

# New Jersey Teachers' Professional Learning About Climate Change

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*During the 2022-23 academic year, New Jersey became the first state in the United States to adopt learning standards that support climate change education K-12 across all subject areas, offering an ideal context for exploring the relationship between education and climate change. Although New Jersey has provided financial funding to support teachers in teaching about climate change, little is known about teachers' preparedness to implement developmentally appropriate climate change instruction in K-12 settings. This study utilizes interviews from 50 New Jersey teachers who participated in a classroom observation study conducted during the 2023-24 academic year to describe their professional learning related to climate change. Though professional learning varied considerably across the dataset, most respondents indicated that self-directed learning was their primary mode of professional development about climate change, followed by attendance at workshops or webinars. Several participants reported having no access to professional development provided by their school or district on the topic, despite the introduction of standards. When asked about plans for future professional development related to climate change, the majority of interviewees asserted that they had plans, but these varied with their grade bands. The findings suggest that more coherent professional learning opportunities are needed to support teachers in integrating climate change into their teaching. More mechanisms should be implemented to acknowledge teachers' self-directed learning on climate change.*

*Keywords: Climate change education, educational policy, professional learning.*

## Introduction

2024 was the planet's hottest year on record, exceeding the record from 2023 (Vlock & Jacobs, 2025). The world is experiencing intensified effects of climate change, including increased floods, extreme weather, wildfires, and changes to ecosystems and biodiversity (National Oceanic and Atmospheric Administration [NOAA], 2023). New Jersey (NJ) residents face magnified climate change effects in comparison to other places in the United States (U.S.) (NJ Department of Environmental Protection [NJDEP], 2020). NJ is predicted to have more extended periods of higher temperatures, sea level rise, precipitation, related flooding, and drought events by 2050 due to a changing climate.

Children are among the most vulnerable to the effects of climate change (Environmental Protection Agency [EPA], 2023). Children should be placed at the forefront of climate change solutions. They are at increased risk for asthma and allergies, exposure to pathogens, and displacement from homes due to flooding (EPA, 2023). Higher heat

exposure has a negative correlation with students' academic achievement. The EPA notes that "temperature " increases of 2°C and 4°C of global warming are associated with, on average, 4 percent and 7 percent reductions in academic achievement per child, respectively, relative to average learning gains experienced each school year" (EPA, 2023, p. 6). To build a flourishing and resilient future, it is critical to both adapt education to meet the constraints educational systems face due to our changing climate and to educate children about climate change. As Woodard and Schulz (2024) noted:

Today's children will undoubtedly have to learn about and adapt to this global emergency over the course of their lifetimes. Climate change education can help them to understand the causes, consequences, and potential solutions. It can also offer a space to reimagine and act toward a more just future. (p. 5)

Education about climate change is a powerful potential climate solution. Education is among the best tools for mitigating climate change through reducing atmospheric carbon emissions (Bapna, Simpson, & Colenbrander, 2024; Kwauk & Winthrop, 2021). Yet, the power of education is rarely leveraged in climate action plans. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) reports that Sustainable Development Goal 4 on quality education was addressed in only two of 72 transnational climate initiatives covered in their 2024 Report, *Education and climate change: Learning to act for people and planet* (UNESCO & MECCE, 2024). Controversy surrounds efforts to support climate change education in many parts of the world, including the U.S. In some instances, policies prevent teachers from addressing the topic in their classrooms altogether (Kamentez, 2023; Waldman, 2023). The State of NJ has been at the forefront of climate change education over the past several years (Madden, 2022). In 2020, NJ's First Lady, Tammy Murphy, announced that the state would be the first in the U.S. to require learning standards to support climate change instruction across grade levels and subject areas (NJ Office of the Governor, 2020). Predictive studies suggest that education for climate change has the potential to reduce carbon emissions similarly to many of the top solutions suggested by Project Drawdown, such as transitioning to electric cars and concentrated solar panels<sup>1</sup> (Project Drawdown, n.d.; Kwauk & Winthrop, 2021). Including learning standards that address climate change directly in K-12 instruction can help to build a scientific knowledge base among all NJ citizens, preparing them to develop solutions to this monumental global problem.

Standards to support climate change learning (NJ Department of Education [DOE], 2022) were released in 2022. Their implementation began in 2022-23. Little is known about teachers' preparedness to implement climate change content in elementary school. Most climate change education studies focus on middle school and later (e.g., Bofferdint & Kloser, 2015; Plutzer & Hannah, 2018). The Next Generation Science Standards (NGSS) make explicit connections to climate change with the *Global Climate Change Disciplinary*

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<sup>1</sup> Concentrated solar, electric vehicles, and education are predicted to reduce carbon emissions on the order of 10-20 gigatons.

Core Idea (DCI), but it is not introduced until middle school (National Research Council [NRC], 2013). My work studies NJ K-12 teachers' professional development experiences about climate change during the second year of the standards' implementation. Understanding the ways teachers can be supported in teaching about climate change confidently is critical for building a thriving, scientifically literate populace.

### ***Teachers' Preparedness to Implement Climate Change Instruction***

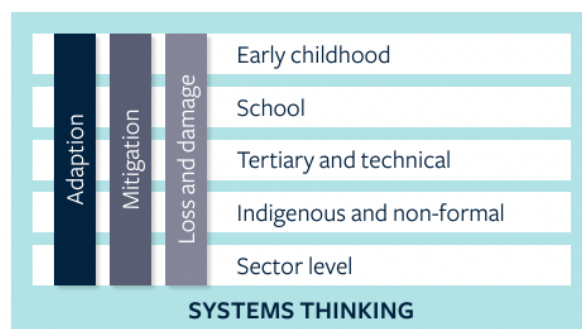
Though NJ's state-level governing structures provide an environment conducive to learning about climate change and require instruction in this area with specific standards, teachers' preparedness to implement the subject is varied. A survey-based study revealed that many teachers across NJ had low confidence in their ability to teach about climate change, and sometimes held misconceptions about the topic (Madden et al., 2023). The findings are not unique. Will (2023) reported that only 21 percent of U.S. teachers felt very confident in their ability to teach about climate change on a North American Association for Environmental Education (NAAEE)-sponsored survey, where nearly all respondents agreed that it was important to teach about the topic. Other research from the U.S. supports the notion that many teachers enter the profession feeling unprepared to cover climate change in the space of their classrooms, highlighting the critical importance of professional learning on the topic (Drewes et al., 2018; Kirk, 2017; Parnes et al., 2025). Studies demonstrate that climate change professional learning can result in increased confidence and content knowledge about the topic, yet exposure to this kind of professional learning is not always ubiquitous (e.g., Madden et al., 2023a; Drewes et al., 2018). Mavuso and colleagues (2022) found that despite nationwide efforts in South Africa, Nigeria, and Kenya to support climate change education, teachers had little guidance on how to do so, indicating a need for professional development. Amoakwa and co-authors (2024) found that teachers in Ghana requested professional learning to better prepare teachers to include climate change in their instruction. Greer and colleagues (2023) reported that fewer than half of the teachers surveyed in the United Kingdom reported receiving any professional development on climate change, and of those who did, much of their learning was self-taught. Ennes and others (2021) reported on barriers to U.S. teachers' engagement with professional development related to climate change, finding that a multitude of influences served as barriers, but time and teachers' confidence in their scientific knowledge about the topic were key factors.

### **Conceptual Framework**

Bapna and colleagues (2024) put forth the Climate-Education Research Framework (CERF, Figure 1), which illustrates many of the overlaps between climate change and education within the context of systems thinking. The CERF framework delineates the different categories of education (horizontal) with types of learning about climate change (vertical). All of these different categories overlap and affect change at the systemic level. Figure 1 below depicts this framework:

**Figure 1**

*The Climate-Education Research Framework (Bapna et al., 2024)<sup>2</sup>*



The CERF framework asserts that climate change education occurs at all levels through formal schooling, non-formal (or informal) learning settings, and various sectors through professional development. It acknowledges that climate change education encompasses adaptation and mitigation to climate change effects, as well as understanding specific examples of lasting effects of climate change, including loss and damage. I focus on how teachers are prepared at the sector level through professional learning about climate change itself and how to teach it across early childhood, primary, and secondary school settings. The systems-thinking underlying the CERF framework allows for identifying how factors in one component of the framework affect others (e.g., sector-level issues influencing early childhood and school settings). The CERF framework asserts that climate change education can take many forms and address the components of climate change education (adaptation, mitigation, and loss and damage).

## Methodology

The study takes place within a larger statewide project examining K-12 climate change instruction in NJ. It included observations and interviews with teachers in NJ to give a snapshot of the status of climate change education approximately one year into the implementation of new learning standards. 50 teachers joined. Observations took place in 20 of NJ's 21 counties. Teacher participants were spread evenly across grade levels: 17 taught at elementary schools, 16 at middle schools, and 17 at high schools (Table 1).

**Table 1**

*Distribution of teacher observations across grade levels*

Grade Level	Participating Teachers
Elementary School: Grades K-5, ages ~5-11	n=17 (34%)
Middle School: Grades 6-8, ages ~11-14	n=16 (32%)
High School: Grades 9-12, ages ~12-18	n=17 (.34%)

<sup>2</sup> Retrieved from <https://media.odi.org/documents/ODI-OM-CERF-WP-Feb24-Proof05.pdf>

Participating teachers comprised a voluntary response sample. Recruitment took place via email outreach to professional teacher listservs and social media posts on LinkedIn, Instagram, and Twitter/X. The participating teachers responded to these calls for participants by completing a survey. Participants invited researchers to their classrooms to observe a lesson of his or her choice. A team of four researchers from The College of New Jersey observed the teachers, with a researcher visiting a classroom at a time. Lesson duration varied by teacher and ranged from approximately 30 minutes to just under two hours, with most observations in the 50-60 minute range. The observer sketched the classroom or learning space and documented what the teacher and students were doing for each of the lesson segments. The observer recorded which instructional strategies and curricular materials were used during the observed lesson.

Teachers were observed teaching a climate change lesson during the 2023-24 academic year.<sup>3</sup> Following the observation, the researchers interviewed each participating teacher over Zoom to debrief and provide context for the observation. The interviews were transcribed. Names and identifying information were removed. During these interviews, teachers described their professional development experiences related to climate change and plans for future professional learning related to climate change. Researchers coded the teachers' responses to these questions using a grounded approach (Saldana, 2015).

### ***Participants***

Around a third of teachers fell into each grade band. While most observed lessons were in science classes, researchers observed various subjects and classroom settings (Table 2).

**Table 2**

*Teaching assignments for each of the observed teachers*

	<b>Elementary n = 17</b>	<b>Middle School n = 16</b>	<b>High School n = 17</b>	<b>Total N = 50</b>
<i>Elementary General Education</i>	12 (71%)			12 (24%)
<i>Elementary Inclusion</i>	2 (12%)			2 (4%)
<i>Art</i>	1 (6%)	1 (6%)		2 (4%)
<i>Technology</i>	1 (6%)		2 (12%)	3 (6%)
<i>Science</i>	1 (6%)	8 (50%)	11 (65%)	20 (40%)
<i>English Language Arts</i>		3 (19%)		3 (6%)
<i>Mathematics</i>		1 (6%)		1 (2%)

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<sup>3</sup> Since the participants were volunteers and recruited from the author's professional network, there is potential for bias within the sample.

<i>Social Studies</i>		1 (6%)	1 (6%)	2 (4%)
<i>Physical Education</i>		1 (6%)		1 (2%)
<i>Multidisciplinary Advisory</i>		1 (6%)		1 (2%)
<i>World Languages- Spanish</i>			2 (12%)	2 (4%)
<i>English as a Second Language</i>			1 (6%)	1 (2%)

### ***Elementary Teachers***

12 of 17 teachers (71 percent) were classroom generalist teachers in grades ranging from K-5. 2 were teachers in inclusion classrooms (12 percent). The remaining 3 (18 percent) were 'specials' teachers (1 art teacher, 1 technology teacher, and 1 science specialist).

### ***Middle School Teachers***

8 of the 16 middle school teachers were science teachers. 3 (19 percent) were English-Language Arts teachers. Just a teacher (6 percent) taught each of these subjects: Mathematics, Art, Multidisciplinary Advisory, Social Studies, and Physical Education.

### ***High School Teachers***

Of the 17 participating high school teachers, a large majority were science teachers, 11 or 65 percent were science teachers. Two, or 12 percent, were Spanish teachers, and another two, or 12 percent, were Technology teachers. A teacher (or 6 percent) taught these subjects: English as a Second Language, Technology, Art, and Social Studies.

### ***Research Questions***

My study asks what kinds of professional learning experiences related to climate change are reported by teachers engaging in standards-aligned instruction on climate change? And what are teachers' plans for future professional learning on climate change?

### ***Data Sources***

After each classroom observation, the teacher participant engaged in a debriefing interview with the observer within 48 hours of the observation. The interviews lasted approximately 20 minutes and followed a semi-structured protocol. Researchers asked the teachers, *How did you prepare for teaching about climate change? And do you have any plans for future professional development on climate change? If so, what are they?* The interviewers were encouraged to probe for information regarding formal coursework, workshops, school- or district-provided professional development, and self-directed learning. The interviews took place synchronously over Zoom. They were audio recorded and automatically transcribed. Each interviewer returned to the transcript to remove identifying information and correct any transcription errors.

### **Data Analyses**

Interview transcripts were coded using a grounded approach (Saldana, 2015). Trends and themes that emerged across responses were identified using constant comparison. These trends and themes were used as organizational categories. Sub-trends from within these categories emerged and are described in the findings. Most of the themes were in line with the researchers' expectations, as the interviewees were responding to specific questions about their professional learning. If a teacher mentioned attending a specific workshop, their response was coded in the category of webinars and workshops. The interviewers probed the teachers to identify self-directed type activities that might not always be considered professional development, such as reading or listening to podcasts. If teachers identified these types of tasks, they were coded as self-learning with subcategories for the type of professional learning (e.g, reading, documentaries, etc.).

Though the focus of this study is on teachers' preparedness and professional learning about climate change, some teachers shared information throughout their interviews that shed further light on their experiences. Participants shared whether they had the support of administrators. Others commented on the importance of seeking information from reliable sources for their professional learning, as well as information they shared with the children in their classes. These findings provided context on teachers' approaches to professional learning about climate change, and are also presented below.

### **Findings**

The large categories in types of professional learning that emerged from the analysis were: self-directed learning, workshops or webinars, and relying on prior knowledge and experiences (Table 3). These categories included sub-themes, which I unpack further below. Responses that were coded 'self-directed' indicated teachers sharing that they sought out resources of many kinds (readings, videos, podcasts, social media feeds, etc.) to supplement their content knowledge, and to possibly share with their students. If a teacher noted a workshop, workshop series, webinar, or webinar series focused on climate change-related content or pedagogical skills and techniques for teaching climate change, it was coded as 'webinars or workshops.' If a teacher referred to prior knowledge from earlier coursework at the undergraduate or graduate level, or prior work or life experiences, it was coded 'prior knowledge.' Note that in many cases, teachers listed one or more examples of types of professional learning they experienced. Category totals are higher than 100 percent across all categories and grade bands.

**Table 3**

*Distribution of professional learning experiences cited among observed teachers*

	<b>Elementary Teachers (n = 17)</b>	<b>Middle School Teachers (n = 16)</b>	<b>High School Teachers (n = 17)</b>	<b>Total (N=50)</b>
<i>Self-Directed</i>	13 (76 %)	11 (69%)	13 (76%)	37 (74%)

<i>Webinars or Workshops</i>	10 (59 %)	9 (56%)	13 (76%)	32 (64%)
<i>Prior Knowledge</i>	8 (47%)	3 (19%)	11 (65%)	22 (44%)

### ***Self-Directed Learning***

Nearly three-quarters of the participants (37 out of 50, or 74 percent) reported engaging in self-learning about climate change. The examples given were varied but included readings, documentaries, news programming on television, radio, or podcasts, websites, and social media pages addressing climate change.

Twenty-three of the participants (6 elementary teachers, 7 middle school teachers, and 10 high school teachers) cited reading books, magazines, or news media sources. One elementary teacher shared, "I like to keep an eye out for any articles that come my way, related to climate change, and share those with the students," in her interview. Another elementary teacher noted, "I am always trying to stay abreast of everything in the news about climate change. That way, in turn, I am knowledgeable so that I can do my job as a teacher, but also turn the information over to other colleagues." A middle school teacher emphasized sharing readings she did outside of class with her students:

I read some articles and brought them to my students. They were about Christmas trees, and how we are using trees, and whether natural or artificial is better for the environment. I let the students discover and come to conclusions on their own after reading.

A high school teacher noted:

I read a lot. I typically have three books in my circulation. I usually have one nonfiction book, one book based on my interests, and then at least one science book, which could be either anatomically themed or environmental science. They all inevitably bring up climate change, even if it's not a climate change book.

4 interviewed elementary school teachers described watching documentaries or other video-based informational sources about climate change as part of their professional development on the topic. A teacher shared, "I learn a lot about climate change from watching documentaries on Disney like *Planet Earth*." 3 middle school teachers expressed how they used documentaries or videos for self-directed learning on climate change. In the words of one middle school teacher talking about a video she found:

Adidas is collecting plastic bottles off of coastlines, taking those plastic bottles, turning them into threads, and then making their shoes out of them, called Parlay. They recently made a completely recyclable shoe. So when you are done with that shoe, you ship it back to them, and they recycle it into a new shoe. I learned a lot from that video and shared it with my students.



7 high school teachers cited videos or documentaries they used as sources for self-directed learning during their interviews. A teacher mentioned the Netflix series *You Are What You Eat*, which helped him frame some thinking about broader climate solutions. In his words: “teaching kids that it is not just about buying an electric car. It is about what you eat because that is a huge part of climate change, you know, getting away from a meat-based diet, getting more water, and a plant-based diet.”

2 elementary teacher participants explained that they followed various professional organizations and teachers on social media as part of their self-directed learning. For instance, “on my social media platforms, I follow a lot of different teachers and a lot of different entities ranging from NASA to the National Wildlife Federation to Audubon.” No middle school teachers shared about social media feeds from professional organizations, but 4 high school teachers did. A high school teacher mentioned the organization Save Coastal Wildlife’s social media presence and his affiliation with them:

I went and did their winter seal survey with them. So it is located in Sandy Hook. They get harbor seals, sometimes gray seals, very rarely harp seals, but my zoology teacher and I went a couple of winters ago, and then last year we took the kids.

4 elementary school teacher respondents described researching their curricular materials using the NJ standards as a guide for better understanding ways to integrate the topic into their teaching. For example:

I have been preparing by reading the district’s curriculum guides, available on the district website. Anybody can view them but become knowledgeable through the resources and activity guides that they share, and look for places to drop in the climate change context where it makes the most sense.

A middle school teacher shared about curricular connections, along with 4 high school teachers. A high school Spanish teacher discussed using climate change as an opportunity for bilingual communication: “There are limited handouts and limited signs in Spanish. So we are thinking of how being bilingual can enhance bilingual communication and can enhance the global push towards addressing climate change in various and various areas.”

### ***Workshops or Webinars***

Another large group of participants (32 out of 50, or 64 percent) shared that they participated in workshops or webinars related to climate change. 10 were elementary school teachers, 9 were middle school teachers, and 13 were high school teachers. Not all interviewees gave specifics about the workshop or webinar providers, but those who did fell into several large categories, including national or international organizations, institutions of higher education, and informal learning centers such as nature centers and museums. Only 2 of these respondents described a workshop hosted by their school

or district. This is an indication that teachers did not necessarily have access to professional learning opportunities about climate change provided by their schools, and instead had to seek these out on their own. An elementary teacher made a point to directly address this, "I would say that preparing to teach about climate change for me is made up of 100 percent of things outside of the official PD that my school offers."

Several interviewed teachers (5 at the elementary level, 3 at the middle school level, and 8 at the high school level) cited webinars or workshops hosted by national or international organizations such as Audubon, the National Science Teaching Association (NSTA), Climate Generation, and SubjecttoClimate. For example, an elementary teacher shared, "I participated in the NSTA's webinar series where they helped align lessons to climate change content." Another elementary teacher mentioned:

I am participating in the Subject to Climate workshops where they walk you through the science of climate change, the social, emotional learning aspects, and the ways to spark student action. For me, that propelled me to open my eyes and become more aware of opportunities where I could integrate it.

A middle school teacher noted, "I went to a formal presentation on environmental economics run by the New Jersey Council for Economics, which included climate change." A handful of participants mentioned professional development events hosted by institutions of higher education (two elementary teachers, 4 middle school teachers, and 3 high school teachers). For example, a middle school teacher mentioned, "Columbia College has this great guy who runs an Earth workshop. He takes scientists and brings them together with teachers, mostly high school teachers. I have attended those." 2 respondents discussed workshops or webinars hosted by informal learning sites, a teacher at the elementary school level, and another at the high school level.

### ***Prior Knowledge and Experience***

Twenty-two of the 50 participants (44 percent) shared that they relied on their prior knowledge and experience to prepare for teaching about climate change. These included 8 elementary school teachers, 3 middle school teachers, and 11 high school teachers. These teachers mentioned a variety of different ways in which they built their prior knowledge. For example, several discussed classes that they took as part of their undergraduate or graduate coursework, such as one high school teacher who described:

Way back when, for my undergrad, I went to the [university], and they had this idea of allowing students to apply to these programs as freshmen, and they were a strand of four classes, and the one that I applied to and was accepted into was all on environmental science. I learned a lot there.

Others mentioned personal interests or passions about climate change. As one elementary school teacher noted:

I remember being in high school around 1988, and there was a magazine that I subscribed to at the time with a cover story on what was then called global warming. Since then, I have been learning about the topic. We've been talking about this in a big way for decades.

Still other interviewees referred to prior careers related to environmental education. A high school teacher shared: "I have spent my entire career in wildlife biology and conservation. Now, I am focusing more on how to teach and design the curriculum." Another high school teacher shared, "I received my undergrad degree in Wildlife Biology at Stockton University and a graduate degree from Clemson University in Environmental Science and Sustainability. After working in the field for years, I just wanted to come back home and teach." These teachers drew on prior career experiences to build their knowledge bases for teaching about climate change.

### ***Other Trends***

Discussing professional learning, more trends emerged among teachers. Some noted that at the elementary level, English-language arts and mathematics take priority over science and social studies. As a result, climate change can end up on the back burner. Of the 50 teachers who invited researchers into their classrooms, the researcher was greeted or acknowledged by an administrator in just six (12 percent) of the observations. Using reliable sources for self-directed professional learning and then sharing with students was also important. As an elementary teacher explained:

I am spending time just staying one step ahead of the students and trying to figure out exactly what sources are good sources for accurate climate change information. Because it is a touchy subject, because you know exactly what and what makes sense for your students [developmentally], and what uses evidence-based and science to make conclusions. I have been using the US EPA and NASA websites a lot.

Information literacy was a critical component of teachers' planning process when developing climate change lessons.

### ***Future Plans for Professional Learning***

The vast majority (37 out of 50) participants discussed plans for future professional learning, and in many cases (23 out of 37, or 62 percent), these teachers had specific ideas about their future professional development, as displayed in Table 4 below.

**Table 4**

*Plans for future professional learning among observed teachers*

	Elementary Teachers (n=17)	Middle School Teachers (n=16)	High School Teachers (n=17)	Total (N=50)

<i>Intend to attend climate change-related professional development in the future</i>	16 (94 %)	12 (75%)	9 (53%)	37 (74%)
<i>Specified ideas for future professional learning</i>	11 (64 %)	7 (44%)	5 (29%)	23 (46%)

Nearly three-quarters of the observed teachers commented that they were planning to continue learning on their own about climate change. Many teachers noted that they did plan on attending future professional development, but did not specify in what way they hoped to engage. For example, a high school teacher said, “I do want to continue learning about climate change, because I think this is the most important issue that we have in our time.” Similarly, an elementary teacher shared:

Yes, I do plan to continue to learn about climate change, because I think it is a very important thing. Not just for me to know as an individual, but I think as an educator. You know, we hold a pretty empowering torch that can be passed on, and I think if we don't do our best, then it could fall to the wayside.

The statements were promising but did not show how or what the teachers hoped to pursue learning about through professional development. Yet, other teachers shared specific plans about their future professional learning, which tended to follow the same general themes as their prior professional learning, mentioning things like self-directed learning, workshops and webinars, and formal coursework. A middle school teacher noted, “Next year I will probably try to read more about climate change,” while another shared, “I got accepted to attend a professional development workshop at the Museum of Natural History about starting conversations about keystone species with students.” An elementary school teacher shared that she hoped to learn more about how to integrate climate change into novels: “I do plan on continuing learning about climate change down the road. It. It worked out well to insert climate change and care for the environment into this book, and I would like to learn how to integrate it differently.” The interviewed teachers’ plans for future professional learning differed among grade bands taught. Elementary school teachers were nearly unanimous in their interest in pursuing future professional learning (94 percent), and this percentage decreased to 75 percent at the middle school level and 53 percent at the high school level.

## Conclusion

From this statewide study, it is clear that even in a state where climate change education is required, professional learning opportunities for teachers are inconsistent. Similar to what Greer and colleagues (2023) found among United Kingdom teachers, many of those who participated in this study (74 percent) engaged in self-directed learning related to climate change. While this type of experience can build science content

knowledge, these self-directed experiences cannot be quantified in a way that attendance at workshops or coursework in higher education can, or done in a way that provides a coherent experience for all teachers within a school, district, or state. There is no way to measure the quality or accuracy of information conveyed in self-selected learning materials. There is little opportunity for this type of self-directed learning to count toward teachers' professional learning requirements, which could potentially decrease teachers' motivation for seeking out information on their own. The challenges with self-directed learning experiences are amplified when we consider that very few (just 2, or 4 percent) of the participants in this study were allowed to explore climate change learning opportunities through their schools or districts.

The small number of school administrators who acknowledged researchers visiting their classrooms (6, or 12 percent) suggests that school district support for climate change education, or climate change professional development, may not be strong enough to support implementation at schoolwide scales. The observed support from school district administrators was mixed across the dataset. However, the finding that elementary school teachers were much more likely to have plans for future professional development was promising. Existing curricula aligned to the NGSS introduce climate change at the middle school level, indicating that there is a greater need to support teachers in the elementary grade levels. Many of the participating teachers described efforts to ensure they were accessing reputable resources, understanding the best places to integrate climate change into existing curricula, and committing to professional growth. Given that they were volunteer participants, it is likely that they already felt confident teaching about climate change. Mechanisms should be created to help leverage the experiences of these already confident teachers to provide in-house expertise as schools take on the challenge of adopting the new climate change standards. As this global issue continues to negatively impact our planet, it is critical to develop the skills and knowledge in children to innovate solutions. Creating standards around climate change is an excellent first step, but teachers should also have the tools they need to effectively implement this content in a comprehensive and meaningful way.

Perhaps one strategy for leveraging the collective knowledge of teachers who are already confident about climate change content and the prevalence of teachers engaging in self-directed learning is to implement professional learning communities or reading discussion groups within schools or districts centered on shared experiences. These types of activities could fit within the scope of a teacher's standard planning periods and would not require additional funding, transportation, or substitute teacher costs. They could also boost morale, as teachers who are already knowledgeable about the topic could serve as in-house experts. Another strategy could be including legislation around climate change professional learning, which might include a requirement to expose all teachers to some baseline content knowledge and pedagogical skills, which would support widespread implementation of these standards.

Climate change is perhaps humanity's greatest challenge, and teachers must be prepared to introduce this content effectively. This study provides an inside look at teachers' current level of preparedness to tackle this topic in a state where teaching about climate change is required. The findings can be used to inform professional learning efforts both in states that require climate change education and those that do not.

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