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Article *in* Environmental Education Research · August 2023

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To cite this article: Ekaterina Novikova, Annette Pic & Myae Han (2023): Language use in indoor and outdoor settings among children in a nature-based preschool, Environmental Education Research, DOI: 10.1080/13504622.2023.2246688

To link to this article: https://doi.org/10.1080/13504622.2023.2246688

Published online: 15 Aug 2023.

ENVIRONMENTAL EDUCATION RESEARCH
https://doi.org/10.1080/13504622.2023.2246688

Language use in indoor and outdoor settings among children in a nature-based preschool

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ABSTRACT

Research shows that experiences with nature have positive direct and indirect effects on multiple domains of child development, including language skills. However, few studies have examined the relationship between young children's language and outdoor nature settings. In this quantitative study, we compared children's language use in an indoor classroom and an outdoor nature setting. Language samples from 16 preschool children (including seven Dual Language Learners) collected in indoor and outdoor settings of a nature-based preschool were analyzed using the CLAN (Computerized Language ANalysis) program. Data analysis showed that for both the entire sample and the sample of Dual Language Learners, children's language had higher syntactic complexity measured by Mean Length of Three or Five Longest Utterances in the outdoor nature setting. The implications of the study results are discussed.

ARTICLE HISTORY
Received 20 March 2023
Accepted 6 August 2023

KEYWORDS
Language; nature-based education; early childhood; outdoor nature settings; dual language learners

Introduction

Exposure to nature provides multiple benefits for children's learning and development, including physical, social-emotional, language, and cognitive development, as well as psychological well-being (Chawla 2015; Gill 2014; Johnstone et al. 2022). The benefits of exposure to nature prompt researchers to investigate the connection between nature-based education and children's learning and development in nature-based education programs. Although a Forest School and nature preschools are not exactly similar, a review of scholarship published between 2000 and 2019 that pertain to the impact of Forest School (outdoor and environmental education) on children identified seven positive impacts (Dabaja 2022a, 2022b): social and cooperative skills, physical skills, self-confidence and self-esteem, learning performance and cognitive skills, emotional and mental well-being, risk management skills, and environmental awareness. Dabaja (2022a) divided learning performance and cognitive skills into three subcategories; studies pertaining to language development were categorized within the subcategory curriculum related knowledge. The reviewed language studies suggest Forest School helps children improve language and communication skills (Dabaja 2022b). Ardoin and Bowers (2020) conducted a systematic review of 66 early childhood nature-based education program research papers published between the years 1995 and 2018. The authors found that only 9% of the literature addressed

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language and literacy outcomes in nature-based education compared to 25 studies (38%) that addressed cognitive developmental outcomes such as cognitive functioning, academic content, and creativity; 25 studies (38%) that addressed social and emotional developmental outcomes such as social skills, self-regulation, and sense of autonomy; and 14 studies (21%) that addressed physical developmental outcomes such as increased physical level and skills.

Early language development, such as oral language skills, is crucial for children's later academic and social development (Kastner, May, and Hildman 2001; Longobardi et al. 2016). Oral language refers to spoken language used to express knowledge, ideas, and feelings (Brooke 2017). Empirical research has identified oral language as the foundation for vocabulary acquisition, literacy development, reading comprehension, word recognition, grammatical knowledge, listening comprehension, and writing development (Biemiller 2003; Hart and Risley 1995, 2003; Hirsch 2003). Oral language skills also include the use of comprehensive language such as semantics (word meaning) and pragmatics (turn-taking, contexts). Early oral language skills have both a direct and indirect impact on the transition to school and provide the necessary foundation for later reading and literacy development (NICHD 2005; Storch and Whitehurst 2002). Outdoor nature settings present rich conversational opportunities for children, which prompts examination of the connection between setting and child language use. Research on children's language and exposure to outdoor nature settings reports that language in indoor and outdoor nature settings varies by content and amount (Prins et al. 2023).

The purpose of this study was to examine monolingual and dual language learner children's language use in indoor and outdoor settings among children attending a nature-based preschool to add to the body of knowledge on nature-based education and children's language development. We examined children's language use measured by syntactic complexity (sentence sophistication), lexical diversity (vocabulary richness), and conversation participation (turn-taking) in indoor and outdoor settings during free play. Additionally, we examined the use of language by Dual Language Learners (DLLs) in indoor and outdoor settings since the research including DLLs in nature-based education settings is scarce. This study contributes to the understudied area of nature-based preschool education in connection with early language development for both monolinguals and DLLs.

Child development and nature

A growing body of knowledge supports the theory that nature-based outdoor classrooms benefit children's development. There are several reviews of research that investigate the connection between nature and children's development in addition to the previously mentioned review conducted by Dabaja (2022a, 2022b). Kuo, Barnes, and Jordan (2019) reviewed approximately 50 papers to examine the role of nature experiences in learning and development. The review includes various types of scholarly articles such as literature reviews, meta-analyses, and empirical articles. The connection between nature and personal development was mainly studied using qualitative research methods. Experiences with nature fostered social-emotional skills such as improved leadership, self-confidence, resilience and communication skills, and positively influenced cognitive development by means of increased critical thinking and problem-solving abilities. The quantitative and experimental studies compared nature-based education to traditional instruction identifying that experiences with nature positively affected academic achievement through 1) increased attention, self-discipline, and engagement in a less restrictive and more cooperative setting; 2) reduced levels of disruptive behaviors and stress promoted by calmer and quieter outdoor nature settings; and 3) boosted physical activity and physical wellness levels encouraged by vast open spaces. Further, students exposed to nature demonstrated better grades and standardized test scores, higher knowledge gains and academic skills, and retained higher amounts of academic information.

Language development and nature

Interactions with the natural world encourage children to communicate their perceptions in a potentially more elaborate and complex language because nature provides children with sensory experiences through a multitude of colors, textures, and shapes (Wilson 2007).

Recently, researchers have started exploring the connection between nature and child's language development. Cameron-Faulkner, Melville, and Gattis (2018) investigated how outdoor nature settings influence communication quality between parents and young children in comparison with an indoor setting. Eighteen parent-child dyads engaged in interactive communication in both settings. The results showed that, compared to the indoor setting, there were significantly more child utterances, longer parent-child connected communication episodes, and higher parent and child responsiveness rates in the outdoor nature settings. At the same time, there was no difference in mean length of utterance or lexical diversity between the settings. In their ethnographic study, Hackett, MacLure, and McMahon (2021) described how the introduction of an outdoor classroom into an English daycare routine brought noticeable changes in two-year-old children's use of language. Moving literacy activities outdoors led to higher engagement in speech activities among the children who rarely spoke. The authors used results of the monitoring tool, Every Child a Talker (ECaT), which assesses children's language proficiency, to compare different cohorts of children. The study suggested that there might be a positive connection between language and social skills and exposure to an outdoor classroom setting.

There exists rich literature on how play promotes children's language and literacy development by providing more opportunities for children to learn new vocabulary and practice language skills (Han et al. 2010; Owens 1996). Studies have found that children engage in longer play episodes when playing in outdoor nature settings. Luchs and Fikus (2013) investigated 59 German preschool children's play episodes in traditional versus naturally structured playgrounds and reported that young children's play episodes lasted longer in the outdoor nature setting, which would indicate higher concentration and involvement in a play activity. Longer play episodes are likely to provide children with more opportunities to practice and express their language skills.

One study on the effect of attending a Forest School in England reported a positive impact on children's language and literacy outcomes (O'Brien 2009). This intervention study was conducted for eight months with 24 preschool-aged children randomly drawn from seven participating schools in England. Over the observation period that consisted of (bi)weekly sessions, practitioners reported children's language improvement among other skills under study. Using data obtained through self-appraisal templates, reflection workshops, and parents' reports, the study found that children's written and spoken language had become more sophisticated, with increased spontaneous talk and use of descriptive language. Such changes were attributed to the abundance of visual and sensory tools, unfamiliarity of the outdoor nature setting, and multiple opportunities for cooperation with both same-age and older peers. This way, children were provided with exposure to more expert speaker talk and improved their self-confidence, which allowed them to engage in communication more freely (O'Brien and Murray 2006). It is notable that some parents and teachers noticed the proliferation of enhanced language skills to both the indoor classroom and home settings.

Another evaluation study conducted in the U.S. also reported advances in language as one of the themes that appeared during interviews with parents whose children were enrolled in a farm-based preschool program (Rymanowicz, Hetherington, and Larm 2020). Semi-structured interviews were conducted with parents of 16 children and reported children's enhanced conversation skills, higher eagerness to engage in conversations, and more in-depth questions being asked. Norling and Sandberg (2015) explored perceptions of the connection between outdoor nature settings and language development in children by interviewing 165 preschool staff members. Participant interview analyses revealed the necessity to manipulate natural

materials to promote child talk and interaction. Interviewees noted that outdoor nature settings afforded children more opportunities to interact with each other in different areas. Interestingly, while the perceived greater freedom for children to engage in conversations was seen as a positive aspect of exposure to outdoor nature settings, staff mentioned that vast outdoor spaces created a distance between teachers and children, which led to fewer opportunities for more complex teacher-child verbal interactions than would occur among preschool children.

A few studies on nature-based education measured language outcomes quantitatively. In a small-scale multiple-case study, Richardson and Murray (2017) measured four children's productive language in an indoor classroom, an outdoor classroom that replicated the traditional learning process, and an outdoor nature setting. The authors reported the highest level of children's lexical diversity measured by type-token ratio to be in the outdoor nature setting compared to other contexts for three out of four children. Another study investigated children's language use in the context of play in preschool outdoor nature settings (Prins et al. 2023). The authors analyzed ten-minute recordings of 18 children's speech in both an outdoor nature setting and a traditional playground. It was found that the mean number of utterances produced by children was significantly higher in the outdoor nature setting compared to the traditional playground.

Dual Language Learners and nature

The population of Dual Language Learners (DLLs) has substantially increased in recent years and is the fastest growing subgroup of students in the U.S. There are various terms referring to the children who learn to speak more than one language in the U.S. such as Dual Language Learners (DLL), English Language Learners (ELL), Emergent Bilinguals (EB), and Culturally and Linguistically Diverse children (CLD). In this study, we use the term DLL since this is the most widely used term in education and school contexts.

While research shows that DLL children fall behind on achievement when entering school compared to English-only peers (Soland and Sandilos 2021), there are multiple studies that describe successful interventions directed at narrowing the language and literacy gap between the groups. Han, Vukelich et al. (2014) investigated how the Early Reading First intervention impacted low-income at-risk DLLs and monolingual English speakers' language skills from preschool to second grade. The authors assessed the language and literacy skills of 62 children using a battery of standardized measures and found that early reading intervention had an impact on children's later receptive vocabulary, story recall, decoding, and letter and word identification for both DLLs and monolingual children, bringing them to the norm group levels. In another study investigating the language skills of 118 DLL Spanish-speaking children at pre- and posttest, it was also found that the children demonstrated a significant improvement in receptive and expressive vocabulary and achieved the age norm after receiving Head Start and Early Reading First interventions (Han, Silva et al. 2014). Silverman (2007) studied the outcomes of a vocabulary intervention implemented in five kindergarten classrooms by comparing the results for 44 monolingual and 28 DLL children. The skills assessment was conducted three times: before the intervention, right after the intervention, and at a follow-up after a six-week period. The author found that DLLs demonstrated a faster growth rate on a picture vocabulary task over the intervention cycle compared to monolingual children and did not significantly differ from them at posttest. Although oral vocabulary growth rates were similar for the groups throughout the intervention, both DLLs and monolingual children demonstrated significant improvement in knowledge of the target words at posttest.

Research focusing on DLL children's language in outdoor nature settings is very scarce. One study described the integration of a garden program in one school with high numbers of DLLs (Cutter-Mackenzie 2009). The author used participatory design to show how an outdoor garden

program allowed the children to acquire language directly through collaboration, exchange of ideas and culture, and use of language in real-life situations, while also fostering a sense of belonging and allowing time for reflection. Similar themes were mentioned in other literature with an emphasis on experiential learning in outdoor nature settings promoting language development in DLLs (Escamilla, Gonzalez-Garcia, and Alvarez 2020; Tangen and Fielding-Barnsley 2007).

Together, these studies suggest that exposure to nature during the early years might have a relationship with early language learning and development. However, more studies are needed to fill the gap in understanding the connection.

Most literature on children's language in nature settings seems to use a qualitative approach and rely on observations or interview data. In our study, we employed quantitative analysis to compare the children's language use between the indoor classroom and the outdoor nature setting in a nature-based preschool.

Research questions

The present study aims to answer the following questions:

1. Does children's language use measured by syntactic complexity, lexical diversity, and conversation participation differ between the indoor classroom and the outdoor nature setting in a nature-based preschool?
2. Does DLL children's language use measured by syntactic complexity, lexical diversity, and conversation participation differ between the indoor classroom and the outdoor nature setting in a nature-based preschool?

We hypothesize that the whole sample of children as well as DLLs will demonstrate higher levels of syntactic complexity, lexical diversity, and conversation participation while in the outdoor nature setting.

Methods

Participants

Table 1 reports the demographic information of the participants. Sixteen children aged 36–60 months ($M = 49.3$ months) were included in this study. Nine of the children were female. Nine children were identified by their parents as Caucasian, two as Greek, two as Asian, and three as other (White/Filipino, Pakistani, Serbian). Four of the children attended the nature-based preschool program the previous year, and seven were DLL.

Settings

The nature-based preschool where the study took place is part of a university located in the mid-Atlantic area of the United States. The preschool is open to the general public and admits children aged two to five years. It also serves as a research site and a field experience area for university students. The present study was conducted in a Nature Preschool classroom, where 16 three- to four-year-old children were enrolled at the time. For this particular classroom, hours of operation are Monday to Thursday from 9:15 AM to 1:00 PM and Friday from 9:15 AM to Noon. The children go outdoors in all weather types for the period from 9:15 AM to 11:15 AM and from 12:00 PM to 1:00 PM. The outdoor nature setting consists of a forested area, a meadow, a creek, and a pond. The outdoor forested space is approximately 5,000 square feet and provides

Table 1. Demographic information of participants.

Child ID #	Gender	Age in Months	Language Status
001	M	48	English
002	F	49	English
003	F	54	English
004	M	48	Greek/Spanish/English
005	F	36	Greek/English
006	M	50	English
007	M	45	English
008	F	56	English/Serbian
009	M	49	English
010	F	48	Greek/Spanish/English
011	M	49	English
012	F	56	Chinese/English
013	F	40	English
014	F	60	English
015	F	58	Korean/English
016	M	43	English/Urdu

children with access to natural materials. For this study, the recording of observations took place in the forested space only. The indoor setting is an Art room that also serves as a preschool classroom in the morning and an elementary school Art room in the afternoon. The indoor space is 700 square feet and is set up as centers. Staff normally present in the classroom consists of a lead teacher, a pre-service teacher, university field placement undergraduate students, and a preschool staff member (for more information about the study site, see Pic, 2020).

Procedure

This study is part of a larger study in which data were collected in compliance with the Institutional Review Board (IRB) at a mid-Atlantic university. Parental consent and child assent were received prior to collecting video data. Naturalistic observation data were collected for five consecutive weeks in November and December. Each focal child was videotaped one day for 30 min during free play in two settings—indoor classroom and outdoor nature setting—for a total of 60 min per child. A total of 461 min, 52 s of indoor data and 474 min, 31 s of outdoor data were collected. Nonjudgmental written field notes were completed at the beginning of each video session and maintained throughout recording to document pertinent contextual information (Phillippi and Lauderdale 2018). Field notes and video clips were reviewed with the lead teacher during member checking sessions to verify data and ensure accurate and correct representation of the children (Marshall and Rossman 2016). All 32 transcripts were transcribed verbatim and then coded using the Codes for the Human Analysis of Transcripts conventions (CHAT; MacWhinney 2000). Coding was continuously discussed by researchers in group meetings.

Measures

The following parameters were measured in children's language samples: Mean Length of Utterance (MLU), Mean Length of Three Longest Utterances (MLU-3), Mean Length of Five Longest Utterances (MLU-5), Type-Token Ratio (TTR), the measure of lexical diversity *D,* Mean Length of Turn (MLT), and mean number of utterances per turn. For descriptive purposes, we also measured the Number of Different Words (NDW), Total Number of Words (TNW), and Total Number of Utterances (TNU) for language samples from indoor and outdoor nature settings. These measures are widely used by researchers and clinicians in examining children's language use.

Syntactic complexity

Syntactic complexity of children's language samples was measured by Mean Length of Utterance (MLU), Mean Length of Three Longest Utterances (MLU-3), and Mean Length of Five Longest Utterances (MLU-5).

Mean Length of Utterance (MLU) is a measure of syntactic complexity in preschool and elementary school-age children, which is calculated by dividing the total number of words by the total number of utterances (Brown 1973). For example, two child's utterances, 'oh you own a helicopter' and 'I know how to' have a length of 5 words and 4 words, respectively, and their mean length is 4.5 words. Research reports on a strong correlation between the measurement of MLU in words and in morphemes (Parker and Brorson 2005; Rice et al. 2010). For this study, utterance was conceptualized as the smallest unit of speech, and utterance boundaries were defined either by a pause that lasted two seconds or longer, evident terminal contour of the phrase, or change of speaker (Retherford, Schreiber, and Jarzynski 2019). Utterances that contained unintelligible speech were dropped from the count of all measures except for the mean length of turn and mean number of utterances per turn. Fillers and stuttering were not counted as words.

Mean Length of Longest Utterances (MLU-3, MLU-5). Despite MLU being a widely used measure in language sample analysis, it can be skewed by the number of simple utterances produced by a child. Klee and Fitzgerald (1985) found that children produced more single-morpheme utterances while engaged in conversation with an adult despite being developmentally beyond the one-word utterance stage. Likewise, Davis (1937) noticed that the abundance of one-word utterances resulted in MLU leveling off more complex utterances and not reflecting children's ability. Similar to prior research (DeMaris and Smith 2017; Smith and Jackins 2014; Wu 2020), this study used Mean Length of Three Longest Utterances (MLU-3) and Mean Length of Five Longest Utterances (MLU-5) as additional measures of syntactic complexity.

Lexical diversity

For lexical diversity determination, we obtained the following measures: Type-Token Ratio (TTR) and the measure of lexical diversity *D*.

Type-Token Ratio (TTR) is the proportion of types (number of different words in the language sample) and tokens (total number of words), which has been used to measure child language vocabulary richness (Richards 1987). For example, a child's utterance, 'but I don't know how to do it in a pumpkin or in wood' contains 13 types (different words) and 14 tokens (total words), and therefore, the TTR is 0.93.

D. Owen and Leonard (2002) noted that as the sample size increases, the inevitably repetitive use of function words decreases the TTR score. A similar situation occurs when the child stays on the same conversational topic, which prompts her to recycle content words, thus not accurately reflecting the child's lexical ability. Therefore, we used another measure of lexical diversity, *D* (Durán et al. 2004), calculated using the *vocd* program, which operates within the Computerized Language ANalysis software (CLAN; MacWhinney 2000). The CLAN software compares the actual type-token ratio with the tokens of a curve sample by randomly selecting words from the language sample and then uses a curve-fitting procedure to identify the best fit. This value is the index of lexical diversity for the language sample, where higher values mean greater diversity (Schnur and Rubio 2021). CLAN calculates *D* three times and ultimately outputs an average value. Malvern et al. (2004) recommended that samples contain at least 50 tokens to produce reliable values of *D*.

Conversation participation

To assess children's conversation participation, we calculated Mean Length of Turn (MLT) and mean number of utterances per turn for the language samples.

Mean Length of Turn (MLT). For this study, a turn was considered everything the child vocalized and communicated through gestures until the point when another speaker took over the conversation. The total number of words produced by the target child in a language sample was divided by the number of child's conversational turns. The turn count included both verbal (meaningful utterances, vocalizations, sighs) and nonverbal communicative behaviors (nodding, waving; Crowe, Norris, and Hoffman 2000) as well as utterances completely consisting of or containing unintelligible words. For example, two child's turns, 'Look. I'm gonna do this one now' and 'What?' amount to 7 words for the first turn and 1 word for the second turn, and the MLT is 4 words.

Number of utterances per turn. This measure was calculated by counting all utterances the child produced in a language sample and dividing the sum by the number of conversational turns. Prior research used both MLT and number of utterances per turn (Kelly, Nixon, and Quigley 2022; Lloyd, Lieven, and Arnold 2001; Minami and McCabe 1995) to estimate child conversation participation. For the example listed under the description of MLT, the first turn consists of two utterances and the second turn consists of one utterance, which results in a mean number of utterances per turn of 1.5.

Analysis

The Computerized Language ANalysis (CLAN) software (MacWhinney 2000) was used to analyze the language measures. Paired-samples *t*-tests using SPSS software (Version 28) were conducted to compare the pairs of transcripts on the language measures.

Results

To answer the first research question, we compared the measures of language obtained from CLAN software (MacWhinney 2000) for the indoor classroom and the outdoor nature setting for the entire sample of children ($N = 16$). Figure 1 shows the means for number of different

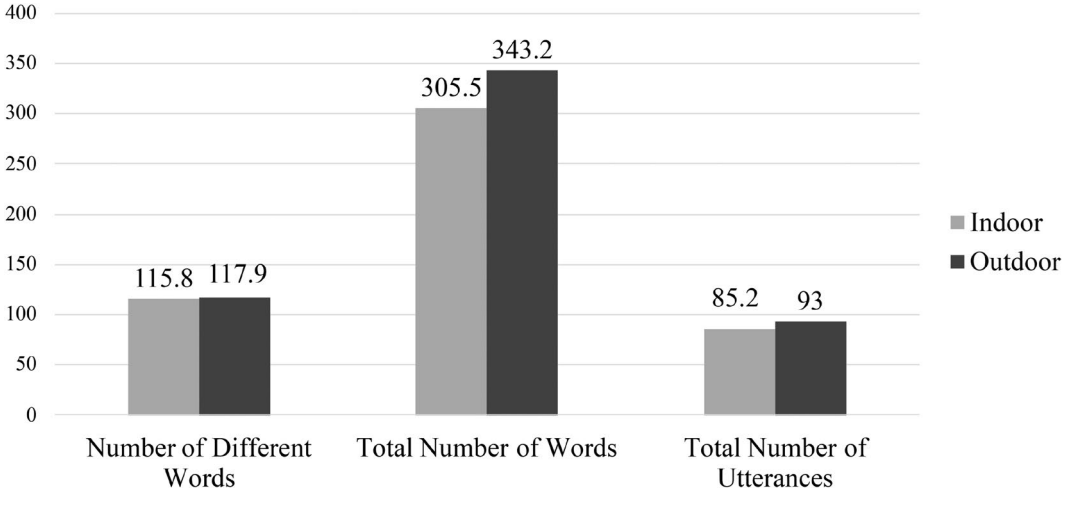

Figure 1. Mean number for children's language samples ($N = 16$) in indoor classroom and outdoor nature setting.

words (NDW), total number of words (TNW), and total number of utterances (TNU) between indoor and outdoor nature setting. We conducted *t*-tests to compare these language measures between the indoor classroom and the outdoor nature setting. There were no significant differences between the settings for NDW, $t(15) = -0.19$, $p = 0.43$, TNW, $t(15) = -0.88$, $p = 0.2$, or TNU, $t(15) = -0.71$, $p = 0.24$.

Next, we compared measures of syntactic complexity, lexical diversity, and conversation participation between language samples from the indoor classroom and the outdoor nature setting. Since the sample size was less than 20, Hedges' g (1981) was used to calculate the effect size. For Hedges' g, 0.2 is considered a small effect, 0.5 a medium effect, and 0.8 a large effect. Table 2 shows statistics for paired-samples *t*-tests comparing the language use measures between indoor and outdoor transcripts. Although none of the results reached statistical significance ($p < 0.05$), there was a marginally significant difference (i.e., $0.05 \leq p < 0.1$) found for mean length of three longest utterances between the indoor classroom ($M = 10.90$, SD = 3.73) and the outdoor nature setting ($M = 13.13$, SD = 5.84), $t(15) = -1.72$, $p = 0.053$, Hedges' g = −0.41, with higher scores in the outdoor nature setting. The results did not show any statistically significant difference for other measures of syntactic complexity – mean length of utterance, $t(15) = -0.24$, $p = 0.41$, or mean length of five longest utterances, $t(15) = -0.68$, $p = 0.25$; any measures of lexical diversity – type/token ratio, $t(15) = 0.75$, $p = 0.23$, or *D*, $t(13) = 1.07$, $p = 0.15$; or any measures of conversation participation – mean length of turn, $t(15) = 1.37$, $p = 0.91$, or mean number of utterances per turn, $t(15) = 0.43$, $p = 0.34$. The results thus strive toward statistical significance for some measures in the domain of syntactic complexity and display a medium effect size (Hedges 1981).

To answer the second research question, we compared the measures of language use for the indoor classroom and the outdoor nature setting for the sample of DLL children only ($N = 5$). For this analysis, we dropped two children since they had insufficient language data due to being in the silent stage. Means for the properties of DLL children's language samples are displayed in Figure 2. The mean differences were not statistically significant on total number of words (TNW), $t(4) = -0.96$, $p = 0.20$, or total number of utterances (TNU), $t(4) = -0.65$, $p = 0.28$, but showed a marginally significant difference for number of different words (NDW), $t(4) = -1.63$, $p = 0.09$, Hedges' g = −0.58 (medium effect size), with higher scores in the outdoor nature setting.

Next, measures of syntactic complexity, lexical diversity, and conversation participation were compared for the sample of DLL children. Table 3 shows statistics for paired-samples *t*-tests. For DLL children, marginally higher scores for mean length of three longest utterances were found in the outdoor nature setting ($M = 14.33$, SD = 6.36) compared to the indoor classroom ($M = 9.93$, SD = 3.09), $t(4) = -1.68$, $p = 0.08$, Hedges' g = −0.60. We also found a marginally

Table 2. Children's language use in indoor classroom and outdoor nature setting: paired samples test.

		Indoor	Outdoor		
Measure	*N*	M (SD)	M (SD)	Paired *t*-test	Hedges' g
Mean Length of Utterance	16	3.47 (0.82)	3.50 (0.95)	−0.24	−0.06
Mean Length of 3 Longest Utterances	16	10.90 (3.73)	13.13 (5.84)	−1.72*	−0.41
Mean Length of 5 Longest Utterances	16	9.78 (3.20)	10.44 (4.56)	−0.68	−0.16
Type/Token Ratio	16	0.43 (0.11)	0.40 (0.14)	0.75	0.18
D (lexical diversity)	14	59.41 (17.95)	55.26 (15.96)	1.07	0.27
Mean Length of Turn	16	4.60 (1.72)	4.15 (1.37)	1.38	0.33
Mean Number of Utterances per Turn	16	1.38 (0.33)	1.34 (0.20)	0.43	0.10

*$p < 0.1$

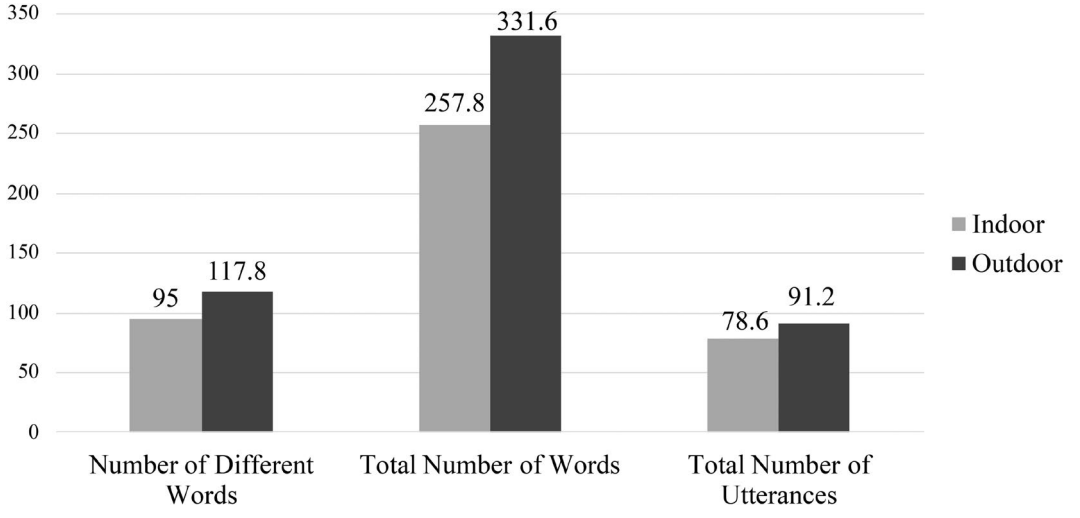

Figure 2. Mean number for DLL children's language samples ($N = 5$) in indoor classroom and outdoor nature setting.

Table 3. Dual Language Learners' language use in indoor classroom and outdoor nature setting: paired samples test.

		Indoor	Outdoor		
Measure	*N*	M (SD)	M (SD)	Paired *t*-test	Hedges' g
Mean Length of Utterance	5	3.47 (0.75)	3.61 (0.93)	−0.61	−0.22
Mean Length of 3 Longest Utterances	5	9.93 (3.09)	14.33 (6.36)	−1.68*	−0.60
Mean Length of 5 Longest Utterances	5	8.88 (2.59)	12.04 (4.48)	−1.73*	−0.62
Type/Token Ratio	5	0.44 (0.16)	0.37 (0.07)	1.26	0.45
D (lexical diversity)	5	52.84 (22.59)	49.52 (20.16)	0.67	0.24
Mean Length of Turn	5	5.22 (2.24)	4.26 (1.27)	1.03	0.37
Mean Number of Utterances per Turn	5	1.61 (0.49)	1.30 (0.13)	1.26	0.45

*$p < 0.1$.

significant difference for mean length of five longest utterances between the indoor classroom ($M = 8.88$, SD = 2.59) and the outdoor nature setting ($M = 12.04$, SD = 4.48), $t(4) = -1.72$, $p = 0.08$, Hedges' g = −0.62, with higher scores in the outdoor nature setting. Although these results did not reach statistical significance ($p < 0.05$), there was a trend towards significance for the measures of syntactic complexity, both of which displayed a medium effect size (Hedges 1981). There were no differences found for the third measure of syntactic complexity – mean length of utterance, $t(4) = -0.61$, $p = 0.29$; any of the measures of lexical diversity – type/token ratio, $t(4) = 1.26$, $p = 0.14$, or D, $t(4) = 0.67$, $p = 0.27$; or any measures of conversation participation – mean length of turn, $t(4) = 1.03$, $p = 0.18$, or mean number of utterances per turn, $t(4) = 1.26$, $p = 0.14$.

Discussion

Early childhood is a critical period for language development, and numerous contextual factors can affect the process of language learning. Our study investigated whether children's language

use differs depending on the contexts, such as an indoor classroom versus an outdoor nature setting. Our study showed that syntactic complexity measured by Mean Length of Three Longest Utterances was higher in the outdoor nature setting, while the rest of the language measures did not differ between the settings. For DLL children, syntactic complexity measured by the Mean Length of Three and Five Longest Utterances was higher in the outdoor nature setting with larger effect sizes compared to the indoor classroom.

There might be various reasons why children used longer utterances in the outdoor nature setting. Vast outdoor spaces and the abundance of loose parts such as leaves, twigs, and planks reduce the necessity to compete for limited space or for play materials, allowing children to concentrate on the elements of play, play roles, and use of play items and engage in conversation with their peers. For example, Pic and Han (2021) reported that preschool children engaged in more conflicts centered around play ideas in the outdoor nature-based setting, as opposed to distribution of resources conflicts in the indoor classroom. The authors suggest this may be due to engagement in more meaningful conflicts in the outdoor nature setting. These meaningful peer conflicts provide children with opportunities to practice social skills through negotiation and argumentation, which requires the use of more advanced sentence structure and going beyond the one-word exchange of possession claims. In Flannigan and Dietze's (2018) study, the availability of loose parts was also shown to promote peer interactions and more complex social behavior.

Outdoor nature settings seem to be a more positive context for DLLs language development, allowing children to speak longer and produce sophisticated utterances. A less structured, sprawling outdoor space could provide more opportunities for risk-taking, decision-making, and exploration and thus promote DLL children's self-esteem and confidence in engaging in conversations with peers and adults. In prior research, practitioner interviews contained instances of usually shy children becoming more talkative when in a Forest School setting (Harris 2017). The open space could also create a sense of safety for children who are afraid or shy to speak, as their voice would be intertwined with other sounds in the outdoor space.

Our study contributes to a literature that demonstrates mixed results. For example, Prins et al. (2023) and Cameron-Faulkner, Melville, and Gattis (2018) reported that children used significantly more utterances in the outdoor nature setting. Cameron-Faulkner et al.'s (2018) study with mother-child dyad conversations in indoor and outdoor nature settings reported no difference on lexical diversity among children. Richardson and Murray (2017)'s study with four children reported a higher type-token ratio in the outdoor nature setting.

Although not all measures in our study showed statistically significant differences in language use between the indoor and outdoor settings, descriptive data showed higher means on the total number of words, total number of utterances, and number of different words in the outdoor nature setting. We also found the number of different words to be higher in the outdoor nature setting for the sample of DLLs, indicating a possible benefit for vocabulary richness when exposed to nature and calling for further research on the effect of setting on lexical diversity for DLL children.

Limitations

Important strengths of our study include utilizing direct measures of child language use (as opposed to parent or teacher report) and a within-subjects design that controlled for child characteristics. Despite these strengths and demonstrated promising results, this study has limitations. Our study was limited to one-time indoor and outdoor language sample recordings collected from 16 children. According to our power analysis, the ideal sample size is 27 or higher to detect a medium effect size at the statistical significance of 0.05. While having a larger sample size would increase statistical power, our data were collected as part of a prior

study, and therefore we were limited to the available data. Due to the constraints of the prior study design, we were also not able to consider the possibility that, in addition to the situational effects of being outdoors, there may be long-term or sustained effects of attending a nature preschool on language development. These sustained effects could result in language use indoors that is closer to the language use observed outdoors than would be true of children attending a regular preschool and tested in indoor and outdoor settings. In our study, this phenomenon might have masked the strength of the effect of outdoor nature settings for language development.

Future directions

In order to enhance power, future studies should examine language use with a larger sample size and collect more observations in the indoor and outdoor settings. Additionally, as described in Nelson (1981), children can use different vocabulary depending on the setting. Future research should therefore examine different types of vocabulary use in both settings using qualitative analysis. Finally, to examine and account for the possible sustained effects of nature preschool attendance on child language function, future studies might consider examining language use in indoor versus outdoor settings for both a nature preschool and a traditional preschool.

Conclusion

Outdoor nature settings could have considerable potential for children's development, including language learning and may be a particularly rich setting for language development for DLLs. Additional research using larger samples, mixed methods, and longitudinal and nature-based versus traditional educational setting comparison designs are needed to confirm and extend our findings and to clarify the inconsistencies that currently exist in the literature.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Data availability statement

These data are not publicly available in order to protect the identity of study participants.

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