were administered by two researchers over a three-week period in April and May 2017. Because of the multiple administrators in this study at hand, an inter-rater reliability was assessed using an Intraclass Correlation Coefficient (ICC) to evaluate the degree that raters provided consistency in their rating of fluency, originality, and imagination across subjects (McGraw & Wong, 1996). For fluency and imagination, the resulting ICC was in the excellent range, ICC = 0.99 and ICC = 0.88, respectively (Cicchetti, 1994), indicating that coders had a high degree of agreement and suggesting that fluency and imagination were rated similarly across coders. The high ICC suggests that a minimal amount of measurement error was introduced by independent raters, and therefore statistical power for subsequent analyses is not substantially reduced. For originality, the ICC was 0.66, which is in the range considered good (Cicchetti, 1994). Fluency, originality, and imagination ratings were therefore deemed to be suitable for use in the present study.

All tests were scored per TCAM's scoring procedures by the same researcher for consistency. Tables for converting raw scores into standard scores are included in the TCAM scoring guide for ages three to six (Torrance, 1981a) and were used in this study; by doing so, the age of participant was able to be accounted for, which controlled for participant age.

RESULTS

Increase in Nature Preschoolers' Creative Thinking

A paired-samples *t* test was conducted to evaluate whether young children who participated in nature preschool had a significant increase in creative thinking from the beginning of the school year to the end of the school year. In this study, the data from the treatment and baseline groups were analyzed through two separate paired-samples *t* tests, due to the very unequal group sizes ($n = 11$ and $n = 75$, respectively). Differences in ages are accounted for in these results, as the standard scores, which incorporate the children's ages, were used in the analysis. Tests were run for each of the dimensions of creative thinking: fluency, originality, and imagination (see Table 2 for the Means and Standard Deviations for nature and non-nature preschool groups for these three dimensions).

The results for the nature preschool treatment group (see Table 2) indicated posttest means for fluency, originality, and imagination were significantly higher than pretest means for these three dimensions, $t\ (74) = 4.49$, $p = < 0.001$; $t\ (74) = 4.33$, $p = < 0.001$; and $t\ (74) = 4.72$, $p = < 0.001$, respectively. These results suggest that there was a significant increase in nature preschoolers' fluency, originality, and imagination from beginning to end of the preschool year. In contrast, the results for the non-nature preschool baseline group (see Table 2) indicated posttest means were not significantly higher than pretest means on these three dimensions of fluency, originality, and imagination, $t\ (10) = 1.31$, $p = 0.22$; $t\ (9) = 2.06$, $p = 0.70$; and $t\ (9) = 2.14$, $p = 0.06$, respectively. These results suggest that there was not a significant change from pretest to posttest for fluency, originality, or imagination in the non-nature preschool baseline group.

Table 2

Paired-samples t test results for treatment and baseline fluency, originality, and imagination standard scores

	Fluency		
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Treatment (nature preschools)	89.89 (17.76)	104.76 (28.35)	t (74) = 4.49, p = < 0.001*
Baseline (non-nature preschool)	97.55 (14.64)	106.55 (22.88)	t (10) = 1.31, p = 0.22
	Originality		
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Treatment (nature preschools)	96.13 (20.16)	113.61 (36.58)	t (74) = 4.33, p = <0.001*
Baseline (non-nature preschool)	105.20 (14.13)	126.00 (30.59)	t (9) = 2.06, p = 0.07
	Imagination		
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Treatment (nature preschools)	89.85 (17.68)	99.99 (18.42)	t (74) = 4.72, p = < 0.001*
Baseline (non-nature preschool)	92.30 (16.52)	103.00 (12.03)	t (9) = 2.14, p = 0.06

Note. Baseline: n = 11 for fluency and n = 10 for originality and imagination; Treatment: n = 75 for fluency, originality, and imagination

Note. * indicates statistical significance

To investigate if the significant growth from pretest to posttest in the nature preschool participants remained when controlling for gender and prior participation, a general linear model with gender and prior participation as covariates and time (pretest to posttest) as the main effect was used. For fluency, originality, and imagination, the results suggest the increases from pretest to posttest remained significant when controlling for both gender and prior participation. The results further suggest the treatment did not vary based on gender and prior participation, and the treatment seemed to have a positive impact on the fluency, originality, and imagination results for both boys and girls regardless of whether they had prior participation or not.

For fluency, the results indicated that there was no significant interaction between the main effect of time (pretest to posttest) and gender ($p = 0.11$), and there was no significant interaction between main effect of time and prior participation ($p = 0.88$). The increase from pretest to posttest in fluency standard scores remained significant when controlling for both gender and prior participation, $F(1, 72) = 11.55$, $p < 0.001$. These results suggest the treatment did not vary based on gender and prior participation; the treatment seemed to have a positive impact on the fluency of both boys and girls, and also regardless of whether they had participated prior to this study or not.

For originality, the results indicated that there was no significant interaction between the main effect of time (pretest to posttest) and gender ($p = 0.09$), and there was no significant interaction between main effect of time and prior participation ($p = 0.79$). The increase from pretest to posttest in originality standard scores remained significant when controlling for both gender and prior participation, F (1, 72) = 9.171, $p < 0.01$. Similar to the results for fluency, these results for originality suggest the treatment did not vary based on gender and prior participation; the treatment seemed to have a positive impact on the originality of both boys and girls, and also regardless of whether they had participation prior to this study or not.

For imagination, the results indicated that there was no significant interaction between the main effect of time (pretest to posttest) and gender ($p = 0.56$), and there was no significant interaction between main effect of time and prior participation ($p = 0.84$). The increase from pretest to posttest in imagination standard scores remained significant when controlling for both gender and prior participation, F (1, 72) = 7.31, $p < 0.01$. Similar to the findings for both fluency and originality, these results for imagination further suggest the treatment did not vary based on gender and prior participation; the treatment seemed to have a positive impact on the imagination of both boys and girls, and also regardless of whether they had participation prior to this study or not.

Variations in Nature Preschools' Influence on Creative Thinking

Paired-samples *t* tests were used to analyze the data to investigate if there was variation among nature preschool programs in terms of their influence on creative thinking. For these analyses, the data from each nature preschool site was evaluated separately (See Table 3). The results for nature preschool A indicate there was significant growth for the dimensions of fluency and originality. The results for nature preschool B indicate significant growth for the dimensions of fluency and imagination. The results for nature preschool C indicate significant growth in the dimension of imagination. The results for nature preschool D indicate significant growth across the dimensions of fluency, originality, and imagination. Collectively, these results suggest that variations in nature preschool implementation, setting, and/or approach seem to be influencing their effectiveness on fostering creative thinking in their preschool-aged participants.

Table 3
Paired-samples t test results for nature preschool A, B, C, and D fluency, originality, and imagination standard scores

	Nature Preschool A		
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Fluency	90.42 (16.03)	108.26 (29.68)	t (18) = 2.14, p = 0.05*
Originality	95.11 (11.92)	122.11 (37.66)	t (18) = 2.89, p = 0.01*
Imagination	93.05 (17.58)	96.32 (15.81)	t (18) = 0.72, p = 0.48
	Nature Preschool B		
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Fluency	89.92 (17.41)	108.85 (28.00)	t (12) = 3.73, p = < 0.01*
Originality	89.08 (30.89)	106.46 (54.76)	t (12) = 1.62, p = 0.13
Imagination	90.00 (21.11)	104.23 (19.00)	t (12) = 2.36, p = 0.04*

Nature Preschool C			
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Fluency	89.59 (21.14)	95.65 (18.01)	t (16) = 1.38, p = 0.19
Originality	98.41 (20.46)	105.00 (20.79)	t (16) = 1.17, p = 0.26
Imagination	83.59 (16.50)	91.82 (18.81)	t (16) = 2.24, p = 0.04*
Nature Preschool D			
	Pretest Mean (SD)	**Posttest Mean (SD)**	**Significance**
Fluency	91.19 (17.63)	106.12 (32.93)	t (25) = 2.45, p = 0.02*
Originality	98.92 (18.35)	116.62 (32.90)	t (25) = 2.62, p = 0.02*
Imagination	91.54 (16.65)	105.88 (18.00)	t (25) = 4.22, p = < 0.001*

Note. Nature preschool A: n = 19; nature preschool B: n = 13; nature preschool C: n = 17; nature preschool D: n = 26
Note. * indicates statistical significance

DISCUSSION

The results of this study must be considered in the context of the limitations and threats to the validity associated with this study. One limitation of this study was the use of multiple test administrators or coders for the TCAM instrument in both pretesting and posttesting. The use of multiple coders could have led to inconsistencies in data collection if the individual test administrators coded differently than the other test administrators. This was addressed through an inter-rater reliability analysis to confirm that coding across administrators was suitable for use in this study. Fluency and imagination ratings show a high degree of agreement, and the originality rating shows a good degree of agreement (Cicchetti, 1994), so the ratings were deemed suitable for use. However, this threat is not entirely eliminated.

A second limitation of this study is that TCAM assessments were administered both indoors and outdoors. Since the nature preschool sites conduct part of the school day indoors and part of the school day outdoors, it was necessary to allow for indoor and outdoor testing as the test administrators were intentional not to interfere with the normal flow of the school day. Nevertheless, the variation in settings may have introduced variation in child responses as different distractions and visual prompts may have influenced the child. Similarly, the fact that the weather varied greatly from sunshine to snow to rain throughout the administration of the pretests and posttests that occurred outdoors introduced another validity threat. Such differences could have influenced the amount of time a child could focus on TCAM activities. For instance, if it was warm and sunny, the children appeared to focus for longer than when it was colder or wet. Once again, due to the nature of the study and certain parts of the school day taking place outdoors, it was necessary to administer TCAMs in all weather.

Another limitation of this study was the temperaments and shyness of some children who participated in this study. Young children are quite unpredictable and can be shy one day and confident the next day. They can also be easily distracted or uninterested in participating in the TCAM activities at any time. And some children are simply more out-going than others. Thus, the validity of a child's score and consequently the findings overall should be considered with this in mind. Attempts to address this were made through spending time with the preschoolers prior to administration of the instrument to familiarize children with the researchers and through spending a bit of time with children individually prior to beginning the assessment to increase the children's level of comfort with the researchers. Additionally, if a child was very shy or unwilling to complete the TCAM assessment for any reason, it was noted and the data was not utilized in the final analyses, as the scores may not have reflected the child's actual creative thinking levels.

Additionally, there is a limitation presented by the potential subjectivity of some responses. The scoring guide provides lists of likely responses for activities one, three, and four and a point value is associated with each response. However, if the response was written slightly differently, it is possible that the response could be scored differently than the scoring guide anticipated. This was addressed by having just one of the three test administrators score the TCAMs, which allowed for consistent scoring.

With these limitations in mind, as well as the potential limitation of variations in group sizes across the sites, the results of this study show a significant increase in the creative thinking levels of children who attended a nature preschool across the creative thinking dimensions of fluency, originality, and imagination. In contrast, children who attended the university-administered, non-nature preschool did not show a significant increase in creative thinking for the dimensions of fluency, originality, and imagination. A potential concern regarding the results of this study is that nature preschoolers' families may spend more time outdoors in general, due to their voluntary selection of a nature preschool for their children, and this may have been adding to the influence the nature preschools. However, if differences in family time in nature or familial disposition toward nature engagement was influencing on results, it would be expected that nature preschool children would have started with higher creative thinking scores, from the prior exposure to time in nature. This, however, was not the case in this study, as the baseline group had higher pretest creative thinking scores than children in the nature preschools. This suggests that differences in posttests creative thinking scores can likely be attributed to the nature preschool attendance, as opposed to family nature engagement.

Based on the characteristics of nature preschools, perhaps it is not surprising that the results of this study suggest significant growth in creative thinking. Nature preschools strive to provide children with extended daily periods of nature play. This time allows young children to experience the constantly-changing outdoors by playing in and with nature while engaging all of their senses and encountering new situations (Banning & Sullivan, 2011). New situations may require children to solve new problems, find new ways of doing routine activities, or try something brand new in their play. Each of these tasks requires a child to think creatively as they figure out the best way to solve the problem, adjust their routine, or test out a new activity (Healy, 2004). Because opportunities to think creatively arise so often in nature play, they regularly reinforce brain pathways required for creative thinking, which likely contributes to those pathways becoming better established and more permanent (Feist, 2010; McCain et al., 2007; Shore, 1997).

Not only do regular nature play experiences wire the brain to think creatively, but they provide countless opportunities for young children to learn through constructivism. The theory of constructivism suggests that people have existing schemas or ideas about the world in their minds, and when new information is acquired it is either added it to an existing schema via assimilation or a current schema is reconstructed to align with new information through accommodation (Piaget, 1952). Each time a person restructures information obtained during nature play to fit an existing schema they are thinking creatively (Runco, 2003). Thus, the plethora of new information provided by the ever-changing nature of the outdoors may also be offering children with the chance to develop mini-c creativity as the child makes novel and personally meaningful interpretations of an experience to understand it better (Beghetto et al., 2012) and develop little-c or everyday creativity as they invent new information (Runco, 2003). Furthermore, the variety of open-ended loose parts children choose to interact with in nature introduce creative thinking opportunities. When loose parts are open-ended, the child must assign roles to them. For instance, a rock could be a rock or a frog or a shovel or a shelter. Each time a child invents a new role for that rock to enhance their play, the child must think creatively to assign the rock a novel identity that is useful for their play. Emphasis on mini-c and little-c creativity and practice generating and implementing new ideas may foster creative thinking skills in nature preschoolers.

The results of this study further indicate variation among the nature preschool programs in terms of their influence on creative thinking. Understanding how sites vary and how those variations impact creative thinking is important in pinpointing the underlying factors at nature preschools that contribute to creative thinking growth. This understanding is necessary for knowing best how to foster creative thinking at nature preschools, particularly for nature preschools for whom this is an important intended outcome. Differences in each nature preschool that participated in this study may account for the variation in growth across the dimensions of fluency, originality, and imagination indicated in the results. This study did not attempt to control for the aspects of the participating nature preschools that make them different, as this study was exploratory in nature. Thus, it is important to note that the discussion that follows regarding variations in nature preschools and how that may have influenced creative thinking is conjecture as well as grounds for further research.

One possible reason nature preschools A, B, and D saw significant growth in fluency is that the children in these three schools attended nature preschool all day, and thus had 1 to 2 more hours of daily outdoor nature play. More time playing in nature may provide more opportunities for children to become fully engaged in their play and come up with new ways to use play spaces or loose parts (Banning & Sullivan, 2011). This extra practice and extra time to become engaged in play may further reinforce brain pathways associated with the development of new ideas (McCain et al., 2007; Shore, 1997). Thus, it is possible length of day may contribute to the development of fluency in nature preschoolers.

It also is possible that length of day partially influenced the significant increase in originality at nature preschool A and D as these are both all day programs. As with fluency, more time playing in nature could account for increases in originality because more time playing in nature allows children more time to come up with unique ways of playing with or using the natural environment and loose parts (Banning & Sullivan, 2011). Furthermore, the encouragement of original or unconventional ideas helps foster the development of creative thinking (Alkhudhair, 2015). Thus, it could potentially be extrapolated that children who have more opportunities to develop original ideas at all day nature preschool programs would have received more encouragement from teachers regarding their unique ideas, which fostered originality in those children. However, if the only factor influencing originality were length of day, then it would be expected nature preschool B would also see a significant increase in originality over the course of the school year. As such, while length of day may play a role, another unknown factor that links nature preschool A and D may be the reason behind the increase in originality within these programs.

Similarly, it is possible that length of day partially influenced the significant increase in imagination at nature preschool B and D as they are both all day programs. However, nature preschool A would have also been expected to see a significant increase in imagination if length of day was the only factor, while nature preschool C, which had a significant imagination increase, would not be expected to increase. Future research might seek to investigate the role of time, aiming toward an understanding of how duration of preschool participation influences creative thinking, as that would provide helpful guidance to sites who desire to have a positive influence on creative thinking.

As described previously, imagination helps children begin to develop empathy for others (Torrance, 1981a). This idea may help explain why nature preschool C saw a significant increase in imagination. One key feature of nature preschool C is that the children have daily interactions with a wide variety of farm animals. Allowing children to care for animals helps foster empathy as they learn to put themselves in the shoes of animals and imagine what it is like to be those animals (Wilson, 2014), and thus there may be relationships among this interaction with animals, the development of empathy, and the development of imagination. Nature preschools A, B, and D do offer some opportunities to care for animals, but nature preschool C provides frequent and sustained opportunities to do so. Once again, this cannot entirely account for the variation across programs as nature preschool B and D also saw growth in imagination, but it may partially explain this variation in imagination scores. Further research is needed in investigating the role of interaction with and caring for live animals and how this influences creative thinking in general and specifically in imagination.

Additionally, another important consideration would be variations in the teachers across these sites, as well as variations in guiding philosophy and primary aims. As this study was not designed to uncover specific mechanisms that influenced the results, here too one can only speculate as to the role variations in teaching style and philosophy may have played. With the recognition that variation in effectiveness exists, coupled with the overall positive influence suggested by the collective results, it would be helpful for continued research that aims to extend this current study focused on impact toward understanding the mechanisms at play.

IMPLICATIONS

This study has important implications for the field of environmental education. By demonstrating that nature preschools seem to be supporting the development of creative thinking this study provides environmental educators with a strategy (nature preschools and/or extended periods of nature play) with which they can encourage this skill from a young age. This is significant for the field because there are numerous environmental issues that require creative solutions (Csikszentmihalyi & Wolfe, 2014). From the early childhood environmental education standpoint, the results of this study provide further empirical evidence suggesting that nature preschools provide developmental benefits for young children who participate in them. Nature play is an important factor in promoting these benefits, as it is widely accepted in environmental education as a means of fostering holistic developmental growth (Banning & Sullivan, 2011) and instilling lifelong environmental values in young children (Ewert et al., 2005; Iozzi, 1989; Samuelsson & Kaga, 2008). Each new piece of evidence that nature preschools and nature play are beneficial for young children is important for the field of environmental education because it may help convince more families to participate in nature play, and thereby promote the goals of environmental education.

Early childhood practitioners in non-nature preschools can use these results as evidence as to why it is necessary and beneficial to the children in their programs to incorporate elements of nature preschools such as nature play and natural loose parts into their non-nature preschool classrooms. Early childhood educators sometimes find that they are expected to provide early childhood instruction that is not age appropriate in order to prepare children for higher grade levels by increasing teacher-directed academic instruction and decreasing play opportunities (Gray, 2016). As such, the results of this study add to the body of literature demonstrating that nature preschools and nature play can help promote early learning by helping young children meet early childhood learning indicators of progress through developmentally appropriate experiences that will help them become ready to learn across a range of domains when they enter elementary school.

Ideally, the results of this study may also be used by advocates of nature preschools, environmental education, and holistic early childhood learning to encourage administrators of non-nature preschool programs to incorporate nature play into these programs. A systematic review of literature on the benefits of children engaging with nature indicates that nature experiences, particularly when those experiences include play, benefit children in several ways (Gill, 2014). The review found well-supported evidence that time in nature is associated with adult pro-environmental attitudes, increased physical activity, motor development, and improved mental health and emotional regulation (Gill, 2014). Further, the review found that there is at least some evidence that engagement with nature can also promote social skills, self-control, well-being, self-confidence, and language and communication development in children (Gill, 2014). Each of these benefits offer advocates more evidence supporting the importance of nature play in early childhood. The present study's results which indicate that nature preschools have a positive influence on creative thinking development builds upon previous research and, when considered with the literature a whole, may encourage administrators in the early childhood field to adapt their programs to include nature play.

RECOMMENDATIONS

This study explored the influence that nature preschools have on creative thinking in young children. The results suggest positive influence. However due to the small sample size and the lack of random assignment to treatment and control groups, further research confirming these findings would be useful. The study also found that variation exists across nature preschool programs in relation to which dimensions of creative thinking were positively influenced. Because of the decline of creative thinking among children and because of the importance creative thinking has in the context of both environmental issues as well as key skills and habits needed for today's world, future research is needed to help pinpoint the elements of nature preschool that influence the development of creative thinking. Beyond the influence of the amount of time, the role of unstructured play specifically in nature within nature preschools could be further studied to see if this unstructured play accounts for the growth in creative thinking. For example, a study comparing the growth of creative thinking between programs rooted in unstructured play in nature versus unstructured play in a classroom could begin to answer this question; if results were to indicate greater growth through unstructured nature play, it would lend weight to the idea that unstructured play in nature contributed to this study's results. Furthermore, a recent study found that features of two outdoor preschool classrooms, including time, a routine of going outdoors, open-ended materials, and a supportive adult, boosted creativity in participating children (Kiewra & Veselack, 2016). Future research could seek to determine if and how variations in this set of factors contributes to variation in effectiveness in supporting the development of fluency, originality, and imagination.

Future research should also seek to determine the role of the nature preschool teacher in the development of creative thinking. Different qualities of teachers and how teachers behave during unstructured nature play time may lead to different outcomes. For instance, one nature preschool teacher may choose to interact with children more often than another during nature play for any number of reasons. The number and length of these interactions may contribute to varied creative thinking growth. A study that investigates the qualities and behaviors of nature preschool teachers during nature play may help determine if teachers play a significant role in the development of creative thinking during nature play in addition to any effects that nature play itself may have on creative thinking development.

CONCLUSIONS

Overall, the findings from this study suggest that nature preschool experiences positively influence creative thinking in young children. The results indicate significant growth in the creative thinking levels of nature preschoolers over the course of the school year, as compared to the lack of significant growth in the creative thinking levels of non-nature preschoolers. These results were not influenced by gender or prior participation. The results also indicate variations among nature preschool programs in terms of their influence on creative thinking. Each program saw an increase at least one measured dimension of creative thinking measured by the TCAM (fluency, originality, or imagination), but which aspects increased differed across programs. These results have important implications for the field of environmental education, early childhood environmental education, and early childhood education as this study helps demonstrate that nature preschools and nature play can play a significant role in the development of valuable skills in young children and toward the development of citizens who are prepared to creatively solve environmental problems.

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