

# Examining the relationship between middle school students' sociocultural participation and their ideas about climate change

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## ABSTRACT

This case study applied sociocultural theory to examine the climate change ideas communicated by one group of middle school students ( $N = 39$ ) in a suburban community on the U.S. East Coast. We investigated the ways in which students' participation in the sociocultural activities of their varied communities appeared to inform their understandings of climate change prior to formal classroom science instruction on the topic. Data sources included an 18-item multiple choice Climate Science Knowledge Assessment Instrument (CSKAI), interviews investigating students' content knowledge and perspectives related to climate change, and drawings examining how students saw climate change in relation to their own lives. We interpreted learners' sociocultural activities as having implications for: (1) the kinds of scientifically-informed climate change ideas they brought to the classroom; (2) the sources of climate change information they perceived as trustworthy; and (3) the extent to which they viewed climate change as problematic, or as having potential connections to their lives. Findings also suggested that students' engagement with media within and beyond their school-based learning experiences – even prior to formal instruction on climate change – appeared to most strongly inform their ideas about climate change. We concluded that viewing students' climate change understandings as a product of the unique sociocultural activities in which they are already participating may provide a valuable foundation for planning science learning experiences that resonate personally with students.

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## Introduction

As climate change becomes an increasingly urgent societal concern, there is a growing need to expand climate literacy among the next generation of citizen decision-makers. While climate change is a relatively new topic in many school science curricula, accompanying the release of the Next Generation Science Standards (NGSS Lead States 2013), many young people are already learning about climate change through their participation in various communities within and beyond the world of school. In this case study, we describe our use of a sociocultural perspective to investigate the climate change ideas that one group of adolescent students expressed prior to engaging in formal instruction on climate change. The purpose of our investigation was to contribute new knowledge of students' thinking about climate change, which may be used to inform curriculum, instruction, and assessment in climate change education. We viewed students' ideas about climate change as being influenced by disciplinary

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content knowledge gained through formal school science learning experiences, as well as by learning experiences across other social and cultural contexts in which they participate.

Our case study was guided by the question: *How does middle school learners' participation in the sociocultural activities of their varied communities inform their understandings of climate change?* We regard this question as having important implications for guiding instructional decision-making in climate change education, particularly toward the goals of building on and expanding students' existing climate change understandings, connecting with aspects of climate change they see as most relevant to their lives, and meeting instructional goals related to climate literacy.

## Literature review

Students may become aware of climate change as a result of its presence in diverse sociocultural arenas, including political discourse (Albe and Gombert 2012; Boon 2010), media (Boyes, Stanisstreet, and Yongling 2008; Hansen 2010); school-based curriculum and instruction (Bodzin and Fu 2014; Boon 2010; Kılınc, Stanisstreet, and Boyes 2008; Varma and Linn 2012); and out- of-school learning environments (Devine-Wright, Devine-Wright, and Fleming 2004). As a result of such diverse information sources on climate change, students may come to the classroom with varying prior knowledge and prior mindsets (Feinstein 2015) regarding climate change.

Researchers have examined diverse dimensions of students' conceptual understandings of climate change. A number of researchers have explored students' understandings of the greenhouse effect (e.g. Boyes and Stanisstreet 1997; Rye and Rubba 1998; Shepardson et al. 2009) and the carbon cycle (Jakobsson, Mäkitalo, and Säljö 2009; Jin, Zhan, and Anderson 2013; Mohan, Chen, and Anderson 2009). This body of research has highlighted key concepts that may present challenges for learners, including conflation between the greenhouse effect and the ozone hole, factors that exacerbate the greenhouse effect, and the role of greenhouse gases in increasing global temperatures.

Regarding students' understanding of human activity and climate change, researchers have suggested that students may be aware of a number of anthropogenic contributions to climate change, such as fossil fuel use and deforestation (e.g. Bodzin and Fu 2014; Boyes, Stanisstreet, and Yongling 2008). However, they may also identify irrelevant human activities as relevant to climate change (Boyes and Stanisstreet 1993). Students may describe how reducing or stopping certain activities could serve to mitigate climate change, but may also cite any environmentally-friendly action as helpful for mitigating climate change, without explaining the cause-effect relationship at hand. Similarly, students may be able to appropriately identify climate change consequences such as ice melt, sea level rise, and threats to plants and animals. However, they may have difficulty explaining why these consequences may occur (Shepardson et al. 2009) and on what scale (Gowda, Fox, and Magelky 1997).

Finally, some researchers have examined students' levels of concern about climate change. Leiserowitz, Smith, and Marlon (2011) reported that a majority of U.S. teen participants in their survey-based study were either *not very worried* or *not at all worried* about climate change. However, studies in other international contexts have reported that adolescents and teens do generally express concern about climate change (e.g. Boyes and Stanisstreet 2001; Chhokar et al. 2011). Byrne et al. (2014) observed that students tended to base their concerns, as well as their ideas about climate change mitigation strategies, on potential impacts for people's everyday lives, including their own.

Taken together, research on students' ideas about climate change suggests that they may come to new learning experiences with varied prior understandings and perspectives. We argue that these ideas may have potential implications for developing and meeting instructional goals in the climate change education arena.

## Theoretical perspective

Our thinking was informed by Rogoff's (2003) sociocultural perspective, which posits that: 'Humans develop through their changing participation in the sociocultural activities of their communities, which

also change' (398). Considering climate change learning from such a perspective departs from a focus on individual students' mental schemes or models of climate change. Instead, it reorients its attention toward an examination of how students' social interactions within varied communities may shape how they engage with and come to understand climate change. Robbins (2007) argued that research adopting such a perspective could offer a promising means of acknowledging the 'complex, dynamic, often collaborative and contextualized' (47) nature of science learning.

We argue that a sociocultural perspective – with its attention to learners' contexts – is particularly valuable for gaining insight into student learning related to climate change, a phenomenon experienced variably across places (USGCRP 2009) and interpreted variably across communities (Howe et al. 2015). Further, we view Rogoff's (2003) emphasis on the changing nature of the sociocultural activities of communities as especially relevant to climate change and climate change education. The scientific community, presumably the foundational source of the scientific information presented to students in their classrooms, continues to evolve in its climate change understanding and research practices. The local communities in which students live and learn are experiencing and continuing to determine how they will respond to climate change impacts. And the school communities in which students are embedded are evolving in their instructional practices around climate change as they adopt new curricula, particularly in response to the NGSS. In the midst of the changing practices of these communities and others, students asked to make sense of a complex and dynamic scientific topic. Rogoff's sociocultural perspective on learning would suggest that it is students' participation in the sociocultural activities of their communities that fosters this process and informs their climate literacy development.

## **Methodology, study context, and participants**

We conducted a qualitative case study (Stake 1995) within the context of a suburban charter school in a Mid-Atlantic U.S. state, which employed a blended learning instructional approach. The school was located near a large university, within a county whose residents generally accepted that climate change was occurring (72% agreement), but were divided on whether climate change was caused by human activity (49% agreement) (Howe et al. 2015). However, a majority of local residents expressed concern about climate change (60% agreement) and believed that it posed a threat to future generations (62% agreement) (Howe et al. 2015). Within the school context, students were primarily middle class, though 17% were eligible for free or reduced-price lunch. The school was racially diverse with approximately 60% Black/African American students, 15% Latino students, 13% White students, 6% students of two or more races, and 5% Asian students. Participants in this study ( $N = 39$ , 26 girls and 13 boys) were all in the first year of middle school (6th grade) and enrolled in a general science course.

## **Data collection and analysis**

We collected data on students' climate change ideas prior to formal classroom instruction on the topic through: (1) an 18-item assessment of students' climate science knowledge; (2) a climate change drawing activity; and (3) individual interviews. During our first phase of analysis, we sought to simply identify the ideas that students appeared to communicate about climate change. Toward this end, and to check the reliability of our findings, each data source was first reviewed independently by at least two members of our research team. Next, we reviewed our individual interpretations as a group and discussed any discrepancies in interpretations until we reached consensus. We then triangulated our data by examining the varied data sources collectively to examine key ideas emerging across the corpus of data. During our second phase of data analysis, we sought to identify the possible ways in which students' interactions within their varied sociocultural contexts appeared to inform the ideas they expressed regarding climate change.

## **Multiple-choice Climate Science Knowledge Assessment Instrument**

We used a researcher-crafted valid and reliable instrument, piloted over a two-year period prior to this study. Changes were made in an iterative manner between administrations based on student responses.

The final instrument consisted of 18 multiple-choice items (see Supplemental Files) with distractors for each item based on alternative conceptions found in the literature and in our pilot study. For select multiple-choice items, students were asked to provide written explanations of the rationale for their responses. Due to anticipated participant fatigue, as well as our confidence in the validity of the questions, each student in the present study provided explanations for four purposefully selected questions. These explanations provided essential data to triangulate responses with the other data sources. Of the 39 students who consented to participate in the study, 38 completed the Climate Science Knowledge Assessment Instrument (CSKAI). In analyzing CSKAI results, we recorded the percentages of participants who selected the scientifically-supported option for each item, as well as the percentages of participants who chose research-based distractors. We also coded students' written explanations to the select CSKAI items for further insight into how participants were understanding the scientific basis of climate change.

### ***Climate change drawings***

In addition to the CSKAI, all students were asked to respond to the prompt: 'Draw what comes to your mind when you think about climate change. Please include yourself in the drawing, and some details about how climate change relates to your life or your community (if you think it does).' They were also prompted to provide a written description of what they wanted to communicate through their drawings. The purpose of the drawings was to gain insight into students' climate change ideas, including which aspects of climate change were most salient to them when they considered the implications of climate change for their own lives. Prior research has demonstrated how drawings can provide a fruitful modality for learners to express not only their science content knowledge, but also their personal connections, emotions, and values in relation to environmental topics (Alerby 2000; Barraza 1999; Bonnett and Williams 1998; McGinnis and Hestness, 2017; Shepardson et al. 2007). Of the 39 students who consented to participate in the study, 35 completed the drawing activity. Due to the high-inference nature of interpreting the drawings alone, we analyzed the drawings in tandem with students' CSKAI instruments and interviews, examining them for ideas that supported or challenged our interpretations of these data sources.

### ***Interviews***

We used two interview protocols with subsets of the participants: a climate science content knowledge interview protocol and a sociocultural interview protocol.

#### ***Content knowledge interviews***

We used a researcher-crafted interview protocol (see Supplemental Files) with a purposefully selected subset of students ( $n = 14$ ) who completed the CSKAI. The audio-recorded interviews were approximately 20 min in duration. The interviews followed the sequence of climate change constructs included in the CSKAI, beginning with students discussing how human activity was related to climate change. Then, after discussing the mechanism behind climate change, as well as the consequences, we ended the interview with a focus on mitigation and adaptation strategies. In addition, we asked students how certain they believed scientists were about climate change, as well as if they personally believed climate change was taking place. To analyze these interviews, two members of our research group coded interview transcripts with attention to students' science content knowledge related to: (1) climate change mechanism, (2) climate change consequences, (3) the role of human activities, and (4) climate change adaptation and mitigation.

#### ***Sociocultural interviews***

With a separate, purposefully selected subset of participants ( $n = 15$ ), we administered another researcher-crafted interview protocol designed to provide insight into students' sources of information on climate change and their senses of personal connection to the issue (see Supplemental Files). Interviews

were 12–15 min in duration and were also audio-recorded. We began by asking students what they had previously heard about climate change, and where they had gotten their information. Next, we showed students a short introductory video clip on climate change produced by the U.S. Environmental Protection Agency. We located the video on the Climate Literacy and Energy Awareness Network (CLEAN) website ([www.clean.org](http://www.clean.org)), a site that provides a vetted collection of scientifically and pedagogically-sound climate change education resources. The purpose of the video was to introduce students to (or remind them about) the issue of climate change, since the interview was being conducted prior to classroom instruction on the topic. The video introduced the enhanced greenhouse effect, climate change consequences, and suggested possible mitigation actions. Following the video, we asked students how they saw climate change relating to their own lives and communities. Sociocultural interviews were coded independently by two members of our research group, with attention to students' *sources of information* on climate change across their varied sociocultural contexts, as well as the extent and ways in which students saw climate change *as locally and personally relevant*.

## Findings

To address our research question: *How does middle school learners' participation in the sociocultural activities of their varied communities inform their understandings of climate change?*, we report our insights at two levels. First, we describe the climate change understandings that participants appeared to bring to the 6th grade science classroom. Second, we describe our insights into how learners' participation within varied communities may have been informing those understandings.

### ***Learners' understandings of climate change prior to formal instruction***

Our analyses of students' responses to the CSKAI items, the content knowledge interview, and the drawing prompt all provided insight into their understandings of climate change prior to instruction in the 6th grade science classroom. The mean score on the CSKAI was 10.39 correct responses ( $SD = 3.77$ ) out of a possible 18 correct responses, though participants' content knowledge varied regarding different dimensions of the phenomenon. We report our findings in terms of participants' understanding of climate change mechanism, consequences, the roles of human activities, and climate change mitigation and adaptation.

#### ***Mechanism***

Regarding the climate change mechanism construct, including the enhanced greenhouse effect and the role of greenhouse gases, students were generally aware that the atmosphere functions to hold heat energy to warm the Earth (77% on CSKAI) and that fossil fuels were increasing the amount of carbon dioxide (68% on CSKAI). However, they disagreed about the mechanism by which global warming was occurring. Some (42%) attributed global warming to ozone layer depletion (see Figure 1), and others (39%) attributed it to Earth's atmosphere getting thicker. Many explanations included reference to fossil fuels, carbon dioxide, or gases, even though they varied in their descriptions of how these were increasing global temperatures. Figure 1 presents one student's drawing of the mechanism of climate change. He explained, 'I made a picture of a factory with fumes coming out which is depleting the ozone layer. This is causing climate change' (Devon, drawing data). In general, prior to formal instruction on climate change, many of the 6th grade participants came to the classroom with awareness that pollutants, typically from fossil fuels, interacted with the atmosphere to cause climate change. However, they generally did not express scientifically-informed explanations of the enhanced greenhouse effect.

#### ***Human activities***

Related to their shared awareness that pollutants, particularly from fossil fuels, played a role in climate change, students generally agreed that human activities were contributing to climate change. On the CSKAI, a majority of students (81%) indicated that increases in atmospheric carbon dioxide were a

result of increased fossil fuel use by humans, and that the recent increase in global temperatures was attributable to human-generated air pollution (74%). However, during interviews, students generally spoke about human activities releasing pollution or gases, and did not refer specifically to carbon dioxide. For example, as Michelle explained, 'Sometimes when people use cars, they permit gas and that makes the earth sometimes hotter than it usually is' (Michelle, content interview). In their drawings, students represented a variety of human activities that generate pollution associated with climate change, including car use, home energy use (Figure 2), and factory operations. A small number of students



Figure 1. Devon's drawing representing ozone depletion as a mechanism of climate change.



Figure 2. Kayla's drawing representing fireplace use and driving as contributing to climate change.



referenced human activities unrelated to climate change, such as littering, polluting waterways, or using nuclear power. In general, however, students attributed recent increases in global temperatures to human activities that pollute the air, though they varied in their ideas about how these activities lead to warmer temperatures.

### **Consequences**

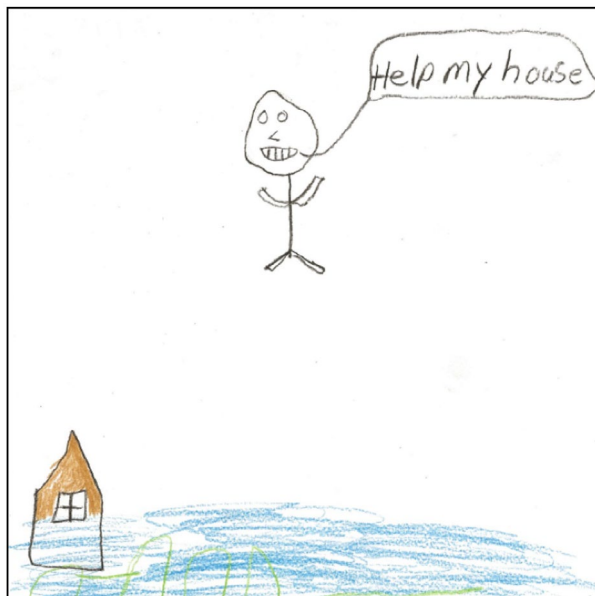
Of all the dimensions of climate change we examined, students had the most ideas to communicate regarding climate change consequences. On the CSKAI, a majority (77%) of students indicated that a warmer global climate would have impacts for humans and Earth's ecosystems, and that sea level rise would impact people who live on the coast (68%).

Participants described a wide array of climate change consequences, such as hotter temperatures, ice melt, sea level rise, damage to coastal communities, changes in precipitation, dying plants and animals, poor air quality, human displacement, and human illness and death. Figure 3 presents an example of how a participant represented sea level rise causing damage to homes.

While participants cited many scientifically accepted climate change consequences, some also cited unrelated issues, such as acid rain (Figure 1) and chemical pollution in waterways. A small percentage of participants expressed the scientifically-unsupported views that climate change consequences would only affect polar regions (13%) or that temperature increases would be evenly felt around the world (16%). However, most participants were able to cite several scientifically-supported ideas about climate change consequences.

### **Mitigation**

Consistent with their widely shared view that human activities that rely on fossil fuels exacerbate climate change, most participants (84%) agreed on the CSKAI that driving cars less often would help to mitigate climate change. Through their interviews and drawings, participants also suggested actions such as using alternative sources of energy, government action, public education campaigns (see Figure 4), planting trees and plants, and recycling. Some participants believed that actions unrelated to climate change, such as banning ozone-depleting chemicals (35%) and keeping waterways free of litter (29%) could help mitigate climate change. A small number held the view that there was nothing humans could do to mitigate climate change (16%).



**Figure 3.** John's drawing representing sea level rise and damage to homes as consequences of climate change.



Figure 4. Sasha's drawing representing public education campaigns as a climate change mitigation strategy.

### **Linkages between sociocultural activities and understandings of climate change**

In our next level of analysis, we examined the data for insight into how students may have developed the climate change ideas revealed in the CSKAI, drawings, and interviews. We noted that media use, school, and everyday activities all appeared to inform students' ideas.

#### **Media**

Nearly 75% of students referenced media sources when they spoke about their climate change learning experiences. Primarily, they described getting information about climate change online. Students mentioned using Google, and other reference sites such as Wikipedia; however, they often expressed that these information sources were not always trustworthy. As Jennifer<sup>1</sup> stated, 'I don't trust Wikipedia that much because people can go on there and edit [content] themselves. Sometimes if you Google things... right below that you can click a website, and it'll [tell you] where they got [their information] from' (Jennifer, interview). Such messages related to information literacy were commonly conveyed by teachers at participants' blended learning school, where they engaged in much of their learning online. Students also described learning about climate change on television. Most commonly, they spoke about stories they had seen on the news, often including locally-relevant information about climate change impacts. For example, in describing a story he had heard on the local television news, Marco stated, 'I heard that gases from the factories are killing the atmosphere [and] ... melting the polar ice caps and raising the waters and oceans. So it might be dangerous for the East Coast of the United States [and] who is around the coast' (Marco, interview). In a few instances, students spoke about discussing stories they had seen on the news with their family members, such as instances of flooding or natural disasters.

Aside from digital media sources, some students described experiences learning about climate change from books and magazines. For example, Bianca stated, 'When I was little, we had this science pop-up book, and there was a whole chapter about climate change' (Bianca, interview). Other forms of print media that learners mentioned as informing their ideas about climate change included newspapers and science articles in other periodicals such as *Popular Science*, *Scientific American*, and *Time for Kids*.

#### **School**

Nearly as often as they referenced media, participants referenced learning about climate change through interactions at school. Although climate change was not explicitly included in the state's elementary



science curriculum, and had not yet been addressed in the 6th grade science classroom, participants mentioned learning about climate change in school, though not necessarily as a part of formal instruction. For example, Malia explained, 'Yeah, once in the fifth grade we were using computers in the computer lab ... then I just typed in "global warming"' (Malia, interview). In a few cases, however, students did mention experiences that did appear to be part of formal instruction, such as watching videos in class on the topic. Students spoke about specific people at school who had given them information about climate change. Primarily, they mentioned teachers, though one student mentioned talking with the principal about climate change, and another mentioned visitors from the university who had led a school-wide assembly on sustainability. Students rarely mentioned talking to peers or classmates at school about climate change, or to their family members at home. Finally, another school-based source of information on climate change that became apparent was students' participation in our research. In particular, participants referenced what they had learned from the video that we (the researchers) had shown them while administering the sociocultural interview protocol.

### ***Everyday activities***

Since most students were already aware of a connection between energy use and climate change, many spoke about their use of computers at school as something that was contributing to climate change. As Daniela, stated, 'We have to use computers and it prepares us for college, but I don't think ... we should be plugging in to charge our laptops 24/7' (Daniela, interview). Students made similar comments about home energy use (e.g., leaving the lights or the television on as wasting energy and contributing to climate change), but also talked about engaging in environmentally-friendly practices, such as recycling, as ways their families were helping to address climate change. For example, Richie explained, '[At] my house, we're going to switch to solar because ... it's easy, because the sun is a renewable source which we can keep on using' (Richie, interview). Students also made personal connections to climate change in speaking about how climate change consequences had the potential to affect their activities, such as their ability to play outdoor sports. For example, Jeremy described how some of his favorite activities could be jeopardized by climate change: 'Ice skating, soccer – because the fields could be flooded, basketball – people might not be able to go on the courts because you can't play on a flooded field or a flooded court' (Jeremy, interview).

We noted that students were particularly likely to express their emotions about climate change when they discussed it in relation to their everyday activities. For example, students sometimes expressed guilt related to their own or their families' energy consumption, sadness related to threats to their ability to engage in activities they enjoyed, and hope related to their personal and family actions to mitigate climate change. In this way, students' discussion of their everyday activities related to climate change provided us with a broader perspective on their thinking, particularly the affective dimensions of their climate change ideas.

### ***Summary***

Our analysis of the data revealed that students' participation in communities within and beyond the world of school did appear to inform their thinking about climate change. In particular, their interactions with media (e.g. Internet, television) and their school-based learning experiences (e.g. conversations with teachers) appeared to most strongly inform the ideas they brought to the 6th grade science classroom. Conversely, we found that it was less common for students to see their climate change ideas as being informed by their family members or peers. The initial ideas about climate change that learners had developed – whether scientifically supported or not – led the learners to make connections between climate change and their everyday activities. That is, our findings show they not only came to the classroom with ideas about the causes of climate change, its consequences, the role of human activities, and the potential for mitigation, but also they came to formal science education instruction with some initial ideas about how these were relevant to their participation in the daily activities of their lives.

## Discussion

Returning to our guiding question in light of our findings, we highlight how students' participation in varied sociocultural activities appeared to inform their understandings of climate change. Within their school community, we interpreted learners' participation in: (1) a technology-focused learning environment where, (2) trusted adults were open to discussion about climate change, as aspects of the school context that facilitated student thinking about climate change. Regarding participation in a technology-focused learning environment, which are increasingly more common in education, we noted that students' near-constant access to online information led to gaining new information about climate change, even when it was not part of a specific lesson. This finding is consistent with prior literature that suggested that media may be an important source of climate change information for young people (Boyes, Stanisstreet, and Yongling 2008; Hansen 2010). We noted that students' participation in digital literacy education at their blended learning school appeared to have implications for their interpretations of online information. Namely, they had been explicitly taught to exercise caution with online information, and tended to view its trustworthiness as variable.

Beyond being embedded in a technology-focused learning environment, students were embedded within a school community where people were open to discussion about climate change. That is, climate change did not appear to be a controversial topic within their school context. If the school were a reflection of the community in which it was embedded, which we hold to be plausible, then this observation is consistent with prior research suggesting that members of this particular community were generally accepting of and concerned about climate change (Howe et al. 2015). Participants referenced talking with their teachers about climate change, as well as other trusted adults, such as visitors from the nearby university. It is possible that these conversations, including interactions with our research team and engagement in our data collection approaches (e.g. interviews with video discussions embedded), may have shaped learners' climate change ideas in some ways. Despite this openness to conversation around climate change, most participants said they had not spoken much, or at all, to their peers about climate change. However, since we did not encounter major differences in climate change perspectives amongst the students, it may be the case that they assumed their peers shared their ideas, and opted instead to talk with others they assumed to know more.

Outside of school, students' participation in activities as part of their family lives also appeared to inform their climate change ideas. As at school, these students had access to media nearly constantly at home. While some of their media use was similar at home and school (e.g. searching topics online), their lives at home provided additional opportunities to learn about climate change online, in books, and on television. Some of these were activities in which students chose to engage for entertainment, and others may have been a product of their embeddedness in their everyday home environments, such as overhearing a television news story that their parents were watching. However, discussion between students and their parents about the topic was infrequent, for reasons that are unknown.

In returning to Rogoff's notion of 'participation in the sociocultural activities of communities,' on the surface the relatively passive activity of media consumption might be viewed as minimally *participatory*. However, we argue that students' media consumption – and surrounding discussions of media they consumed – could be viewed as a dimension of their participation in twenty-first century family communities. As Morelli, Rogoff, and Angelillo (2003) noted, young children in middle-class European-American communities in the U.S. are often segregated from the work of their family members. While our participants were adolescents, and most were not European-American, we saw reflections of this phenomenon for these students. It is possible that their media consumption may, in part, stem from a need for young people to live relatively independently at home, and to be able to complete schoolwork and entertain themselves while their parents engaged in other kinds of work inside and outside the home. Viewed this way, adolescents' media consumption arguably could be considered an aspect of their participation within the family community. We also noted that, in a few instances, media consumption could serve as a catalyst for discussions at home – such as when an adolescent and a parent

heard something related to climate change on the news, which subsequently incited conversation. In these instances, media consumption became more participatory, because it prompted interaction within the family community around climate change.

Despite a lack of explicit conversation about climate change at home, we found that learners' participation in certain activities appeared to lay foundations that informed their receptiveness to climate change information. For example, many participants spoke about their families' engagement in environmentally friendly practices such as recycling and energy saving, which they associated with helping to address climate change. Just as participants engaged in daily activities at school and home they saw as connected to climate change causes, their daily activities appeared to inform the ways they thought about climate change effects. For example, spending most of their time in buildings located in flood-prone areas may have heightened some participants' concerns about potential infrastructure damage associated with climate change. Similarly, spending recreational time outdoors, such as playing organized sports, may have heightened some participants' concerns about the threats that climate change posed to their future participation in outdoor activities they enjoyed.

In reflecting on our sociocultural analysis of students' climate change ideas, it appeared that the sociocultural activities of the varied communities in which they participated had implications for their climate change understandings in terms of: (1) the kinds of scientifically-informed (or not) climate change ideas they brought to the classroom; (2) the sources of climate change information they perceived as trustworthy; and (3) the extent to which they viewed climate change as problematic or having potential connections to their everyday lives and activities.

## Conclusions and implications

Viewing students' climate change understandings as a product of the unique sociocultural activities in which they are already participating provides a valuable foundation for planning science learning experiences that may resonate with learners and meet their particular needs. We suggest that it is a worthwhile endeavor to interrogate students' climate change understandings, and to anticipate that – particularly because of its increasing presence in the media – adolescent learners may be preliminarily acquainted with the topic prior to formal instruction. In recognizing students' climate change understandings as linked to their participation in the activities of varied communities, a clear implication of our study is that educators should be informed of the need to develop pedagogical approaches that emphasize linkages between climate change and the communities and activities that matter to their students. For example, teachers might consider focusing on regionally-relevant climate change impacts as outlined in scientific assessment reports on climate change (e.g. the U.S. National Climate Assessment). They might also consider the use of drawings as a pre-assessment strategy as modeled in this study, as a means of gaining insight into the dimensions of climate change that are already salient – and potentially emotionally resonant – to their students. We recommend additional socioculturally-oriented research in varied contexts examining students' climate change understandings – especially among students embedded in communities in which climate change may be considered a particularly sensitive or politicized topic – as a way to contribute insights on how to meaningfully present climate change to students in differing sociocultural contexts.

## Note

1. All student names reported in this study are pseudonyms.

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