MODESTUM

Research Article

Identity development for teaching climate change: Exploring personal, professional, and political factors

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ARTICLE INFO	ABSTRACT
	The climate change crisis causes not only environmental and civic challenges, but also educational complexity which must be untangled to better prepare educators and students alike. This study investigated teachers' beliefs, attitudes, and motivations around the integration of climate change instruction in their classrooms and where these constructs intersected within an identity theoretical framework. The overarching research question was: How do teachers' lived experiences shape their science teacher identity development as a teacher of climate change? Utilizing a narrative inquiry approach to interview 15 middle and high school teachers in the USA, the results of this study demonstrate how trends such as personal valuation of nature, instructional support and agency, and socio-scientific literacy influence identity development. A conceptual model is presented that highlights the personal, professional, and political contexts that promote or hinder identity development. Implications for teacher development efforts include the need to attend to the 'messy' lived contexts of competing personal, professional, and political considerations.

INTRODUCTION

Climate change is an environmental issue that is a "defining challenge of our time" and a "common concern of humankind" as described by the United Nations (UN, 2015). Not only is it a challenging problem to address via individual and societal actions but quite simply it is a challenge even to understand the phenomenon at work and the far-ranging impacts on natural and human systems (Intergovernmental Panel on Climate Change [IPCC], 2023).

Compounding the complexity of the phenomenon, the relevant scientific facts are too often twisted in political debate (Nisbet & Mooney, 2007) leading to an even grander social controversy. Often referred to as climate change sceptics, the forces behind the manufactured misinformation and doubt (Oreskes & Conway, 2010) are more accurately labelled as climate change denialists (Union of Concerned Scientists [UCS], 2015). These climate change deniers take advantage of the public's naïve understandings (Inman, 2012) and media sources' desire to discuss the phenomenon like an election with the false perception of balance from both supposed sides of the debate (Boykoff & Boykoff, 2004) to create an air of uncertainty around scientific predictions and recommendations for climate change.

To address these concerns and the growing climate crisis, this topic has been included in the predominant science standards for the USA, *Next Generation Science Standards* (NGSS) (NGSS Lead States, 2013) and codified in various US states' student learning standards (e.g., New Jersey in 2020–Madden, 2022). However, educational researchers have studied student and teacher understanding of this topic for quite some time. Their conclusions are clear: developing a deep understanding of the causes and impacts of climate change is quite difficult for students (Boyes & Stanisstreet, 1993) and their teachers (Boon, 2010). Some of the obstacles for teaching and learning about climate change deal with its surrounding controversy (Andersson & Wallin, 2000), its abstract underlying phenomena (Koulaidis & Christidou, 1999), and its misconception-laden nature (Rye et al., 1997).

Teacher knowledge and teacher beliefs related to climate change vary broadly (Liu et al., 2015) and these constructs have frequently been used by science education researchers to describe and explain teaching practice (Pajares, 1992). Yet these lines of research fail to address the whole teacher when

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Preliminary version of this study was presented at recent AERA and NARST conferences.

studying attributes such as beliefs, attitudes, or knowledge (Enyedy et al., 2006). Science teacher identity (Avraamidou, 2014a) is a theoretical perspective that can be employed to describe and understand teachers' experiences while enacting climate change instruction, and the personal, professional, social, political, and contextual factors which influence their pedagogical choices.

Research is needed to better understand this vital responsibility placed on teachers regarding their instruction and their perspectives towards this important and timely issue (Liu et al., 2015). This research study sought to gather these perspectives and to meet Colston and Ivey's (2015) call for more research into the lived experiences of science educators as they "understand, incorporate, and negotiate the implementation of climate change education in the face of such public controversy about climate change" (p. 774).

Employing Identity as a Theoretical Lens

Content knowledge expertise has long been a key component of educational research to better understand teaching practice (Cochran-Smith & Lytle, 1999). Undoubtedly, a teacher must be knowledgeable in the subject matter in which she aims to teach, demonstrate this knowledge to her students, and share this expertise with them through meaningful pedagogical approaches (e.g., Cochran-Smith & Lytle, 1999). The depth of a teacher's preparation has been linked to her success in the classroom time and time again (Gess-Newsome & Lederman, 1999). Knowing about a topic deeply, especially a complex science phenomenon, is a critical component of any teacher's development (Loughran et al., 2004).

Prior literature reveals that educational research on climate change and socioscientific issues related instruction has often relied on a knowledge-oriented framework and the effects that teacher knowledge has on pedagogical practice both positively (McNeal et al., 2014) and negatively (Stevenson et al., 2016). These studies have demonstrated a consistent lack of in-depth knowledge related to socioscientific issue topics like climate change (Boon, 2010). Specific knowledge on socioscientific issues, and especially on climate change, is important, albeit insufficient to understand why and how teachers integrate these topics into their teaching.

Another vastly popular aspect of educational research has been the effort to establish the link between teachers' beliefs and their teaching practice. Nearly every study referenced in this paper thus far on teacher perceptions of climate change teaching takes a beliefs-driven approach to research. This line of investigation into teachers' beliefs and the impact on teaching practice has dominated the research field for quite some time (Pajares, 1992). Nespor (1987) put forth a model of teacher beliefs that shows how teacher belief systems are influenced by past experiences, which then also influence current practice. This model has found utility in the work of many subsequent researchers as they empirically seek to confirm the relationship between teacher beliefs and their influences on teacher practice (Roehrig et al., 2007). As with any popular theory, there are a few detractors (e.g., Wallace & Kang, 2004) that have been able to demonstrate a frequent disconnect between the espoused beliefs and the beliefs activated during practice. Teacher beliefs have also been shown to be exceptionally resistant to change, even when these beliefs are incongruent with the learning goals (Cronin-Jones, 1991).

Considering the highlighted failings of the common theoretical frameworks of beliefs and knowledge, I contend that teacher identity serves as a better theoretical framework to understand and describe the overall phenomenon of teaching climate change. This perspective pushes educational researchers to move away from questions like "What do I know and believe in this teaching moment?" to questions of identity like "Who am I in this teaching moment?" (Connelly & Clandinin, 1999). Identity is an immensely useful and "valuable lens" to employ in educational research to examine and describe teacher practice and its development (Enyedy et al., 2006).

Luehmann (2007) offers identity as a theoretical framework to better incorporates "the importance of overlooked elements such as the unique challenges and personal risks involved in taking on a new professional identity that runs counter to the norm …" (p. 837). Identity offers researchers an explanatory variable not previously considered by knowledge-only, beliefs-only, or practice-only approaches to investigating teaching and learning, especially in educational settings deemed novel or with an untraditional focus. Enyedy et al. (2006) puts forth another model that incorporates teacher identity as an important part of the decision-making process in which teachers engage to meet their instructional goals. Previously these components of personal stories and cultural history had not been considered as influential on practice. But Enyedy et al. (2006) argue that identity lies at the intersection of these ideas and is shaped in several directions by these and other political, historical, and social forces (Rodgers & Scott, 2008). Due to these promising new directions for insight, researchers have suggested that identity and its formation "take centre stage" as it encompasses the concepts of self, knowledge, beliefs, attitudes, dispositions, interests, and orientations (Drake et al., 2001).

Often, identity is loosely defined and rarely agreed upon in research literature across various fields. Identity is multifaceted in nature and can be viewed from a wide range of perspectives which does little to give this concept a clear research focus.

Teacher identity can be described employing the three-dimensional narrative framework (Clandinin & Connelly, 2000) and its dimensions of *interaction*, *context*, and *continuity*. *Interaction* refers to the relational aspects of identity. This includes personal components and relations to oneself such as one's values, beliefs, aspirations, and knowledge regarding teaching and learning (Helms, 1998). It also incorporates the social relationships that teachers form with students, colleagues, administrators, and parents, and the social expectations of these people for what makes a good or an effective teacher (Rodgers & Scott, 2008). Teacher identity is also *contextually* based on the various situations teachers encounter daily. In short, place also matters to teacher identity as it influences who one is at any particular time and how prepared a teacher is to handle educational challenges or cultural differences (Olsen, 2008). The third dimension is *continuity,* and it refers to both the dynamic and storied nature

of identity. Identity itself is dynamic with a history of past experiences and future goals for one's own teaching practice and hopes for one's students (Enyedy et al., 2006).

Identity is best expressed through narrative constructions to make sense of and give meaning to teaching and learning experiences. Rogers and Scott (2008) describe how "the most widely embraced way of making sense is through the practice of narrative, or the telling of stories" (p. 736). The sharing of stories is the discussion of experiences and how a teacher makes sense of these experiences (Sachs, 2001) which can illuminate noteworthy components of a teacher identity. Drake et al. (2001) describe this phenomenon as "stories, complete with themes, plots and characters revealing the ways in which individuals know themselves and their lives"–in essence, their identity (p. 2). Several researchers go further to describe the narrative stories along with the construction and re-construction of meaning via these stories <u>as</u> one's identity (e.g., Sfard & Prusak, 2005). Sfard and Prusak (2005) divide the narrative construction of identity into the present tense, current state of affairs (actual identity) and the future oriented goals and idealized roles one intends to enact (designated identity). Identity classifications are best shared through the selection of and characterizations of the stories that are shared.

The teacher identity as narrative framework allows the researcher to look beyond only knowledge and beliefs and more deeply into the dynamic, contextual, relational, and storied components of the lived experiences of teachers (Avraamidou, 2014b). Science teacher identity has been studied previously with an attentive eye to specific types of teachers (e.g., "reform-minded"–Luehmann, 2007) and I contend that this theoretical perspective is fruitful for the examination of the development and evolution of professional identities of teachers as 'teachers of climate change'.

METHODS

The purpose of this study was to investigate and describe the lived experiences of teachers of climate change. In applying the theoretical construct of identity as narrative to investigate the climate change related instructional experiences, I posed the central research question: **How do teachers' lived experiences shape their science teacher identity development as a 'teacher of climate change'?**

Study Description

Participants

The participants in this study are science teachers who teach or have taught climate change in their middle and high school classrooms (grade 5-grade 12). The participants were recruited from teachers who have participated in climate change professional development provided by MADE CLEAR, an NSF-funded project, that provides professional development to [mid-Atlantic region, Maryland and Delaware] science teachers related to climate science and climate change. There were approximately 70 teachers who are past participants that were eligible for recruitment efforts.

Sampling

The sampling approach that was utilized is Intensity Sampling which allows for examination of "information-rich cases that manifest the phenomenon intensely, but not extremely" (Creswell, 2007). This sampling strategy was chosen to gather teachers with a range of teaching experiences and life histories as interesting cases of likely science teacher identity development as a teacher of climate change. While a diverse group was desired, this qualitative sampling approach was not intended to be generalizable in any traditional sense (Merriam, 2009).

Data Collection Procedures

Data sources

Primary data sources include two interviews per teacher. The first interview focused on gaining a good sense of the teacher's personal narrative of science teaching (their preparation and teaching experiences) as well as their general personal relationship with science (early encounters and more recent science experiences). The second interview pivoted to focus on climate change teaching experiences, and the teacher's preparations and reflections on these experiences in their classroom. An additional primary source of data is a written reflection completed by the teacher after the two interviews. This reflection included prompts for the teacher to think back about the planned design and the actual enactment of their most recent climate instruction experience.

Data Analysis

Analytic approach

The interview transcripts and reflections were analysed in two phases. Each phase was comprised of multiple steps the employed a reflexively iterative process. Broadly, phase 1 focused on vertical analysis to better understand who the teachers are, along with their backgrounds in science learning and teaching and their general experiences teaching climate change. Then the goal of phase 2 was to compare these personal, professional, and contextual or political elements of the climate change teaching experiences to construct a conceptual model for identity construction amongst the teachers.

RESULTS

Participant Characteristics

As described above, 15 teachers were recruited to participate in this study. Key characteristics, such as state representation, school type, geographic locale, student population, teacher gender, and years of experience, were compared between the recruited sample and the overall population of cimate academy teachers. While as in any qualitative research, the results from this sample are not meant to be statistically representative nor be overly generalizable, but the findings of this study should represent the likely beliefs, understandings, orientations, motivations, etc., of the broader population of climate academy teachers. **Table 1** lists the teachers participating in this study where all names are pseudonyms.

Table 1. Teacher demographics

Name (pseudonyms)	Gender	School type	School location	Teacher preparation	Teaching experience (veteran > 5 years)
Amanda Kerry	Female	High school	Suburban	Alternative route	Novice
Barbara Pender	Female	Middle school	Rural	Traditional	Veteran
Beverley Sanders	Female	High school	Rural	Traditional	Veteran
Connie Stevens	Female	Middle school	Urban	Traditional	Veteran
Emily Skand	Female	Middle school	Suburban	Traditional	Veteran
Fiona Henry	Female	Middle school	Rural	Traditional	Novice
Fred Robbins	Male	Middle school	Suburban	Traditional	Veteran
Garrett Tresler	Male	High school	Suburban	Traditional	Novice
Karmen Losa	Female	High school	Suburban	Alternative route	Veteran
Krista Czapkas	Female	High school	Rural	Traditional	Novice
Mary Jenkins	Female	High school	Rural	Alternative route	Novice
Melissa Eckerds	Female	Middle school	Rural	Traditional	Veteran
Tara Thorpe	Female	Middle school	Suburban	Traditional	Novice
Veronica Acker	Female	Middle school	Suburban	Alternative route	Veteran
Wanda Katz	Female	Middle school	Urban	Alternative route	Veteran

Table 2. Structural codes and code frequency

Code	Short Description	Total code count	Percentage of teachers represented
PS	Past experience	758	100%
CU	Current experience	342	100%
FT	Future experience	128	100%
CX	Contextual element	386	100%
PR	Personal attribute	388	100%
SL	Social relationship	405	100%

The first analytic step taken was to create a narrative profile for each participant to briefly summarize their experiences, goals, motivations, etc. to demonstrate my initial understanding of their storied identities related to climate change teaching. These teacher narratives served to "distil the essence of the biography into more manageable form, retaining the teacher's 'ordinary' language for the most part, but organizing the material in a sociologically meaningful way" (Woods, 1985, p. 23). Kelchtermans (1994) describes the creation of these types of narrative profiles as a critical step in the research process and as more involved than simply relaying anecdotes or straightforward reporting of teachers' experiences. In these profiles I included examples of how each teacher described their enactment of climate change teaching in their classroom and the motivations behind some of the pedagogical choices as shared during the teacher interviews and reflections. These profiles served as additional field texts for the subsequent steps of this narrative inquiry. Examples of the developed narrative profile can be found in **Appendix**.

Differences Within Teachers' Climate Change Experiences

This section showcases the results from coding efforts undertaken during the vertical analysis phase to understand the differences between teachers' experiences through structural *a priori* coding and descriptive emergent coding. Vertical analysis allowed for intensive analytic attention on each teacher individually before making comparisons between teachers during later horizontal analyses.

Structural a priori coding

In the initial round of qualitative analysis, each set of teacher documents was coded via structural coding (Saldaña, 2013) utilizing the *a priori* codes from Clandinin and Connelly's (2000) three-dimensional narrative frameworke. The *a priori* codes were comprised of personal, social, contextual, past, present, future. **Table 2** shows the code counts and frequency for these *a priori* codes.

A preliminary review of the code frequency by teacher showed that all teachers relayed experiences that contained all elements of the three-dimensional narrative framework, comprised of continuity aspects (past, present, and future), contextual aspects, and interaction aspects (personal and social). This is important information for the utility of this theoretical structure, but more nuanced coding was needed to delve more deeply into the development of teacher identities.

Descriptive emergent coding

The findings from descriptive coding efforts were able to peel back some of the layers from the overarching structural codes provided by the three-dimensional narrative framework. The codes presented in **Table 3** were emergent during the multiple reviews of each teacher's documents (two interview transcripts and a reflection). A fully expanded codebook for this collection of emergent descriptive codes, including exemplar teacher codes for each of the 18 codes and a few examples of the 90 sub-codes can be accessed by contacting the corresponding author.

Similarities Across Climate Change Teaching Experiences

Patterns of similarities and differences between teachers and their climate change teaching experiences uncovered through horizontal analysis are explored in this section.

Theoretical coding

The emergent codes were evaluated for the predominant elements from the identity theoretical framework. The personal, professional, and political elements served as

Table 3. Emergent codes and code frequency

Code	Short description	Total count	Percentage of teachers represented
Activ	Incorporate climate activism or advocacy	63	100%
Build	Build interest in science	85	100%
Curr_Conn	Cross-curricular connections to climate change	95	100%
Display	Display self as a science person	38	100%
Do_Sci	Enjoys doing science	63	100%
DPI	Deep personal interest in science	99	100%
DTT	'Drawn to teaching'	84	100%
Need	Resources needed to encourage cimate change instruction	101	100%
Poli	Political influence on teaching climate change	107	100%
Role	Perceptions of role and responsibility for teaching climate change	79	100%
Support	Support for teaching climate change	112	100%
Agent	Teacher agency in the classroom	58	93.3%
Ed_Ch	Educational challenges	78	93.3%
Geo	Geographically local or relevant connections to climate change	48	93.3%
Evid	Evidence based approach to climate change education	47	86.7%
Confid	Confidence to teach climate change	35	80.0%
Learn	Love of science learning	56	80.0%
Res	Participation in scientific research	18	53.0%

Table 4. Personal (P1), professional (P2), and political (P3) categorization of descriptive codes

Descriptive code	PE		
	P1	P2	P3
Display self as a science person	X		
Deep personal interest in science	X		
Confidence to teach CC		X	
Cross-curricular connections to CC		X	
Drawn to teaching		X	
Educational challenges		X	
Build interest in science		X	
Enjoys doing science with others		X	
Love of science learning		X	
Geographically local or relevant connections to CC		X	
Resource needs for teaching CC		X	
Support for teaching CC		X	
Participation in scientific research			X
Incorporate climate activism/advocacy			X
Evidence focused approach to CC education			X
Political influences on CCE			X
Teacher agency in classroom	X	X	X
Perceptions of role and responsibility for teaching CC	X	X	X

Note. PE: Predominant element(s) & CC: Climate change

overarching categories for the descriptive codes previously explored for each teacher.

As shown in **Table 4**, the stories shared by teachers most frequently contained professional elements.

Patterns Among Descriptive Codes

Throughout the coding process patterns were uncovered to reveal personal, professional and political elements in the teachers' descriptions of their work as climate change educators. Each of these elements are described in more detail below.

Personal elements

Teachers often spoke of genuinely personal reasons for pursuing a career as a science educator. Stories from their childhood and adolescence held key memories for many of the teachers as they described their love of science. One

descriptive code was *deep personal interest in science*. This code highlighted these stories of past interactions with science and nature. One example of this is from Fiona Henry who spoke of her love of nature as it relates to her identity as a science teacher:

> "I feel like I'm a different kind of science teacher because a lot of science teachers, well I think most science teachers are big in the fields of math and science. Growing up I was not the best at math, I actually didn't really like math but as far as science when it comes to memorizing plants, memorizing climate, memorizing weather patterns, memorizing like different types of animals, and the environmental portion of it that's what I really enjoy and that's what I really find my passion towards."–*Fiona Henry*

Other teachers shared how their interest and passion for science and its inherent problem-solving characteristics influenced their personal trajectory in life. Garrett Tresler shared the early influences that science learning experiences had on him:

> "I remember one I really was fascinated with was oil spills and trying to come up with the best way to clean up an oil spill and like mixing all sorts of cleaners to try and degrease the oil. I was just fascinated with like what you could come up with to solve a problem, and being frustrated with the fact there wasn't like an answer out there, you start seeing and hoping for like a recipe that–just mix two parts of this detergent and one-part baking soda. And it wasn't, and so you had to just figure it out. And while it was frustrating, it was really fascinating too. It kind of caught my attention. And then I'd say in high school that spawned into being really interested in science and finding out I had a gift in figuring stuff out and problem-solving."–*Garrett Tresler*

Another personal element to the participating teachers' identity development was the common assertion that they like to *display themselves as a science person* outwardly to others

through their words, actions, and/or appearance. Fred Robbins discussed how he came to regularly don his science lab coat while teaching:

> "And I mean I wear a lab coat 80% of the time not because I necessarily have to, but because A, I can get away with it, and B, really it sparks the interest of the kids. They're like, you know, he's wearing a lab coat. And the reason why I put it on to begin with was because I found it in a drawer that I was cleaning out in my new classroom that I thought, oh, let me check this out, it was my size, and so I went, okay, there's a reason why this thing is my size. I have to wear it. And then it stuck. The kids wouldn't let me take it off. They're like, no you got to have your lab coat on. It's who you are. And since then, I just, you know, I think science just by itself is a little bit more exciting because it can be, and I embrace that as well. And I sort of wear it, I flaunt it, you know, why not? Science is fun. It can be fun. You can do neat things with science, so why not?"–*Fred Robbins*

Fred's desire to lean into how he displays his science identity and to 'flaunt it' demonstrates how deeply personal elements were strong influences in the overall identity development process for these teachers.

Professional elements

One of the most dominant collection of influences on the teachers' identity development surfaced around professional teaching elements. These were internal characteristics and motivations held by the teachers to engage in high-quality climate change instruction that is personally meaningful, geographically relevant, timely, and of interest to their students. Multiple external components also emerged related to the teachers' ability to enact climate change education; namely focused on challenges experience, resource needs, and support from others.

A sample descriptive code from this category of professional elements is that teachers reported having (or lacking) the *confidence to teach climate change* in their classrooms. Connie Stevens identified the underlying reason for her confidence to integrate climate change into her classroom teaching was because there is strong scientific data and evidence for this human-caused phenomenon.

> "I think the things that have helped me feel prepared is having access to reliable data. When I can point to specific data about CO_2 levels in the oceans and in the atmosphere, then I feel that what I'm telling my students, the information that I'm presenting to my students and the conclusions that they are able to draw on their own is based in fact, and I think that's very important. I think that's helped me feel prepared to discuss the topic with my students."–*Connie Stevens*

Other teachers highlighted the many opportunities for *curricular connections* to bring climate change topics into their regular teaching. Veronica Acker shared how she links climate change to the personal impacts her students will likely experience to heighten those connections.

> "So, I try to bring those kinds of things out there, so they can make the connection from what they are learning to the real world. Because they are middle school and that all seems really far away, even when it is not. So, I try to bring in those things and show little video clips."–*Veronica Acker*

The participating teachers described a wide range of readiness to enact climate change education, from just starting out in small ways to highly experienced with these effects. Veteran climate change educator Wanda Katz described her advice to novice teachers on how to build curricular connections to climate change:

> "I think I would [recommend to] start small and choose lessons that make sense to you, and then add to it over time so that as you have a better understanding over time, you can bring more of that to the classroom. And don't give up. If it seems complicated, just like you tell your students, if it seems complicated, you still need to stick with it and figure it out."–*Wanda Katz*

A second example of a professional element is the intention of teachers to design and enact climate change lessons that demonstrate the *geographically local connections and effects*. Emily Skand highlighted how her school's local community is currently, and will continue to, face negative effects from climate change and how she uses this fact as motivation to teach and learn more about climate change.

> "I also wanted them to understand how they themselves would be impacted locally. Most of the kids that attend my school live in [coastal midAtlantic] County, which has a lot of shoreline. A lot of my students go home on the weekends and then go boating or some of them even have waterfront property. They're going to see this happen if they haven't already started seeing changes. For them, again, I wanted to show them how they would be impacted locally."–*Emily Skand*

A final sample professional element is the pedagogical drive the teachers expressed to *build student interest in science* broadly and specifically in climate change. Barbara Pender shared her motivation to develop her students' scientific literacy.

> "I mean it affects us and one of my goals is to not only build the next generation of innovators, scientists, and technicians and try to pass that passion on. Because kids, they know if you're passionate about something. But also, to build some scientific literacy in our communities so that people make better decisions about things that affect all of us. It doesn't get any more real than that."–*Barbara Pender*

Meanwhile, Connie Stevens found ways to build her students' interest in science by incorporating engaging experiences, often utilizing outdoor learning opportunities, into her regular instruction.

> "My students, the sixth graders who are 11 and 12 years old. My real driving passion is that I do not want them

to lose their enthusiasm for learning. Sometimes along the way, especially in high school, it's easy for kids to develop apathy about school and about learning. I know I was there when I was a high school kid. So, all that eagerness and enthusiasm that they have as elementary school kids, I want that to persist for as long as possible. So, in terms of their science education and what happens when they come to my classroom, I want them to be engaged, to be excited about learning. I want them to be walking through the door every day saying "Hey, what's going to happen today? What are we going to learn today? What are we doing today?" And I want them to walk out talking about science. And you know, the days that that happens, then I know that it's been a really good day regardless of what they score on the multiple-choice science tests the county says that they have to take. I think it's that inquiring mind and that eagerness to learn is what I really want to see from my students."–*Connie Stevens*

Political elements

The final collection of influences of identity development coalesce around the political realm. These political elements often showcased teachers' valuation of the scientific evidence for climate change in the face of politically driven misinformation, their appreciation of the epistemic links to the process of scientific research, their ability to navigate the political surroundings in the school and in the wider community, and a predilection towards or away from advocacy and activism on climate change.

A common feature of teachers' espoused beliefs demonstrated the *educative power of evidence and data* to support the teaching of climate change generally, and more specifically as an anthropogenic phenomenon. Barbara succinctly describes this perspective: "And I have seen attitudes shift with the kids, year after year. We don't just *believe* in climate change, we understand the data and there's less of a pushback."

Teachers also shared stories of how the *political landscape around climate change conversation* influences their instructional efforts. Krista discussed how she felt it was important to equip her students with enough scientifically accurate information on climate change to empower them to evaluate that evidence and make decisions for themselves on why or how to engage with the issue:

> "Either way I just want them to be able to be fearless about thinking differently than their parents. And they even said that to me, I asked them near the end of the year I said, is climate change something that your generation is going to need to be creative with, to tackle, and to try and change? And every kid in both of my classes, every kid was yeah, we need to do something. And one kid said, it's hard though because a lot of us come from somewhere where they don't believe in climate change and our parents don't believe in that. But that's all right, you guys are younger, and you are learning new stuff and they didn't learn about this probably back when they were in high school. So,

just kind of I want them to be able to break those boundaries."–*Krista Czapkas*

Emily shared the surprising scenario where informational websites from the environmental protection agency (EPA) were quite literally disappearing from the internet day by day throughout her instructional unit due to partisan mandates from the federal government:

> "I will say probably one of the biggest driving factors this year was the current political climate. The resources that were available online through the EPA started disappearing when I was in the middle of my unit. And while that was slightly inconvenient, to say the least, it also did provide conversation and also the concept that here we are learning about science as a process, but it can't be taken in a vacuum. Because if you look at the history of science, so many scientists and so many new ideas were suppressed and were counter to what the people in power wanted you to think. It was a challenge to what people believed. And so, this year for me, and I have to say and speaking to my other fellow faculty members who do teach science, that was a huge motivating factor because we really felt like that information was going to disappear and that we needed to address it because the kids, especially in their position of being the next generation coming up and having to deal with what we choose to or choose not to deal with, they're the next ones to do it. So that was a huge influence in how much depth I chose to get into it this year."–*Emily Skand*

Emily utilized this event as a teaching opportunity and motivator to encourage other teachers to discuss climate change with their students despite the dampening influence from the broader political landscape.

A final example of a politically linked factor for identity development as a climate change educator is the degree to which teachers felt *advocacy or activism* was appropriate to share, encourage, or even require with their students. Krista decided that she would prefer to lead by her own example for climate action:

> "Another thing that I want to change, which kind of goes into the action portion is I'd like to lead a little bit more by example. Yeah, I'm still starting out, I'm a second-year teacher, I just moved down here two years ago, but eventually when I buy a house, I would like it to be more energy efficient. I would like to use some kind of renewable, I'd like to buy a more efficient vehicle. I still drive a pretty efficient one, but maybe one that is electric. I'd like to lead more by example to kind of help with that action piece, too."–*Krista Czapkas*

Meanwhile, Tara felt that her students were ready to engage in developmentally appropriate climate action now:

> "I would say out of everything that I've taught this year this has been the topic that they've grabbed onto the most because they feel that they can do something about it and working with gifted kids a lot of them really

Table 5. Comparison of identity theoretical frameworks

Proposed identity framework		Primary framework elements		
Current study	Personal	Professional	Political	Temporal
Clandinin and Connelly (2000)	Interaction (both social and personal aspects)		Context	Continuity
Avraamidou (2014a)	Personal histories	Process of teacher learning and development	Role of context	Histories (implicit)

want to do something and help the world in some way like they feel it is personal justice to fix and solve problems and this ties in with that greatly."–*Tara Thorpe*

Across all three elements (personal, professional, and political) themes of teacher agency and perceptions of responsibility or their role for teaching climate change. These codes manifested in more nuanced ways and will be examined more deeply in the future by the author.

DISCUSSION AND IMPLICATIONS

Throughout the analysis of the teachers' narratives, a framework to examine the various components was utilized that modified a previous model to best suit the emergent needs to accurately describe teaching and learning a controversial socio-scientific issue like climate change. The predominant elements of personal values and beliefs, professional learning and teaching experiences, and political context of student and community interactions were examined to explore the developmental trajectory of identity.

It is clear from examining these storied narratives, that personal identity develops first, though professional identity for science teaching evolves through teacher preparation efforts and teaching experience in the classroom. The results of this study demonstrate that when educators enact climate change education, often voluntarily, the contextual element of one's identity gains a more nuanced, deeper dimension than merely the physical context. Instead, robust identity development as a climate change educator requires the integration of an explicitly political dimension to one's identity. The word *integration* is a specific and intentional choice as the identity of a climate change educator is manifested through an individual's beliefs and demonstration of practices related to personal priorities, the perceptions of one's professional teaching responsibilities, and the navigation through the political landscape of one's own space on multiple scales (e.g., self, classroom, school, community, and beyond). This study also demonstrates how storied narratives can demonstrate a temporal influence on identity as teachers shared retrospective, reflective, and aspirational aspects of who they are as educators, and more specifically as teachers of climate change.

These elements infused aspects of identity theoretical frameworks posed by prior researchers (Clandinin & Connelly, 2000) and modified the three-dimensional narrative framework as others have similarly done (e.g., Avraamidou, 2014b, 2016a; Carrier et al., 2017). For example, there are parallels between the identity characteristics of storied, dynamic, relational, and contextual components to the proposed identity framework which can be seen in **Table 5**.

However, the critical difference is the acknowledgment of a political contextual influence on teacher identity construction when teaching a socio-scientific issue like climate change. In this study the political landscape could influence, support, or constrain other developmental pathways for identity and should be attended to more explicitly, especially considering the particularly contentious environment surrounding the social controversy of climate change and related educational efforts. These findings primarily focus on the three elements of personal, professional, and political influences, but also extend our collective understanding of identity development and climate change instructional experiences in several ways.

Personal Elements

The first finding of this study focused on the depth of influence from individual values and beliefs on the perceived importance of protecting the environment. These commitments to personal environmentalism manifest in a motivation towards teaching students about the need to preserve these places for our current and future benefits. This study reiterates the strong influence of intensely held personal values and beliefs on teacher identity (Helms, 1998) and how past experiences, such as frequent outdoor play and leisure activities, can initiate shifts in those attitudes and orientations related to identity development for science teaching (Avraamidou, 2016b).

The direct influences from one's teacher identity and personal values are clear in the teachers' motivations for teaching climate change as an important environmental issue. This finding supports the work of Eick and Reed (2002) where they concluded that in pre-service teachers, there are innate predispositions in one's teacher identity that may lead teachers to enact particular pedagogical practices. Additionally, the results extend the findings of Lee and Witz (2009) which found that teachers were teaching socio-scientific issues due to their personal commitments to the issues, but that this led to a wide variety of learning goals for their students, from cognitive development to critical thinking skills to civic and political action.

Professional Elements

Professional considerations for science teaching and learning also had an impact on the identity development for teaching climate change in this study. The dialectic between prioritizing content knowledge development in students and engaging students via their individual interests shows that these goals are not mutually exclusive. Yet, this study found that teachers often hold distinct priorities for their climate change instruction which impact the development of their teacher identity(ies) for climate change. The focus on content knowledge supports a teacher identity as an expert in the subject area (Mitchener & Anderson, 1989) and often the teachers expressed a commitment to teaching their assigned

curriculum while infusing connections to climate change throughout these required topics. The issue of the fit of climate change into curricular standards was salient in this study, as well as others (e.g., Hughes, 2000; Wise, 2010) but generally was not an overwhelming concern voiced by the teachers. More frequently teachers described the integration of climate change due to its broader importance as a timely issue and included climate change through novel or informal approaches (Baker & Loxton, 2013; Colston & Ivey, 2015).

The professional considerations in identity development also were evident in the perceptions teachers shared of what makes a "good" science teacher. Engaging student interest in climate change through explicit connections between their lives outside of school and the science content was a priority for many teachers in this study, similar to other research findings (e.g., Barrett, 2008; Bossér et al., 2015). Development of an identity as a teacher of climate change was more broadly impacted by the expected roles and visions of what it means to be an effective science teacher (Volkmann & Anderson, 1998). Most often the teachers expressed an emphasis on getting students to meaningfully engage in the practices of science and to ask and answer questions about climate change. This participation in the discourses (Gee, 2005) of an effective, reform-based, inquiry science teacher demonstrates their professional commitment to the expectations of how to be and act (Sachs, 2001) as a teacher of climate change.

Political Elements

The most modified element of the identity theoretical framework is that of context, for which the findings support viewing more as the political landscape for the contextual elements of teaching socially and/or scientifically controversial topics like climate change. The elements within the political context for identity development first take into consideration how a teacher's personal and professional knowledge are enacted in context and how the broader contextual elements, namely political, cultural, and moral factors, can direct the enactment of climate change instruction.

These results demonstrate the importance of a teacher's epistemic understandings of the nature of science, scientific research procedures, and the weight of scientific evidence (Hashweh, 1996). When teachers were able to draw upon their epistemological orientations for science, they more frequently provided instructional opportunities for students to examine climate change data patterns and to critique the omission of evidence in the claims made by climate change denialists. Through the promotion of epistemic cognition and skills development, students were encouraged to think more about "definitions of knowledge, how knowledge is constructed, and how knowledge is evaluated" (Hofer & Pintrich, 1997, p. 88). This instructional focus also allowed students to delve more deeply into their social, epistemic, and conceptual understandings (Duschl, 2008; Sezen-Barrie et al., 2017) to combat misinformation and naïve ideas on climate change that exist all around them culturally.

This study has demonstrated the strong influence that the political landscape imposes on teachers and the development of identities as teachers of climate change. Most teachers in this study described a perceived responsibility for preparing their students to live, work, and effectively interact with the issue of climate change within a politicized future as civically minded adults. Walsh and Tsurusaki (2018) suggest that this responsibility includes practices such as promoting meaningful dialogue, critical thinking, and complex problem solving even if conflicting worldviews are present. In fact, "rather than seeing controversies as something to be feared … we should instead view this as an opportunity to foster deeper science learning and to engage students in exciting cutting-edge science" (Walsh & Tsurusaki, 2014, p. 262). Teachers in this study often spoke of climate change as a novel occasion to enact these types of positive perspectives on socially and politically interesting scientific ideas.

The imperative need to address climate change is a key problem of our time (Feierabend et al., 2011) and the overall volatility of the climate change issue with the purposeful efforts of climate sceptics and deniers to misrepresent the data through anti-science campaigns (Colston & Ivey, 2015; Lambert & Bleicher, 2014; National Center for Science Education [NCSE], 2012) has led to the development of a teacher identity that includes strong mentoring roles to model for students how to address such a politicized socio-scientific issue. Many of the study teachers did seek to teach about climate change within their local political context which allowed their students to become aware of how "science relates to societal concerns" (Walsh & Tsurusaki, 2014, p. 261).

Overall, this modified theoretical framework for identity development with the key components of personal, professional, and political elements more suitably fits the lived experiences and identity development trajectories most commonly undertaken by the teachers in this study. This framework would also contribute to other studies of teacher identity development surrounding politically charged issues beyond climate change–anything from other socio-scientific issues to educational reform efforts and the integration of high stakes testing programs.

This study has offered findings that explore the diverse range of roles and identities (MacLure, 1993) to better explain how teachers develop, enact, and reflect on their climate change instruction. Through a narrative approach, the "area where practice and professional identity meet" (Watson, 2006) was examined to describe how identities for teaching climate change are constructed and influenced by personal, professional, and political elements.

To support teachers in their development of a climate change teacher identity (and thus the further enactment of quality climate change instruction to meet the growing climate crisis), teacher education programs and professional development providers must attend to this political contextual influence on identity development. Ample research shows that mere presentation of evidence, appealing to scientific reasoning through the use of reform-based teaching practices can have some positive impact on student learning of climate change phenomenon. But to truly meet the staggering demand to deal with the ramifications of the climate crisis in the near future, more creative and actionable learning experiences are needed. This would allow students and teachers alike to more fully develop agencies around climate action to meet the challenges ahead.

CONCLUSION

An identity theoretical framework exposed the multitude of past, present, and future influences on teachers' constructions of identities including their values, beliefs, understandings, commitments, and actions related to climate change education. Broadly these influences on identity were categorized as personal, professional, and political to reflect the nature of these different factors in identity development. Additionally, this study demonstrates the critical need to support climate change educators to strengthen their perceptions of instructional agencies to effectively overcome challenges to the enactment of climate change lessons. If our society desires a climate literate population that is ready to engage with the climate crisis civically and democratically, then we need to lift up the voices of climate change educators, validate their experiences, and empower them in their efforts for the teaching and learning of climate change in the K-12 classroom and beyond.

Ethical statement: This study was approved by the University of Delaware's Ethics Committee on 28 March 2017 with approval number 1046437-1. Written informed consents were obtained from the participants.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the author.

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APPENDIX

Example Teacher Narrative Profiles

Beverley Sanders narrative profile

Beverley is a high school chemistry teacher who teaches various chemistry courses and a newly introduced, required freshmen course called Physics of Earth and Space Science. She is a veteran teacher of 11 years and is the science department chair for her rural high school. Beverley has extensive chemistry focused content knowledge and research experience from her undergraduate studies. While most of her formal training is in chemistry, more recently she has begun to get interested in learning more about agricultural and life sciences as her family now lives on a working farm with numerous cows, pigs, chickens, and other farm life. Beverley was inspired to be a chemistry teacher by her own high school chemistry teacher and the innovative science learning opportunities that she experienced. She enjoyed the challenge of "hard sciences" and works to share that excitement for, and success with science, especially chemistry, with her students. "I think the biggest reward for me is when I hear it from my students that it was the most challenging and fun class that they had and that it really made them think" (Beverley, Interview #1).

Along with her colleagues, whom she refers to as her work family, she has collaborated to revise and implement a science curriculum that is strongly integrated among the different science disciplines, that is personally relevant to the students, and that is based on real-world science inquiry. "I'd say my number one [goal] is for them to enjoy it. Number two will be for them to not only understand [science content] but be able to apply it and make connections to the real world... because without those connections, why are we here, like what are we doing?" (Beverley, Interview #1). For example, the same 'fun' greenhouse effect tag game that other teachers enjoyed, Beverley harshly critiqued because she felt the students really didn't learn accurate content knowledge due to the liberties taken to transform the actual greenhouse effect mechanism to an interactive learning experience.

Her efforts coincide with a desire to develop students that are scientifically literate and "be able to have a conversation about science because they're all going to be voters one day. They're all going to be citizens and they need to be knowledgeable enough that they can make the right decisions" (Beverley, Interview #1). She hopes that by making direct connections to science content knowledge in her teaching that students will come to appreciate and love it as she does – which she hopes will encourage them to pursue science careers to address the issue of climate change.

Most of the topics on which she focuses science literacy development come directly from her curriculum and she generally follows these guidelines for instruction. In her chemistry courses, she feels that she is only able to highlight connections to climate change in passing, such as when writing chemical formulas, she mentions the CO_2 molecule's presence and increase in abundance in the Earth's atmosphere and briefly how it affects students' lives. Conversely, the new Physics of Earth and Space Science curriculum includes many scientifically accurate references to climate change even though she describes her local area as strongly Republican. While she expected denialist pushback from more skeptical students, parents, and/or community members, she experienced none and instead her colleagues were "on board" and very excited to teach climate change as they "respect the science and the evidence" (Beverley, Interview #2).

Her original expectations compared to the reality served to contextualize Beverley's experiences teaching climate change and solidified her desire to educate her students on the facts of climate change. Yet she views her role "more as the teaching and educating part, but in the hope that it would lead to inspiring action later. I don't think I ever want to be a teacher twisting a kid's arms to make an action... I feel like that's almost asserting your religion, it's a little too pushy for me personally" (Beverley, Interview #2). Beverley clearly wants to help prepare her students to be literate about climate change in the future, but her community and school context seemingly have nudged her to take a more nuanced approach to teaching climate change that primarily focuses on content knowledge development to avoid the appearance of any undue influence on her students' beliefs.

Emily Skand narrative profile

Emily is a veteran middle school science teacher. When she was young, she remembers experiencing lots of informal science learning, especially in nature outside of a traditional educational setting. "My parents were of the attitude that regardless of where you're going to be, you're engaging with the surroundings that you have, and you're going to be learning" (Emily, Interview #1). Whether watching for hawks on road trips or trying raw oysters while out sailing, Emily was encouraged to appreciate the natural world around her and her connections to it by her informal science educator parents. She seeks to repeat these types of learning opportunities for her students to garner a similar appreciation of their connections to nature and a sense of concern for environmental protection efforts. For example, she has incorporated student research projects about how the Chesapeake Bay is utilized by people in their local area, how the area is also being impacted by climate, and how people can act through their choices to help slow the negative changes from climate change.

Emily grew up with several role models for authentic science learning – both her parents were in science education fields and she developed a close relationship with her high school environmental science teacher who acted as a great exemplar for effective pedagogy. Over her 18 years in the classroom, she has taught in private, Christian middle and high schools, as well as in a public high school. Throughout these teaching placements, Emily views herself as a perpetual learner of science content and professional practice. "Your curriculum and the activities that you do are not going to be stuck in place. There's always going to be an ebb and flow, especially depending upon the kids that you're teaching" (Emily, Interview #1). Most recently in her current

private school, Emily enjoys great curricular autonomy where she "can do whatever I want… and we can take a topic and we can teach it however we want – there's a lot of flexibility there" (Emily, Interview #1).

This freedom and agency allow Emily to engage students in science instruction around relevant and "cool" topics like nanotechnology that relate to her overall curriculum. She also integrates topics like climate change which she feels strongly that her students need to know about. But climate change also is a topic that "lends itself to every discipline and science because it deals with so much, there's something for everyone when it comes to climate change. There's chemistry involved, there's physics involved, there's meteorology involved, you can really infuse it wherever you want to" (Emily, interview #2). To this end, Emily has her students create video PSAs to present to other students in their school to discuss climate change where her students examined the issue and its connections to curricular topics from photosynthesis and the carbon cycle, atmospheric changes and the greenhouse effect, and other environmental aspects found in their local area. Her students really were excited by this project and were responsible for all components from writing the scripts, performing, filming, and editing the videos for uploading to YouTube.

Emily's climate change instruction has also been deeply influenced most recently as she believes there will be grave implications from the current denialist political landscape and the Trump administration's efforts related to climate change. She feels a newfound motivation to teach climate change to demonstrate that it is a science topic that is both personally relevant and current. "Not that it's not going to be any less urgent next year, but the fact that it's here and it's being discussed, and so hotly discussed to the point of somebody calling it a hoax. When you have that constantly going in news feeds, it does definitely make it difficult to not address it" (Emily, Interview #2). Her instruction has been explicitly impacted by the broader political conversation when the EPA climate change websites quite literally were re-written in the middle of her class using these online resources. Emily used this occurrence as an opportunity to discuss with her middle school students that science does not exist in a vacuum and will always be influenced by others' perspectives and that it is their responsibility to understand and be prepared to act on this issue in the future. "You want to give them the science that allows them to understand why they would be making changes in their lives. But then you also want to give them to tools to be able to make those changes and to get excited about it" (Emily, Interview #2).

Emily also incorporated climate change related projects on wind turbine blade design and energy usage poster projects that allowed students to hone their scientific decision-making skills and civic awareness for their future role as climate literate citizens. She works to "give the kids something to do" and her students discussed with their families their collective carbon footprints and possible changes they can make together to reduce their impacts. Her stance on including student advocacy issues gathered a few parental concerns specifically related to a discussion on the economic versus environmental benefits of the Paris Accord, however her administration and colleagues strongly supported her empowering approach to climate change education.