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Climate Change Education in Early Childhood Classrooms: A Nature-Based Approach

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ABSTRACT

Climate change is an urgent global issue that requires concern and action among a climate literate citizenry. Early childhood climate change education (CCE) affords strong potential for developing this climate literate citizenry. Early childhood educators are critical for this endeavor, and their climate change perspectives, teaching practices, and resource needs must inform future curriculum and professional development. Thus, the purpose of this study is to better understand early childhood educators' perspectives on climate change instruction and use of CCE resources. An explanatory mixed-methods design was selected for this study. In the first phase, a quantitative survey was used to determine important types of CCE resources for early childhood. In the second phase, selected participants were interviewed to explain and elaborate on their quantitative results. In terms of findings, early childhood teachers particularly valued nature-based material resources, human resources that could improve their own climate change response knowledge, and social resources that included trustworthy sources of climate change information. Interviewed teachers elaborated on qualities that make CCE resources particularly useful: age-appropriateness, curriculum alignment, ease of use, engagement, place-based, and trustworthiness. In addition, we present a place-based example of a kindergarten climate change teacher who exemplifies the use and valuation of these CCE resources. Implications for curriculum development and teacher professional learning are provided.

Keywords: climate change education, place-based education, nature-based education, early childhood education, educational resources, environmental education

Climate change is an urgent global issue that is already having physical and human impacts worldwide (Intergovernmental Panel on Climate Change [IPCC], 2021). Mitigation and adaptation actions are critical for limiting the worst impacts of climate change (IPCC, 2021). Education is one strategy to prepare an informed citizenry that can contribute to individual and collective climate actions and advocate for governmental and intergovernmental climate responses (Anderson, 2012; Stevenston et al., 2017). Further, proponents of climate change education (CCE) suggest that education will reduce vulnerability and increase resilience (Muttarak & Lutz, 2014). However, in the US, climate change can be considered a distant concern, leading to a lack of urgency (Center for Research on Environmental Decisions [CRED], 2009; Leiserowitz, 2007). Additionally, many students do not often have an in-depth understanding of climate change (Leiserowitz et al., 2011; Shepardson et al., 2009; Shepardson et al., 2014).

One solution to preparing an informed climate literate citizenry is to introduce climate change topics into early childhood. In this study, we define early childhood education as formal education in the classroom with children between the ages of five and eleven. However, there are some challenges to CCE with young children. Elliott and Davis (2009) note that some educators maintain that environmental concerns are too challenging for young children to understand. Others argue that children feel they have limited power and are thus vulnerable to climate anxiety

(Hickman et al., 2021). Yet, Elliott and Davis (2009) assert that these arguments are specious and underestimate young children.

Several environmental and science educators have presented a strong case for why climate change instruction can and should be addressed in early childhood. First, young children have demonstrated their sophisticated reasoning about environmental problems (Palmer & Suggate, 2004) and pro-environmental solutions (Kos et al., 2016). Second, when environmental issues are taught in grade-appropriate ways, young children feel empowered to be a part of environmental solutions (Gambino et al., 2009). Third, compared to adults, young children are going to be both more impacted by climate change impacts and required to take adaptation actions (Hahn, 2021). Thus, young children's climate literacy is particularly important. Fourth, compared to adolescents who have less frequent outdoor experiences and lower nature connectedness (Chawla, 2020), young children have more pro-environmental attitudes (Otto et al., 2019) and willingness to take action (Lee et al., 2020). Further, young children are likely more receptive to climate instruction (Lieflander & Bogner, 2014).

Given this potential for early childhood CCE, environmental and science educators need to understand early childhood educators' perspectives, current teaching practices, and desired CCE resources for young learners. With this knowledge, environmental and science educators can develop resources that address barriers to climate instruction and align with early childhood educators' climate change teaching goals. Therefore, the purpose of this study is to better understand early childhood educators' perspectives on climate change instruction and use of CCE resources. Specifically, this study included early childhood science teachers in Northeast Ohio. The following research questions were used to guide this study:

(1) What CCE resources do early childhood teachers identify as important for teaching about climate change?
(2) What are early childhood teachers' perceptions of useful CCE resources?
(3) What does climate change instruction look like in early childhood?

Framing the Study

This study was framed through the lenses of resources and place-based education. Educational resources are "assets that teachers can access in classrooms, school, or community contexts to improve their pedagogy and development" (Navy et al., 2020, p. 186). There are three main categories of resources (Lee et al., 2016; Spillane & Thompson, 1997), known as primary resources (Navy et al., 2020). In education, primary resources include material, human, and social (Navy et al., 2020). Material resources include physical handouts, curriculum, technology, equipment, and learning spaces (Lee et al., 2016; Navy et al., 2020). Human resources include an individual's knowledge and skills (Lee et al., 2016; Navy et al., 2020; Spillane & Thompson, 1997). Social resources include relationships, trust, and collaboration (Navy et al., 2020).

Previous research has demonstrated the importance of social resources in educational settings (Navy et al., 2020; Rivera Maulucci, 2010). For instance, Rivera Maulucci (2010) demonstrated the importance of colleague support for new science teachers. Similarly, Navy et al. (2020) found that new secondary science teachers most frequently accessed social resources, such as collaborating with peers. This study expanded on the resource literature by identifying the primary CCE resources used by early childhood teachers.

The frame of place-based education is also relevant to this study. Place-based education situates "learning in local phenomena and students' lived experiences" (Smith, 2002, p. 586). In the US, climate change can be considered a distant concern (CRED, 2009; Leiserowitz, 2007). Due to the lack of urgency, place-based education can be used to help communicate the severity of climate change (Gislason et al., 2021; Hernandez et al., 2022). Further, making climate change personally and locally relevant to students can increase agency (Littrell et al., 2020) and thus help to alleviate climate anxiety (Gallay et al., 2022).

Place-based education has been subdivided into five themes: cultural studies, nature studies, real-world problem-solving, internships, and induction into community processes (Smith, 2002). In this study, nature studies are

particularly relevant for CCE and young learners. In nature studies, students investigate "local natural phenomena" by exploring the outdoors or incorporating field trips (Smith, 2002, p. 588). Local learning can provide a foundation for learning about distant phenomena (Smith, 2002). In the context of CCE, students may first learn about local climate change impacts by noting the impacts of extreme weather events or phenological changes before broadening their understanding to global impacts.

Nisbet et al. (2009) proposed the construct of nature relatedness to address individuals' appreciation for humans' relationships with other living things and an understanding of the importance of the totality of nature. Nisbet et al. (2009) contended that nature relatedness has affective, cognitive, and experiential dimensions and found that this connection to nature was associated with environmental attitudes, behavior, and frequency of time in nature. Barrable (2019) asserted that nature connectedness should be a distinct goal in early childhood curricula and proposed a pedagogy of connection that includes contact and engagement with nature's beauty, cultivating compassion towards non-human nature, and mindfulness. Interventions that engage students in natural environments have successfully improved young children's connectedness to nature (Bruni et al., 2017; Cho et al., 2018; Kosta et al., 2022).

Globally, climate change impacts and severity vary from place to place. This study was situated in northeast Ohio, a midwestern state that does not have as extreme climate change impacts compared to some regions (i.e., coastal, or glacial) (Melillo et al., 2014). Therefore, teachers must find relevant and meaningful ways to connect learning about climate change with students' experiences and knowledge relative to Ohio. The findings from this study offer implications for how early childhood teachers can incorporate place-based climate change topics into their curriculum, as well as which CCE resources they may be able to use.

Barriers to Climate Change Education

Clearly, climate change education is required to respond to current and future climate changes (Anderson, 2012; Herman, 2015), yet many teachers do not frequently include climate change in their curriculum due to significant barriers (White et al., 2014; Wise, 2010). A leading barrier is the need for quality CCE resources (Colston & Ivey, 2015; Foss & Ko, 2019; Sullivan et al., 2014; White et al., 2014). Specifically, teachers require CCE resources that are relevant, engaging, and encourage collaboration (Bozdogan, 2011; Monroe et al., 2019; Schweizer et al., 2013). A recent study on CCE found that national parks offer a variety of CCE resources that are collaborative, engaging, and offer place-based connections (Beaver & Navy, 2023). Thus, outdoor learning spaces can be a particularly useful material resource for climate change instruction.

Another barrier to climate change instruction is the limited formal education that educators receive. Climate change is a complex interdisciplinary subject (IPCC, 2021). Yet, the literature indicates that most teachers do not receive a formal education on climate change (Colston & Ivey, 2015; Plutzer et al., 2016). For instance, Plutzer et al. (2016) found that less than half of the teachers they surveyed reported any climate science instruction in college. Instead, most science teachers learn about climate change informally, often through books and websites (Colston & Ivey, 2015).

A final barrier to CCE is alignment with the curriculum (Colston & Ivey, 2015; Foss & Ko, 2019; Hannah & Rubart, 2020; Sullivan et al., 2014; White et al., 2014; Wise, 2010). White et al. (2014) identified that science teachers are more likely to include climate change in their curriculum when they have content standards. Similarly, Hannah and Rubart (2020) found that teachers spend more time teaching about climate change when they have explicit standards. For early childhood teachers, this may be especially difficult due to the limited climate change standards (Next Generation Science Standards [NGSS] 2013; Ohio Department of Education [ODE], 2018).

In the US, individual states have their own set of science standards, and thus, climate change instruction can vary significantly. For instance, the Ohio Learning Standards Model Curriculum has only one mention of climate change in early childhood in the fourth-grade standard 4.LS.1. The standard states that "Ecosystems can change rapidly (e.g., volcanic activity, earthquakes, fire) or very slowly (e.g., climate change)" (ODE, 2018, p. 103).

The National Center for Science Education (2020) completed a state-by-state analysis of climate change science standards. Each state was assigned an overall grade based on four key points: (1) climate change is real, (2) climate change is anthropogenic, (3) climate change negatively affects nature and society, and (4) there is hope through mitigation and adaptation. Ohio received a score of a "D" on its climate change standards, indicating poor climate change connections. Only five US states (Alaska, Colorado, New York, North Dakota, and Wyoming) received a score of an "A" on their climate change standards. Hence, the US has a long way to go in order to have a robust climate change curriculum across all states.

Weldermariam et al. (2017) compared the early childhood sustainability curriculum in five countries: Australia, England, Norway, Sweden, and the US. The authors analyzed the curricula for four major themes, including the presence of sustainability, the view of the child, human-environment relationships, and philosophical and theoretical underpinnings. The authors found several differences across the five curricula. First, only Australia and Norway explicitly addressed sustainability in their curriculum. Further, Australia, Norway, and Sweden discussed outdoor learning, whereas England and the US did not. Second, the five curricula offered different views of children. Sweden, Australia, and Norway viewed children as active agents in learning. While England and the US treated children not as active agents but as supported by adults. Third, the five countries had similar views concerning the human-environment relationship, in which children could act upon the environment, including caring for and appreciating the environment. Finally, the authors determined that the five curricula were "predominantly based on child-centered sociocultural, social constructivist and Piagetian developmentalism learning theories, relating children's learning to activities, experiences and situations, and interactions with their physical environments" (Weldermariam et al., 2017, p. 347).

Early Childhood Climate Change Education

Young children have some understanding of climate change. When asked about the impacts of global warming on polar creatures, very young (four-year-old) children described short-term effects, but 90% of ten-year-olds suggested reasonable long-term effects (Palmer & Suggate, 2004). In fact, in a review of youth perceptions of climate change, most children accurately understand climate change impacts as including rising temperatures, melting ice caps, and ecosystem changes (Lee et al., 2020).

Some areas of climate change are less well-understood at the early childhood level. In Boylan's (2008) survey of Australian elementary students, only 59% of children correctly identified that "climate change, greenhouse effect and global warming all mean different things" (Boylan, 2008, p. 12). Children's understanding of the causes of climate change varies in correctness, from pollution fumes (correct) to common climate change misconceptions such as a hole in the ozone layer, the sun getting nearer to the Earth, and seasonal change (Lee et al., 2020; Palmer & Suggate, 2004). Although children understand some common impacts of climate change, they tend to believe these impacts are on "wild" organisms rather than on agriculture and humans (Lee et al., 2020). To address these areas of misunderstanding, many science education researchers recommend teaching climate change at the early childhood level (Boylan, 2008; Lee et al., 2020).

Although often not specifically addressing climate change, early childhood-level environmental education interventions have yielded very positive results. Children ranging from ages four to six have improved environmental knowledge (Gambino et al., 2009), environmental attitudes (Gambino et al., 2009; Samur, 2018), and an awareness of how they, as humans, influence the environment (Kos et al., 2016; Samur, 2018). Furthermore, early childhood-level interventions may find a particularly receptive audience given that environmental attitudes and behaviors are moderately high from six to eight years of age, increase from ages seven to ten, plateau until high school age, and then decrease until adulthood (Boyes et al., 2008; Collado et al., 2015; Evans et al., 2007; Otto et al., 2019).

Few studies have addressed early childhood teachers' perspectives of climate change instruction. When interviewed, several preschool teachers indicated that teaching climate change in an early childhood context was not a developmentally appropriate practice because children have a limited understanding of time and climate change instruction might engender hopelessness in young children (Ginsburg & Audley, 2020). These teachers cited lack of curricular time and inadequate family engagement as barriers to teaching about sustainable practices (Ginsburg &

Audley, 2020). Yet, early childhood teachers believe environmental education in natural settings promotes children's connection to nature and readily accept their role as co-explorers of nature with students (Beery & Fridberg, 2022). Further, in a global study of an early childhood Education for Sustainable Development curriculum, researchers found that adults consistently underestimated children's knowledge about the environment and sustainable practices (Engdahl, 2015).

Methods

This study was a sequential explanatory mixed-methods design that included a quantitative phase and a qualitative phase (Creswell & Plano Clark, 2018). A sequential explanatory design was selected so that quantitative trends could be further explored in qualitative interviews. In the first phase, quantitative survey data were collected and analyzed to better understand early childhood teachers' interest in CCE resources. Next, interview questions were designed based on the quantitative data. In the second phase, selected participants were interviewed to explain and elaborate on their quantitative results.

This study's sample was part of a larger study (n=54) in which K-12 science teachers were purposefully selected from 41 schools near a national park. All the selected schools were within a 30-minute drive to the park. The overall response rate was found to be 10.9%. Surveys were excluded from this study if participants were not in early childhood or did not complete all aspects of the survey.

In total, 22 early childhood science teachers were included in this study. These teachers represented grades K-5, teaching students within the age range of five to eleven. Table 1 shows participants' experience, grade level, and school classification. In addition, the majority (59.1%) of participants planned to teach about climate change during their current school year, and 31.8% reported having climate change standards in the grade level in which they teach.

Table 1

Participant Experience, Grade Level & School Classification (n=22)

	n	%
Grade Level		
K-2	9	40.9
3-5	13	59.1
School Classification		
Public - Rural	0	0
Public Suburban	19	86.4
Public - Urban	0	0
Private	3	13.6
Teaching Experience		
0-5 years	2	9.1
6-10 years	5	22.7
11-15 years	2	9.1
16-20 years	8	36.4
21-15 years	4	18.2
26+ years	1	4.5

An item on the survey asked participants if they would be willing to be contacted for a follow-up interview, and 10 indicated interest. All participants who indicated a willingness to be interviewed on their survey were contacted. For participation in the interviews, participants received a $10 Amazon eGiftCard. In total, four participants were interviewed during the qualitative phase (see Table 2). These teachers were given pseudonyms to ensure confidentiality.

Table 2
Qualitative Participants (n=4)

Pseudonym	Grade Band	Teaching Experience (year)	School Classification
James	K	11-15	Public - Suburban
Katelyn	3	16-20	Public - Suburban
Melissa	K	16-20	Public - Suburban
Elizabeth	2	16-20	Public - Suburban

Quantitative Data Collection & Analysis

Quantitative data consisted of closed-ended survey responses using an author-designed instrument. The survey was created on Qualtrics following the guidelines of Fowler (2014) and Ruel et al. (2016). For content validity, the survey was pre-tested with seven educational experts, including four education doctoral students and three education professors. The survey was updated based on expert feedback, including making questions more descriptive, changing to Likert-style questions, and adding an exhaustive list of responses.

Within the survey, participants were asked questions about their climate change teaching and interest in CCE resources. For instance, the first section asked teachers about their plans to teach about climate change and their climate change standards. In the second section, participants were asked resource-specific questions. For instance, participants were asked to rate the importance of material, social, and human CCE resources. A question asked, "Please rate the following items in terms of importance to you in relation to teaching about climate change," and responses included "not important," "slightly important," "moderately important," "important," and "very important."

The survey was distributed to all science teachers within the previously described geographic area. Teachers received three follow-up emails, each spaced ten days apart. The survey was closed after 40 days, and survey data were downloaded from Qualtrics. Quantitative data were analyzed using frequency distributions and descriptive statistics.

Qualitative Data Collection & Analysis

Qualitative data consisted of follow-up interviews with four participants conducted by the authors. The interviews were semi-structured to allow the researchers to dive further into certain topics or discussions. The interview questions were designed after quantitative data analysis so that the interviews could be used to expand upon the quantitative results. For instance, participants rated collaborative resources as the least important. To further understand this finding, we asked the follow-up question, "How important is it to you to have opportunities to collaborate with scientists for your own climate change learning or your student's learning? Please explain."

The qualitative sample was contacted via email to schedule an interview at their convenience. The audio-recorded interviews occurred through Google Meet and lasted from 20-39 minutes. During the interview, participants were asked questions about their climate change teaching, use of CCE resources, and interest in CCE resources.

After the interviews, the audio recordings were transcribed using Otter AI transcription software. The first and second authors then analyzed the transcriptions in Dedoose through multiple rounds of coding. Coding procedures were followed with guidelines from Saldaña (2021). To answer research question two, "What are elementary teachers' perceptions of useful CCE resources?", data were coded using an inductive approach. Hence, we developed codes as we went through each transcript. For instance, when Katlyn mentioned that she would like to "prioritize things that are more hands-on, more site-based, more engaging" the codes "place-based" and "engaging" were developed.

To answer research question three, "What does climate change instruction look like in early childhood?", data were coded using both a deductive approach and an inductive approach. The initial resource codes of "material," "social,"

and "human" were developed prior to coding to represent the three primary resources (Navy et al., 2020). However, inductive codes were developed for climate change topics, including "biotic," "abiotic," and "action." In addition, participants described many types of material resources, and thus, these were coded inductively as well.

The coding process occurred in several cycles. In the first cycle, we coded two transcripts together, and discussion occurred on any disagreements to reach a consensus code. For instance, James described a Ranger-led experience in a local park. The first author wanted to code this section as a social resource. The second author then explained that the park itself is also a material resource. After discussion, both "social" and "material" codes were applied to the Ranger-led experience within a park. After the first cycle, we collapsed codes and developed an initial code book.

In the second cycle, we coded the last two transcripts together, again discussing any disagreement on the codes until we reached a consensus. We updated our codebook at this point and again collapsed codes into larger categories. For instance, "convenient" and "easy to use" were collapsed into a single code of "ease of use." We then used these consensus codes to develop assertions related to our research questions, as presented in the Results section.

Results

Important Types of CCE Resources for Early Childhood

To answer the first research question on important CCE resources, data were analyzed from the surveys (n=22). Participants were asked, "Please rate the following items in terms of importance to you in relation to teaching about climate change" and response options included a 5-point Likert scale from "not important" to "very important." The data were analyzed using frequency distributions (see Table 3). Qualitative interviews were used as a secondary data source to help elaborate on the quantitative results.

Table 3
Teachers' Perceptions of "Important or Very Important" CCE Resources (n=22)

	n	%
Material Resources		
Having access to CC curriculum and/or lesson guides and worksheets	18	81.8
Having access to CC data	17	77.3
Having access to technology/tools for teaching and learning about CC	20	90.9
Having access to outdoor classrooms for teaching and learning about CC	18	81.8
Human Resources		
Attending professional development about CC education	15	68.2
Improving my own knowledge of the causes of CC	17	77.3
Improving my own knowledge of the evidence of CC	17	77.3
Improving my own knowledge of the impacts of CC	17	77.3
Improving my own knowledge of the response strategies to CC	19	86.4
Improving my own science skills/practices for studying CC	16	72.7
Social Resources		
Collaborating with scientists about CC	12	54.5
Collaborating with other science teachers about CC	11	50.0
Collaborating with the local community about CC	9	40.9
Trusting where my CC resources come from	20	90.9

The survey had three sections representing material, human, and social CCE resources. For material resources, participants selected "having access to technology/tools for teaching and learning about CC" as the most important material resource with 90.9% selecting either "important" or "very important." For human resources, participants selected "improving my own knowledge of the response strategies to CC" as the most important human resource with 86.4% of participants finding this resource "important" or "very important." Finally, for social resources,

participants selected "trusting where my CC resources come from" as the most important social resource with 90.9% selecting either "important" or "very important."

Across all the listed CCE resources, participants identified "trusting where my CC resources come from" as the most important. In total, 18 of the 22 participants selected "very important" for this resource. Whereas "having access to technology resources/tools for teaching and learning about CC" only 10 participants selected "very important". The qualitative results helped to explain the importance of trust regarding CCE resources. Katelyn, a third-grade teacher, shared:

> *So, I just think it's important that I have the best and latest information. You know, when you're teaching something, you want to make sure that what you're teaching is the right stuff and you're doing what is, you know, currently the best thoughts on the topic. So, I think it adds to my credibility as their teacher that I'm providing them with the latest and most current information.*

When comparing the different types of CCE resources, the items on collaboration were found to have the lowest importance to participants. Specifically, "collaborating with the local community" was identified as the lowest importance, with only 40.9% of participants finding this important. Collaborating with other science teachers (50.0%) and collaborating with scientists were also low (54.5%).

The qualitative results helped to explain the low interest in collaboration. James, a kindergarten teacher, explained the challenges of having professionals work with children sharing:

> *I've had scientists come in or chemists and doctors and people come in and try to do work in the classroom. And that's the biggest challenge is having somebody of, you know, just a great mind and science come in and try to break it down and make it presentable for a five-year-old, without the five-year-olds going to sleep.*

Useful Qualities of CCE Resources for Early Childhood

The qualitative sample of early childhood science teachers (n=4) shared their perceptions of useful qualities of CCE resources. Six themes emerged from the qualitative interviews (Table 4). Participants most frequently discussed useful qualities associated with age-appropriateness, engagement, and place-based connections.

Table 4
Teachers' Perceptions of Useful Qualities of CCE Resources (n=4)

Useful Qualities of CCE Resources	Example Quote
Age-Appropriate	"Just ways to set up, you know, age-appropriate projects for them to do ways to get them involved." (Katelyn)
Curriculum Alignment	"Resources and kind of like, concepts that if they could intertwine to the current curriculum, so I could like take it and just kind of fan it out a little bit bigger." (Melissa)
Ease of Use	"At least in my district, it's got to be kind of quick and easy." (Elizabeth)
Engaging	"Try to like prioritize things that are more hands-on." (Katelyn)
Place-based	"I would like to see some units that are based locally." (James)
Trustworthy	"Years of data, years of science to back it up." (James)

Participants most often discussed the importance of having CCE resources that are age-appropriate for their young students. Melissa explained that very little direct climate change content is addressed in kindergarten. Instead, students learn about the needs of living things. For example, Melissa asked, "If we get rid of all the ice, then where are the polar bears gonna catch their seals?" Similarly, Elizabeth, a second-grade teacher, also approaches the topic of climate change through ecology. She explained that "climate change is a little, you know, bit bigger for them. But they can think of it… more as if I take care of the Earth, then there'll be trees."

Participants frequently described the importance of having engaging CCE resources. Elizabeth described wanting to do a hands-on project where students build bird feeders to learn about taking care of the Earth. In connection to climate and being good stewards, Elizabeth would tell students, "We're gonna help take care of the birds by putting out something in the cold weather; they'll have something to eat." Katelyn also described prioritizing resources that are hands-on or project-based for her students.

Place-based CCE resources were also commonly discussed by the participants. Katelyn described wanting site-based CCE resources and explained the importance of making learning "relevant and real to a child, and they can see it like in their own backyard." Similarly, James discussed the importance of using CCE resources relevant to Ohio. In his classroom, James connects climate change to monarch butterflies and maple trees, things his students can literally find in their backyard or outdoor classroom.

To a lesser extent, participants also discussed alignment with the curriculum, the trustworthiness of CCE resources, and the ease of use. Melissa described wanting CCE resources that are situated in the state's science standards. Elizabeth explained the importance of having trustworthy CCE resources: "It adds to my credibility as their teacher that I'm providing them with the latest and most current information." Finally, James explained that climate change units should be "easily replicated in the classroom for teachers that are not as comfortable teaching this topic."

Climate Change Instruction in Early Childhood

To explain what climate change instruction looks like in early childhood education, this section is split into three parts. First, primary CCE resources relevant to early childhood education are discussed. Next, climate change topics in early childhood education are shared. Finally, an example is presented to show how climate change can be taught in kindergarten through a place-based nature lens.

Primary CCE Resources in Early Childhood

The qualitative participants (n=4) discussed material, social, and human CCE resources at the early childhood level. Most frequently, participants discussed material resources and described several types of material CCE resources (Table 5). The most frequently discussed material resource was the use of natural spaces. James shared that his district has an outdoor classroom and that the students "look forward to our day, every day, because we have an outdoor classroom." In the outdoor classroom, James' students plant flowers for the butterflies and track animal prints, and he has also used grants to take students to local parks. Melissa also uses outdoor spaces for learning about climate and ecology. Her students observe and sketch nature, including nuts and trees, to understand their ecological importance.

The use of climate change related books at the early childhood level was also discussed frequently by participants. For example, Melissa discussed using fiction and nonfiction books about caring for the Earth. Similarly, James described building a read-aloud collection connected to climate change; his collection includes books on trees, monarch butterflies, and forests. James explained that he can use this read-aloud collection cross-curricular in science and reading. Finally, Elizabeth described using the *TIME for Kids* magazine to learn about taking care of the environment.

Table 5
Types of Material CCE Resources (n=4)

Material Resources	Example Quote
Books	"I've been kind of building this set of read-alouds." (James)
Live Species	"We've planted plants in the in the outdoor classroom." (Elizabeth)
Natural Spaces	"But going out into a park and kind of seeing the effects of it or getting a hands-on real-world experience, I think would be really great for them." (Katelyn)
Natural Materials	"They like rocks and nuts and leaves." (Melissa)
Projects	"They're also gonna make little bird feeders outside there." (Elizabeth)
Trunk/Tool Kit	"Ohio Department of Natural Resources, they have trunks that you could rent out." (James)

To a lesser extent, trunks or tool kits were also described as a material resource used to teach about climate change. For instance, James explained that he could order a trunk from a local park to use in his classroom. This trunk would include natural materials such as furs and animal prints. These materials could be used to discuss animal migration. However, James explained that he needed to order the trunks a year in advance because "there's so few and far between." Katelyn explained that she likes toolkits because they are readily available, and she does not need to find the materials herself.

Next, teachers described using social CCE resources. Some teachers discussed interacting with park rangers on field trips. For instance, Elizabeth explained that rangers interacted with her students in the forest by pointing out living things and discussing them with the students. She further shared, "The parks are again really very important, and I kind of wish there was a little more collaboration with them." James described collaborating with the Environmental Education Consortium of Ohio (EECO), which has a network of naturalists.

Finally, teachers described the importance of their knowledge, a human resource, regarding climate change. For instance, Katelyn explained that professional development (PD) on climate change could help "to grow my knowledge in this area and to think about ways to incorporate climate change into what I'm already teaching." Similarly, James explained that he would like to learn "more of the scientific terms, more of the processes, so I can feel comfortable teaching that to my students." He further explained the importance of providing students with accurate information on climate change.

Climate Change Topics in Early Childhood

The qualitative participants (n=4) discussed connecting climate change topics to biotic factors, abiotic factors, and pro-environmental actions. Teachers most frequently connected climate change topics to biotic factors such as animals and ecology. Melissa discussed deforestation in the Amazon with her students and explained that "people are cutting down the rainforest, so there's not as much places for them [animals] to live." Similarly, Elizabeth also introduces climate change by discussing how animals are impacted. She explained that in early childhood, "It's mostly like where pollution and climate change and things like that come in with animals and how it changes our environment, their environment, living things…and talking about, you know, how we're going to keep that from happening." Finally, James introduces climate change by discussing seasonal and migrational changes.

Participants also described connecting climate change topics through pro-environmental actions. Elizabeth explained that in second grade, talking about "actual raising temperature and the polar ice caps, that's a little beyond what they can hit." However, students can think about climate change in terms of taking care of the environment. Elizabeth elaborated that her students learned about the importance of plants providing oxygen and then acted by planting new plants in an outdoor learning space. In the future, Elizabeth would like to have her district's high school students collaborate with her early childhood students to construct bird feeders to help care for the Earth. Similarly, Melissa wanted her students to learn how they "can be good stewards of the environment" by conserving resources and limiting pollution.

A few participants even described collective action. For instance, Melissa shared that her students can take action by creating an "opinion piece about saving the planet." While James and his students take pro-environmental actions by creating action posters to spread awareness about issues like pesticide use impacting bees and the lack of resources for butterflies. He further explained that his students "feel empowered" to bring awareness to these issues, and they "do a lot of like posters and like public outreach programs at a kindergarten level."

Finally, to a lesser extent, teachers described connecting climate change to abiotic topics such as weather and energy. For instance, Melissa discussed energy alternatives, like solar energy, with her students. In addition, Melissa shared that she frames her teaching as "solution-oriented and not doomsday-oriented." In contrast, Elizabeth introduces her students to weather and introduces natural disasters. As this is an introduction, she does not feel that at this age, students need to hear "the extra step to say there's more natural disasters because of warm weather."

James' Example: Teaching Climate Change Through Place-Based Nature

James is a kindergarten teacher in northeast Ohio, working with students ages five to six. We share his teaching because his climate change instruction uses a wide range of CCE resources, illustrates several broad trends from the quantitative survey, and exemplifies how climate change can be addressed at a very young age. James indicated that he does not have any climate change standards at his grade level. In addition, he explained that his students cannot understand climate change impacts worldwide, or even in other US states, because "that's not part of their life." However, James described himself as "personally invested in wanting to do something about climate change." Thus, regardless of explicit climate change standards, James finds a way to incorporate place-based climate change instruction into other relevant science topics.

In the fall, James connects climate change to the monarch butterfly, a species that migrates through Ohio. James reads *Winged Wonders: Solving the Monarch Migration Mystery* by Pincus (2020), a picture book that explains how citizen science was used to understand monarch migration. In addition, his students become invested by raising their own monarch butterflies. With a foundational understanding, James then explains how climate change impacts their food sources and that both climate change and deforestation has landed them on the endangered species list. When James asks his students what actions they can take to help the monarchs, they respond by sharing, "We really want to plant more wildflowers because that's what they eat, and we really want to plant more milkweed because that's where they lay their eggs."

During the winter season in Ohio, James incorporates climate change into topics of forest ecology. James reads the book *Can You Hear the Trees Talking? Discovering Hidden Life of the Forest* by Wohlleben (2019). Students also learn about species' needs in the winter including shelter, food sources, and hibernation. Then, for a place-based project, students create their "own animal based on what animals in Ohio have to do to survive the winter here."

In the springtime, James connects climate change to the maple trees in Ohio. In their outdoor classroom, they have about ten maple trees that they tap each year to collect maple syrup. James explains how the seasons are shifting due to climate change and that it is difficult to know when the sap will run out. James further explains that they are completing their first maple syrup boil earlier in the season than in previous years.

Moving forward, James shared that his main goal in relation to teaching his students about climate change is to give his students as much experience in nature as possible. James referenced the book *Last Child in the Woods* by Louv (2008) and explained that students are getting "pulled away from that natural connection." Thus, his goal is to provide his students with as much time outdoors as possible to develop an emotional connection with nature. With this emotional foundation, James feels that his students will grow up being concerned about environmental issues.

Discussion

Educational resources can be considered material, social, or human (Navy et al., 2020). The findings from this study indicate that material resources were most important to this sample of early childhood teachers for climate change instruction. Material resources included natural spaces, natural materials, books, projects, and tool kits. Often, these material resources had a nature-based connection.

During the qualitative interviews, participants elaborated on the use of material CCE resources. One important material resource that emerged was the use of natural spaces to teach about climate change. James used his outdoor classroom to teach about climate changes that impact local maple trees and migrational butterflies. Previous research (Fisher-Maltese, 2016) supports the potential of outdoor school gardening experiences for promoting environmental attitudes like those in James' classroom.

Children's books about climate change were another CCE resource that was highly valued, used, and sought by this study's interview participants. However, children's books about climate change tend to lack informational text, address distant habitats, emphasize impacts on non-human organisms, and emphasize individual and political action over collective action (Benevento, 2023). Children's books may also underemphasize the role of plants for mitigating climate change (Jones & MacLeod, 2022). Clearly, teachers are seeking high-quality children's books that are free of these limitations.

One material resource not often cited in literature was the use of trunks or toolkits. Participants described renting trunks from local parks. The trunks can contain curriculum materials and natural materials for students to engage with. However, James explained that the limited availability of these trunks was a significant barrier. This limited availability is understandable, as a trunk of natural materials is much harder to reproduce than handouts or virtual resources. Yet, because of this limited availability, teachers may not have access to this engaging and often place-based resource.

Collaboration is considered a social resource (Navy et al., 2020). Climate change education literature highlights the importance of having collaborative CCE resources (Monroe et al., 2019). Therefore, it was surprising to see that participants rated the collaboration survey items as the least important. This also differs from past educational resource studies that have found social resources to be prominent (Navy et al., 2020; Rivera Maulucci, 2010). The qualitative interviews helped to explain this surprising result in that these social resources are sometimes not age-appropriate for engaging young learners. Hence, collaboration at the early childhood level may not be as important compared to older grade levels.

Trust is also considered a social resource (Navy et al., 2020). Although most of the social items were ranked low importance on the survey, participants ranked "trusting where my climate change resources come from" as very important. Katelyn explained that sharing credible climate change information with her students is essential. As a barrier to CCE includes limited formal learning about climate change, it is understandable why teachers place high importance on finding trustworthy resources (Colston & Ivey, 2015; Wise, 2010).

Regarding the useful qualities of CCE resources at the early childhood level, participants most often discussed engagement, age-appropriateness, and place-based connections. Engagement was not a surprising quality identified as several studies on CCE point to the importance of having engaging resources (Bozdogan, 2011; Monroe et al., 2019). When participants described engaging resources, they discussed hands-on projects such as building bird feeders to help care for Earth.

Relevant to early childhood education, participants discussed the importance of age-appropriate climate change content. Unlike critics of early childhood climate education that maintain that climate instruction at young ages is not a developmentally appropriate practice (Ginsburg & Audley, 2020), several of this study's teachers maintained that climate change instruction could be age-appropriate. Multiple teachers explained that the complexities of global climate change were too large for their students to understand, but they could understand local climate changes and how to take care of the Earth. In this way, using local place-based CCE resources was a way of making climate instruction age-appropriate.

Participants also more explicitly discussed the importance of having place-based CCE resources. Place-based education is particularly important in CCE to convey the urgency of climate change (Gislason et al., 2021; Hernandez et al., 2022). In this study, participants frequently described using several nature-based material resources, including natural spaces, live species, natural materials, and nature-related books to teach about climate change. These material resources exhibit place-based learning through the theme of nature studies (Smith, 2002). For instance, James used his outdoor classroom to teach about the climate changes to maple trees. However, Smith's (2002) other place-based themes were not described by participants, such as cultural studies. This may be a missed opportunity as cultural connections can be used to make climate change relevant to students.

Finally, James' example was included to show a place-based nature approach to teaching about climate change. James noted that his students could not understand the complexities of global climate change. Yet, James was able to teach his students about climate change by focusing on local nature studies about maple trees and monarch butterflies (Smith, 2002). Therefore, James' example shows that regardless of geographic location, climate change instruction can be made local and relevant to students.

Limitations

A few limitations of this study may limit the generalizability of this study's findings. First, the sample of early childhood teachers was part of a larger study where participants were purposefully selected from schools in northeast Ohio near a public park. These selected teachers do not represent the full knowledge of all early childhood teachers. Further, these participants may be biased in favor of using natural spaces and materials due to their proximity to a public park. Second, only a limited number of survey participants were interviewed. Some participants who were contacted for an interview expressed not having the time. A larger qualitative sample would have given further insight into climate change teaching.

Implications

Findings from this study have implications for early childhood teachers and informal sectors. Early childhood science teachers should try to incorporate introductory climate change topics into their curriculum even when explicit climate change standards are not available. Teachers can connect climate change topics to standards on ecology and weather (NGSS, 2013; ODE, 2018). Further, teachers should incorporate place-based connections to climate change to communicate the urgency of climate change and inspire action. One way to do this is through using nature-based material resources. If teachers have access to an outdoor classroom, they can use natural spaces, including live plants and animals, to discuss how climate changes impact local species. If teachers do not have access to the outdoors, they can still use natural materials and nature-based books in the classroom.

Informal sectors, including parks, zoos, and aquariums, should consider collaborating with early childhood teachers in the creation and sharing of nature-based CCE resources. These informal sectors could also share access to their outdoor spaces. Further, due to the high interest in natural materials, informal sectors can work to create additional trunks for teachers to rent out. Finally, these sectors may even consider creating PD to teach about local place-based connections to climate change.

Future research should explore students' experiences and outcomes associated with nature-based CCE resources. Studies could research if the use of these materials impacts students' perceptions or knowledge regarding climate

change. Further, studies could investigate if experience in outdoor spaces influences students' environmental agency.

Conclusion

Overall, the survey and interview responses indicate that early childhood science teachers are interested in teaching about climate change, regardless of their limited state standards. Climate change can be introduced to young students through topics of ecology and pro-environmental actions. To be both relevant and age-appropriate, early childhood teachers make local, place-based connections to climate change. Nature-based material resources were found to be especially important for early childhood. Climate change can be challenging to teach at the early childhood level, yet these teachers show it is possible.

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