Effects of Nature-Based Learning on Elementary Students' Sustained Attention: An Exploratory Study

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Abstract

Nature-based learning (NBL) is a growing approach to education, and is backed by decades of research showing that when people spend time outside, they experience benefits to their physical and mental health, relationships, academic performance, and beyond. As this style of education gains traction, it is important to explore the impact it has on students. The present study looked at the impact of NBL on the sustained attention of 16 fifth grade students by evaluating their sustained attention ability directly before and after a NBL lesson and an indoor control lesson. Results showed that after students experienced a NBL lesson, they responded significantly faster on a sustained attention measure, as compared to the pre-lesson results and the indoor control lesson results. Implications of this research and further research recommendations are provided.

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Chapter 1: Introduction

Background

One afternoon in early spring, the five children at a community nature preschool were vibrating with energy. They were jumping off couches, yelling, running in circles, wrestling, and seemed like they needed to be physically feeling the world. It seemed impossible to hold their attention. The teachers felt it necessary to get them outside as soon as possible, and went through the tough task of getting them well-dressed for soft March snow. As soon as they made it into the yard, their energy seemed to expand and relax. One child, who had been wrestling inside and yelling “I just want to fight!” was now jumping into deep snow and burying himself. Another, who had been jumping on and off the couch, was lying in the snow counting all the flying things she could see. Aloud, she guessed whether they were planes, ravens, or eagles. Two other children were building a snow castle together - sharing the “best” snow between them. When they went back inside a bit later, they were able to focus deeply on an activity about tree buds, sharing space and ideas with ease. Their fractured attention was seemingly healed by time spent connecting with the natural space right outside.

This experience of fractured attention is increasingly common in youth today. A recent study found that among children aged 6-11 years, the prevalence of attention-deficit/ hyperactivity disorder (ADHD) diagnoses is 9.3% (Bitsko et al., 2022). This population of students takes up a significant amount of school resources. While a staggering 69.3% of students with ADHD receive one or more school services, a recent study found that at least one in five students with ADHD are not receiving school services despite experiencing significant academic and social impairment (DuPaul et al., 2019). Nevertheless, a student does not need a diagnosis of ADHD to feel the symptoms of inattention and impulsivity. Throughout the school day and the

rest of their lives, children are asked to attend to many things they may not care about much. A math worksheet, a history lecture, or a whiteboard list of household chores may not be inherently stimulating enough to grab a fifth grader's attention, yet we expect them to pay attention to such things with enough quality that they complete these tasks. It may be no surprise that their attention is susceptible to fatigue throughout the day.

Another aspect that has arisen is the increase in "screen time" and mobile apps that are designed specifically to be stimulating enough to grab and hold the attention of young minds. A record 3.8 trillion hours were spent on mobile apps in 2021 (Flynn, 2022). This time spent is profitable. Globally, $336 billion was spent on ads in 2022 (*State of Mobile 2023*, n.d.). We see that mobile devices are being given to young minds more and more. Yearly hours spent on "early childhood learning" apps grew from 2.14 million in 2019 to 34.54 million in 2022. This means that American children are spending 16 times as many hours in early childhood apps than they were just 3 years earlier (*State of Mobile 2023*, n.d.).

This intense demand for our youth's attention is experienced in more than just their screen time. In formal learning settings, school-age students are asked to attend to information that is important, but perhaps uninteresting, which can drain their ability to pay attention (S. Kaplan & Berman, 2010). Environmental psychologists have identified two ways to conceptualize attention: direct attention, when "attention is directed by cognitive-control processes," and indirect attention, when "attention is captured by inherently intruding or important stimuli" (Berman et al., 2008, p.1207). These have also been named 'voluntary' and 'involuntary' attention due to the conscious or less conscious experience of each. Essentially, directed attention is the ability to focus attention and ignore distractions (Kaplan, 1995).

The terms sustained attention and directed attention are used similarly in the literature to refer to the mechanism of "top-down" attention, that is, attention that requires effort and voluntary control (Pinto et al., 2013). Where directed attention refers to the voluntary ability to focus attention without distraction, sustained attention refers to the ability to sustain this effortful attention over time (Berman et al., 2008; Betts et al., 2006). For the purpose of the study at hand, we will use the term *sustained attention*.

Commonly referred to as "concentration" or "focus" in everyday life, sustained attention refers to the ability to maintain attention on goal-directed activities over an extended period of time (Betts et al., 2006). Sustained attention has been identified as a common resource for executive functioning and self-regulation, indicating that an increase in sustained attentional skills will benefit overall executive function and self-regulation abilities (Kaplan & Berman, 2010). Sustained attention abilities have been positively correlated to academic skills like math fluency, reading comprehension, and statewide standardized test scores in both laboratory and real-world settings (Gallen et al., 2023). In addition to executive function, self-regulation, and academic skills, sustained attention also assists with memory, cognition, and emotion (Berto, 2005; Jonides et al., 2008; Posner & Rothbart, 2007; Taylor et al., 2002).

The ability to sustain attention has been shown to deteriorate as one focuses on a task, and this process of deterioration may also be referred to as directed attention fatigue (Kaplan, 2001). When one's ability to focus attention has depleted, staying on task and inhibiting impulses becomes increasingly challenging. Through their research, Rachel and Stephan Kaplan found that natural environments assist in the recovery from attentional fatigue, supporting their theory of Attention Restoration (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995, 2001). Even brief exposure to nature has been linked to a decrease in inattention and impulsivity - common

symptoms of ADHD (Lee et al., 2015). Additional research has looked at the positive impact of nature exposure on attentional performance tasks such as the backwards digit span and attention network task (Berman et al., 2008; Dadvand et al., 2017). The restorative effects of nature have been highlighted in multiple studies and research reviews since the Kaplans first described ART (Basu et al., 2019; Crossan & Salmoni, 2021; Lee et al., 2015; Ohly et al., 2016). While much of this research has looked at the effect of nature exposure on adults, some studies have investigated its effects on children. For example, one study found that children who took a 30-minute walk in a natural environment produced a faster and more stable pattern of response on a task measuring attentional skills (Stevenson et al., 2019). When children spend time in these natural spaces, studies show overall benefits to their concentration and focus (Faber Taylor & Kuo, 2009; Moll et al., 2022; Taylor & Kuo, 2006).

Given the significant potential for nature exposure and experiences to positively influence attentional skills, teachers and caregivers of children may be particularly interested in integrating nature exposure as an essential part of a child's school day. One well-documented approach is through nature-based learning (NBL). According to Dr. Cathy Jordan (2022), Consulting Research Director for the Children & Nature Network, NBL can be understood as

> an educational approach that engages children with the natural environment and natural elements as a pathway for learning. NBL includes learning about the natural world, but extends to engagement in any subject, skill, or area and is often implemented in interdisciplinary ways (para 2).

Studies show that incorporating NBL throughout K-12 education is associated with positive effects on classroom engagement (Kuo et al., 2018), increased focus, and decreased negative behavior (Claffey-Bow, 2017; Salsabila & Muna, 2023). NBL is further associated with

many beneficial qualities in academics: higher test scores, increased attendance, increased engagement with math, improved problem-solving skills, and increased cooperation and interpersonal communication skills (Smith & Sobel, 2014).

In light of the integral role sustained attention plays in academics and everyday functioning, it is important to investigate the potential of NBL to enhance the students' sustained attention, particularly the sustained attention capacity that students bring to subsequent indoor academic learning. This would further underscore the merit of NBL within formal education.

Grounding Theoretical Context

In his 1798 book *On Attention and its Diseases*, Sir Alexander Chrichton may have been the first to describe attention in a written form, as a way an external object occupies one's mind (p. 200). Since then, research has identified this ability as a valuable resource that can be depleted (Kaplan & Berman, 2010). As mentioned in the earlier section, direct attention fatigue contributes to challenges of focus, irritability, social situations, and more (Kaplan, 2001).

Fortunately, research shows that this resource can be replenished. Research in Attention Restoration Theory (ART) has found that exposure to nature restores direct attention. Pictures of natural scenes, a walk in the park, and even the act of looking out a window have all been shown to replenish our ability to sustain attention (Berman et al., 2008; Kaplan, 1995, 2001; Kuo et al., 2019; Lee et al., 2015; Stevenson et al., 2019). Children and adolescents who are exposed directly to nature are likely to have better cognitive development (Dadvand et al., 2015), higher academic performance (Gallen et al., 2023; Kuo et al., 2019), and increased emotional resilience (Chawla et al., 2014).

With the multitude of benefits of nature exposure and NBL, educators and researchers have been investigating more nature-integrated structures for learning. David Kolb's experiential

learning theory posits that an engaging and tangible learning experience is best integrated when there is a space for four modes of learning: concrete experience, reflective observations, abstract conceptualization, and active experimentation (Kolb, 1984). NBL is supported by this theory, as natural spaces inherently encourage these four elements of learning. For instance, picture a child discovering holes in some tree bark. They might first experience the situation when they are captivated by the sight, and then come up with many ideas about how and why this happened. Maybe it reminds them of something else they've seen at their grandma's house. Their next step might be to pick at the bark to see if there is anyone living inside the holes. That concrete experience could start the process all over again. There are then a multitude of ways to integrate this experience into writing, physics, biology, mathematics, and beyond. Of course, this process may happen in a matter of seconds for a young mind, and the point is that a natural environment holds an abundance of spaces in which to be curious, and inherently provides a space for the experiential learning cycle. This mode of learning helps to explain why experiences in nature may be conducive to supporting sustained attention skills.

With over 4 million students in the United States having reported emotional, cognitive, and behavioral disabilities, teachers are constantly faced with the challenge of holding students' attention (Szczytko et al., 2018). Research suggests a positive relationship between nature exposure and children's cognitive and emotional recovery (Moll et al., 2022), and classroom engagement has been shown to increase after NBL experiences (Kuo et al., 2018). The proposed research aims to add to the literature specific insight into the aftereffects of NBL on students' sustained attention.

Research Purpose and Question

While traditional classrooms may not hold all the characteristics of a restorative environment, many schools have access to outdoor spaces they could utilize for the enhancement of sustained attention. The purpose of this study was to explore if a NBL activity will have continued positive effects on sustained attention upon returning to the classroom. Specifically, the following research question guided the study: Are there positive aftereffects of a NBL experience on elementary students' sustained attention? The study hypothesis was that when children have time outdoors and the opportunity to learn and observe nature and reflect on those observations, their sustained attention after returning indoors is better than if they had remained in indoor classroom learning.

Definition of Terms

Sustained Attention

Sustained attention refers to the ability to maintain attention on goal-directed activities over an extended period of time (Betts et al., 2006). Sustained attention is a "top-down" mechanism, indicating it requires voluntary effort and control. This is opposed to a "bottom-up" mechanism like indirect attention that does not require conscious effort or control (Pinto et al., 2013).

Nature-Based Learning

In the context of this research, nature-based learning (NBL) is an approach that uses nature as a pathway for learning by engaging children with the natural environment. In the pedagogy of NBL, students learn with, through, and about the natural world by being with their environment in significant, often interdisciplinary, ways. NBL often includes nature walks,

natural views, nature play, outdoor teaching and activities across the curriculum, and beyond (Jordan et al., 2017).

Chapter 2: Literature Review

The link between increased sustained attention and NBL is present in the literature and informs the purpose of the study. The purpose of this study is to explore the potential for NBL to enhance the sustained attention functioning of upper elementary students upon their return indoors and as they resume their classroom-based learning. This chapter will review the concepts of sustained attention capacity and NBL, summarize results of studies related to the proposed study, and describe how this research may be integrated into the larger context of nature-based research in academics. This literature review will conclude with a summary of key points and an introduction to the goals and approach of the present study.

Sustained Attention and Its Significance

Sustained attention is not a new concept. In Crichton's 1798 book, *On Attention and its Diseases*, attention is defined as "when any object of external sense, or of thought, occupies the mind in such a degree that a person does not receive a clear perception from any other one" (p. 200). William James further defined the nature of attention in 1890, and the earliest research specifically on sustained attention was in 1948, with N.H. Mackworth's article *The Breakdown of Vigilance during Prolonged Visual Search.* Since then, there has been an increasing amount of research on the topic of attention in general, with sustained attention making many appearances in the literature.

Sustained attention is conceptualized as a cognitive ability that improves over the course of development (Gallen et al., 2023) and contributes to maintaining focus and engagement in goal-oriented tasks, particularly when it comes to work that is repetitive and monotonous (Unsworth et al., 2021). Sustained attention is voluntary, stimulus-driven, and goal-oriented. This

is contrasted with the concept of indirect attention, which is involuntary and utilizes a bottom-up mechanism (Pinto et al., 2013).

Michael Esterman and David Rothlein (2019) reviewed research on the varied models of sustained attention and found that the essential aspects of sustained attention processes are highly correlated with common mechanisms of information processing. Esterman and Rothlein categorized two models of sustained attention: vigilance decrements and vigilance fluctuations. Vigilance decrements promote the theory that attention is a resource that can be depleted, while vigilance fluctuations refer to the moment-to-moment changes in one's attention that are influenced by numerous factors like arousal, effort, and mind wandering.

The resource-control theory (Thomson et al., 2015) proposes that the default state for individuals is mind wandering, and attentional control is required to get "in-the-zone." Attentional control is associated with the frontal-parietal and dorsal attention networks in the brain, while mind wandering is associated with the default mode network. This theory suggests that communication between these two brain regions should be minimized during optimal attentional control. In fact, greater coupling between dorsal attention and the default mode network was associated with increased variability in attention, and greater "out-of-the-zone" states of attention, suggesting that the relationship between these brain regions impacts sustained attention (Rothlein et al., 2018). When one is "in-the-zone" and sufficiently sustaining attention on a task, this may be experienced as effortful, top-down control (Esterman & Rothlein, 2019), or as an effortless and time-bending "flow state" (de Sampaio Barros et al., 2018). In either case, we continue to see evidence of how sustained attention underlies many essential cognitive processes.

Further, sustained attention seems to underlie more complex attentional forms such as selective attention, as well as the cognitive domains of learning and memory (Sarter et al., 2001). Sustained attention is also thought to underlie executive function and self-regulation. Research by Baumeister and colleagues (1998; 2005; 2007) and Schmeichel (2007) indicated that the domains of both executive function and self-regulation are impaired if either one is depleted. Building on this research, Kaplan and Berman (2010) recognized that executive function and self-regulation seem dependent on a common resource. They define *resource* as something in the cognitive system that is "finite in quantity and depleted by heavy demands" (pg 43). This common, depletable resource has been referred to as "voluntary attention" or "directed attention," and researchers now commonly use the term sustained attention. This builds on the idea that when one must pay attention to something that is not inherently interesting, it takes a significant amount of effort. This effort to sustain attention is a limited resource, and is necessary for many real-world skills in daily life, including executive function and self-regulation.

Sustained attention is also linked to academic outcomes. Attentional selection (the ability to focus specifically on a single object or task) begins to emerge in early infancy, and this ability to sustain focused attention is important for the development of memory and learning later in life (Fisher, 2019). In one study looking at German 11th and 12th graders, sustained attention ability significantly moderated the relationship between students' verbal intelligence scores and their grades (Steinmayr et al., 2010). Success in school is multifaceted, and sustained attention affects the paradigms across the academic sphere. For example, researchers at the University of California San Francisco investigated the relationship between sustained attention functioning and several academic skills in a study of over 700 students in northern California, ages nine to fourteen (Gallen et al., 2023). Researchers assessed sustained attention and other executive

function skills using tasks from the Adaptive Cognitive Evaluation Classroom (ACE-C), a novel digital assessment battery (*ACE Explorer - Researcher Guide*, n.d.). Each of the ACE-C assessment tasks was developed from established cognitive assessments that are commonly used in cognitive research. These tasks used a psychometric staircase approach, making them adaptive for each individual student. After a few weeks, researchers returned to administer a digital targeted assessment of math and reading abilities. Schools also shared students' scores on statewide standardized academic testing. Results showed that higher scores on sustained attention ability were associated with higher scores on math fluency, reading comprehension, and statewide standardized test scores (Gallen et al., 2023).

Interestingly, in spite of its importance and benefits, there is such a thing as too much sustained attention, particularly from an evolutionary standpoint. As explained by Kaplan and Berman (2010), if sustained attention was unlimited and we ignored everything else for an indefinite amount of time, it would leave us vulnerable to external threats (Kaplan & Berman, 2010). An indefinite length of focus is unlikely however, as performance on tasks utilizing sustained attention decreases (Slattery et al., 2022), or fatigues (Kaplan, 1995), over time, preventing such vulnerability. Fortunately, our attention reserves can be restored, allowing us to once again draw on this important resource. This fatigability has been labeled as vigilance decrement (Parasuraman, 1979) or directed attention fatigue (Kaplan, 1995).

Development of and Influences on Sustained Attention

One's capacity for sustaining attention develops steadily through early childhood, with a significant period of development from approximately age six to nine, after which the development of this capacity plateaus with only minor growth (Betts et al., 2006; Slattery et al., 2022). On the shorter timescale, we know that certain circadian rhythms can influence levels of

fatigue, but time of day has shown no influence on participants' accuracy on sustained attention tasks (Duggan, 2000; van Schie et al., 2014).

Due to its links to learning and academic outcomes, there has been significant research on potential interventions to assist with increasing sustained attention capacity. In their article, *Popular Interventions to Enhance Sustained Attention in Children and Adolescents: A Critical Systematic Review,* Eadaoin Slattery and colleagues (2022) reviewed thirty-seven intervention studies aimed at improving sustained attention. The intervention in each study was either cognitive training, physical activity, or meditation. Overall, cognitive attention training showed limited evidence for improving sustained attention. However, physical activity and meditation interventions demonstrated significant benefits to sustained attention. While further research is necessary, these results indicate that sustained attention may likely be positively influenced by an intervention that includes physical activity and meditative qualities. One approachable way to include both of these qualities could be achieved by structured time outdoors.

Sustained Attention and Nature-Based Interventions

Exposure to natural environments has been shown to restore the sustained attention abilities of children and adolescents in numerous studies, as found in a recent review (Moll et al., 2022). Even a short exposure to nature is impactful. Kate Lee and colleagues (2015) found that when university students took a micro-break to view green space through a window, they were better able to concentrate on a given task, and made significantly fewer errors, than students who looked out at a concrete roof. This thread continues with the results of a study exploring the effects of a thirty-minute nature walk on fourth - sixth grade students' attention. Researchers found that students who participated in this short nature walk showed a better response to an attentional task than students who walked through an urban setting (Stevenson et al., 2019).

Kaplan & Kaplan's Attention Restoration Theory (ART) (1989) is useful for interpreting the results of such studies, as well as for thinking more broadly about what interventions might support optimal sustained attention functioning. According to ART, a restorative environment has four elements: Extent, Being Away, Fascination, and Compatibility (Kaplan, 1995). While nature has these elements and thus serves to restore depleted attention, one can see how these elements are also offered through meditation (Kaplan, 2001). All of these elements could also be found in a cozy corner in a backyard or a school forest, and can bring similar benefits to one's attentional capacity as meditation practices.

Meta-analyses of Attention Restoration Theory research showed that exposure to natural environments is associated with significantly better performance on three measures of attention: Digit Span Forward, Digit Span Backward, and Trail Making Test B (Ohly et al., 2016). Each of these tasks requires significant cognitive resources. For example, the Digit Span Backwards requires participants to remember the numbers and manipulate them by reversing the series they heard. The results of these attentional measures indicate that exposure to nature significantly increases results of attentional measures that require significant cognitive resources. According to ART, living within urban lifestyles increases the demands on our cognitive resources, like sustained attention, and is likely linked to attentional fatigue (Kaplan & Kaplan, 1989; Kaplan, 1995). Exposure to nature can be one antidote to this attentional fatigue. Nature exposure increases one's ability to sustain attention on various tasks, and may also increase students' ability to learn (Ohly et al., 2016).

Given the significant benefits of nature interaction, it is no surprise that learning rooted in nature is gaining popularity. NBL practices have been shown to increase classroom engagement overall (Kuo et al., 2018). Nature-based instruction has also been shown to mitigate the

disparities in outcomes due to demographics like socioeconomic status, gender, and English as a second language. That is, student demographics had a significant impact on science scores when a lesson is taught in the classroom, but when the lesson was moved outdoors, all students had similar scores, indicating that nature-based instruction may be a better fit for more students than traditional indoor lessons (Faber Taylor et al., 2022). Teaching in the natural environment is also associated with increased student engagement. One study looked at 13 and 14 year old students in a socioeconomically disadvantaged city in Australia and found that students spent more time on-task in the outdoor classrooms at the rate of fifteen fewer teacher redirects per hour, and this effect on their increased engagement lasted for several weeks. As well, Class A, identified as the most difficult class, showed the greatest improvements in engagement overall (Norwood et al., 2021). For teachers, less time spent redirecting attention means more time spent teaching and presenting the lesson to the class.

NBL practices have also been shown to positively affect children's wellbeing and cognitive function. Preschools that used nature-based practices had more positive effects on protective factors important for resilience than preschools with minimal nature-based practices (Ernst et al., 2019, 2021). Ernst and colleagues (2022) also found that children in preschools using nature-based practices had significantly higher levels of executive functioning. Executive functioning is essential in helping children stay focused, resist impulses and temptations, and be flexible to change (Blair & Ursache, 2011). Research illustrates a strong relationship between executive function and children' s early literacy and mathematical skills (Shaul & Schwartz, 2014) as well as a connection to working memory and higher-level cognition (McCabe et al., 2010). Due to its relation to many aspects of learning, memory, and cognition, executive function is an essential component for students' academic success.

In a recent review of nature and learning in academics, nature-based instruction consistently out-performed traditional instruction. This review also highlighted the mounting evidence that nature promotes learning by reducing stress and improving learners' attention, interest, and physical activity. As well, natural learning environments seem to provide a calmer, quieter, and safer learning context for students of many abilities (Kuo et al., 2019).

Key Points and Project Goals

We know that NBL is associated with many positive outcomes, and further research on the specific impact of NBL on sustained attention in students is necessary. The goal of this study was to investigate the effects of NBL on the sustained attention capacity of upper elementary students.

Sustained attention is a critical cognitive ability that is important for learning outcomes, and NBL is associated with positive learning outcomes and increased sustained attention capacity. Based on this literature surrounding sustained attention, NBL, and their interrelationships, the researcher has chosen to evaluate the impact of a NBL experience on the sustained attention capacity of elementary students.

Chapter 3 : Methodology

Introduction

Research examining NBL has been increasing in recent years, supporting long-held beliefs that learning in nature is beneficial. Studies have shown that learning in nature increases concentration in students with ADHD (Faber Taylor & Kuo, 2009), decreases the impact of life stressors (Wells & Evans, 2003) and increases children's overall well-being (Largo-Wight et al., 2018). Further research has shown that time in natural settings increases one's ability to sustain attention (Kaplan, 1995; Kaplan & Berman, 2010). Our ability to sustain attention is one of the most powerful things we can do as a human - it is how we take action, pursue creative tasks, and show up in relationships. Examining the impact of a nature-based intervention provides further insight into the connection between NBL and sustained attention.

The purpose of this exploratory study was to determine whether a NBL activity had continued positive effects on students' sustained attention upon returning to the classroom. The research used a quantitative approach to investigate the following research question: Are there positive aftereffects of a NBL experience on elementary students' sustained attention? The researcher hypothesized that when children have time outdoors and the opportunity to learn and observe nature and reflect on those observations, their sustained attention after returning indoors is better than if they had remained in indoor classroom learning.

Participants

The participants included all fifth grade students at an independent K-12 school in Minnesota. This age group was selected because due to the research indicating a plateau of sustained attention growth (Betts et al., 2006; Slattery et al., 2022), and their availability to the researcher. The two fifth grade classrooms were invited to participate in the study based on their interest in NBL and on their teachers' receptivity to this study. Due to small class sizes, all 16

fifth grade students from across the two classrooms were combined into one learning group for the research visits, based on the preference of the teachers and because the lessons were more conducive to a larger group of students. This school has access to a school forest, and students were accustomed to being outdoors and had appropriate outdoor clothing.

Design

A within-subjects pretest-posttest design was used in this study. The independent variable was the learning experience (nature-based learning or non-nature-based learning), and the dependent variable was students' level of sustained attention. The fifth grade students received both the intervention and control learning experiences, with the order of the programming based on weather conditions. The intervention lesson was scheduled to occur first if there was no challenging weather (high winds, freezing temperatures, or rain), and to occur second if there was challenging weather on the first scheduled date. On the day of initial data collection, the weather was fair, so the fifth graders experienced the intervention (nature-based learning lesson) on the first visit, and the control (non-nature-based lesson) on the second visit (see Figure 1).

Treatment

The treatment (nature-based lesson) for this study was students' participation in a walk through a natural space and a 30-minute NBL experience in their nearby school forest with the Voyageurs Conservancy's Mobile Classroom, and a return walk back to the school. The Voyageurs Conservancy, founded in 1965, is the non-profit partner of Voyageurs National Park.

The Voyagers Conservancy holds a mission to "connect people to Voyageurs National Park, enhance the visitor experience, and protect the park for present and future generations" (Voyageurs Conservancy, n.d.). The Mobile Classroom brings educational programs to school districts to help Minnesota school children learn more about the Park and also to connect

Figure 1

Diagram of experimental design

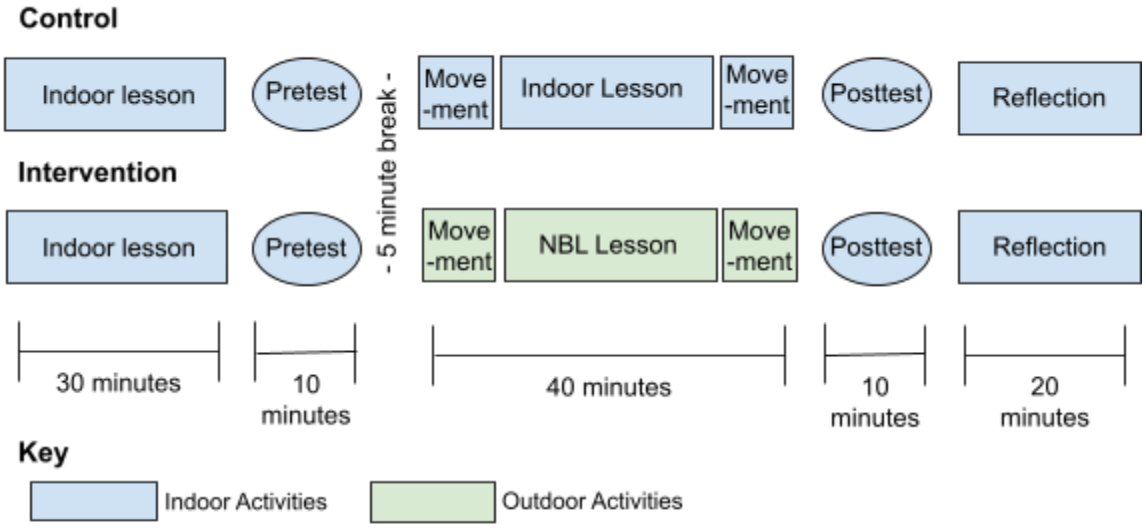

Figure 1. Design included an intervention (lesson in nature and with a walk to lesson site before and after) and a control (classroom lesson indoors with a movement game before and after), with sustained attention assessments before and directly after the outdoor lesson.

students with their local environments. Mobile Classroom programs align with many academic standards, including Minnesota state academic standards, Common Core, and Next Generation Science Standards. These standards are implemented in an experiential, NBL context at participating classrooms' available outdoor spaces. Lesson plans incorporate place-based learning, science-based investigation and data collection, phenology (study of observable seasonal phenomena), and direct observation of nearby natural spaces. Lesson plans vary based on grade level and season.

The NBL lesson in this study was the "Sensational Seasons: Squirrels and Springtime" lesson plan, written by the researcher. This particular lesson aligned with the standard criteria for the fifth grade 2019 Next Generation Science Standard 3.1.1 Developing and Using Models: "Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others" (2019).

The learning experience began as soon as students stepped outside. Once outside the school, the students, teacher, and researcher walked to the nearby school forest. Once everyone arrived at the appropriate teaching location, the group was asked to find their heartbeat (pulse) and calculate their beats per minute (bpm). Average heart rates of the group and of the general human population were discussed. Then, the group was instructed to run up and down a hill and do 30 jumping jacks before finding their heartbeat again. Average heart rates were recorded and discussed again, then compared to the average bpm of small mammals like squirrels, mice, and shrews. There was a group discussion about why the heart beats of small mammals might be so high, and what they needed to do to stay alive. Students were then put into partner groups and given instructions for a "squirrel and scientist" game, where one partner was a squirrel and "cached" 10 nuts around the forest and the other scientist partner recorded their movements. After a round of hiding nuts, the squirrels were told that winter had come and they needed to go find their caches of food, while the scientist recorded their movements again. Once the group was back together, the partner groups calculated the percentage of their caches they successfully found and compared that to the average success of squirrels (85%). The group then entered a discussion about what happens to the food squirrels do not find, how they gather food in spring, and how energy from the sun moves into plants and eventually into the bodies of small mammals. When the lesson was finished, the class walked back through the forest to the school building. The total time of the nature-based intervention lesson was 40 minutes, including time walking to and from the school forest.

The indoor control lesson included a movement activity called "frogger" in which students arranged themselves in a circle and had one student in the middle who was the "detective." The detective had three chances to guess the "frogger" - another student who was able to "eat flies" (the other students in the circle) when they stuck out their tongue. Both the

detective and frogger players were selected secretly by the teacher when students had their eyes closed. Students moved around between rounds, and played the game for about 5 minutes before and after the primary indoor lesson. The purpose of this was to mirror the walking aspect of the nature-based intervention lesson. After the frogger game, the class learned about what frogs do in springtime and about different species of frogs in northern Minnesota. The primary indoor lesson included an introduction to tracking animals in the north woods of Minnesota. Students learned about the various animals that might leave tracks in mud or snow, then were given the task of identifying unlabeled tracks that were set around their common space. Once the class came back together, they reviewed the identities of the unnamed tracks and discussed what those animals might do in springtime.

Construct and Measure

Sustained attention is the ability to maintain attention on goal-directed activities over an extended period of time (Betts et al., 2006). Sustained attention is a "top-down" mechanism, indicating it requires voluntary effort and control. This is opposed to a "bottom-up" mechanism like indirect attention that does not require conscious effort or control (Pinto et al., 2013). In order to best assess students' sustained attention abilities, a cognitive assessment tool was used.

The cognitive testing instrument that was used to assess the dependent variable of sustained attention was the Adaptive Cognitive Evaluation Explorer (ACE-X). The ACE-X was developed by the Neuroscape team at the University of California San Francisco (USCF) building on decades of scientific research (Ace Explorer- What is it?, n.d.). The subtests on ACE-X replicate electronically existing validated "gold-standard" cognitive assessment tasks that have been evaluated rigorously and have been used to assess cognitive abilities for decades (ACE for Researchers, n.d.).

The ACE-X comprises 14 subtests, and these subtests are designed to be administered individually or in sets, or the instrument can be administered as a whole. Each subtest can be completed on a computer or tablet, and incorporates an adaptive algorithm to respond to the abilities of the participants. Each task can be completed in two to five minutes, and the adaptive algorithm ensures that comparisons between participants of different abilities, ages, genders, races, and cultures will measure actual cognitive abilities and not their disparities in testing parameters (*ACE Explorer - Researcher Guide*, n.d.).

The specific subtests selected for use in this study are those that assess control and attention, so as to align with the dependent variable of sustained attention. In this study, each student used their personally assigned school iPad to complete the testing. This made it possible for every student to complete the task at once, instead of administering the test to one student at a time. To establish a baseline of response, students first completed two control tasks. Control tasks include "Basic Response Time," which measures basic response speed, and "What's This Number," which measures participants' ability to distinguish color. The task measuring sustained attention is "Venus UFO" (See Table 1).

The sustained attention test is broken down into two measures for analysis: mean correct and response time. Mean correct identifies how often students responded correctly to the prompts, while response speed measures how quickly students responded correctly to the prompts. The cognitive battery of the control tasks and the sustained attention task take approximately eight minutes to complete.

Data Collection Procedures

This study followed the guidelines for human research of the Institutional Review Board (IRB) for the Social and Behavioral Sciences at the University of Minnesota. The IRB approved

Table 1

ACE Explorer Tasks

Name	Measure	Time to Complete (minutes)	Description
Control Tasks			
Basic Response Time	Basic response speed	2:00 - 3:00	Participants are instructed to identify a symbol (target) always appearing in the center of the screen without distraction by tapping a button each time the symbol appears (see Anguera et al., 2013).
What's This Number	Color vision	1:00	Based on the Pseudoisochromatic Plate (PIP) test by Ishihara (1972). Participants are shown a number made of multiple colored dots and asked to identify the number.
Attention			
Venus UFO	Sustained attention	3:30 - 4:00	Based on TOVA by Greenberg, Leark, Dupuy, and Corman, (1991). Participants see a symbol appear on the top of the screen (target) or bottom of the screen (distractor). Participants are instructed to press a button when the symbol appears at the top of the screen, and ignore the symbol when it appears on the bottom.The target appears infrequently.

Note. Descriptions of the ACE-X subtests utilized in this study. Adapted from "ACE for Researchers - Neuroscape" Copyright 2016 by Neuroscape.

the research protocol and all related materials required for this project. After school and teacher permission was granted, parent consent and student assent were obtained. Parents received an "opt-out" consent form where they were provided with an informational consent form about the study more than one week before it began, and instructed to sign and return the form if they did not want their student to participate (see appendix A). Students were read the verbal assent script at the start of each visit (see appendix B). Prior to administration of the research instrument, the students received a 30-minute indoor presentation about how spring experiences at Minnesota's Voyageurs National Park compare to spring where they live, how Indigenous peoples of the area navigated this time throughout history, and their relationship to animals in the forest, like squirrels. The class reviewed the different species of squirrels and other small mammals that exist in Minnesota. They also discussed what characteristics define mammals in general, and what defines a small mammal. The purpose of the indoor presentation before the lesson was to give students the chance to settle in and provide a consistent baseline for the control and

intervention pretest. After the indoor presentation, the researcher administered to students the two tasks to establish the baseline and the sustained attention task from the ACE-X.

After cognitive testing, there was space for a five-minute break for students to use the restroom and gather gear before going outside for the NBL lesson. The outdoor NBL lesson was 40 minutes, then students returned to the classroom. Once inside again, students immediately completed cognitive testing to assess their sustained attention ability. The program wrapped up with a short reflection and review of what was learned. This was meant to provide students with a sense of closure before the researcher departed the classroom.

A similar sequence was used approximately a week later, when the researcher returned to implement the control lesson. A 30-minute indoor presentation was given, focusing on animal signs and tracking. Following baseline cognitive testing, there was space for a five-minute break for students to use the restroom and transition into the common space for the movement activity. Students then received instruction for the movement activity game: Frogger, and walked to the commons area to play it. After the movement game, students were put into pairs and instructed to complete an animal tracking activity, for the indoor lesson. Before returning to the classroom for the sustained attention measure, the students completed another round of the movement activity to simulate the level of physical activity undertaken during the walk back to the classroom in the NBL condition. Once back in the classroom, students immediately completed cognitive testing to assess their sustained attention ability. The program wrapped up with a short review of the lesson and what they had learned over the two visits.

Data Analysis

The data from the ACE-X was analyzed using a provided “R,”package, which was a free, open-source programming language that provides statistical and graphical tools for data analysis.

After the raw data was processed through R, the data was imported to SPSS for statistical testing. An initial analysis was run to see if scores of mean correct and response time differed significantly by gender to determine if gender should be incorporated into the subsequent analysis as a covariate. To examine the impact of the NBL intervention, dependent sample t-tests were conducted to see if there was a significant increase from pretest to posttest for each sustained attention measure (mean correct response and response time). A second set of dependent sample t-tests were conducted on the pretest and posttest scores from the non-nature-based lesson, to help interpret the findings of the data from the NBL intervention.

Researcher's Role

As the investigator for the project, the researcher was a key part of the study, and their prior experiences influenced the interpretation of the data. They are a professional environmental educator, and currently work with the Voyageurs Conservancy as an education field fellow and lead educator for the Mobile Classroom. These previous experiences and present role gave them an advantage throughout the research process, as they had a deeper understanding of the experience of the participating students. That said, their depth of experience in this field and role in the Mobile Classroom may have provided opportunity for bias or assumptions in this research as compared to someone newer in the field or in a separate role. The researcher worked to counter these potential biases by capturing factual and neutral data and waiting until analysis to interpret the data (Robson, 2018).

Chapter 4: Results

Introduction

The purpose of this research study was to explore if there were positive aftereffects of a NBL experience on elementary students' sustained attention. The study engaged fifth grade students from two classrooms, combined into one learning group (N=15), in two 40-minute lessons during March, 2024: one nature-based intervention lesson and one non-nature-based control lesson that were taught one week apart. Immediately before and after each lesson, students took the sustained attention measure on the ACE-X instrument, also known as "Venus UFO." These scores were used in the analysis to investigate the research question at hand.

Participants

16 different students participated in the study and supplied data. For the first visit (intervention), one student entered their ID number incorrectly in the posttest measure, thus only 15 students supplied pretest and posttest data for the initial visit. For the second visit (control) one student was absent, one student left school before the posttest measure, and one student entered their ID number incorrectly and didn't complete the instrument. In this testing group, there were eight students identified as female, and eight students identified as male (See Table 2).

Table 2

Frequency of gender by test group

	Female	Male	Total	Total Analyzed
Intervention Pretest Count	8 (50%)	8 (50%)	16	15
Intervention Posttest Count	8 (53.3%)	7 (46.7%)	15	
Control Pretest Count	7 (50%)	7 (50%)	14	13
Control Posttest Count	6 (46.2%)	7 (53.8%)	13	

To determine whether gender would be needed as a covariate in the analysis, an independent sample t-test was performed for each of the pre and post measures. Results indicate no significant difference in scores between genders for the mean correct intervention pretest $t(14) = -1.19$, $p > .05$ or posttest scores $t(14) = -1.32$, $p > .05$, or for the mean correct control pretest $t(12) = -.79$, $p > .05$ or posttest scores $t(11) = -.84$, $p > .05$. There was also no significant difference in scores between genders for the response time intervention pretest $t(14) = -1.56$, $p > .05$, or posttest scores $t(13) = -.07$, $p > .05$, or for the response time control pretest $t(12) = -1.36$, $p > .05$, or posttest scores $t(11) = -.32$, $p > .05$. Given these results, gender was not incorporated into the analysis.

Results of the ACE-X Sustained Attention Measures

Two variables of attention were collected with the ACE-X measure: mean correct and response time. The mean correct scores measured how accurately students responded to the sustained attention test and whether they made any errors of omission or commission. The response time measured how quickly the students responded correctly during the test.

Mean Correct Results

The average mean correct sustained attention scores increased by 42.24 from the pretest to posttest for the intervention lesson, and decreased by 35.65 from the pretest to posttest for the control lesson (see Figure 2; also see Table 3 for Mean and Standard Deviation values for the pretest and posttest scores for the intervention and control groups). The results of the dependent samples t-test indicate that there was not a significant change in mean correct sustained attention scores from pretest to posttest for the intervention, $t(14) = 1.73$, $p > .05$, nor was there a significant pretest to posttest change for the control group, $t(12) = 1.35$, $p > .05$. This suggests that the nature-based lesson did not result in a sustained attention aftereffect for the study

participants on the mean correct measure. The nature-based lesson appears to have neither increased nor decreased student's sustained attention, as measured by mean correct scores.

Figure 2

Mean correct scores for the ACE-X sustained attention measure

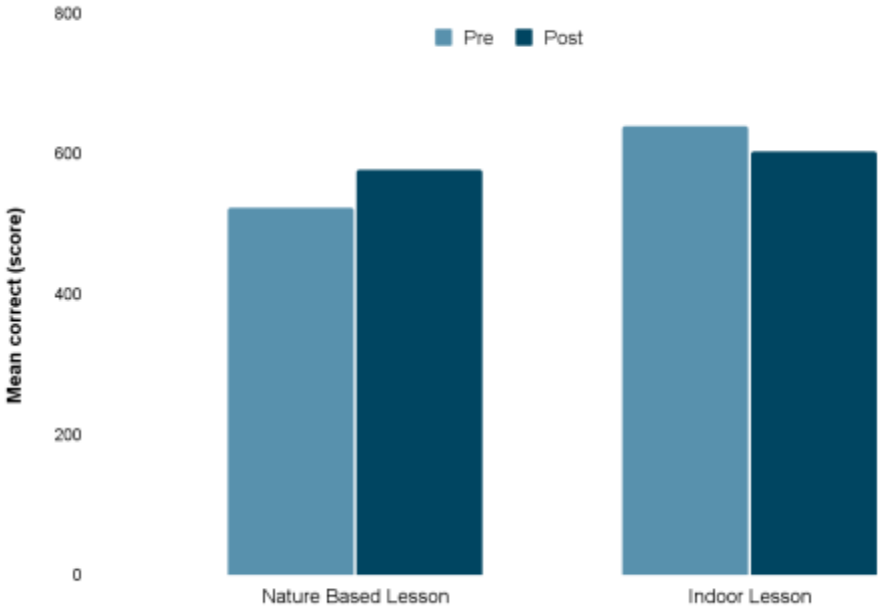

Table 3

Paired samples statistics for ACE-X Sustained Attention: Mean Correct

	Mean	Std. Deviation	Std. Error Mean	N	Difference between pretest and posttest scores	t	df	Two-sided p
Intervention Pre	524.53	131.55	33.94	15	42.24	-1.73	14	.11
Intervention Post	566.77	113.25	29.24					
Control Pre	638.55	126.46	35.07	13	-35.65	1.35	12	.20
Control Post	602.90	131.45	36.46					

Response Time Results

The mean response time decreased by 74.19 milliseconds (ms) from the pretest to posttest for the intervention lesson, and increased by 7.05 ms from the pretest to posttest for the control

lesson (see Figure 3; also see Table 4 for Mean and Standard Deviation values). The results of the dependent samples t-test indicate that there was a significant change in response time sustained attention scores from pretest to posttest for the nature-based lesson (treatment), $t(14) = 2.49$, $p = .03$. However, for the non-nature based lesson (control), there was not a significant change, $t(12) = -8.54$, $p > .05$. This suggests that the nature-based lesson appears to have supported sustained attention aftereffects, as measured by response time. While students' correct responses did not appear to be significantly influenced by type of learning experience (nature v. non-nature based), students had significantly faster response times after the nature-based lesson.

Figure 3

Response Time scores for the ACE-X sustained attention measure

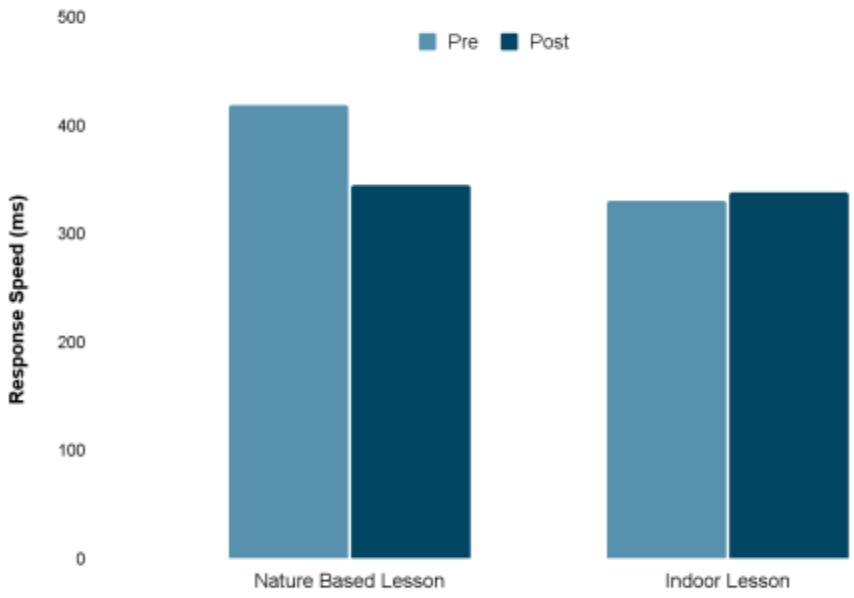

Table 4

Paired samples statistics t-test for Sustained Attention: Response Time

	Mean	Std. Deviation	Std. Error Mean	N	Difference between pretest and posttest scores	t	df	Two-sided p
Intervention Pre	419.53	105.78	27.31	15	74.19	2.49	14	.03*
Intervention Post	345.34	39.05	10.08					
Control Pre	331.19	24.05	6.67	13	7.05	-8.54	12	.41
Control Post	338.24	42.99	11.92					

*p<.05

Chapter 5: Discussion

Limitations

It is important to consider the results in the context of the study's limitations. The findings of this study have limited generalizability, due to the small sample size and having a single test site. With the sample size of 16, the analysis likely lacked sufficient statistical power to detect significant differences. Additionally, with students combined into a single group of participants, counterbalancing the ordering of treatment and control learning experiences was not possible. Ideally there would have been two separate classes, with one of the groups taking the nature-based intervention lesson first and the other taking the indoor control lesson first, to minimize the practice effect. Thus, the sustained attention posttest scores after the treatment, along with the subsequent pre- and posttest scores from the control lesson may have been impacted by students familiarity with the instrument.

The data does suggest a potential practice effect, with scores on the mean correct sustained attention measure generally increasing across the last three test implementations (see Figure 2). However, the posttest mean following the control (indoor) lesson decreased slightly, but not significantly, which may suggest that learning indoors causes no decrement in sustained attention, or that a small but important decrement in sustained attention after an indoor lesson could not be detected due to insufficient power resulting from the small sample size.

Additionally, the mean correct pretest scores were significantly different from one another; the first visit, the intervention lesson, had a mean of 524.53, and the second visit, the control lesson, had a mean of 638.55, $t(11) = -2.93$, $p = .01$). The posttest scores, however, were not significantly different from one another, with the first visit, the nature-based intervention, lesson having a mean of 566.77, and the second visit, the indoor control lesson, having a mean of

602.9, $t(11) = -.72$, $p > .05$. Alternatively, this may reflect differences in the indoor presentation (or students' experience of the indoor presentation) that preceded the lessons. Since the first indoor presentation that preceded the treatment lesson was more novel, it may have been more fatiguing to students in contrast with the second indoor presentation that preceded the control lesson; students were familiar with the researcher and the content and context, and thus it may have been less fatiguing. Another potential confounding factor was the difference in the "walk" that began the treatment and control sessions (that happened after the pretest). For the nature-based intervention, it was a walk to the school forest, but for the indoor control lesson, it was a game that students found enjoyable. While physical movement is associated with sustained attention, not all physical movement is equally restorative and enjoyable. It is possible that the game was both familiar (not novel) and sufficiently enjoyable to have provided a restorative effect, particularly when coupled with the engaging content and interactive experience of the indoor lesson, potentially masking a more typical indoor learning experience (directed instruction) and its depleting attentional effects.

Data from the response time measure also indicates the possibility of a practice effect, with scores generally decreasing (quicker response time) across the trials (see Figure 3). Practice effects in sustained attention tasks seem to be due primarily to faster item-solving processes and slightly faster perception of expected items (Blotenberg & Schmidt-Atzert, 2019). As was the case for mean correct response scores, pretest scores for response time also were significantly different from one another, with the first visit, the intervention lesson, having a mean of 420.45, and the second visit having a mean of 331.60, $t(11) = 2.88$, $p = .02$. The posttest scores were not significantly different from one another, with the first visit, the nature-based intervention lesson, having a mean of 347.85, and the second visit, the indoor control lesson, having a mean of

336.85, t (11) = 1.72 , p > .05. While there may have been a practice effect, it seems likely that it would have been favoring (or to the benefit) of the control (non-nature-based) lesson, since it was taught second. Thus, with the treatment lesson implemented first, and with students less familiar with the instrument, it is possible that there may be stronger (more positive) after effects on sustained attention than what these findings at hand suggest. Alternatively, it might be that after one experience with the instrument, they reach proficiency with the instrument, without further practice effects on any number of subsequent trials. Thus, without the counterbalancing of ordering providing the opportunity to have examined the potential impact of a practice effect, the results remain difficult to fully interpret. In hindsight, if the control lesson had been implemented first, it would have reduced the possibility that changes in sustained attention were due to practice effects.

Another limitation is that this school does incorporate outdoor learning and environmental education experiences. Thus, external validity is limited, as participants were from a small, private school and they were accustomed to outdoor learning and had proper outdoor clothing. If students were part of a larger class, unaccustomed to outdoor learning or improperly dressed for being outdoors, findings may have differed from what unfolded in the study at hand.

The small sample size in this study also contributed to limitations of generalizability. The researcher originally intended to include at least two classrooms of approximately 20 students from a public school district, but due to the timeframe required to get permissions from the district, principals, and school board, and the limited time provided for a Masters' program, the researcher was unable to go the route of the public schools. The researcher turned to an independent school, which was able to provide permissions and send out consent forms to

parents quickly. The school has very small class sizes, so even when taking the entire fifth grade cohort of the school, the sample size was limited to 16 students.

Discussion of Findings

Significant research has shown that exposure to nature and natural settings has positive effects on attention and focus (Berman et al., 2008; Dadvand et al., 2015; Lee et al., 2015; Kaplan, 1995). Since the description and development of Attention Restoration Theory (ART), many studies have illustrated the restorative effects of nature for adult attention (Basu et al., 2019; Crossan & Salmoni, 2021; Lee et al., 2015; Ohly et al., 2016). Additional studies have looked at the effects of nature exposure for younger populations and found overall benefits to concentration and focus (Faber Taylor & Kuo, 2009; Moll et al., 2022; Stevenson et al., 2019; Taylor & Kuo, 2006). Despite this depth of research, there is still space for further research into specifically NBL lessons and how they affect students' sustained attention. This study specifically looked at whether there were positive aftereffects of a NBL experience on elementary students' sustained attention.

The results of the ACE-X sustained attention measure showed that students had a significantly better mean response speed after the nature-based intervention lesson than the indoor control lesson. While encouraging, in light of the study's limitations, these results suggest that further research into NBL and its effects on sustained attention is necessary to confirm the patterns uncovered in the present study.

The present study was exploratory in nature and was grounded in decades of research supporting the positive relationship between nature exposure and sustained attention. Specifically, this study looked at the impact of NBL on fifth grade students' sustained attention. Students performed better after the nature-based intervention lesson for both the mean correct

and response time measures, but the response time measure was the only one with significance (p= .03). Because of the study design, it is difficult to rule out a practice effect. However, given the significance of obtained results and the consistent pattern of findings even if lacking statistical significance, coupled with underlying theory and prior research, it is possible that a true effect exists but could not be detected given the small sample size.

Additionally, NBL is a multifaceted intervention. As such, the study design at hand makes it difficult to know if any changes in SA in the treatment group are the result of the treatment in its entirety (the pedagogy, the physical movement, and the nature setting), or if one facet of NBL is associated with SA impact. Since the treatment lesson involved much more physical activity than the control lesson, an alternative hypothesis surfaces: Positive aftereffects of a nature-based learning experience on elementary students' sustained attention may be influenced by the increased level of physical activity typically present in NBL.

Implications and Recommendation for Future Research

The results of this study suggest improvement in sustained attention response speed through NBL. It's possible that if there were a larger sample size, the significance of the NBL impact may have been magnified and also potentially observed in the mean correct response measure as well. Further research with a larger sample and multiple groups to allow for controlling for practice effects would be useful to confirm the intervention effect tentatively suggested by this study's findings.

In future studies, the researcher recommends contacting the public schools as early as possible in the research process in order to get through the lengthy procedure of gaining permission from public schools and the IRB. Expanding research to include public school students is recommended, as it would increase the population available, increase the sample size,

and expand demographics to include students from a variety of backgrounds, improving generalizability. The researcher also recommends including a qualitative component to the research. Teachers and students alike frequently have positive comments about the NBL environment, and it would be interesting to add a dynamic view of what students and teachers think about the experience. Comments are generally about the positive impact that NBL experiences provide.

At present, there is a growing demand for more learning outdoors. Particularly in Minnesota, there is great support for outdoor learning and outdoor schools. At the time of this research project, the “Outdoor School for All" bill is moving through the Minnesota Senate. This bill would establish a state-wide grant program to provide access to outdoor schools for all students grades four through eight in Minnesota (*Let’s Get All MN Kids Outside! | Outdoor School For All Minnesota*, n.d.). The support for outdoor learning and outdoor schools is expansive across politics as well; this bill has been cited as “the most bipartisan bill [currently] in the legislature” (WDIO, n.d.). With all this in mind, there is obvious space for further research into what is actually happening when students are learning outside.

Conclusion

Are there positive aftereffects of a NBL experience on elementary students’ sustained attention? The researcher hypothesized that when children have time outdoors and the opportunity to learn and observe nature and reflect on those observations, their sustained attention after returning indoors would be better than if they had remained in indoor classroom learning. This hypothesis was supported by descriptive evidence showing better performance overall in scores of mean correct and response speed, with response speed having a statistically significantly better performance after the NBL lesson as opposed to the indoor control lesson. As

the demand for NBL grows, it is important to understand the ways that this approach to learning affects our students. A healthy capacity to sustain attention significantly affects students' ability to pay attention in the classroom and thrive in school and life overall.

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Appendix

Appendix A - Consent Form

PARENT/CHILD INVITATION AND CONSENT FORM FOR RESEARCH PARTICIPATION

Dear Parents and Guardians,

Your child is invited to be in a research study exploring the influence of nature-based learning on children's sustained attention abilities. Sustained attention is the ability to stay focused on a given task over time, and is associated with learning, memory, and self-regulation. This study builds on prior research supporting the positive effects of nature-based learning on sustained attention. After reading this information, if you decide that you do not wish for your child to participate in the research project, you will need to fill out the form at the end of this packet and return it to the school. If we do not have a copy of this form on file by March 1st, then we will assume you permit your child to participate in the study.
We only need a form returned if you do NOT wish for your student to participate in the study. Thank you sincerely for your time and consideration!

Title of Research Study: Effects of Nature-Based Learning on Elementary Students' Sustained Attention

Investigator Team Contact Information:

For questions about research appointments, the research study, research results, or other concerns, call the study team at:

Primary Graduate Investigator: Moss Schumacher Graduate Program: Masters of Environmental Education, UMD Phone Number: 218-260-8543 Email Address: schum605@d.umn.edu	Faculty Advisor: Dr. Julie Ernst Advisor Departmental Affiliation: Applied Human Sciences, UMD Phone Number: 218-726-8241 Email Address: jernst@d.umn.edu

Key Information about This Research Study

The following is information to help you decide whether or not to be a part of this research study.

What is research? The goal of research is to learn new things to help people in the future. Investigators learn things by following the same plan with a number of participants, so they do not

usually make changes to
the plan for individual research participants. You, as an individual, may or may not be helped by volunteering for a research study.

Why am I being invited to take part in this research study?

We are inviting your child to take part in this research study because your child attends school at the site participating in this research study.

What should I know about a research study?

- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Why is this research being done?

The purpose of this study is to explore the role of nature-based learning in the development of children's sustained attention abilities. There is a need to understand and develop strategies that support children's sustained attention, given the significant connection among sustained attention, learning, memory, and self regulation.

How long will the research last?

This study will take place during March 2024.

How many people are expected to be in the study?

We expect about 16 5th graders will participate from the Duluth area.

What will I need to do to participate? What happens if I say "yes" to allowing my child to participate?

The researcher will be visiting your child's classroom on two days during regular school hours. These two researcher visits will be on the same days as the two nature-based programs that your child's teacher has signed up for (one that takes place outdoors and one that takes place indoors). If you allow your child to
participate, the researcher will invite your child to participate in the research study. If you do not want your child to participate in the study, they will still participate in the two nature lessons.

If you do say "yes" to allowing your child to participate, and if your child also agrees to participate upon the researcher's verbal invitation, your child will be invited to play three short games on a computer or chrome book. These games will take fewer than 10 minutes. Participating children will play these three assessment games right before and again right after the nature lessons. Children

will play these assessment games at the
same time in a computer lab or in the classroom on the school's iPads. In addition, teachers will provide the researcher with demographic information on participating children (age, gender). This information will be coded, as will the data from the games, so that it is not identifiable (your child's name will not be associated with their demographic information nor their responses to the three games).

Is there any way that being in this study could be bad for me? What are the risks? There is potentially a risk of your child tiring from participation or getting bored during the games. Children who are hesitant around unfamiliar adults may be less comfortable participating. The teacher and researcher will both be watching for children who are hesitant or do not want to participate, as well as for children who lose interest in participating. While these risks are possible, they are not severe, and efforts will be made to minimize the possibility of these risks occurring.

Will being in this study help me in any way?
There are no benefits to you from your taking part in this research. However, possible benefits to others include helping educators learn more about how to support sustained attention in children.

Will it cost me anything to participate in this research study?
There will be no cost to you for any of the research activities.

Will I be compensated for my participation?
You will not be compensated for allowing your child to participate.

What happens if I do not want to be in this research?
You can choose to not allow your child to participate. It will not be held against you or your child in any way. If you do not allow your child to participate in the study, they will still participate in the two nature lessons. When the other children play the assessment games, your child will be able to look at books or color/draw on paper.

What happens if I say "Yes" but I change my mind later?
Your child can leave the research study at any time, and no one will be upset with you or your child. You can let your child's teacher know that you would like to remove your child from the study, or you can contact the researcher directly.

What happens to the information collected for the research?
If you allow your child to participate, they will be assigned a code, and your child's game/task responses and demographic information will be labeled through that code, rather than your child's name. Research records will be stored securely, and efforts will be made to limit access to the data other than the researcher and potentially the research review board at the University of MN, in the event they would need to inspect the study. The stored data will not contain identifying information, and the data will be stored according to current University policy for protection of confidentiality. In

any sort of journal article stemming from this research that we might publish, we will not include any information that will make it possible to identify a participant, and we will not indicate the name of the specific teachers. In addition, the results will be presented at an aggregate level (not at an individual level). We will be sharing the aggregate results with the participating classrooms, if they express interest in knowing the results, but we will not be disseminating these results to individual parents. The data from this study will not be used for any future research after this study is complete.

Whom do I contact if I have questions, concerns or feedback about my experience? This research has been reviewed and approved by an IRB within the Human Research Protections Program (HRPP). To share feedback privately with the HRPP about your research experience, call the Research
Participants' Advocate Line at 612-625-1650 (Toll Free: 1-888-224-8636) or go to z.umn.edu/participants. You are encouraged to contact the HRPP if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research participant.
- You want to get information or provide input about this research.

Will I have a chance to provide feedback after the study is over?
The HRPP may ask you to complete a survey that asks about your experience as a research participant. You do not have to complete the survey if you do not want to. If you do choose to complete the survey, your responses will be anonymous. If you are not asked to complete a survey, but you would like to share feedback, please contact the study team or the HRPP. See the "Investigator Contact Information" of this form for study team contact information and "Whom do I contact if I have questions, concerns or feedback about my experience?" of this form for HRPP contact information.

Option to opt-out
Fill out this section if you DO NOT want your child to participate in this research study. If you do not sign and return this form, we will assume you have given permission for your child to participate in this study.

I, _____, parent/guardian of

_____, would like to opt my child out of this research study.

_____ _____

Student Name (Printed) Parent/Guardian Signature

_____

Date

Appendix B - Assent Script

ASSENT SCRIPT

Project Title: Effects of Nature-Based Learning on Elementary Students' Sustained Attention
Principal Investigator: Julie Ernst
Supported by: n/a

Hi, my name is Moss Schumacher. If you have any questions about what I am telling you, you can ask me at any time.

I want to tell you about a research study we are doing. In this study, we want to find out more about how learning outside or inside affects elementary students' ability to pay attention.

You are being asked to be in this because you are an elementary school student who gets to learn outside and inside with the Voyageurs Mobile Classroom.

If it is okay with you, I will ask you to play some short games about attention on a computer before and after we go outside for the Mobile Classroom activities. The games will take about 10 minutes each time.

If you get too tired, scared, or if the games seem too hard just let me know. If you want to stop at any time, just tell me and we will stop.

You do not have to be in this study. It is totally up to you. You can say yes now and still change your mind later. All you have to do is tell me. No one will be mad at you if you change your mind.

The people taking care of you, like your parents and your teacher, say it is okay for you to be in this study. If you have questions for me or for your teacher, you can ask them now or later.

Do you have any questions? So I know that you understand, will you tell me what I'm asking you to do before and after we go outside for the Mobile Classroom activities?

End of verbal script.

To be completed by person obtaining verbal assent from the participant:

Child's/Participant's response: ☐Yes ☐No

Check which applies below:
☐The child/participant is capable of understanding the study
☐The child/participant is not capable of understanding the study

_____
Child's/Participant's Name (printed)

_____ _____
Name (printed) and Signature of Person Obtaining Consent Date

Appendix C - Coding Sheet

School Visit - _____

Code	Consent Obtained?	Gender	Age	
M1				
M2				
M3				
M4				
M5				
M6				
M7				
M8				
M9				

M10				
M11				
M12				
M13				
M14				
M15				
M16				