Assessment of 6- to 20-Grade Educators' Climate Knowledge and Perceptions: Results From the Climate Stewardship Survey

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ABSTRACT

The southeastern United States (SEUS) faces numerous potential impacts from a changing climate; however, the population has been characterized with a predominance of naysayers and few climate policies have been implemented by state governments in the region. As such, public education is an important avenue for achieving a climate literate citizenry in the region. Yet little is known about the needs of and influences on this community. We developed the Climate Stewardship Survey (CSS) to assess grades 6–20 educators' knowledge and perceptions of climate change in the SEUS (South Carolina, North Carolina, Georgia, Texas, Mississippi, Alabama, Louisiana, Tennessee, Florida, and Arkansas). The population sampled was an informed volunteer sample of convenience. Our findings demonstrated little misinformation among this informed group was evident and strong knowledge and perceptions of the issue were prevalent. However, some uncertainties about the impacts and causes of climate change persisted. Also, in regard to political orientation, Democratic Party and Republican Party educators had statistically significant ($p < 0.05$) differences in their knowledge and perceptions, and this difference was even stronger once Protestants were subdivided by political preferences. These differences indicate that the issue is polarized in the SEUS among educators and that the coupling of political and religious orientation can strongly influence this group's climate change knowledge and perceptions. As such, this population in the SEUS may be potentially more susceptible than others to cultural cognition influences, especially since relatively few SEUS state education standards address geoscience or climate change content, particularly at levels beyond middle school, with fewer than half of the states surveyed participating in the Next Generation Science Standards development process. Although this sample was limited in its distribution among states and respondent ethnicity, the findings presented are informative about potential SEUS educators' perceptions and knowledge about climate change. As such, our findings can be used to help inform future trainers in regard to what content areas might be the principal professional development opportunities and provide future researchers potential avenues for further investigation. © *2014 National Association of Geoscience Teachers*. [DOI: 10.5408/13-098.1]

Key words: Climate Stewardship Survey, climate literacy, teachers, religious and political orientations, misconceptions

INTRODUCTION

Authoritative reports from the Intergovernmental Panel on Climate Change (IPCC, 2013) clearly show that the greenhouse gases primarily responsible for global warming are persistently increasing. Projected global warming of a few degrees in this century will likely cause drought, floods, extreme weather events, stronger cyclones, and sea-level rise. The southeastern United States (SEUS) faces some of the greatest impacts as a result of climate change of any region in the U.S., and these impacts present considerable and costly adaptation challenges (Karl et al., 2009; Melillo et al., 2014). The current SEUS climate is primarily the temperate/mesothermal type with long, warm summers; mild winters; and significant precipitation in all seasons. While climate changes vary somewhat across the region, in general, the SEUS is experiencing an increase in temperature and increased frequency of droughts and high-magnitude storm events (Karl et al., 2009). While there is little appreciable change in mean annual precipitation, the seasonal distribution of precipitation is changing, with increases observed in autumn but declines in summer and winter (Karl et al., 2009). Numerous impacts are forecasted as a result of these climate changes, including alterations of forest species composition, reduced productivity of commercial forests, decreased agricultural productivity, increased agricultural water use, and rising sea levels and their associated impacts upon natural and built environments (McNulty et al., 1996; Bachelet et al., 2001; USCCSP, 2008; Karl et al., 2009).

While climate change impacts and associated adaptation challenges in the SEUS are among the greatest of any U.S. region, people in the SEUS tend to be more dismissive of climate change than are those elsewhere in the country (Pew Research Center, 2008; Leiserowitz et al., 2010a). The SEUS has the most conservative political ideology in the United States (Halpin and Agne, 2009), the highest poverty rates (Bishaw and Renwick, 2009), and the highest percentage of evangelical Protestant Christians (Kosmin and Keysar, 2009). These and other characteristics influence public perceptions of climate change in ways that differ from the rest of the country and suggest that climate change educational strategies need to be tailored specifically for the region (Weber, 2010). Climate change education for the SEUS can be particularly challenging given the region's large demographic of naysayers. Leiserowitz (Leiserowitz, 2003a, 2003b; Leiserowitz et al., 2010b, 2014) reports that climate

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change naysayers are predominately white, male, Republican, politically conservative, highly religious, and distrustful of most institutions, holding proindividualism, prohierarchism, and antiegalitarian worldviews, along with antienvironmental attitudes. These groups influence the worldview of many people, spanning the entire socioeconomic and ethnic spectrum of the SEUS.

The disconnect between the severity of climate change impacts in the SEUS and the dismissive attitudes toward this issue among people in the region suggests the need for policy and behavioral change—and, particularly, for inclusion of climate literacy in public education. However, the public and students often (1) have difficulty understanding complex Earth system phenomena (Raia, 2005; McNeal et al., 2008) like global climate change (Gautier and Rebich, 2005; Grotzer and Lincoln, 2007), (2) maintain an overreliance on personal experience (Dunlap, 1998; Moser, 2010; Weber, 2010), and (3) participate in decision making driven by affect and values rather than evidence (Weber and Stern, 2011; Kahan et al., 2012). Educators in public education offer opportunities to address the relevance of climate science to real life (e.g., Hobson, 2001) and improve students' and ultimately the future citizenry's understanding of climate and climate change.

However, Sweeney and Sterman (2007) find that while teacher understanding of systems is higher than student understanding, teachers still hold conceptually immature ideas. Both teachers and students, for example, have difficulty understanding climate change feedbacks, a key to grasping the complexity of the climate system. Studies over decades have found that teachers confound the greenhouse effect and ozone depletion (e.g., Dove, 1996; Groves and Pugh, 1999; Khalid, 2001; Papadimitriou, 2004; Arslan et al., 2012), do not understand the atmospheric greenhouse process (Lambert et al., 2012), do not understand that it is a natural process (Matkins and Bell, 2007; Michail et al., 2007), tend to think that warming is caused by increased solar radiation (Groves and Pugh, 1999), and have confusion about the differences between weather and climate (Lambert et al., 2012). Overall, the literature suggests that teachers have immature mental models about the greenhouse effect, its causes, the consequences of rising temperature for the planet and people, and how climate change impacts can be mitigated (e.g., Ikonomidis et al., 2012).

Such educator misconceptions can lead to the transfer of inaccuracies in classrooms, misconceptions among students, and even the absence of climate and environmental science instruction. Many middle school and secondary science teachers report they feel underprepared in their science content backgrounds to teach climate change in the classroom, and few take college-level courses related to climate science (Wise, 2010). As a result of poor preparedness, or perhaps outside influences from parents and administrations and the belief that climate change is controversial in the climate science community (Matkins and Bell, 2007; Wise, 2010), many teachers feel it necessary to teach both the accepted scientific evidence side and the side of those that do not accept the scientific evidence, and the majority believe both arguments have equal scientific validity (Wise, 2010).

Although prior research exists about the perceptions of the public, educator misconceptions, and role of sociopolitical influences on the public, there is little work that specifically examines educators in the SEUS and how these multiple factors play a role in their climate understandings and perceptions. As such, the purpose of our research was to (1) assess in-service and college educators (grades 6–20) in the SEUS through a volunteer sample of convenience to determine their knowledge and perceptions of climate change and better understand the association; (2) determine what, if any, factors such as political or religious orientation, gender, or education level may have had on educators' responses; and (3) identify potential response trends to help make recommendations for future areas of educator climate training and research within the SEUS. The project was conducted as part of a larger National Science Foundation (NSF)–funded climate change education program, the Climate Literacy Partnership of the Southeast (CLiPSE), that aimed to craft a climate literacy strategic plan for the region with multiple target audiences. Formal education spanning from 6th grade to graduate education (6–20) was a primary interest of the group's effort.

METHODS

Stages of Development of the Climate Stewardship Survey

To develop the Climate Stewardship Survey (CSS), we used a three-stage approach following Fraser (1986) and others (Jegede et al., 1998; Walker and Fraser, 2005; Walker, 2010) for the development of social perception survey instruments. The first stage required the identification of salient scales to establish knowledge and perception dimensions as they relate to global climate change. Stage 2 included the development and field testing of items internal to each of the knowledge and perception scales established in Stage 1. Stage 3 involved field testing each item followed by scale and item analyses and validation. Each process for each of the three stages is as follows:

1. Identification and development of salient scales involved four steps. The first step involved a literature review associated with environmental psychology and prior climate change studies from a social or social–anthropology point of view (Boon, 2009; Sundblad et al., 2009; Leiserowitz et al., 2010b; Nolan, 2010; Reynolds et al., 2010; Rutherford and Weber, 2012). The purpose was to identify key knowledge and perception components previously deemed important by researchers and practitioners. The second step involved examining previously developed instruments for their knowledge and perception scales that we could modify for the CSS or that could be useful in informing the development of new CSS scales. Step 3 required the classification of knowledge and perception scales to ensure adequate coverage of these two dimensions. Step 4 involved developing a set of preliminary scales to be reviewed by a panel of experts. The review was done by three university climate scientists, one geoscientist, an economist, and a public policy professor. Five scales were eventually agreed upon: the knowledge dimension scales (1) impacts of climate change, (2) causes of climate change (with subscales of temperature, contribution, and greenhouse gases), and (3) misunderstandings about climate change (with sub-

TABLE I: The 279 6- to 20-grade educator respondent's demographic characteristics: (a) state of residency, sex, ethnicity, and education and (b) religious affiliation and political orientation.

(a) SEUS States %		Sex %		Ethnicity %		Highest Educational Attainment %	
		M	F				
AL	0.7	31.2	68.9	White	87.8	High school	1.1
AR	6.8			Black/African American	9.3	Associate	1.4
GA	14.0					Bachelor	20.1
FL	2.9			Native American/ Native Alaskan	1.8	Graduate	76.7
LA	3.6						
MS	2.2			Non-Hispanic	98.3		
NC	0.8						
SC	49.1						
TN	16.8						
TX	2.9						

(b) Religious Sectors %		Political Sectors %	
Catholic	10	Independent	26.9
Protestant	61.3	Democrat	30.8
Evangelical	18.7	Republican	22.2
Protestant, other	77.8	Other/none	19.4
Other	29.8		

scales of climate versus weather and misinformation) and the perception dimension scales (4) issues (with subscales of concern, importance, informed about, sources of, and beliefs about) and (5) policy (with subscales of role, environmental quality, and priority).

2. Writing individual items required adapting items from previously published surveys and developing new items for the five knowledge and perception scales. At this stage, we also developed demographic items, some of which are distinctive to this survey: religion, political party affiliation, and occupation, among others. Finally, the instrument was typed into a Web platform or interface and a pilot test of the online instrument was run to check for errors in layout, design, and data retrieval.
3. Field testing and analyses was a two-step process of field testing with a sample to collect responses for analyses and feedback. The field testers were recruited from the larger CLiPSE project and were project partners from K–20 education, as well as some from agriculture, faith, leisure, and outdoor organizations, but were not those recruited from the larger volunteer sample of convenience reported on in the results of this study. The field test participants were asked to report how long it took them to complete the instrument and to validate the content by offering comments regarding spelling errors, items not making sense, and other practical usage comments. The second step in this stage was to establish construct validity through factor analysis to identify items whose removal might enhance the factor structure of the instrument and analysis of internal consistency reliability. These analyses were conducted in order to refine scales and provide reliability and validity of the refined scales. Data were analyzed using Cronbach's alpha coefficient to measure internal consistency in terms of item intercorrelation. Items not highly correlated within their a priori scale were removed, and data were reanalyzed until all items with low item–scale correlations were removed and alpha coefficients were maximized.

Survey Dissemination

The survey sample was a nonprobability sample of convenience drawn from voluntary participants predominantly associated with secondary and postsecondary environmental and geographic education in the SEUS. The CSS was available on the Web through a survey development platform that allows for organized survey posting, data collection, and data download. A link to the CSS was distributed to CLiPSE partner organization representatives, who were then asked to distribute the Web address for the CSS to their constituencies. Specifically, examples of the CLiPSE educational partners that distributed the survey to their constituencies and memberships via their own listserves included the Geographic Education Alliances from each SEUS state, institutes of higher education in each state, the Louisiana and Mississippi Departments of Education, and the Mississippi Environmental Education Alliance. Participants completed informed consent prior to completing the survey, and human subject research approval was granted by the lead university's institutional review board. The sample of respondents consisted of 420 people overall (including responses from noneducation CLiPSE professionals), of which 279 respondents were educators loosely associated with CLiPSE. Of the sample, 87.8% indicated their ethnicity as white, while 9.3% selected black. Seventy-six percent indicated they have a graduate-level education, and 20.1% have only a bachelor's degree. Of that population, 68.9% were female. In terms of spatial distribution, the majority (49.1%) was in South Carolina, with 16.8% in Tennessee, 14.0% in Georgia, 6.8% in Arkansas, and the remainder spread across other SEUS states. Furthermore, most respondents (61.3%) were Protestant and near evenly distributed in political orientation, with 30.8% Democrat, 22.2% Republican, and 26.9% Independent (Table I).

A limiting factor in this study is related to the unequal spatial distribution of the respondents—a concentration in South Carolina—and the unequal ethnic background of the study population, whereby only 9.3% of the respondents were black. Therefore, the results presented here are not generalizable based on these margins yet are still insightful for the SEUS climate literacy effort.

CSS Validation and Reliability

We investigated construct validity through principal component factor analysis with varimax rotation and Kaiser normalization. The intention of factor analysis was to determine the basic structure of the variables and thus

TABLE II: Scale reliability using Cronbach's alpha coefficient.[1]

Dimension/Scale	Number of Items	Alpha Reliability
Knowledge Dimension	**35**	**0.78**
Impacts of global climate change	11	0.88
Causes of global climate change	16	0.75
Misunderstandings about global climate change	8	0.73
Perception Dimension	**63**	**0.91**
Issue perception	50	0.91
Policy perception	13	0.66

[1]$n = 420$.

determine how strong items load on a priori scales. All items loaded at least 0.45 with their own scale (Walker and McNeal, 2013). In terms of reliability, we analyzed the data using Cronbach's alpha coefficient and found the overall instrument reliability was 0.91 on a scale of 0 to 1. Reliability of the knowledge dimension and its scales and the perception dimension and its scales is presented in Table II.

Survey Results Analysis Methods

Participant responses for the CSS knowledge and perception dimension and scales were analyzed for differences in religious and political orientation, gender, and educational background using a one-way analysis of variance (ANOVA). A one-sample Kolmogorov-Smirnov test for normality was conducted, and since not all data were normally distributed, the nonparametric Tamhane test for interactions was used. The Levene test for homogeneity of variance showed no differences; as such, this assumption of ANOVA was satisfied. The nonparametric Pearson correlation was applied to the knowledge and perception dimensions and scales in order to determine how knowledge and perceptions were related across the entire sampling pool. Statistical analyses were performed with Microsoft Excel and the Statistical Package for Social Sciences (SPSS) Statistics Version 21 (SPSS, Inc., 2012).

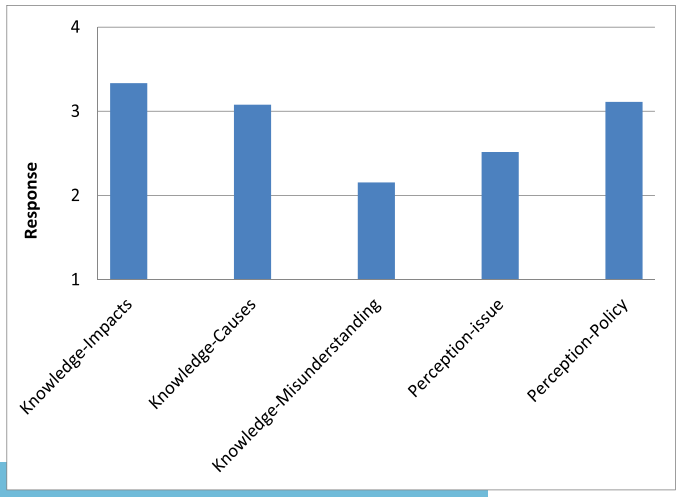

FIGURE 1: Overall educator respondents' knowledge and perceptions.

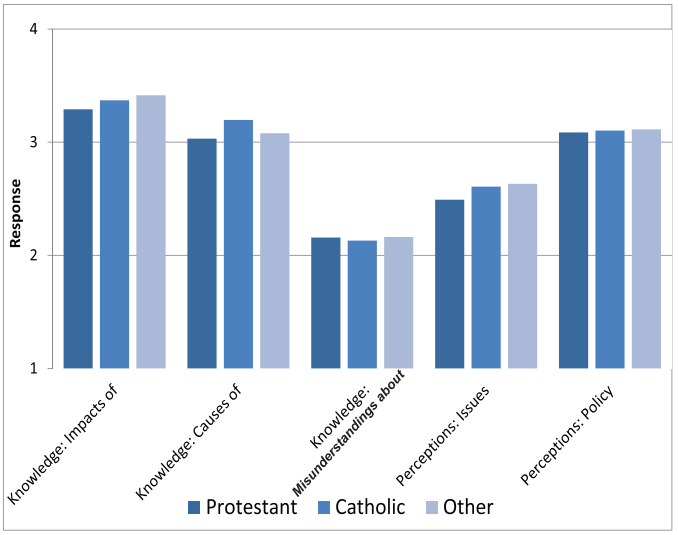

FIGURE 2: Educator respondents' knowledge and perceptions by religious affiliation.

RESULTS

In the following sections, we describe the results of the CSS. However, an important feature to note of the CSS is that in the response scale of 1 to 4, a response of 4 represents a "strongly agree," "definitely true," "very much," or an equivalent depending upon the item stem. Likewise, a selection of 1 represents a "strongly disagree," "definitely false," "not at all," or an equivalent response based on the item stem. Furthermore, some items are in reverse order. For example, on the scale of misunderstanding, where an item reads, "Climate and weather mean the same thing," a response of "definitely true" (4 on the response scale) is actually a low understanding response. The final survey is included in the appendix materials of this paper for reference (available at http://dx.doi.org/10.5408/13-098s1).

Educator Knowledge and Perceptions and Influencing Factors

Figure 1 shows that educators ($n = 279$) generally responded highest on the knowledge impacts scale ($M = 3.33$, standard deviation, or SD = 0.79); next highest on the perception policy scale ($M = 3.11$, SD = 0.98), the knowledge of climate change causes scale ($M = 3.08$, SD = 0.96), and the perception issues scale ($M = 2.52$, SD = 0.99); and finally lowest on the knowledge of misunderstanding scale ($M = 2.15$, SD = 0.99). Furthermore, Protestants ($M = 3.16$, SD = 0.87) responded slightly lower than Catholics ($M = 3.28$, SD = 0.89) and other religious affiliations ($M = 3.27$, SD = 0.87) on their knowledge of climate change impacts and causes (Fig. 2), but this difference was not statistically significant ($p > 0.05$). Interestingly, however, political orientation ($n = 225$) showed that Democrats had stronger knowledge of causes ($M = 3.56$, SD = 0.66) and impacts ($M = 3.19$, SD = 0.97) of climate change, fewer misunderstandings ($M = 2.03$, SD = 1.15), and stronger perceptions of the issues ($M = 2.63$, SD = 0.99) and policies ($M = 3.16$, SD = 1.04) than did their Republican counterparts (Fig. 3), and these differences were statistically significant ($p < 0.05$). When looking at only Protestants ($n = 171$) and their political affiliation, this gap

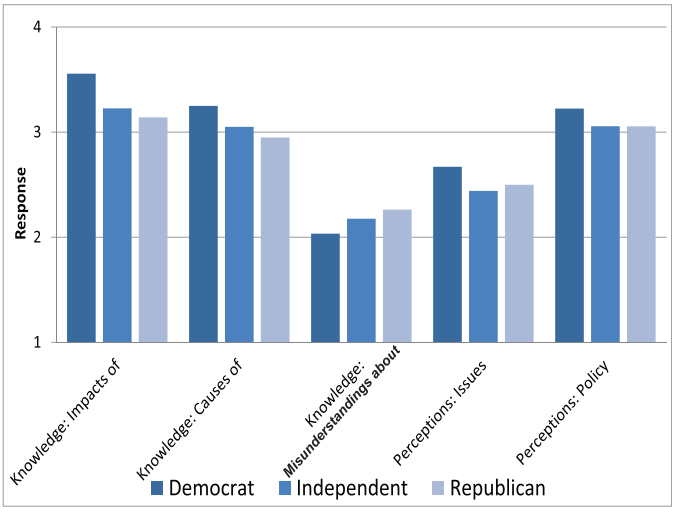

FIGURE 3: Educator respondents' knowledge and perceptions by political affiliation.

between Republicans and Democrats becomes even larger (Fig. 4), especially in regard to the knowledge dimension.

Results for knowledge and perceptions in regard to gender and education level were not statistically significant ($p > 0.05$) for four of the five scales; only those for educators with high school ($M = 2.23$, SD = 1.04) and associate ($M = 2.26$, SD = 0.99) education levels significantly differed ($p < 0.05$) from those with bachelor's ($M = 2.57$, SD = 0.97) and graduate ($M = 2.54$, SD = 1.00) degrees in regard to the perception issues scale. No significant ($p > 0.05$) differences in gender was evidenced in the CSS educator responses.

The Knowledge Dimension Scale and Subscales

The knowledge dimension and its scales, subscales, and individual items were analyzed for all 279 educator respondents. The results of the 11 items related to the impacts of climate change are shown in Table III. The majority of the items provided an average of a 3 or 4

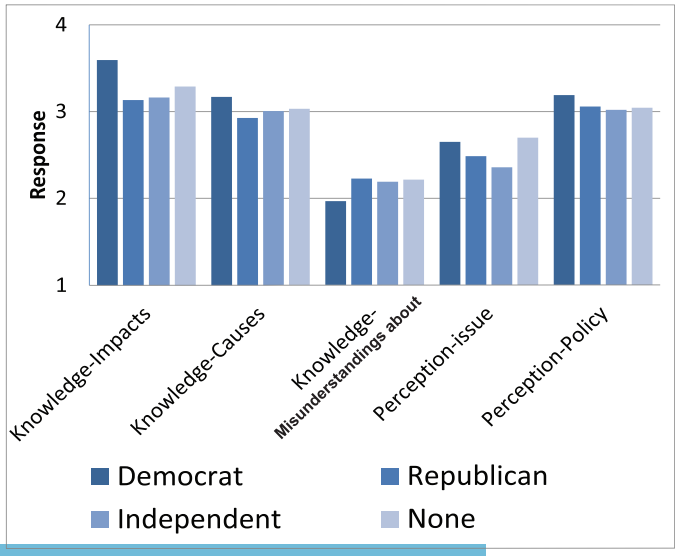

FIGURE 4: Educator respondents' knowledge and perceptions for Protestants by political affiliation.

TABLE III: Educator responses (1–4) for items on the knowledge dimension subscale related to impacts.[1]

Response Option	Average Response (SD)
A warming of the Earth can cause?	
Disruptions in agriculture	3.69 (0.54)
Changes in animal migration	3.68 (0.51)
Changes in regional environment	3.66 (0.54)
More UV radiation	3.25 (0.77)
An increase in ozone hole size	3.03 (0.82)
Sea-level rise	3.54 (0.69)
Glacial melt	3.69 (0.55)
Arctic ice melt	3.65 (0.58)
Coral reef death	3.30 (0.70)
Flooding of NY	2.72 (0.76)
Homeland security threats	2.44 (0.81)

[1]SD = standard deviation; UV = ultraviolet; NY= New York.

response in the teacher respondents, except for the items that referred to impacts on flooding in New York ($M = 2.73$, SD = 0.75) and homeland security issues ($M = 2.44$, SD = 0.81).

In Table IV, the results of the scale of the 16 items related to causes of climate change are shown for the subscales of temperature, contribution, and greenhouse gases. Although most educators disagreed that that hole in the ozone layer contributes to global warming ($M = 1.77$, SD

TABLE IV: Educator responses (1–4) for items on the knowledge dimension causes subscales of (a) contribution, (b) temperature, and (c) greenhouse gases.[1]

Response Option	Average Response (SD)
(a) To what extent do you think each of the following affects Earth's temperature?	
Volcanic eruptions	2.95 (0.67)
Dust in the atmosphere	3.20 (0.64)
Clouds	3.31 (0.76)
Carbon dioxide	3.40 (0.66)
Greenhouse gases	3.51 (0.59)
Methane	3.23 (0.70)
(b) Which of these contribute to global warming?	
Cows	2.58 (1.00)
Automobiles/trucks	3.58 (0.65)
Deforestation	3.65 (0.61)
Burning fossil fuel for electricity	3.56 (0.68)
The hole in the ozone layer (R)	1.78 (0.82)
Chlorofluorocarbons	1.69 (0.74)
Greenhouse gases	3.48 (0.70)
(c) Which of the following are greenhouse gases?	
Carbon dioxide	3.53 (0.76)
Methane	3.40 (0.79)
Hydrogen (R)	2.40 (0.95)

[1]R = reverse scale; SD = standard deviation.

TABLE V: Educator responses (1–4) for items on the knowledge dimension misconceptions of climate change subscales of (a) climate versus weather and (b) misinformation.[1]

Response Option	Average Response (SD)
(a) Please respond to the following:	
Climate and weather are the same thing. (R)	1.26 (0.56)
Climate changes from year to year. (R)	1.92 (1.04)
The Earth's climate has been the same for thousands of years. (R)	1.67 (0.85)
Climate is the average weather measured over long periods of time.	3.64 (0.85)
Weather changes from year to year,	3.50 (0.67)
(b) Please respond to the following:	
The Earth is cooling, not warming. (R)	1.67 (0.65)
Global warming is more beneficial than harmful. (R)	1.62 (0.62)
Global warming is natural and not human caused. (R)	1.96 (0.80)

[1]R = reverse scale; SD = standard deviation.

= 0.82), many did not recognize that chlorofluorocarbons (CFCs) were contributors to global warming ($M = 1.69$, SD = 0.74). Most respondents ranked greenhouse gases as the greatest contributor that affects Earth's temperature; however, there was some uncertainty as to whether hydrogen was considered a greenhouse gas ($M = 2.4$, SD = 0.95).

The results of the misunderstandings about climate change scale and the eight items contained within the subscales of climate versus weather and misinformation are shown in Table V. Responses show that educators tended to illustrate an understanding of the differences between weather and climate and an understanding of global warming.

The Perception Dimension Scale and Subscales

The perception dimension and its scales, subscales, and individual items were analyzed for all 279 educator respondents. The scale of issues and the 50 items related to the subscales of concern, importance, informed about, sources of, and beliefs about climate change are shown in Table VI. Results indicate that respondents rate themselves as "somewhat informed" ($M = 2.97$, SD = 0.64) about climate and climate change and slightly more than "somewhat concerned" ($M = 3.27$, SD = 0.78) about global warming, with more immediate factors such as saving money on home and automobile costs more of a concern ($M = 3.83$, SD = 0.40). When asked where they had learned about global warming from various information sources, the highest responses included the Internet, television, and books. When asked how much they trust a variety of sources, it was clear that governmental agencies such as the National Oceanic and Atmospheric Administration, NSF, and the National Aeronautics and Space Administration were the most trusted ($M = 3.26$, SD = 0.77), which international research bodies such as the IPCC, as well as university scientists, following closely behind ($M = 2.82$, SD = 0.89). The most distrusted organizations included the Cornwall Alliance and Tea Party officials ($M = 1.53$, SD = 0.80). When asked whether "media coverage is exaggerated about global warming," there was a nearly neutral response, and when asked whether there is solid evidence of human-caused global warming, responses indicated "probably true" ($M = 3.15$, SD = 0.77). Responses related to "My church/synagogue should take a position on global warming" received only a lukewarm response ($M = 2.41$, SD = 1.08), but the item "As stewards of the Earth, we should protect it" garnered a strong, "definitely true" response ($M = 3.87$, SD = 0.35).

The scale of policy and the 13 items related to the subscales of role, environmental quality, and priority are shown in Table VII. When asked how much of a role various entities should take in addressing global warming, respondents thought government, businesses, and themselves should take a somewhat to significant role ($M = 3.54$, SD = 0.68). When asked about the environmental quality of today, respondents thought the country was in fair to good standing ($M = 2.58$, SD = 0.64); however, when asked about 10 and 50 years from now, most respondents viewed the condition as getting worse ($M = 1.79$, SD = 0.77). Finally, respondents rated the "protection of the Earth's environment" nearly equally to other sociopolitical concerns for the country ($M = 3.57$, SD = 0.61).

Correlations Between Knowledge and Perception Dimensions

Correlation analyses between educator knowledge and perception dimension and the associated scales and subscales are show in Table VIII. Results show a statistically significant ($p < 0.05$) positive correlation between the perception issue subscale of concern and all knowledge dimension scales and subscales except for the misinformation subscales, which showed a negative correlation ($p < 0.05$). The perception issues subscales also had several statistically significant ($p < 0.05$) correlations with the knowledge dimension subscales. Primarily of interest is the negative correlation between the perception subscale of information sources and the misinformation subscale ($p < 0.05$). Furthermore, the perception policy scale and subscales showed several statistically significant correlations with the knowledge dimension scales and subscales. Particularly, the knowledge misunderstanding subscale of misinformation was negatively correlated with both the role and the priority perception subscales, whereas it was positively correlated with the environmental quality subscale ($p < 0.05$).

DISCUSSION AND CONCLUSIONS

It is clear that the grades 6–20 educator respondents were an informed populous about climate change and global warming for whom few misunderstandings persisted. Those misunderstandings that did appear included educators underscoring the potential impacts of climate change on flooding off New York in August 2011 and homeland security threats, as well as the contributions of CFCs to Earth's warming. However, given the complicated story of CFCs—e.g., their contribution to the ozone hole, the several decades-long regulations on their use and their subsequent decrease, their long residence times, their high absorbing characteristics, and the various classes of CFCs, this topic is rich and likely an area that would need further coverage for

TABLE VI: Educator responses (1–4) for items on the perception dimension issues of climate change subscales of (a) importance, (b) informed about, (c) sources of, (d) concern, and (e) beliefs about.[1]

Response Option	Average Response (SD)	Response Option	Average Response (SD)
(a) Please respond to the following:			
How concerned are you about global warming?	3.27 (0.77)	How important is saving money on automobile fuels to you?	3.85 (0.37)
How important is saving money on home energy costs to you?	3.81 (0.43)		
(b) How informed are you about. . .			
How Earth's climate system works	2.95 (0.63)	Consequences of global warming	3.03 (0.62)
Causes of global warming	2.97 (0.61)	Methods to reduce global warming	2.91 (0.69)
(c) How much have you learned about global warming from these sources?			
Television	2.70 (0.75)	Family	1.95 (0.81)
Radio	2.12 (0.87)	Friends	2.15 (0.80)
Internet	2.75 (0.79)	Zoos, museums, aquariums	2.17 (0.93)
Books	2.65 (0.93)	Movies	1.97 (0.84)
Magazines	2.54 (0.84)	Government	2.34 (0.77)
Newspaper	2.56 (0.77)		
(d) How much do you trust the following sources of information about global warming?			
Federal government	2.37 (0.88)	Intergovernmental Panel on Climate Change	2.93 (0.96)
State government	2.15 (0.87)	University scientists	3.16 (0.77)
Local government	2.03 (0.85)	Government scientists	2.72 (0.82)
President Obama	2.26 (1.07)	Fox news	1.78 (0.89)
Federally elected officials	1.96 (0.76)	MSNBC news	2.06 (0.85)
Republican officials	1.88 (1.03)	CNN news	2.22 (0.89)
Democratic officials	2.23 (0.91)	Weather channel	2.86 (0.76)
Tea Party officials	1.55 (0.80)	Local TV news	2.12 (0.76)
Libertarian Party officials	1.70 (0.85)	Cable TV news	2.12 (0.79)
Green Party officials	2.17 (0.94)	Church, temple	1.96 (0.93)
National Oceanic and Atmospheric Administration	3.40 (0.75)	Focus on the Family	1.83 (1.01)
National Science Foundation	3.78 (0.78)	Family Research Council	1.65 (0.86)
Environmental Protection Agency	2.87 (0.89)	Cornwall Alliance	1.51 (0.80)
National Aeronautics and Space Administration	3.14 (0.80)	School teachers	2.69 (0.79)
(e) Respond to the following items:			
Media coverage is exaggerated about global warming.	2.47 (0.85)	My church/synagogue should take a position on global warming.	2.41 (1.08)
There is solid evidence that human-caused global warming is occurring.	3.16 (0.77)	As stewards of the Earth, we should protect it.	3.87 (0.35)

[1]SD = standard deviation.

the informed but not yet expert educator. Perhaps, this population was just not previously exposed to these concepts, and professional development related to local and regional impacts of climate change, national homeland security issues resulting from climate change, and coverage of greenhouse gases may be important areas for future professional development. Furthermore, the correlation analysis illustrated the strongly inverted relationship between misinformation and several perception scales concerning issues and policies, which points to the need for professional development of educators regarding climate change in order to bridge the information gap and rectify potential misinformation spreading. Also, the findings suggest that educators view the environment as being in fair to good standing today but as getting worse in the next 10–50 years. This may point to fundamental beliefs that climate change (and other environmental occurrences) is a longer-term issue and that impacts may not be as apparent to educators today and instead are something more likely to be seen in the future. However, respondents indicated that the global warming issue is as concerning as other sociopolitical concerns; thus, this group of educators is likely

TABLE VII: Educator responses (1–4) for items on the perception dimension policy subscales of (a) role, (b) environmental quality, and (c) priority.[1]

Response Option	Average Response (SD)
(a) How much of a role should. . ..	
Government take in addressing global warming	3.53 (0.71)
Businesses take in addressing global warming	3.58 (0.64)
Courts take in addressing global warming	3.03 (1.00)
Religious organizations take in addressing global warming	2.76 (1.06)
You take in addressing global warming	3.51 (0.69)
Please rate the overall quality of the environment:	
In this county today	2.59 (0.65)
In 10 years, if we stay on the same track	2.03 (0.74)
In 50 years, if we stay on the same track	1.57 (0.80)
Please rate the following by your priority:	
American's environmental health	3.49 (0.66)
Protection of the nation's environment	3.54 (0.62)
Protection of the Earth's environment	3.58 (0.63)
American's economic health	3.66 (0.57)
America's energy security	3.61 (0.59)

[1]SD = standard deviation.

to realize that today's actions are important for the future. Results from our survey indicated that the CSS educator respondents felt "somewhat informed" about global warming and climate change topics, but it certainly should be a goal to have them express a "very informed" climate aptitude.

The population as a whole was generally well informed and perceived climate change as a priority and, at least in part, a human-made phenomenon. Segregating the overall group reveals significant differences in political orientation (Figs. 3 and 4). These differences are in regard to knowledge and perceptions of climate change and allude to the polarization of the issue in the SEUS. The SEUS is not alone, as many studies have shown an ideological divide (Leiserowitz, 2003a, 2003b; Leiserowitz et al., 2010b, 2014). However, what may make the SEUS different is the high prevalence of Republican, politically conservative (Gallup, 2012) individuals and a majority of evangelical conservatives (Association of Religious Data Archives, 2000), in a region where few climate regulations have been enacted by state governments (Pew, 2011). Furthermore, the lack of and/or inconsistency of climate/geoscience–related K–12 state science education standards (McNeal, 2010) may make the SEUS particularly vulnerable to the influences of sociopolitical agendas and constructs of cultural cognition.

Applications to Teacher Professional Development

Our results illustrate that it would behoove educational planners to work to increase teachers' knowledge and understanding of the science of climate change and Earth's climate system as part of improving the education provided to students in the SEUS. Even among this well-informed group of educators, misunderstandings persist and improvement can still be realized with respect to their knowledge of the causes and impacts of climate change.

Nevertheless, our work illustrates that perhaps sociopolitical variables influence teachers' views of climate change more than their knowledge of the science. Perhaps what could be most useful for these groups would be an environment in which sharing of perspectives among teachers and climate scientists and educators occurred and allowed exploration of these sociopolitical factors. In response to these survey results and input from the larger partnership, the CLiPSE project tested pilot dialogue activities with a diverse set of audiences in order to build relationships, provide safe places to discuss climate change

TABLE VIII: Pearson correlation coefficients of CSS knowledge and perception dimension scales and subscales.[1–3]

Scale	Subscale	Knowledge Impacts	Knowledge Causes			Knowledge Misunderstandings		*M*	SD
		N/A	Temperature	Contribution	Greenhouse Gases	Climate versus Weather	Misinformation		
Issues	Concern	**.229****	**.206****	**.357****	**.098***	**.104***	**-.230****	3.64	.52
	Importance	−.019	**.101***	**.098***	**.134****	−.066	−.057	2.97	.64
	Informed about	**.138****	.015	**−.087***	**.156****	**−.160****	−.056	2.36	.83
	Sources of	.080	.016	.013	.023	.052	**−.130****	2.35	.86
	Beliefs about	.018	.043	**.274****	−.044	**.123****	.030	3.00	.77
Policy	Role	**.355****	**.157****	**.255****	**.241****	−.061	**−.432****	3.28	.82
	Env. quality	**−.264****	**−.205****	**−.402****	**−.139****	**−.137****	**.359****	2.06	.72
	Priority	**.219****	**.120****	**.170****	**.229****	−.008	**−.234****	3.57	.61
M		3.34	3.30	2.94	3.15	2.41	1.76		
SD		.67	.67	.75	.83	.77	.72		

[1]Bold represents statistical significance at $p < 0.05$.
[2]$n = 279$.
[3]Env. = environmental.
*Significance at $p < 0.05$.
**Significance at $p < 0.01$ level.

issues, and share perspectives with others. Our results of this approach with southern conservatives are published in another manuscript (McNeal et al., 2014) in the *Journal of Geoscience Education* Climate Literacy special issue and show that dialogues are an effective strategy for the SEUS population with regard to climate literacy. We suggest a similar approach with educators in which perhaps a portion of professional development workshops could include time for such conversations in order to assist educators in grappling with and recognizing the many influences on their acceptance of and/or misinformation about the Earth's climate system and climate change.

Limitations and Future Work

Since this survey used a volunteer sample of convenience through listserve dissemination, our sample likely does not represent the full suite of grade 6–20 educator knowledge and perspectives in the SEUS. Also, since we do not have data for respondents from each grade level, we cannot know whether certain grade-level educators are more informed than others. Furthermore, our responses were largely (80% of responses) from 3 of the 10 SEUS states from which we received responses (South Carolina, Georgia, and Tennessee). As such, caution should be used about generalizing these results to educators across the SEUS. We recommend that future work apply the CSS, or a similar well-developed survey, with a more randomized sample that is a more accurate cross-section of educators in the SEUS to confirm whether the findings here are replicable among a more spatially distributed sample. However, considering that these potential biases likely lean our results toward those who are more informed and have stronger perceptions of climate change, our findings are a glimpse into the challenges and potential avenues that educator professional development and future research should address in the SEUS.

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