International Journal of Early Childhood Environmental Education

ISSN: 2331-0464 (online)

Nature-Based Education and Kindergarten Readiness: Nature-Based and Traditional Preschoolers are Equally Prepared for Kindergarten

Tori S. Cordiano
Laurel School's Center for Research on Girls, Shaker Heights, Ohio, USA

Alexis Lee
Case Western Reserve University, Cleveland, Ohio, USA

Joshua Wilt
Case Western Reserve University, Cleveland, Ohio, USA

Audrey Elszasz
Nature Pedagogy, Cleveland, Ohio, USA

Lisa K. Damour
Laurel School's Center for Research on Girls, Shaker Heights, Ohio, USA

Sandra W. Russ
Case Western Reserve University, Cleveland, Ohio, USA

Submitted January 7, 2019; accepted June 24, 2019

ABSTRACT

Time spent outdoors benefits children's physical, social and psychological development, although children today spend far less time outdoors than children of previous generations. The nature-based school initiative has grown in popularity as a means of increasing children's connection with nature and harnessing its benefits for their educational development. The current study is one of the first to quantitatively compare a traditional and a nature-based pre-primary program at the same school. Using a multi-method approach, this study aimed to better understand the relationships between learning environment and important developmental variables, including social interaction, play, behavior, school enjoyment and nature appreciation. Results indicate that both groups are equally prepared for kindergarten with regard to social-emotional, academic and pretend play skills.

Keywords: nature-based education, kindergarten readiness, nature preschool, outdoor education, early childhood education

American children today spend far less time outdoors than children of previous generations, with a dramatic decrease in time spent outdoors over the past thirty years (Juster, Ono, & Stafford, 2004). Child development professionals, however, note the medical (Cleland et al., 2008; Pardee et al., 2007) and psychological (Suchert, Hanewinkel, & Isensee, 2015; Maras et al., 2015) risks of excessive sedentary time indoors, and the host of benefits associated with both increased physical activity (Ardic & Erdogan, 2017; Gunnell et al., 2016) and time spent in nature (Schalkwijk, van der Zwaard, Nijpels, Elders, & Platt, 2018; McCormick, 2017). Numerous researchers have

focused in particular on the psychological and physical benefits of time outdoors for children (McCurdy, Winterbottom, Mehta, & Roberts, 2010; Pretty et al., 2009). In response to the trend of more time spent sedentary and indoors, researchers and educators have become interested in ways to increase outdoor time during the school day. The nature-based school initiative has grown in popularity as a means of increasing children's connection with nature and harnessing its benefits for their educational development. Proponents of nature-based education cite numerous benefits for children's academic, social and behavioral development. As the number of nature-based education programs increase, research is needed to better understand the relationships between these environments and children's overall well-being.

LITERATURE REVIEW

Overview of nature-based education

The nature-based school initiative originated in Scandinavia and Germany, is in wide use across England and Wales, and has more recently gained popularity in the United States. Though known by different names, including *nature-based preschool*, *nature preschool*, *forest kindergarten*, *nature kindergarten*, *forest school*, and *Waldkindergarten*, the common theme of all of these programs is that nature shapes their philosophies and methodologies. Larimore (2016) points to Bailie and Finch's (Natural Start Alliance, 2014) three criteria for nature preschools as a guide for program design and developing professional principles. Those criteria are as follows:

1. "Nature is the central organizing concept of the program. That is, nature is the integrating thread that intentionally ties together the preschool's philosophy, methodologies, classroom design, outdoor spaces, and public identity.
2. A nature preschool's program is based on high-quality practices of both early childhood education (developmentally appropriate practices) and environmental education (the North American Association for Environmental Education's "Guidelines for Excellence in Environmental Education" and principles of interpretation), requiring its teaching staff to have skills and experience in both early childhood education and environmental education.
3. A nature preschool program uses the natural world to support dual goals that address both child development and conservation values. These include the development of the world of the child (in all domains – cognitive, physical, social, emotional, aesthetic, and spiritual) and the development of an ecological identity or environmental ethic."

Though some nature-based preschools operated in the United States in the late twentieth century, many more have originated over the past twenty years (Larimore, 2016). A recent nationwide survey documented the rise in popularity of these programs, with over 250 nature-based preschools currently in operation throughout the country (North American Association for Environmental Education, 2017).

Proponents of nature-based preschools cite their many benefits for children's overall development. Preschools with an outdoor learning component offer opportunities for students to develop hands-on reasoning skills, such as scientific inquiry and hypothesis testing (McClain and Vandermaas-Peeler, 2016). They build math vocabulary and concepts, such as spatial orientation, comparison, and estimation, through their work in the outdoors (Vandermaas-Peeler & McClain, 2015). Kiewra and Veselack (2016) note the positive impact of outdoor classrooms on creativity and imagination. They concluded that ample time outdoors and access to open-ended materials were especially important in fostering creativity. This finding highlights the advantages of entirely outdoor classrooms, in contrast to limited time spent outdoors using traditional playground equipment. Outdoor time in a natural landscape holds advantages for students' motor coordination and balance, above what is gained through outdoor time on traditional playground equipment (Fjørtoft, 2001). Nature-based schools may also influence students' attitudes about nature, with attendance at a nature-based school linked to a "pro-environmental attitude" (Turtle, Convery, & Convery, 2015).

The objectives of the current study were to better understand the learning process that occurs in a nature-based pre-primary program and to compare the experience of a nature-based pre-primary program with that of a high-

quality, traditional pre-primary program. A unique aspect of the current study is that both preschool programs were located in the same school and drew students from the same community, ensuring that the groups were matched on important variables, such as location, socioeconomic status, and parents' levels of education. Using a multi-method approach, this study aimed to better understand the relationships between learning environment and important developmental variables, including social interaction, play, behavior, enjoyment of school, and appreciation of nature. The specific variables assessed included children's pretend play, general behavior, social skills, and kindergarten readiness from the perspectives of parents and teachers. The study also assessed children's enjoyment of school and nature appreciation through the children's perspectives.

Overview of development during preschool

The preschool-age is an important developmental stage for acquiring skills related to behavioral and emotional regulation, such as role-playing, perspective-taking, and interacting with peers and adults. Acquisition of these skills, such as emotion regulation and social skills, in turn, begets healthier psychological functioning (Rubin, Coplan, Fox, & Calkins, 1995) and contributes to greater success in early literacy, vocabulary, and math (McClelland et al., 2007). Therefore, by assessing these key skills in preschool programs, we can evaluate the efficacy of preschool programs in establishing the bedrock of later psychological functioning and academic achievement. It is important that young children acquire these skills prior to beginning kindergarten, where demands likely become more complex and expectations are higher. For example, children must learn to ask for help when a challenging task exceeds their capacity, wait their turn for the teacher's assistance, modulate their frustration when they must share a toy, and inhibit impulsive behaviors in order to follow the rules of the classroom. Preschoolers with greater knowledge and understanding of emotions were reported as having greater social awareness and prosocial behaviors at home by mothers and grandmothers, i.e. responding to others' emotions and cooperating with others. Additionally, in the same study, children with greater self-regulation skills, specifically, the ability to maintain positive emotions, were reported by teachers as having fewer inappropriate behaviors in the classroom (Garner & Waajid, 2012).

First, behavioral and emotional self-regulation develop across the preschool period as children must learn to manage upset feelings, cope with frustration, and appropriately express positive emotions with peers. Between the ages of three and five years old, preschoolers strengthen their inhibitory control and emotion regulation (Liebermann, Giesbrecht, & Muller, 2007). The ability to understand specific emotions also develops across the preschool period. While both three- and four-year-old children are able to recognize strategies to cope with sadness, four-year-old children are better equipped to recognize coping strategies for managing anger (Cole et al., 2008).

Preschool is an important venue for teaching, encouraging, and practicing behavioral regulation skills, as they are associated with academic readiness in kindergarten and appropriate behavior in the classroom setting. In a 2012 study, preschoolers who demonstrated greater attentional control and expressed more positive emotions displayed fewer behavior problems in the classroom (Garner & Waajid, 2012). The researchers posited that more frequent expression of positive emotions allows young children to stay motivated and on-task and elicits positive attention from their teachers. In another sample of preschoolers, appropriate behavioral self-regulation skills were negatively associated with disruptiveness in the classroom (Willoughby et al., 2011).

Behavioral regulation in preschool is an important precursor for a child's academic skill development over time. Behavioral regulation skills that are important for academic success include executive functions such as attention, working memory, and inhibitory control, as these skills allow the child to resist distractions, pay attention to the teacher, and follow directions. McClelland et al. (2007) found that three- to five-year-old children's performance on an executive functioning task involving following directions was a significant predictor of their emergent literacy, vocabulary, and math skills in the spring of their preschool year. Additionally, children who made larger gains in behavior regulation from fall to spring of their preschool year also made larger gains in their academic skills. Moreover, self-control has been shown to relate to academic development via its link between interpersonal styles and academic achievement. In a sample of kindergarteners, self-control mediated the relationship between prosocial behavior in the classroom and academic achievement (Normandeau & Guay, 1998). Thus, weaker inhibitory control may in part explain why children who are interpersonally aggressive have poorer academic outcomes.

Understanding and expressing emotions appropriately has important implications for navigating successful peer interactions into kindergarten. In a sample of three- to four-year-old children, those with greater knowledge of different emotions and the situations that elicit such emotions demonstrated higher social competency on both peer nomination and teacher ratings concurrently in preschool and when followed up into kindergarten (Denham et al., 2003). Children's appropriate emotion expression and appropriate responses to their peers' emotions in preschool were also related to their social competency ratings concurrently and into kindergarten (Denham et al., 2003). In another study, four-year-old children who displayed poor emotion regulation in their social interactions were at greater risk for internalizing or externalizing problems. Specifically, children who were more social with peers during free play and were rated by mothers as poor emotion regulators were more likely to have symptoms of externalizing behaviors. On the other hand, children who tended to play alone and were rated by mothers as poor emotion regulators were more likely to have symptoms of internalizing behaviors (Rubin et al., 1995). Conversely, greater emotion regulation across children served as a protective factor and decreased the likelihood of children displaying internalizing or externalizing problems (Rubin et al., 1995). Positive peer interactions have a strong impact on learning and behavior in the classroom. In a sample of preschoolers at Head Start, children who engaged in maladaptive peer interactions, such as starting fights or destroying others' things, were rated by their teachers as having poorer emotion regulation than children who engaged in adaptive peer interactions (Cohen & Mendez, 2010). Peer interactions were assessed with The Penn Interactive Peer Play Scale (PIPPS), the same measure utilized in the current study. Another study with preschoolers at Head Start concluded that a positive peer play interaction style, as measured by the PIPPS, is associated with learning approach, motivation, and attention in the classroom. That is, children who experience more mutually fulfilling and enjoyable interactions with others are more likely to be invested and engaged in their learning. Children who were disconnected or aloof in their play interactions with peers were seen as more inattentive by teachers. Finally, children who were disruptive in their play interactions with peers exhibited more conduct and hyperactivity problems in the classroom (Coolahan et al., 2000).

Children develop the ability to pretend around age three, when they can begin to suspend reality and create imaginary worlds (Vygotsky, 1933). The ability to separate an object from its meaning is a major developmental milestone, as children begin to acquire the ability for symbolic representation. Learning that one object can be treated "as if" it were something else is a crucial cognitive process in pretend play (Fein, 1987) as it promotes the developing imagination. Moreover, acquisition of symbolic representation is a key developmental precursor to language proficiency, as language relies on using symbols to represent ideas, facts, and concepts. Thus, pretend play helps to spur language development in children (Weisberg et al., 2013). Children's own ideas, rather than the characteristics of actual objects, direct the children's play (Vygotsky, 1933). For example, a car can fly or an animal can talk in pretend play, but not in reality. Vygotsky (1933) postulated that through play, children acquire the capacity for abstract thought processes. Children learn rule-governed behavior and can try out a variety of different roles while pretending (Vygotsky, 1933). Pretend play is associated with coping skills, emotion regulation, and creativity longitudinally (Russ, Robins, & Christiano, 1999; Hoffmann & Russ, 2012; Wallace & Russ, 2015).

In order to be successful in the kindergarten classroom, it is essential that preschoolers learn how to cope with difficult emotions, manage frustrations in the face of social conflict or threats in their environment, and understand another child's point of view. Playing out real situations in a play environment allows children the opportunity to practice taking another's perspective. Imaginativeness in first- and second-grade children's pretend play was associated with their ability to generate more ideas to cope with stressful situations four years later (Russ, Robins, & Christiano, 1999). In a sample from an all-girls independent school, elementary school children who demonstrated more organized and imaginative play generated more ideas on a divergent thinking measure four years later (Wallace & Russ, 2015). Finally, in a sample of four- and five-year-old children, a strong orientation towards fantasy and pretend play was a significant and unique predictor of emotion regulation after partialling out variance attributed to age, theory of mind, and verbal ability (Gilpin, Brown, & Pierucci, 2015). Taken together, behavioral and emotional self-regulation and pretend play have important implications for later school success and healthy peer relationships. Thus, in evaluating the quality of a preschool program, it is important to assess these abilities and competencies that define the preschool developmental period.

The specific aims for this study were: (a) to gain a better understanding of the relationships between learning environment (nature-based and traditional classroom) and aspects of academic and social-emotional kindergarten readiness; (b) to determine if children in a traditional pre-primary setting and a nature-based pre-primary setting were equally prepared for kindergarten on these variables; and (c) to add to the quantitative literature on nature-based pre-primary education using a multi-rater, longitudinal research design.

METHOD

Sample

The study population included 26 pre-primary students (mean age = 51.5 months) attending an independent girls' school with a coeducational pre-primary division in the suburbs of Cleveland, Ohio. The racial group identification of the school included 49% White (not Hispanic), 34% multiracial, 12% Asian, 4% Hispanic, and 1% African-American. 46% of students attending the K-12 school receive financial assistance. Twelve of the students were enrolled in the school's outdoor pre-primary program (OPP). Fourteen of the students were enrolled in the school's traditional prekindergarten program (TPK). The OPP class had two co-teachers, and the TPK class had one lead teacher and one teaching assistant. The OPP program, in its first year of operation at the start of the study, consisted of a completely outdoor learning experience, in which the children spent five mornings per week at the school's outdoor campus. The children were outdoors in the forest for 90% of the school day. They were indoors only when putting on/removing gear, thunderstorms were passing through the area, or the wind chill was below zero. The outdoor campus contains a yurt, which was used to house gear and as an emergency shelter in the event of severe storms or cold. Children went outdoors as soon as they put on their gear in the yurt. Depending on the conditions and terrain encountered each day, the children utilized a variety of gear, including pants, full coverage one-piece suits, or a combination of pants and jackets. Once the children understood the benefits of being warm and dry, they were encouraged to make gear choices independently. The children in the TPK program attended class five mornings per week at the school's main campus. As the school's entire pre-primary program incorporates an Eco!Wonder curriculum that teaches all pre-primary children about nature and sustainability, children in the TPK class also spent some time at the outdoor campus throughout the school year. Children in the TPK class visited the outdoor campus one morning per week and spent one immersion week at the outdoor campus in the spring. The remainder of their outdoor time was spent in built environments. Both the OPP and TPK programs lasted for half the day, after which the children in both classes either went home or attended afternoon programming, including both indoor and outdoor activities, at the school's main campus. Approval for the study was received from the Case Western Reserve University Institutional Review Board; parents read an information sheet about the study and were given the opportunity to consent for their children to participate in the study. All of the families in the OPP and the TPK classes elected to participate in the study.

Procedure

One parent of each child completed several rating forms in September and again in the following May. Both teachers of each class completed several rating forms for each student in September, January, and May. The lead and assistant teachers' scores were compiled to create one teacher rating for each child. Teachers were asked to complete measures at the beginning, middle, and end of the school year to gain a more complete data set and allow for more nuanced analysis of changes over the course of the school year. Parents were only asked to complete the measures twice, to decrease the research burden for parents. The children completed two rating forms in September and again in May. The measures are described below.

Measures

Penn Interactive Peer Play Scale (PIPPS). The PIPPS is a 32-item behavior rating instrument assessing aspects of children's peer play behaviors (McWayne, Sekino, Hampton, & Fantuzzo, 2007). It assesses the quality of peer interactions in play across the dimensions of Play Interaction, Play Disruption, and Play Disconnection. The PIPPS was chosen for this study because it is empirically validated and designed for use specifically with preschoolers and kindergarteners from a wide variety of cultural backgrounds (Castro, Mendez, & Fantuzzo, 2002). It provides a

measure of peer play behaviors, which are an important component of social-emotional development and kindergarten readiness. Teachers completed the PIPPS in September, January, and May. Parents completed the PIPPS in September and May.

Preschool and Kindergarten Behavior Scales, Second Edition (PKBS-2). The PKBS-2 is a 76-item behavior rating instrument assessing aspects of children's social skills and problem behaviors (Merrell, 2002). The Social Skills scale assess the dimensions of Social Cooperation, Social Interaction, and Social Independence. The Problem Behavior scale assesses the dimensions of Externalizing Problems and Internalizing Problems. The PKBS-2 was chosen for this study because it is empirically validated, designed for use specifically with preschoolers and kindergarteners, and standardized with a nationwide sample. It provides a measure of internalizing and externalizing behaviors that are related to kindergarten readiness (Nelson et al., 2016). Teachers completed the PKBS-2 in September, January, and May. Parents completed the PKBS-2 in September and May.

Pretend play rating. The pretend play rating consisted of five questions assessing children's imagination in play, use of make-believe, enjoyment of play, amount of emotion expressed in play, and use of make-believe in dramatic play, using a 5-point Likert scale. Kaugars and Russ developed the measure for use in their 2009 study of preschool children's pretend play. A measure of pretend play was selected due to the correlation between pretend play and aspects of coping, emotion regulation, and creativity, all important to kindergarten readiness (Hoffman & Russ, 2012). Parents completed the measure in September and in May. Teachers completed the measure in September, January, and May.

Kindergarten readiness measure. Teachers completed a measure assessing the children's academic kindergarten readiness skills. Skills included letter number recognition, sorting and classifying information, counting, rhyming, and recognizing one's name in print. The skills were rated as "Never," "Sometimes," "Often," or "Always." Given the research question of kindergarten readiness, a teacher rating of this construct was essential to the study. This rating scale was developed in collaboration with the pre-primary teachers at this school, to accurately reflect the pre-primary curriculum goals. Teachers completed the measure in September and May.

Children's Attitudes Toward School (CATS). The CATS is a 14-item rating instrument designed for use with children in kindergarten and first grade (Henry, Mashburn, & Konold, 2007). A range of school activities are read to the child and the child responds to each by pointing to a face on a card that reflects the child's attitude toward the activity. With the author's permission, the CATS was adapted for use with the prekindergarten-aged sample in the present study. The measure was adapted by altering the items to better reflect the pre-primary curriculum. For example, the item, "How do you feel about doing math activities like counting, adding, and subtracting?" was changed to, "How do you feel about doing math activities like counting, sorting, or making patterns?" Items irrelevant to the pre-primary curriculum (e.g., "How do you feel about writing a story?" and "How do you feel about taking math tests?") were deleted and items reflective of the pre-primary curriculum (e.g., "How do you feel about playing with kitchen and housekeeping toys, dolls and puppets, and dress up clothes?") were added. The overall measure was shortened by two items, going from 18 items on the original measure to 16 items on the revised version. Though the children in this study were young, it was important to assess their feelings about school, as school enjoyment may be related to achievement and motivation (Raccanello et al., 2018). A research assistant administered the CATS to the students in September and May.

Children's Attitudes Toward Nature (CATN). The CATN is a 12-item rating instrument created for the present study, using the administration guidelines and instructions of the CATS (Henry, Mashburn, & Konold, 2007) as a guide. A range of nature activities are read to the child and the child responds to each by pointing to a face on a card that reflects the child's attitude toward the activity. Though children's ratings were secondary to the parent- and teacher-ratings in this study, the authors felt it important to assess children's feelings about nature in both classes. As no well-validated measures of children's attitudes toward nature are available for this age group, the CATS format was adapted, with the assistance of the lead OPP teacher, to create this original measure. A research assistant administered the CATS to the students in September and May.

Analyses

Mixed-model analysis of covariance (ANCOVA) was our primary analytic strategy. It was used to test within-class differences across time, between-class differences at each time point, and the School × Time interaction effect. These analyses were conducted with each of the completed measures while statistically controlling for age.

The within-subjects factor was time, with three time points for teacher ratings and two time points for parent ratings and child ratings. As two teachers rated each child on each variable (except for Pretend Play), the teacher ratings were averaged to create one score when possible. Mauchly's test of sphericity was applied to ANCOVAs on teacher reports, as there were three repeated measures (with the exceptions of problem behaviors and kindergarten readiness). When sphericity was violated, we applied the Greenhouse-Geisser estimates of sphericity (Maxwell & Delaney, 2004). The between-subjects factor was school (i.e. traditional or outdoor). Bonferroni-corrected pairwise comparisons were examined to determine at which time points the significant differences, if any, occurred.

Given the relatively small sample size, effect sizes were calculated using partial eta squared estimates (included in Table 1). Partial eta squared estimates are the appropriate effect size estimate to report when analyzing data using ANCOVA: For this statistic, 0.02 is indicative of a small effect, 0.15 is considered a medium effect, and 0.35 is indicative of a large effect (Cohen, 1992).

RESULTS

The results are presented in two sections. The first section focuses on teachers' and parents' ratings of the children on measures of peer play behaviors, social skills, and pretend play, as well as teachers' ratings of the children's kindergarten readiness. The second section focuses on children's ratings of their own enjoyment of school and appreciation of nature. Selected results are described by measure, below (see Tables 1 and 2 for the relevant statistics).

Table 1
Teacher-rated Outcome Measures across Condition and Time

Rater	Variable and Time of Rating	Traditional group mean (SD)	Outdoor group mean (SD)	Within-group Effect (F, η^2_p)	Between-group Effect (F, η^2_p)	Interaction Effect (F, η^2_p)
Teacher composite	Play interaction			7.94**, 0.26	2.70, .11	1.79, .07
	T1	54.96 (2.64)	49.46 (6.99)			
	T2	56.46 (3.40)	51.50 (5.80)			
	T3	55.82 (2.76)	54.69 (5.07)			
Teacher 1	Pretend play			8.96**, .29	0.00, .00	30.76***, .58
	T1	18.21 (2.12)	15.18 (1.66)			
	T2	18.64 (2.71)	17.91 (3.91)			
	T3	18.86 (3.35)	23.45 (2.12)			
Teacher composite	Play disruption			1.36, .06	17.64***, .45	2.72, .11
	T1	43.69 (6.43)	50.38 (5.96)			
	T2	41.92 (4.20)	53.79 (5.33)			
	T3	38.31 (5.53)	47.71 (7.26)			
Teacher composite	Play disconnection			1.98, .08	14.59**, .39	8.60**, .27
	T1	43.71 (5.63)	52.13 (7.34)			

	T2	39.14 (4.51)	55.17 (6.62)			
	T3	40.14 (4.69)	45.75 (9.28)			
Teacher composite	Kindergarten readiness			2.35, .10	4.05, .16	2.87, .12
	T1	23.42 (3.44)	19.09 (3.86)			
	T2	--	--			
	T3	26.79 (1.71)	24.72 (2.87)			
Teacher composite	Social skills			.33, .01	1.98, .08	.11, .01
	T1	110.07 (7.41)	101.92 (11.69)			
	T2	111.89 (5.84)	104.79 (13.95)			
	T3	112.96 (6.29)	106.21 (13.34)			
Teacher composite	Behavioral problems			.55, .02	4.81*, .17	1.33, .06
	T1	82.46 (6.39)	91.58 (9.14)			
	T2	--	--			
	T3	83.93 (5.03)	89.96 (12.26)			

Note: *p < .05, **p < .01, ***p < .001 For η^2_p: small = 0.02, moderate = 0.15, large = 0.35. T1 = September, T2 = January, T3 = May.

Table 2

Parent-rated Outcome Measures across Condition and Time

Rater	Variable	Traditional group mean (SD)	Outdoor group mean (SD)	Within-group Effect (F, η^2_p)	Between-group Effect (F, η^2_p)	Interaction Effect (F, η^2_p)
Parent	Play interaction			1.28, .07	.02, .00	.02, .00
	T1	48.00 (7.00)	46.90 (6.72)			
	T3	51.22 (9.91)	51.30 (7.46)			
Parent	Pretend play			.03, .00	.00, .00	.28, .02
	T1	21.80 (3.58)	20.90 (3.54)			
	T3	22.00 (4.03)	21.50 (3.24)			
Parent	Play disruption			.32, .02	.07, .01	.47, .03
	T1	50.00 (3.81)	49.11 (9.21)			
	T3	44.00 (7.50)	44.89 (8.25)			
Parent	Play disconnection			.48, .03	.01, .00	.83, .06
	T1	50.33 (8.54)	49.63 (11.20)			
	T3	46.11 (9.32)	48.38 (10.04)			
Parent	Social skills			1.60, .08	.87, .05	1.66, .08
	T1	104.00 (7.29)	102.20 (15.51)			
	T3	128.73 (64.96)	108.40 (12.67)			
Parent	Behavioral problems			4.35, .21	.15, .01	1.41, .08
	T1	101.10 (13.16)	97.00 (21.12)			
	T3	95.20 (9.94)	92.67 (16.52)			

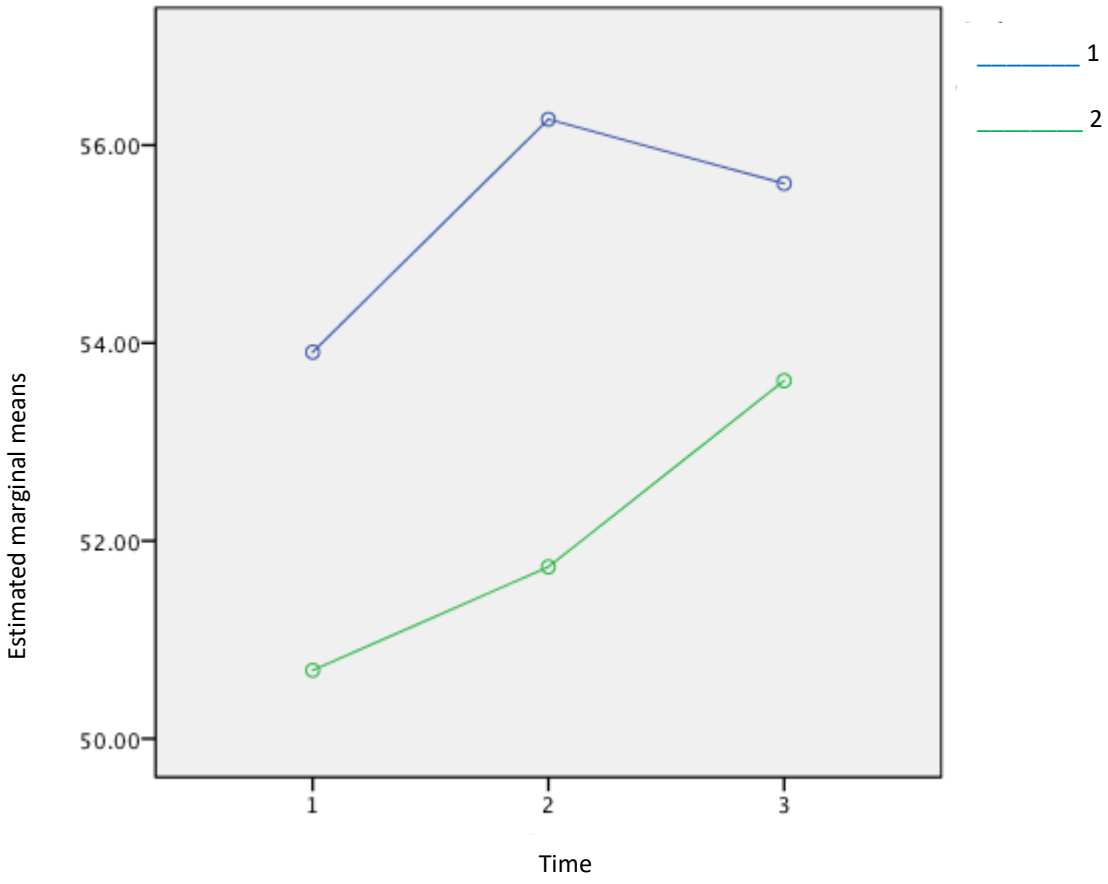
Note: *p < .05, **p < .01, ***p < .001 For η^2_p: small = 0.02, moderate = 0.15, large = 0.35. T1 = September, T3 = May.

Teacher and parent results

Peer play skills (PIPPS)

Play interaction. For the variable of teacher-rated play interaction, Mauchly's test indicated that the assumption of sphericity was met for the teacher-rated variables of Play Interaction on the PIPPS ($\chi^2(2) = .17$, $p = .92$). The mixed ANOVA showed that the main effect of age was not statistically significant ($F_{(1,24)} = 1.41$, $\eta^2_p = .06$, $p = .24$). The effect of school was not significant, nor was the interaction of school x time. The effect of time was significant. Collapsing across groups and using the Bonferroni method to adjust for multiple comparisons, there were significant increases in teacher-rated play interaction between T1 and T2 (mean difference = 1.7, $p < .05$) and between T1 and T3 (mean difference = 2.32, $p < .01$), but there was no difference between T2 and T3 (mean difference = .61, $p = .91$). See Figure 1 for a graphical depiction of these results.

For the variable of parent-rated play interaction, age did not show a statistically significant effect ($F_{(1,16)} = .43$, $\eta^2_p = .03$, $p = .52$). The main effects of school and time on parent-rated play interaction were not significant, nor was the interaction between school X time.

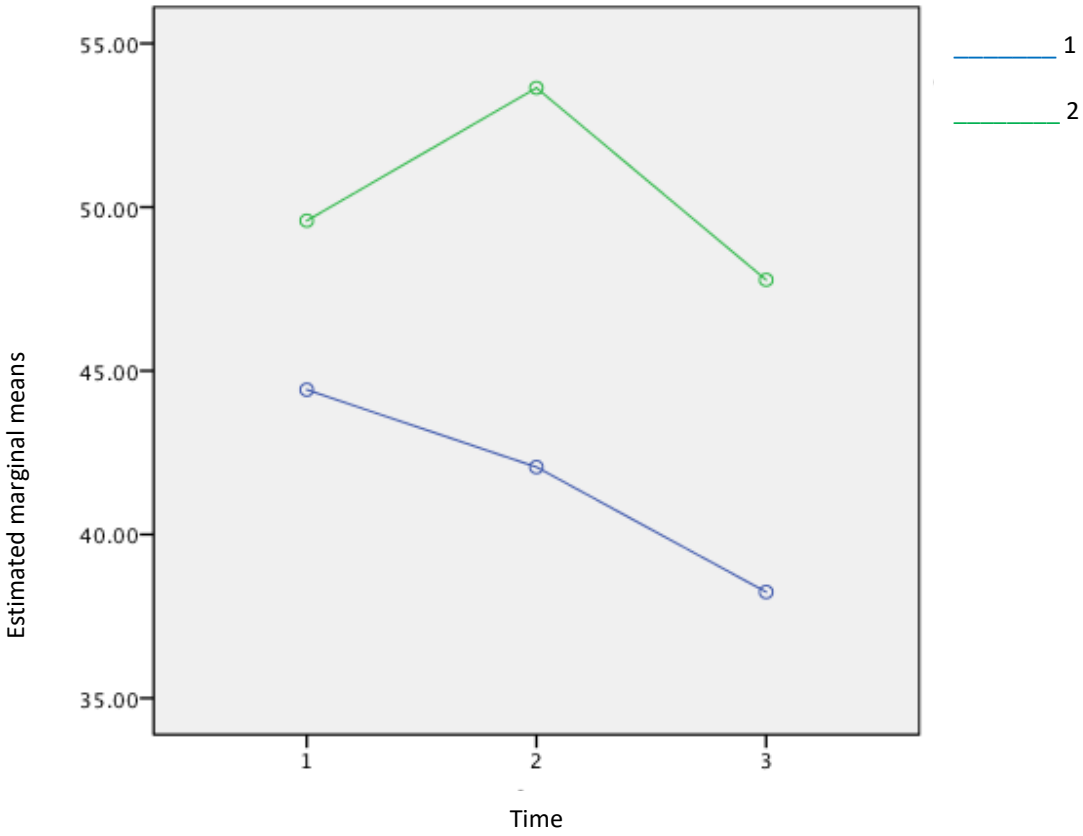


Covariates appearing in the model are evaluated at the following values: 52.3846 months

Figure 1. Estimated marginal means (covarying student age) for teacher-rated play interaction across time (1 = September, 2 = January, 3 = May) and School (Indoor = 1, Outdoor = 2).

Play disruption. For the variable of teacher-rated play disruption, Mauchly's test indicated that assumption of sphericity was violated for the teacher-rated variables of Play Disruption on the PIPPS ($\chi^2(2) = 12.05$, $p < .01$). The degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .70$) (Maxwell & Delaney, 2004). The main effect of age did not show a statistically effect ($F_{(1,22)} = .35$, $\eta^2_p = .02$, $p = .56$). The main effect of school was significant, with the outdoor group showing higher levels of play disruption across time points (see Figure 2). The main effect of time was not significant across the time points, nor was the interaction between school X time in predicting teacher-rated play disruption.

For the variable of parent-rated play disruption, the main effect of age did not show a statistically effect ($F_{(1,15)} = .48$, $\eta^2_p = .03$, $p = .12$). The main effects of school and time on parent-rated play disruption were not significant, nor was the interaction between school X time.



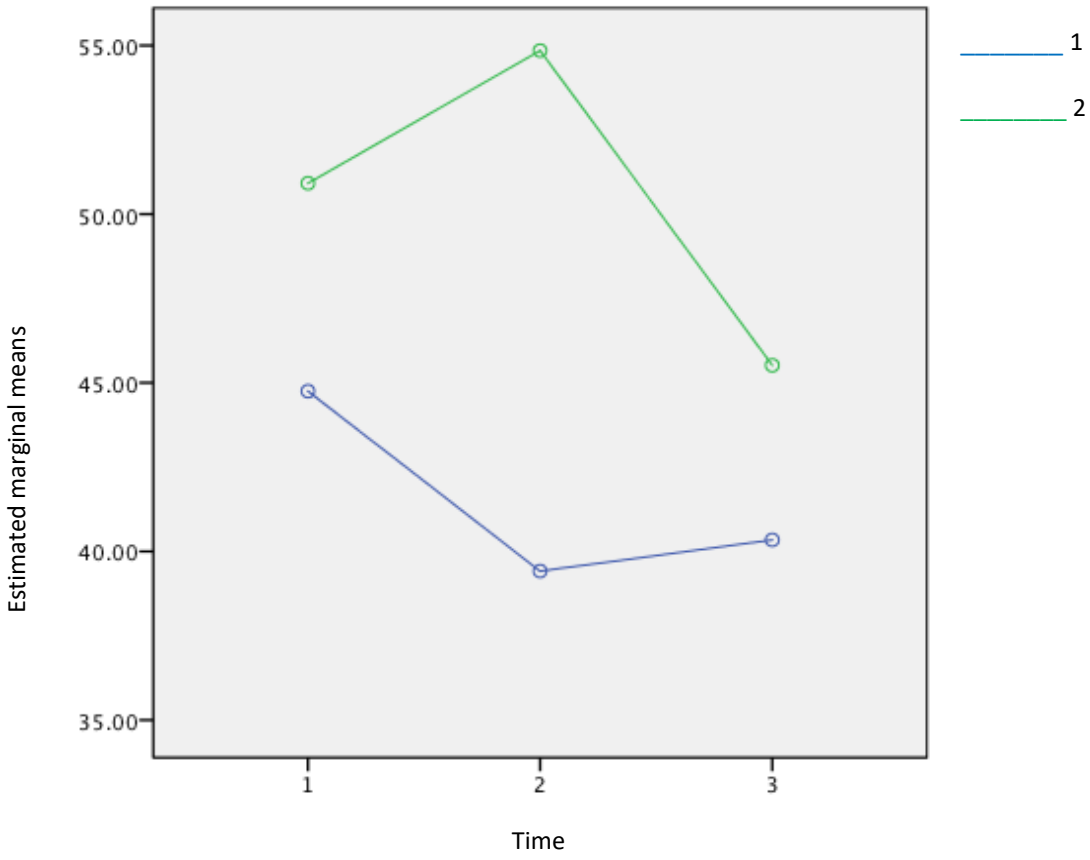
Covariates appearing in the model are evaluated at the following values: 52.3600 months

Figure 2. Estimated marginal means (covarying student age) for teacher-rated play disruption across time (1 = September, 2 = January, 3 = May) and School (Indoor = 1, Outdoor = 2).

Play disconnection. Mauchly's test indicated that assumption of sphericity was violated for the teacher-rated variables of Play Disconnection on the PIPPS ($\chi^2(2) = 12.94$, $p < .01$). The degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .69$) (Maxwell & Delaney, 2004). The main effect of age did not show a statistically effect ($F_{(1,23)} = 1.10$, $\eta^2_p = .05$, $p = .31$). The main effect of time was not significant across the time points. The effect of school was significant; this effect should be interpreted within the significant interaction of school X time. The outdoor group showed higher levels of play disconnection at T1, $F_{(1, 24)} = 10.91$, $p < .01$, partial $\eta^2 = .31$ and

at T2, $F_{(1, 24)} = 53.31$, $p < .001$, partial $\eta^2 = .69$, but there was no statistically significant difference in play disconnection across schools at T3, $F_{(1, 24)} = 3.95$, $p = .06$, partial $\eta^2 = .14$ (see Figure 3).

For the parent-rated variable of play disconnection, the main effect of age did not show a statistically effect ($F_{(1,14)} = .05$, $\eta^2_p = .00$, $p = .82$). The main effects of school and time on parent-rated play disconnection were not significant, nor was the interaction between school X time.



Covariates appearing in the model are evaluated at the following values: 52.3846 months

Figure 3. Estimated marginal means (covarying student age) for teacher rated play disconnection across time (1 = September, 2 = January, 3 = May) and School (Indoor = 1, Outdoor = 2).

Social skills and problem behaviors (PKBS-2)

Social skills. For the teacher-rated variable of social skills, Mauchly's test indicated that assumption of sphericity was violated for the teacher-rated variables of Social Skills on the PKBS-2 ($\chi^2(2) = 6.28$, $p < .05$). The degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .80$) (Maxwell & Delaney, 2004). The main effect of age did not show a statistically effect ($F_{(1,23)} = 0.50$, $\eta^2_p = .02$, $p = .49$). The main effects of school and time were not significant, and there was no interaction between school X time.

For the parent-rated variable of social skills, the main effect of age did not show a statistically effect ($F_{(1,18)}$ = .02, η^2_p = .00, p = .88). The main effects of school and time on parent-rated social skills were not significant, nor was the interaction between school X time.

Problem behaviors. For the teacher-rated variable of problem behaviors, only Time 1 and Time 3 data were available for all children, and thus Mauchly's test of sphericity did not apply. The main effect of age did not show a statistically effect ($F_{(1,23)}$ = .07, η^2_p = .00, p = .79). The effect of school was significant, with the outdoor group showing higher levels of problem behaviors (see Figure 4). There was no main effect of time or interaction between school X time predicting behavioral problems.

For the parent-rated variable of problem behaviors, the main effect of age did not show a statistically effect ($F_{(1,16)}$ = .01, η^2_p = .00, p = .94). The main effects of school and time on parent-rated behavioral problems were not significant, nor was the interaction between school X time.

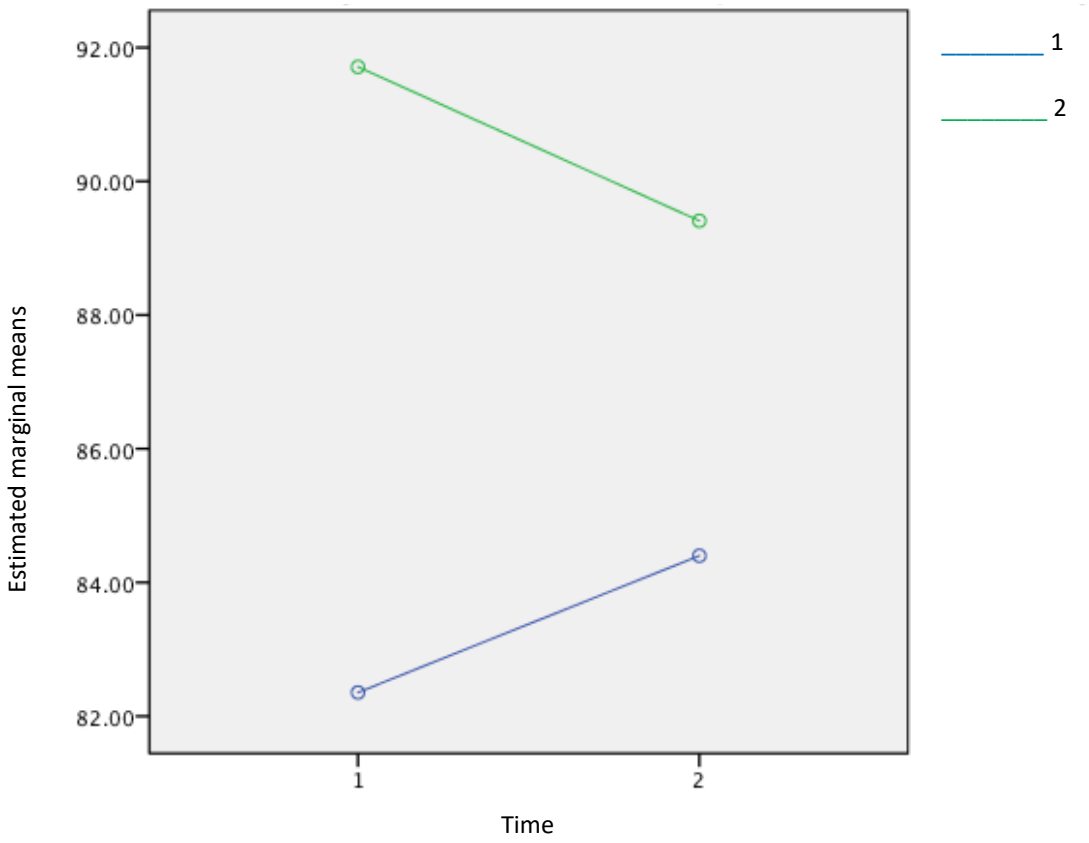
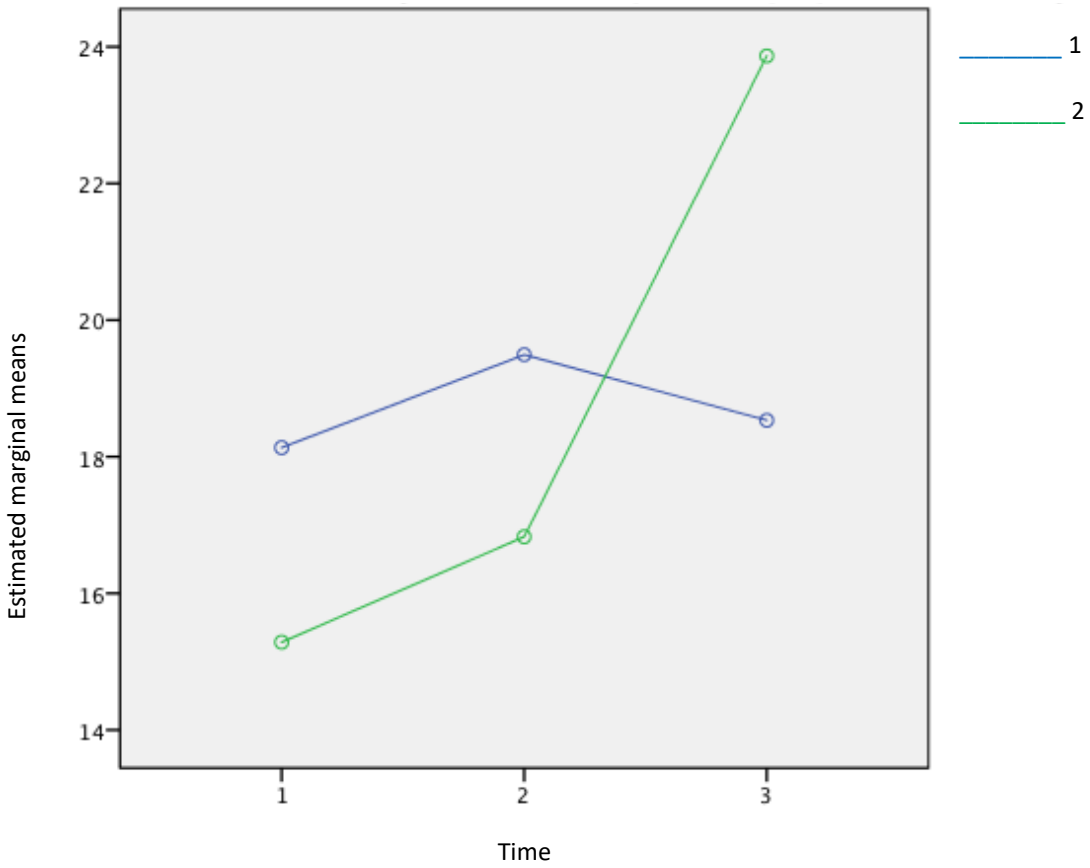


Figure 4. Estimated marginal means (covarying student age) for teacher rated behavioral problems across time (1 = September, 2 = May) and School (Indoor = 1, Outdoor = 2).

Pretend play

For the teacher-rated variable of pretend play, Mauchly's test indicated that the assumption of sphericity was met for pretend play on the pretend play rating ($\chi^2(2) = 5.45$, $p = .07$). The main effect of age did not show a statistically effect ($F_{(1,22)} = 5.46$, $\eta^2_p = .02$, $p = .54$). The effect of school was not significant. The main effect of time showed a statistically significant difference in pretend play at the different time points; this effect should be interpreted within the context of a significant interaction between school X time (see Figure 5). The traditional group showed higher levels of pretend play at T1, $F_{(1, 23)} = 15.15$, $p = .001$, partial $\eta^2 = .40$. There was no statistically significant difference in pretend play across schools at T2, $F_{(1, 24)} = .26$, $p = .62$, partial $\eta^2 = .01$. The outdoor group showed higher levels of pretend play at T3, $F_{(1, 24)} = 17.98$, $p < .001$, partial $\eta^2 = .43$.

For the parent-rated variable of pretend play, the main effect of age did not show a statistically effect ($F_{(1,17)} = .96$, $\eta^2_p = .05$, $p = .34$). The main effects of school and time on parent-rated pretend play were not significant, nor was the interaction between school X time.



Covariates appearing in the model are evaluated at the following values: 52.0800 months

Figure 5. Estimated marginal means (covarying student age) for teacher-rated pretend play (1 = September, 2 = January, 3 = May) and School (Indoor = 1, Outdoor = 2).

Kindergarten readiness

The teacher-rated variable of kindergarten readiness was assessed at Time 1 and Time 3. The main effect of age did not show a statistically effect ($F_{(1,22)}$ = 4.23, η^2_p = .16, p = .05). The effect of school and time were not significant, and there was no interaction between school X time.

Child results

Mixed model analysis of variance (ANCOVAs) were used to examine the effects of condition and time on the child-rated variables of school enjoyment and nature appreciation. These variables were assessed at Time 1 and Time 3. The results are described by measure, below (also see Table 3).

Table 3
Student-rated Outcome Measures across Condition and Time

Rater	Variable	Traditional group mean (SD)	Outdoor group mean (SD)	Within-group Effect (F, η^2_p)	Between-group Effect (F, η^2_p)	Interaction Effect (F, η^2_p)
Student	CATS			.36, .02	.24, .01	3.10, .12
	T1	2.76 (.43)	2.89 (.40)			
	T3	3.17 (.38)	2.90 (.44)			
Student	CATN			.26, .01	3.05, .12	2.59, .11
	T1	2.58 (.76)	3.19 (.53)			
	T3	3.27 (.50)	3.28 (.62)			

Note: $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$ For η^2_p: small = 0.02, moderate = 0.15, large = 0.35. CATS = Children's attitude toward school, CATN = Children's attitude toward nature, T1 = September, T3 = May.

School enjoyment. The main effect of age did not show a statistically effect ($F_{(1,22)}$ = .69, η^2_p = .30, p = .42). The main effects of school and time on student-rated school appreciation were not significant, nor was the interaction between school X time.

Nature appreciation. The main effect of age did not show a statistically effect ($F_{(1,22)}$ = .00, η^2_p = .00, p = .98). The main effects of school and time on student-rated nature appreciation were not significant, nor was the interaction between school X time.

DISCUSSION

The current study presents a unique opportunity to compare a traditional, high-quality prekindergarten program with a new, nature-based pre-primary program among students from the same backgrounds enrolled at the same school. While numerous studies have used qualitative methods to underscore the many benefits of an immersive, nature-based education program for young children, this is among the first to utilize quantitative methods to assess important kindergarten readiness skills in this population. It may also be the first study to use quantitative methods to compare children's skills in these areas between a traditional preschool program and a nature-based preschool program among children drawn from the same population.

These results indicate that children in both types of preschool programs achieved expected developmental gains in their behavior, early academic skills, and social-emotional functioning over the year prior to kindergarten. In most areas and generally overall, the two groups ended the year with equal levels of preparedness for kindergarten in the domains of social-emotional functioning, academic readiness, and pretend play. This study provided a longitudinal, multi-rater assessment of these important skills. Parents' ratings of their children over the course of the year did not

indicate significant differences between the traditional and nature-based groups. Teacher ratings indicated general improvement over the course of the year in both groups. Teacher ratings did indicate significant differences between the groups on several specific variables.

Teacher ratings showed that students enrolled in the nature-based pre-primary program demonstrated higher rates of play disruption across time points. Additionally, teacher ratings show higher levels of play disconnection in the nature-based group at Time 1, though no significant differences existed between the two groups on this variable by Time 3. Finally, teacher ratings showed higher rates of problem behaviors in the nature-based pre-primary program as compared to the traditional prekindergarten program at Time 1 and Time 3. These results raise questions about what factors may contribute to higher rates of challenging behaviors in the nature-based program. However, though these results are statistically significant, they are not clinically meaningful differences. The measures used to assess these behaviors, the PIPPS and the PKBS-2, utilize T-scores as the metric of assessment. While students in the nature-based program showed higher T-scores in the areas of play disruption and problem behaviors overall, their scores remained well within the average range for T-scores. In other words, though there were statistically significant differences between the groups, these differences did not place the nature-based group in a problematic behavior area. Instead, both groups showed low concerns on these measures overall, and students in the nature-based group remained in the average range of concerns compared to other children their age in the normative samples for these measures.

Teacher ratings also provide important information about students' pretend play over the course of the year. Although students in the traditional program showed higher levels of pretend play at the start of the year, students in the nature-based program showed higher levels of pretend play at the end of the school year. It may be that the less-structured, exploratory nature of the outdoor setting allows for children to use imagination and creativity with fewer limits than in a traditional classroom setting. For example, after seeing a bald eagle perched on the top of a sycamore tree along the river on the bus ride to the outdoor campus one morning, the students looked for the eagle everyday afterward. On the days the students saw a bald eagle, they became excited and inspired to use the bald eagle as a play theme. They built a large "bald eagle nest" out of sticks and leaves, took turns caring for rock "eggs" and pretended to be adult eagles searching for fish and bringing the prey home for the nestlings when the eggs hatched. This theme created lengthy conversations about what the bald eagles would eat, how they communicated with one another and how big the nest should be.

In a nature-based program, children are provided unstructured materials (e.g. sticks, leaves, dirt, rocks) that are completely open-ended without prescribed uses. They are constantly involved in transforming these unstructured materials into new things using their imaginations. Children must activate creativity and problem-solving to play in this type of environment. They must learn to think flexibly and adapt to changing circumstances, as dirt becomes mud and rocks and leaves become slippery and wet in the rain. The open-ended materials are conducive to teamwork that incorporates the ideas of the group. In the outdoor setting, children will transform a stick shelter into a rocket ship one day and a grocery store the next.

This study also attempted to assess children's own feelings about school and about nature. Using the well-validated CATS measure and an adaptation of that measure designed for this study that assessed children's feelings about nature, no significant differences were found between the traditional and the nature-based groups. In both groups, the children appeared to understand the measure and reply with a range of responses. In future studies, the adaptation of this measure designed to assess children's feelings about nature should be carefully considered to determine if its statements reflect the processes that occur in a nature-based education program. Parents' nature appreciation and parents' perception of their children's nature appreciation were not assessed in this study, though these would be important variables to consider in a similar study in the future.

Limitations

This study possessed several limitations that would be important to address in future research. The first limitation is related to the generalizability of these results. The current sample was small and represents predominately children from a higher socioeconomic background, whose parents generally possess a higher level of education and

who are exposed to a number of enriching activities outside of school. In order to increase generalizability of these findings, it would be important to replicate this type of study with a larger sample of children from more diverse backgrounds and with a different variety of experiences. It would also strengthen generalizability to replicate this type of study with a publicly funded prekindergarten program.

Second, the traditional prekindergarten program was not a "true" control group, because the assignment of children into the traditional class or the nature-based class was done by self-selection, not random assignment. However, the design attempts to compare groups as similar as possible, as the tuition for the two preschool programs are comparable and the programs are housed in the same school. Presumably, families who selected a nature-based preschool program for their young children might place a higher emphasis on nature and the benefits of the outdoors. This study could not control for the factors that led families to select one type of preschool program over the other for their children and for factors that might have suppressed the effectiveness of the nature-based preschool program. This study also did not assess for previous school experiences, both formal and informal, that might have accounted for differences in some of the skills measured. Finally, the traditional prekindergarten program used as a comparison program in this study is an exceptionally high-quality prekindergarten program that, by nature of the EcoWonder! curriculum at the heart of the entire school's pre-primary division, includes higher-than-average exposure to outdoor learning experiences.

CONCLUSION

This study is a meaningful step in providing empirical support for the benefits of nature-based learning among preschoolers. Importantly, these results illustrate that students enrolled in a high-quality, immersive, nature-based pre-primary program are equally equipped for kindergarten as students enrolled in a high-quality, traditional pre-primary program. This information should help parents and educators choose high-quality, nature-based preschool programs with confidence, knowing that the learning that takes place outdoors provides similar academic and social-emotional benefits as the learning that takes place in a traditional setting.

At a time when nature-based education is receiving high levels of support and schools are attempting to increase the amount of time their students spend outdoors, this study provides important quantitative data supporting the value of nature-based education for young children. Critics of nature-based education programs wonder if young children will be equipped for the demands of formal kindergarten following an immersive, nature-based preschool program. These results suggest that children in a nature-based pre-primary program are as prepared for kindergarten as children in an exceptionally high-quality, traditional pre-primary program. It will be important to examine how nature-based preschool experiences shape students' long-term academic, social-emotional and behavioral outcomes across time. The nature-based program in the current study, the first of its kind in this geographic region, is a high-quality program staffed by experienced teachers and developed over several years' time. Both programs in this study provide a play-based and cognitively rich curriculum that fosters creativity and introduces students to language arts, social studies, mathematics, and science concepts. It is important to consider the quality of any nature-based education program, just as it is important to hold traditional early childhood programs to a high standard of quality. Given the myriad benefits of nature-based education for pre-primary students, as illustrated by the results of the current study and the emerging body of literature in this field, it is worth investigating how to provide a wider population of preschool-aged children increased access to high-quality, nature-based education programs. From entirely immersive nature-based programs, such as the one investigated in this study, to opportunities for nature-based learning in traditional preschool programs, all children deserve the opportunity to learn and play in natural settings. These results underscore the benefits of nature-based, early childhood education and show promise for students' academic, social, and emotional preparedness for the formal schooling to follow.

Acknowledgements

The authors wish to thank Emily Orr for her assistance with scoring and data entry for this project.

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Tori S. Cordiano is a Clinical Psychologist at Laurel School's Center for Research on Girls, Ohio. She can be reached at tcordiano@laurelschool.org.

Alexis W. Lee is a rising fifth year student in the Clinical Psychology PhD program at Case Western Reserve University in Cleveland, Ohio. She can be reached at awl32@case.edu.

Joshua A. Wilt is a Postdoctoral Scholar in the Department of Psychological Sciences at Case Western Reserve University in Cleveland, Ohio. He can be reached at joshua.wilt@case.edu.

Audrey Elszasz is an early childhood educator and outdoor education specialist. You can learn more about her work at www.NaturePedagogy.org.

Lisa Damour is a Clinical Psychologist at Laurel School's Center for Research on Girls, Ohio. She can be reached at ldamour@laurelschool.org.

Sandra Russ is a Distinguished University Professor of Psychology at Case Western Reserve University. She can be reached at sandra.russ@case.edu.