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ARTICLE



Nature contact at school: The impact of an outdoor classroom on children's well-being

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ABSTRACT

Nature contact facilitates healthy child development and a disconnect with nature presents potential health risks. This study was designed to test a nature intervention at an elementary school among children. An experimental crossover design was implemented over six weeks; two teachers taught their respective kindergarten classes the daily language arts lesson in either the control (indoor classroom) or nature treatment (outdoor classroom) conditions. Child well-being measures were compared in the two conditions. Teachers' redirections of child behavior were significantly fewer in the nature condition ($t = 2.49, p < 0.05$) compared to the control. Also, fewer children were off task in the nature condition on average. There were mixed well-being results; children reported no significance difference in happiness in the two conditions, but teachers reported modest benefit in child well-being in the nature condition. The outdoor classroom is a promising method for increasing nature contact and promoting student well-being.

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Introduction

Americans today spend at least 90% of their waking hours indoors. (Samet and Spengler 2003) School-aged children, in particular, spend less time outdoors than at any other time in history. In a population-based study, children's time spent outside significantly declined over five years from 2001 to 2006. (Cleland et al. 2010) Survey findings suggest that about half of children (40% and 55%, respectively) spend less than one hour per day outdoors during non-school hours, including the weekend. (Larson et al. 2011; Stone and Faulkner 2014) Another study used Global Positioning System (GPS) to precisely monitor outdoor behavior of 1010 English students and revealed that they averaged just 41-minutes outdoors per day (after school and on weekends). (Cooper et al. 2010) The reason for the steady decline appears to be multifaceted. Leading causes appear to be societal shifts in childhood toward more structured extracurricular activity and an exponential increased participation in screen time. (Louv 2005; Rideout et al. 2010; Logan and Selhub 2012; Belknap and Hazler 2014)

Children today also spend minimal time outdoors at school. In one study of high-risk young children, teachers reported that nearly 3000 Head Start preschool students spent approximately

30-minutes per day outside. (Marino et al. 2012) Many public schools have recently decreased recess and students' time outdoors as a result of increased emphasis on instructional time and academic performance. (Council on School Health 2013; Bohn-Gettler and Pellegrini 2014) This trend is new. During the previous century, school children in the United States experienced more time outdoors and 'green play' at school through recess and structured physical fitness. (Frost 2009) Children today are clearly spending less time outdoors at home and at school than ever before and research findings suggest that this is a public health concern.

This problem – children's disconnect with the outdoors – was brought to national attention in 2005 by the well-cited book entitled *Last Child in the Woods: Saving our children from nature deficit disorder*. (Louv 2005) In this book, Richard Louv summarizes the scientific and societal costs of the recent 'divide' between children and the outdoors and the subsequent health, development, and learning problems associated with that disconnect. (Louv 2005) Previous findings clearly demonstrate that time outdoors is an important predictor of the following health and learning outcomes among children: inhibition of Attention Deficit Disorder symptoms, increased concentration and impulse inhibition, reduction in myopia symptoms among young children, healthy social development, healthy body weight, increased rates of physical activity, better physician rating of immune functioning, and better generalized health and well-being. (Wells 2000; Wells and Evans 2003; Castonguay and Jutras 2009; Kuo 2013; Waite et al. 2013; Christian et al. 2014; Klinker et al. 2014; Ulset et al. 2017) For children, increased time outdoors appears to improve health and learning-related outcomes.

The question, 'how does time outdoors and nature contact impact health and learning?' has been widely explored. The theoretical framework for this study is based on evidence from evolutionary biology and environmental psychology. From the biological perspective, the Biophilia Hypothesis (Wilson 1984; Buss 1995) contends that nature contact is a healthy environmental exposure that reduces stress and therefore promotes health in people today because of the linkage to the past; nature is 'biologically familiar.' From the psychological perspective, Attentional Restoration Theory (Ulrich et al. 1991; Kaplan 1995) was developed to further explore the exact mechanism of nature and well-being. Attentional Restoration Theory suggests that nature contact promotes health by reducing stress. Specifically, there are two leading explanations on how nature may reduce stress. First, nature may stimulate less utilized areas of the brain and shift concentrated attention away from stressors and thus reduce perceived demands. Second, nature may restore fatigued cognitive resources, such as attention or problem solving, resulting in restored coping resources to effectively manage stress. (Frumkin 2001; Largo-Wight 2011) Finding ways to reduce perceived stress in childhood is important because it is clearly a risk factor for poor health outcomes, risk behavior, and poor learning, even impacting individuals into adulthood. (Fagundes et al. 2013). It is important to determine if/how nature contact interventions (and healthful environments designed with elements of nature contact) can benefit children by reducing stress, improving well-being, and improving learning.

Nature contact through outdoor classroom

Nature at school is important. In a study among European preschoolers, for example, researchers found that as time outdoors increased, hyperactivity decreased, and attention increased (as measured by a standardized digit span assessment). (Ulset et al. 2017) Findings like these point to the importance of outdoor time and 'green play' at school. However, these initiatives are often not successful or sustainable in public schools today. There seems to be 'less time' for outdoor free play. The increasing emphasis on assessment of student learning (and constraints of resources) may limit a school's health and whole-child initiatives, including unstructured outdoor play. (Council on School Health 2013; Bohn-Gettler and Pellegrini 2014) With these current challenges, it is important to explore feasible nature contact interventions at the school. The outdoor

classroom is important to study because it has potential to provide a ‘large dose’ of outdoor exposure without disrupting current academic agendas.

Thus, the concept of outdoor classroom is emerging. Outdoor classrooms are increasing in popularity because of supporting science and practicality. The use of an outdoor classroom for core and required subjects, such as mathematics or literacy, shows great promise. Outdoor classrooms that meet instructional and academic demands may be practical and fit within current public education realities. (Kenney et al. 2003; Braund and Reiss 2004; O’Brien 2009; Rosaleen 2012) Despite the potential, research is limited and studies are primarily correlational and qualitative. (Dyment, 2005; Quay et al. 2002; Broda 2007; Bell and Dyment 2008; O’Brien 2009; Moe 2010; Moffett 2011; Eick 2012; Rosaleen 2012; Fägerstam and Blom 2013; Feille 2013; Jong 2013; Maynard et al. 2013; Thorburn and Allison 2013; Chawla et al. 2014; Sharpe 2014; Becker et al. 2017) The preliminary studies suggest that the outdoor classroom may be suitable for fostering or enhancing reading comprehension and engagement, on-task behavior, ability to express ideas and concepts through drawing, supportive peer interactions, motivation for reluctant learners, environmental ethic and knowledge, and reduced discipline and classroom management issues. For example, Eick (2012) found that outdoor learning and ‘nature-study’ improved science instruction and literacy among third graders. This study, along with most other published findings, took place in Europe and used qualitative methods to review the teacher’s notes. (Eick 2012) Maynard and colleagues (2014), also in the United Kingdom, revealed that teachers who incorporated outdoor classrooms reported more child-centered teaching attitudes and approaches. (Maynard et al. 2013) Fagerstam and Blom (2013) conducted interviews with students in Europe and revealed students taught in an outdoor classroom had increased learning and social interaction-related benefits. (Fägerstam and Blom 2013) Researchers in the United States also found that incorporating outdoor grounds (to support instruction and educational experimentation) appeared to reduce students’ perceived stress (per student interviews among American children). (Chawla et al. 2014) Also, a 2017 review of literature was completed on student-level outcomes of students’ exposure to outdoor education; similar learning and health related benefits were highlighted. (Becker et al. 2017) These preliminary findings suggest that outdoor learning at school appears to be a promising health intervention.

However, there is a great need for additional research for four primary reasons. First, experimental design studies are needed to assess the impact of outdoor classroom as a school-based nature contact intervention. This approach would help better understand the degree that nature exposure at school improves health and learning outcomes. Second, there is a need for additional data collected with sound quantitative methods (with established reliability and validity). Third, there is a need to study the benefits of using of an outdoor classroom as part of the ‘daily routine’, rather than supplementation (or experimentation). Similarly, there is a need to isolate the impact of the *outdoor space* and nature contact alone, independent of the education within the space. It is important to understand if a ‘classroom without walls’ that provides nature contact exposures, is beneficial for children. Fourth, much of the research has been conducted in Europe. There is a need to systematically study and isolate the impact of daily nature contact at school on child well-being and development in the United States.

To our knowledge, experimental designs have yet to be completed that isolate the impact of space or nature only; there is a need to study nature contact exposure while controlling for possible confounders (such as teaching methods, lessons, and instruction) by ensuring the same experience (other than nature contact exposure) in both classroom spaces. This study will meet this important research and practical need. Improving child health and child learning in K-12 schools in the United States is a great societal importance and requires a whole child approach with collaboration from health and education sectors. (Lewallen et al. 2015) The objective of this study was to address the research need and societal need by determining the impact of academic

lessons in an outdoor classroom space (nature contact exposure) on children. Specifically, the aim of this study was to determine the efficacy of learning in an outdoor classroom on the children's attention and health. This study's research question was: Does the outdoor classroom (nature contact exposure) improve children's behavior, attention, and well-being compared to the indoor classroom (control)?

Methods

This study was approved by IRB Institutional Review Board. The teachers gave informed consent to participate in the study. The parents gave informed consent for their child(ren) to participate in the study. The children gave assent to participate in the study.

Participants and study design

A basic outdoor classroom was designed and built at a public elementary school in the southeast United States. An experimental crossover design was used with the outdoor classroom representing the treatment condition and the indoor classroom representing the control condition. Data were collected on 33 days during mid-March to mid-May from 10:30–11:00am.

Two kindergarten classes participated in the study. Each class consisted of a teacher, assistant teacher, and 18 kindergartners. This sample represented a convenience sample. Over the six-week study, the teachers taught their respective kindergarten classes their regularly scheduled language arts writing lesson daily in either the indoor or outdoor classroom. The two kindergarten classes rotated where they delivered the writing lessons; classes were either in the outdoor classroom (treatment condition) or indoor classroom (control condition) during the study. On a standard data-collection day, one research assistant collected data in the indoor classroom while the other research assistant collected data in the outdoor classroom. Interrater reliability was assessed on 11 days where both research assistants collected data on both classes together.

Intervention

The outdoor classroom (see [Figure 1](#)) was located on the school's play yard under a tree and shade tents. The space was defined with a circular boundary of tires, tree stumps, and potted plants. Children sat on carpet squares and used clipboards for writing. The teacher used a chalkboard for instruction.



Figure 1. Indoor classroom (left) and outdoor classroom (right).

Observation methods and instrumentation

Prior to the data collections, researchers were trained on the data-collection methods. This training period was two-weeks in duration and focused on practicing and mastering the observation data collection methods in the outdoor and indoor classrooms. In addition, the teachers provided feedback to minimize classroom distractions.

Data was collected on 33 days over six weeks. Researchers observed both the treatment and control conditions daily. Three outcome measures were assessed during and after the daily writing lesson. Child engagement behavior (teacher redirections) and child focus and attention (on-task behavior) were collected via researcher observation frequency counts. Child happiness and well-being was assessed via Likert-scale surveys administered to the children daily and to the teachers at the conclusion of the study. Inter-rater reliability was measured 11 of the 33 days during the six-week study.

Inter-rater reliability

The degree of rater/observer agreement was measured on 11 days when two raters were present and observing the four outcome measures. The four outcomes included: (1) the average number of students off-task per minute per data collection period, (2) the average number of 15-second periods for which at least one student was off task per data-collection period, (3) the average number of teacher redirects per minute per data collection period, and (4) the average number of 15-second periods for which at least one redirect occurred per data-collection period.

Child behavior methodology

Students' behavioral participation and engagement in the lessons is important for both learning and whole child wellness. (Bradley and Green 2013; Lewallen et al. 2015) During the observation block, researchers kept a count of the number of teacher redirections of child behavior per minute. Teacher redirections were operationalized any time the teacher redirected child behavior through verbal (eg 'show me how you can work on your sentence') or nonverbal (eg pointing to child's paper, snapping, raising eyebrow, and clapping). Teacher redirections represented a measure of children's behavior and specifically participation in the writing lesson.

Child attention and focus methodology

Students' attention and focus at school is important predictor for and correlate of holistic well-being among youth. (Bradley and Green 2013; Lewallen et al. 2015) Attention was measured through a count of children that were 'off task.' During the observation block, researchers kept count of the number of children 'off task' every 15 seconds. Researchers were alerted every 15 seconds through an iPhone timer with ear buds. The buzz would prompt researchers to count the number of children off task at that moment. Off task was operationalized as any behavior other than the intended behavior (eg talking about something other than the activity, playing with something unrelated to the activity, looking away from the activity or at something unrelated).

Child happiness and well-being methodology

In addition, children completed a brief, self-reported 'Face Scale' survey after every writing lesson. The modified Face Scale in this study consisted of one question, 'How did you feel during the lesson today?' The response options consisted of three faces: a smiley face, a straight face, and a sad face. The Face Scale has been widely used among preschoolers and young children to measure a variety of emotional outcomes such as quality of life, perception of pain, and happiness. (Eiser et al. 2000; Voepel-Lewis et al. 2002; Holder et al. 2009; Holder and Klassen 2010) In addition, the teachers completed an online survey at the conclusion of the six-week study to measure teachers' perspectives on children in the nature and control conditions. The child well-being and happiness question to the teachers was: 'In general, how did the children seem to enjoy LMNOP [language

arts writing lesson] in the outdoor classroom compared to indoor classroom [over the six weeks]?’ The response options consisted of the following 5-item Likert scale: ‘much better in outdoor classroom (1), somewhat better in outdoor classroom (2), no difference in outdoor and indoor classrooms (3), somewhat worse in outdoor classroom (4), much worse in outdoor classroom (5).’

Statistical analysis

JMP 11 and SAS 9.3 were used for data analysis. The child behavior variable was measured daily by teacher redirections during one-minute interval divided by the number of children present. The child attention variable was measured daily by the number of children off task during one-minute interval divided by number of students present. Child well-being was measured both daily through the Faces Survey by the percent of *smiley faces* reported and post-only through teacher survey. For each of these measures, direct comparisons were made using independent samples *t*-tests with associated confidence intervals. Child behavior was also analyzed using a mixed effect model in which teacher was treated as a random effect while day (a measure of the time effect) and environment (treatment group) were fixed effects. A mixed effect model with percent smiley faces as the response and classroom environment (indoor/outdoor) and teacher (random effect) as predictors was fit. Interrater reliability was measured 11 of the 33 days with paired *t*-test on the means of the following outcomes: (1) the average number of students off-task per minute per data-collection period (child attention), (2) the average number of 15-second periods for which at least one child was off task per data-collection period (child attention), (3) the average number of teacher redirects per minute per data-collection period (child behavior), and (4) the average number of 15-second periods for which at least one redirect occurred per data-collection period (child behavior).

Results

Demographic characteristics

The two kindergarten teachers in this study were white females that held Bachelor’s degrees in early childhood education (age three through 3rd grade) and English Speakers of Other Languages (ESOL) endorsements. All children in the study were aged five and six years old.

Teacher 1 taught an inclusion class with 18 students (nine boys, nine girls). Two of the children were identified as having special needs; one child was diagnosed with autism and the other child had a language impairment requiring outside speech services. The ethnicity breakdown in Teacher 1’s class was as follows: 16 of 18 or about 88% of the students identified as White, non-Hispanic ($n = 16$); one or about 6% of the students identified as Black/African American ($n = 1$); and one or about 6% of the students identified as Hispanic/Latino ($n = 1$).

Teacher 2 was more experienced and served as the lead teacher for the grade level. Teacher 2’s class had 19 students (11 boys, 8 girls). Three of the children were diagnosed with special needs; two students were diagnosed with language impairments and received speech services and one child was diagnosed with an ‘other health impairment.’ The ethnicity breakdown in Teacher 2’s class was as follows: 16 of the 19 or 85% of the students identified as White, non-Hispanic ($n = 16$); one or 5% of the students identified as Black or African American ($n = 1$); one or 5% of the students identified as Hispanic or Latino ($n = 1$); and one or 5% of the students identified as multiracial ($n = 1$).

Interrater reliability

Interrater reliability was measured 11 of the 33 days during the six-week study. Paired *t*-tests revealed no differences between the two raters for the four outcomes observed: (1) the average

number of students off-task per minute per data-collection period, (2) the average number of 15-second periods for which at least one student was off task per data-collection period, (3) the average number of teacher redirects per minute per data-collection period, and (4) the average number of 15-second periods for which at least one redirect occurred per data-collection period. See Table 1 *p*-values for the paired *t*-tests. The two raters' observations were highly positively correlated.

Child behavior

Child behavior was measured by teacher redirections of child behavior. Table 2 summarizes the number of teacher redirects per minute per student by condition (indoors/outdoors) and teacher. The summary data suggest a treatment effect in which the rate at which redirections occur is lower for the nature condition. This is true for each teacher.

The rates at which redirects occur were affected by the teacher but the rate was lower for the nature condition (outside classroom) for both teachers. An independent samples *t*-test with equal variances assumed indicated that for the aggregated data there was no significant difference between average redirects per minute per child the classrooms (difference = 0.0127, $p = 0.1383$). Similarly, there was no significant difference for Teacher 1 ($p = 0.4711$). However, for teacher 2, the lead and more experienced teacher, the rate of redirects was significantly fewer for the outside

Table 1. Average rater observations and paired *t*-test results for interrater reliability.

	Rater 1	Rater 2	Difference in Means (SED)	<i>t</i>	<i>p</i> value For paired <i>t</i> -test on means (DF)	Correlation <i>r</i> (Significance)
	Mean	Mean				
1. AVG # of students off-task per minute per data collection period	3.036	2.709	0.327(0.192)	1.703	0.119(10)	0.922 (0.0001)
2. AVG # 15 s periods for which at least one student was off task per data collection period	1.864	1.755	0.109(0.073)	1.491	0.167(10)	0.952 (0.0001)
3. AVG # of teacher redirects per minute per data collection period	1.118	0.982	0.136(0.095)	1.426	0.184(10)	0.876 (0.0004)
4. AVG # of 15 s periods for which at least one redirect occurred per data collection period	0.664	0.618	0.046(0.039)	1.165	0.271(10)	0.884 (0.0003)

Note: SED represents the standard error of the difference

Table 2. Number of teacher redirections per minute per student by classroom environment (indoors/outdoors nature contact) and teacher with 95% confidence intervals.

Environment	All			Teacher 1			Teacher 2 (Lead)		
	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>
IN	0.0834	0.0696	140	0.0741	0.0729	90	0.1001	0.0606	50
OUT	0.0707	0.0654	115	0.0645	0.0729	45	0.0747	0.0603	70
IN – OUT	Mean	<i>t</i>	<i>p</i>	Mean	<i>t</i>	<i>p</i>	Mean	<i>t</i>	<i>p</i>
IN – OUT	0.0127	1.487	0.138	0.0096	0.723	0.471	0.0254	2.27	0.025
IN – OUT	SED	LCL	UCL	SED	LCL	UCL	SED	LCL	UCL
IN – OUT	0.00853	–0.00411	0.02947	0.00962	–0.0167	0.03593	0.0112	0.00324	0.0475

Note: *p* is *p* value for independent samples *t* test assuming equal variances with SED (standard error of the difference), LCL (lower 95% confidence limit), and UCL (upper 95% confidence limit).

Table 3. Mixed model for number of teacher redirects per minute.

Term		Estimate	Std Error	DFDen	t Ratio	Prob > t
Intercept		0.120998	0.013421	2.12	9.02	0.0100*
Day		−0.004665	0.000810	251.3	−5.76	< .0001*
1 = In 2 = Out[1]		0.010416	0.004187	250.4	2.49	0.0135*
Random Effect	Var Ratio	Var Component	Std Error	95% Lower	95% Upper	Pct of Total
1 = Tch1 2 = Tch2	0.0531462	0.000213	0.000349	−0.000471	0.000897	5.046
Residual		0.004008	0.000358	0.003390	0.004813	94.954
Total		0.004221	0.000498	0.003393	0.005396	100
Level	Least Sq Mean		Std Error	Lower 95%	Upper 95%	
1 = In	0.08760		0.0117141	−0.0109621	0.1861625	
2 = Out	0.06677		0.0119436	−0.0200739	0.1536097	

Note: DFDen represent degrees of freedom for the denominator for the Kenward-Roger F-test (JMP13 fixed effects mixed model).

Table 4. Number of students off task per minute per student by classroom environment (indoors/outdoors nature contact) and teacher with 95% confidence intervals.

Environment	All			Teacher 1			Teacher 2 (Lead)		
	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>
IN	0.1574	0.0679	140	0.1561	0.071	90	0.1597	0.0625	50
OUT	0.1384	0.0572	115	0.1389	0.0638	45	0.1379	0.0529	70
	Mean	<i>t</i>	<i>p</i>	Mean	<i>t</i>	<i>p</i>	Mean	<i>t</i>	<i>p</i>
IN – OUT	0.0189	1.169	0.244	0.0171	0.678	0.4992	0.0217	0.982	0.328
IN – OUT	SED	LCL	UCL	SED	LCL	UCL	SED	LCL	UCL
IN – OUT	0.01624	−0.013	0.05097	0.02518	−0.03275	0.06689	0.02211	−0.02207	0.0655

Note: *p* is *p* value for independent samples *t* test assuming equal variances with SED (standard error of the difference), LCL (lower 95% confidence limit), and UCL (upper 95% confidence limit).

classroom (difference = 0.0254, $t = 2.27$, $p = 0.025$); that is, the average number of redirects per minute per child was 0.0254 less in the outside classroom (with 95% confidence between 0.003 and 0.048). In a five-minute block of the lesson with 20 children, the experienced teacher had approximately 2.5 fewer observed child behavior redirections in the outdoor classroom (7.5 redirections) compared to the indoor classroom (10 redirections).

A mixed effect model (fitted using REML) with the average number of behavioral redirections per minute per student as the response and environment and day (a measure of time) as fixed effects and teacher as a random effect was significant ($R^2 = 14.1\%$). The REML estimate for the percentage of variability attributable to teacher was relatively low (5.05%: 95% confidence interval 0.0% to 21.2%). Both classroom condition ($t = 2.49$, $p = 0.0135$) and day ($t = -5.76$, $p = 0.0001$) were highly significant. The rate at which redirects occurred was significantly fewer in the nature condition (outdoor classroom) and decreased over the course of the six-week study for both treatment groups. See Table 3 for parameter estimates and note that the coefficient for day is negative and for environment the coefficient associated with IN is positive. The least squares estimates for the average number of redirections (In = 0.0876; Out = 0.0667) indicate the benefit associated with the outdoor classroom.

Child attention and focus

Attention was measured by the number of students off task in a one-minute interval. Table 4 summarized the number of off task per minute per child by condition (indoor/outdoor) and teacher. In a five-minute block of the lesson with 20 children, there were approximately two fewer observed incidences of children off task in the outdoor classroom (14 off task incidents) compared to the indoor classroom (16 off task incidents). While the summary data suggest a nature effect (off task behavior occurred at a rate lower for the outside classroom for both teachers), the difference was not statistically significant at the 5% level ($t = 1.17$, $p = 0.244$).

Child happiness and well-being

Child well-being was measured with a daily Faces Survey with three response options (Eiser et al. 2000; Voepel-Lewis et al. 2002; Holder et al. 2009; Holder and Klassen 2010) and with post-only teacher survey. The well-being response did not differ in the control and treatment condition; on average, children selected the same face in response to the question ‘how did you feel during the lesson today?’ in both classrooms over the six-week study. The *t*-test comparing the percent of smiley faces in the indoor and outdoor was nonsignificant ($t = 1.71$, $p = 0.097$). An ANOVA analysis controlling for time and teacher also failed to show a significant difference between the percent smiley faces for the two groups. A mixed effect model with percent smiley faces as the response and classroom environment (IN/OUT) and teacher (random effect) as predictors was fit ($R^2 = 59.3\%$). The REML estimate for the percentage of variability attributable to teacher was 71.3% indicating that teacher strongly affected the smiley face percentage. For the mixed effect model, the environment was not a significant factor ($F = 0.6489$, $p = 0.4256$). Within teacher there was no significant difference attributable to environment (independent samples *t*-tests with each $p = 0.2907$).

Perceived child happiness and well-being data was also collected from the participating teachers via online survey. The teachers reported that the children enjoyed their daily language arts writing lessons somewhat more in the nature condition compared to the control. Both teachers reported that the children’s enjoyment was ‘somewhat better in the outdoor classroom (2)’ compared to the indoor classroom. The ‘somewhat better’ response option was the second of five ordinal responses options, where response option one (‘much better’) represented the greatest well-being and enjoyment and response option five (‘much worse’) represented the least well-being and enjoyment in the nature condition compared to the control.

Discussion

Nature contact appears to be critical for healthy child development and well-being, a disconnect from nature – excessive indoor time – may be problematic. (Wells 2000; Wells and Evans 2003; Castonguay and Jutras 2009; Kuo 2013; Waite et al. 2013; Christian et al. 2014; Klinker et al. 2014; Ulset et al. 2017) There is great potential to incorporate nature contact into the school day to promote well-being. However, challenges exist for ‘noncore’ health programming because of increased emphasis on student assessment and budgetary constraints (Council on School Health 2013; Bohn-Gettler and Pellegrini 2014) There is a clear need to innovate and develop practical solutions. The outdoor classroom appears to be a realistic way to incorporate nature contact among children into the school day. (Rosaleen 2012)

In this study, the nature condition (outdoor classroom) appeared to have modest benefits; there were fewer teacher redirections of student behavior, fewer students off task, and teacher-reported evidence of somewhat better well-being in the outdoor classroom. It is important to note that these instructional writing lessons were identical in the indoor and outdoor classrooms; the benefits appear to be a direct result of the environment and nature contact exposure.

The outdoor classroom had fewer behavioral issues, as measured by the number of teacher redirections. The difference was significant for teacher 2, the more experienced, lead teacher. Teacher 2 had approximately 25% fewer observed child behavior redirections in the outdoor classroom (7.5 redirections) compared to the indoor classroom (10 redirections) over the course of the six weeks. Because Teacher 2 was identified as the grade-level lead teacher and served a mentor for Teacher 1, the significant findings with Teacher 2 are particularly relevant. This preliminary finding suggests nature contact exposure in an outdoor classroom may foster a sense of well-being and behavioral control. Future replication studies with larger samples of teachers and classes are warranted.

In addition, as the study progressed, teacher redirections decreased further in the outdoor classroom (compared to the indoor classroom). It appears that the outdoor classroom may have become increasingly beneficial compared to the indoor classroom as time progressed. This has important implications for future research. This crossover study lasted six-weeks and the treatment and control sequence rotated daily (eg Monday class1 out, class2 in; Tuesday class1 in, class2 out). Future researchers should consider a longer implementation period and a longer sequence of the treatment and control (eg first 4 weeks = class1 out and class2 in; second 4 weeks = class1 in and class2 out). This approach could help to explore the impact of time while controlling for maturation. Specifically, this will allow future researchers to explore cumulative effects and carry-over effects of the nature condition.

The second outcome measure was child focus and attention. There were fewer number of children off task during the writing lesson in the nature condition. On average, there were approximately 9% fewer observed incidences of children off task in the outdoor classroom (14 off task incidents) compared to the indoor classroom (16 off task incidents), although this difference did not reach statistical significance. Future researchers should further explore this topic by considering variations of the off-task data collection such as randomized observation intervals as well as longer data collection periods, and longer (> 5 min) observation periods of off task.

Previous findings suggest nature contact reduces stress to promote well-being. In this study, there were mixed results. The teachers observed that the outdoor classroom was 'somewhat better' than the indoor classroom for child enjoyment and well-being. However, child-reported feelings of happiness were not higher in the nature condition as expected. There were no significant differences in the percent of smiley faces reported by the children in response to the question 'how did you feel during your lesson today' in the two classrooms. Unexpectedly, the teachers had different percentage of smiley faces reported. This may be a result of the Faces Survey, differences between the teacher 1 and teacher 2 (lead teacher), and or because of the extensive data collection and implementation. Researchers in this study observed and noted increasing issues and concerns with the use of the Faces Survey throughout the six weeks. The children completed the Faces Survey after every writing lesson over the 33-day study. Researchers observed that children began to 'play' with the Faces Survey over time. Researcher observation notes included, for example, 'two students circled all three faces on survey' and 'one student drew own face on survey.' Participant fatigue may have impacted these findings. Less frequent data collections should be tested in future studies.

Future researchers should explore additional ways to assess child well-being. The Faces Survey used in this study has been previously used to measure happiness among young children, but the optimal sampling frequency is not well understood. (Holder and Klassen 2010) Taken together with future cross-over research design recommendations, future researchers should assign classes to the nature contact outdoor classroom for a block of several weeks (and then switch to a control condition). At baseline and at post-test of each condition, the researchers should administer the Faces Survey, but they should not administer Faces Survey each day.

In addition, future research should assess additional measures of health and well-being. In this study, our measures included daily Faces Survey and post-only teachers' perception of child well-being. Although the teachers' data provided some support for well-being, there were only two teachers in the study. Future researchers should consider additional measures such as physiological indicators of stress and well-being and or parent perceptions.

Upon initial review, these findings may be counterintuitive; it seems reasonable to hypothesize that the outdoor classroom would stimulate the children (Holder et al. 2009) and negatively impact attention and behavior. Interestingly, we found no evidence to support this. In fact, we were often surprised while qualitatively observing the children during their writing lessons; the children did not appear to be distracted when a loud motorcycle drove by or when a bird sang loudly nearby. In contrast, in the indoor classroom, the children reacted to routine noises such as a classroom door closing. Future research should measure external noises and distractions (independent of students' behavior and or attention) in both settings. In addition, future researchers should focus on understanding and optimizing design-related features of the outdoor classroom.

In summation, these findings have important and practical implications for improving child health and learning. Our findings provide modest support for the outdoor classroom as an effective nature contact intervention to foster learning and well-being at school.

Limitations

The sample size and the number of teachers were important limitations to this study's findings. Two teachers and 36 children participated in this study. In addition, one teacher in the study was a first-year, novice teacher. This sample of children and teachers represented a convenience sample. A convenience sample was used for two primary reasons. First, this study is the first of its kind and there is no published literature to call upon. Second, this study was an extensive, applied study that required considerable commitment from several stakeholders; because we collected data every day for over two months (including the training period) researchers worked closely with the school administrators, teachers, and parents to ensure that children educational and personal need would not be negatively impacted by the presence of researchers and participation in the study. The sample was ultimately based on feasibility and thus a convenience sample. With significant funding, future researchers should incorporate a larger and more diverse sample of teachers, classes, and children to explore the impact of outdoor classrooms on well-being.

Measurement frequency and the measures were also a possible limitation. As previously mentioned, the Faces Survey measurement frequency may have affected the students and the results. Future researchers should consider less-frequent measurements with longer sequences (in the treatment and control). In other words, class1 may spend the first four weeks in the outdoor classroom and the second four weeks in the indoor classroom and class2 may do the reverse. In that scenario, well-being could be collected only once for each class at the conclusion of each condition. This would account for maturation threat to validity, but may be a more optimal measurement frequency for the self-reported Faces Survey. In addition, physiological measures of stress and well-being, such as salivary cortisol, and parents' perceptions should be considered in future studies.

Last, this study was conducted in the Southeast US. The weather was conducive to spending time outdoors. During the six weeks, it was primarily sunny with temperatures that ranged from the low 70s to mid 80s. The generalizability of this study's findings to areas of the country or world that have more severe weather or temperatures present a possible limitation. Would children in the Mid-West US or Germany, for example, benefit from an outdoor classroom as children in this study did? This question warrants future research. However, we expect the use of a school-based outdoor classroom to be similar to the use of a school playground or play yard. For some regions, the use will be seasonal, whereas in other areas it may be year-round similar to a school playground or play yard. (Frost 2012)

Conclusions

Initiatives such as 'Health by Design' and 'Healthy People in Healthy Places' highlight the need for public health efforts to include environmental contexts to facilitate lasting health and health behavior changes. (Largo-Wight 2011) Creating places that facilitate health and behaviors are some of the most promising approaches in public health. This is especially true in schools. (Jones et al. 2007; Kolbe et al. 2015) There is a growing recognition that the school's physical environment is an important factor for children's overall well-being including academic achievement and health. (Jones et al. 2007) A movement toward 'Whole School' with collaborative partnerships further reinforces the importance of the environment on the child's well-being. (Kolbe et al. 2015) Outdoor classrooms are a promising addition to a healthy school environment. In this study, students used the outdoor classroom for academic lessons in the same way they used the indoor

classroom. Outdoor classrooms appear to foster child health and well-being within the context of school realities, while meeting academic demands.

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