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CLIMATE CHANGE AS A PERSPECTIVE: LOOKING THROUGH THE LENS OF HIGH SCHOOL TEACHERS WITHIN BERKS COUNTY, PENNSYLVANIA

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ABSTRACT: *School districts across the country have different high school science standards. Anthropogenic climate change, for instance, is not part of the science curriculum in the Commonwealth of Pennsylvania. Polarization from politics often stop states from adopting modern science topics and attempts to avoid politically controversial topics. Getting the public engaged and informed in scientific discourse has been cited as one significant step individuals can take to address climate change. One of the most effective ways to communicate how climate change affects our societies is through education. The ability for educators to communicate the established scientific consensus that climate change is occurring primarily through human activities is essential for students to comprehend as it will profoundly impact their economic futures, societal and environmental interactions, and daily routines.*

Berks County in Pennsylvania is located within southeastern Pennsylvania and serves the area around the city of Reading. School districts within Berks County service students in urban, suburban, and rural communities. Electronic surveys were administered to Berks County high school educators within four departments (Mathematics, Social Studies, Science, and English) through QuestionPro. This survey gathered information on the educational background of the respondents, their teaching philosophies, their level of comfort in discussing anthropogenic climate change, and challenges they face. Through these surveys, the degree to which anthropogenic climate change is, or is not, presented in the classroom can be assessed. Results suggest that faculty have some hesitancy to discuss anthropogenic climate change in the classroom fearing a loss of employment or possible personal harm. Additionally, communication between faculty and administration on this important topic appears to be minimal.

Keywords: *climate change, high school education, curriculum*

INTRODUCTION

The notion that our atmosphere can be altered has been rooted in nearly two centuries of experimentation. Joseph Fourier is credited with discovering the greenhouse effect (Cowie 2007) in the 1820s as he predicted that a layer of air surrounds the Earth had a layer of air covering the surface and insulates the planet (Fleming 1999; Baum, 2016). Later, John Tyndall explained the role of atmospheric gases, along with variable gases, had in absorbing infrared energy from the Earth in 1859 (Baum 2016). Prior to this, Eunice Foote had experimented with water vapor and carbon dioxide to determine the underlying thermal properties in 1856 (Jackson 2020). Near the turn of the century, Svante Arrhenius postulated that increasing carbon dioxide would increase Earth's surface temperature (Arrhenius, 1896; Arrhenius, 1897; Baum, 2016) which was later confirmed decades later (Hulbert 1931).

Anthropogenic interference on the climate was then thrust into the public arena when former head of NASA Goddard James Hansen testified before the senate Committee on Energy and Natural Resources on June 28, 1988. Hansen was certain that the cause-and-effect relationship between temperatures and the greenhouse effect was already occurring (Shabecoff 1988) and that the greenhouse effect was responsible for the changing climate (Weisskopf 1988). This served as the catalyst to the formation of the Intergovernmental Panel on Climate Change (IPCC) (United Nations 1988) and the development of climate summits such as Earth Summit in 1992. Since that time, arguments can be made that minimal to no effective action has taken place (Phillips et al 2021; Dutt 2022), political gridlock has stymied progress (Skolnikoff 1990; Gaby 2013), and that populations are not engaging in public discourse of climate change (Koch 2009; Geiling 2014; Gaytan Camarillo 2021).

One method of remediating the latter issue, is through education (Landau et al 2019; Cordero et al 2020; Campbell 2021). This is largely achieved through primary education (Cordero et al 2020; Jones and Whitehouse 2022). A new green learning agenda was recently argued as a valuable tool in overcoming the COVID-19 pandemic

(Harvey 2021; Kudakwashe Manyati and Mutsau 2021; Stern 2021). Within this framework, children to adults would be educated on climate solutions (Harvey 2021; Kudakwashe Manyati and Mutsau 2021) within the classrooms and their local communities (Landau et al 2021; Sacks et al 2021; Barbon et al 2022). To highlight the importance of education, a recent study suggests that teaching climate science to 16% of high school students in high to middle income countries can reduce the amount of carbon by 19 gigatons by 2050 (Cordero et al 2020). Furthermore, the empowerment of woman and their inclusion in the educational pipeline, with an estimated 132 million out-of-school girls across developed countries (UIS 2018) could lower carbon emissions by 85 gigatons by 2050 (Project Drawdown 2022). In another study, educating 70% of women to lower-secondary school education could reduce the deaths from extreme events such as floods, droughts, and wildfires (Streissnig et al 2013).

Incorporating climate change education into the curriculum has been met with broad, and robust, support even across political party lines. In a NPR/Ipsos poll, nearly 80% of respondents stated that climate change should be taught in the classroom (Kamenetz 2019). That support is approximately 90% from Democrats and 67% from Republicans (Kamenetz 2019). In addition, 86% of teachers believe that climate change should be taught indicating an eagerness from faculty to teach the subject (Kamenetz 2019). Unfortunately, that same survey found that nearly 60% of the respondents believe that climate change is not part of their area of expertise (Kamenetz 2019) suggesting that education of faculty on climate change remains a key issue (U.S. Global Change Research Program 2009). With young, student led protests such as the Fridays For Future drawing the support of millions of followers, school children are receptive to developing "green skills" to solve the complex problems posed by climate change (Handayani et al 2021; Kudakwashe Manyati and Mutsau 2021; Nikolajenko-Skarbalė et al 2021). An example of this was done with Nigerian primary school as students experimented with tackling local issues such as deforestation to desertification (Ajitoni and Gbadamosi 2015). Students that were endowed with these "green skills" performed better than the control group across several metrics ranging from environmental knowledge to skills needed to solve future environmental issues (Ajitoni and Gbadamosi 2015). Another study found similar results in Malaysia when teaching climate change as part of biology curriculum (Karpudewan and Khan 2017).

Emerging research has suggested that a "sweet spot" for climate action is around 10,000-100,000 individuals (Bhowmik et al 2020). Such a scale would encompass the school districts and the local community or city suggesting that school children can take on leadership roles in their community and be involved in climate solutions. Stevenson et al. (2016) found that a teacher's stance on climate change can affect their students' beliefs. Overcoming political ideologies has been viewed as a major obstacle in reaching adults (Jacquet et al 2014; McCright and Dunlap 2016). Despite these significant barriers, climate change along with other controversial topics (LaSala 2000), children can influence their parents' views (Lawson et al. 2019). This influence is most profound in girls and even a more profound impact on male parents and conservative minded parents (Lawson et al. 2018). This influence is capable of breaching climate change views and having much broader impacts such as reducing energy consumption (Boudet et al 2016) and waste production (Maddox et al 2011).

When teaching climate change, geographic location, socioeconomic status, education attainment, and political orientation factor into how teaching of climate change is conducted (Howe et al 2015; Huxster et al 2015; Shealy et al 2017) and secondary teachers have offered mixed messages on climate change to students (Blum et al 2013; Ho and Seow 2015; Plutzer et al 2016). Coastal locations coping firsthand with sea level rise and increased storm surge often take a more progressive stance (Zahran 2008) while inland areas, particularly in conservative locations, have low public awareness and support for climate change curriculum (McNeal et al 2014; Foss and Howard 2015). Further challenges emerge as education of students, adults, and faculty may be lacking (McCaffrey and Buhr 2008; Dupigney-Giroux 2010; Bunten and Dawson 2014; Wibeck 2014; Ho and Seow 2015), using outdated textbooks that do not reflect the current state of climate science (McCaffrey and Buhr 2008), housing climate change science into politically biased state curricula (Dupigney-Giroux 2010; Wise 2010; Berger et al 2015; Monroe et al 2017), and an overextension of faculty that lead to a dearth in time and resources (Gillenwater 2011; Colston and Ivey 2015). This can result in failure to adopt climate curricula for reasons such as undue attention from climate skeptic news media (Nisbet 2009; Oreskes and Conway 2010; Wibeck 2014; Boon 2016), a sense of discouragement at tackling a hyperproblem (Norgaard 2011; McNeal et al 2014; Wibeck 2014; Ojala 2015), or having some form of local risk (McNeal et al 2014; Dubois and Krasny 2016; Deng et al. 2017).

Environmental education is conducted in various ways and to different degrees and are dependent on states to set their own curriculum standards (Ravikumar 2020). Some states have passed measures to forbid teachers from discussing climate change (Timmer 2014). A recent national study, performed by the National Center for Science Education and

the Texas Freedom Network Education Fund, analyzed state lesson plans and the inclusion of climate change within those lesson plans and Pennsylvania was one of four states that received a failing grade on their climate change curriculum. (Ravikumar 2020). Recently, adoptions of climate change to the 6-12 curriculum have passed the state Board of Education (Pennsylvania Department of Education 2022). The new curriculum focuses on students to study the climate by collecting data, use models, describe energy flows, and interpret future model output. Despite this new course, there is no direct mention on how humans are affecting the environment and natural systems nor is climate change required to be taught to K-5 students.

This study centers on the surveys of public high school teachers in sciences, mathematics, social studies, and English within Berks County, Pennsylvania. The goal of this paper is to examine how knowledgeable faculty are in various climate related topics, how climate change is broached in high school classrooms, the level of comfort faculty have in discussing climate change with their students. With climate change not a required in the science curriculum, a wide range of responses are expected.

BACKGROUND AND METHODOLOGY

Located in southeastern Pennsylvania, Berks County (Figure 1) has a population of around 421,164 people (Census 2019) and is composed of a total of 73 Townships and Boroughs (Figure 2). These townships are a diverse mix of rural, suburban, and urban settings. The county seat, the City of Reading, is the population center of Berks County with a population of 88,232. There are 18 public high schools that are within Berks County with an average enrollment of 1,104 students. The school systems are Antietam, Boyertown, Brandywine Heights, Conrad Weiser, Daniel Boone, Exeter, Fleetwood, Governor Mifflin, Hamburg, Kutztown, Muhlenberg, Oley Valley, Reading, Schuylkill Valley, Tulpehocken, Twin Valley, Wilson, and Wyomissing (Figure 3). Anomalies within the school districts had to be considered based on grade levels at those schools and also political boundaries. For instance, Antietam and Wyomissing have a combined middle and high school that encompasses grades 7-12 while Muhlenburg only has grades 10-12. Boyertown services students both in Berks County and a portion of Montgomery County to the east. Twin Valley has a similar situation by serving students in Berks County and Chester County in the southern periphery of Berks County.

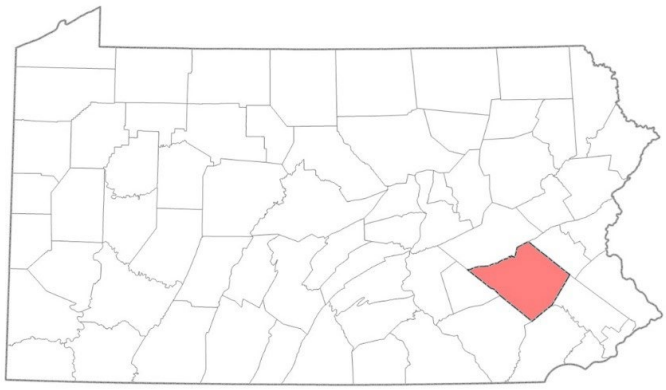

Figure 1. Pennsylvania county map with Berks County highlighted in red. Map courtesy of James Luma.

Surveys were distributed to the schools via email upon permission from administrators during the spring 2020 semester. These anonymous surveys were conducted over the online site *QuestionPro*. English, Mathematics, Science, and Social Studies Departments were targeted for this survey to encompass both the STEM fields and communication aspects of climate change. Unfortunately, only three schools participated in the study in Berks County (Governor Mifflin, Oley Valley, and Wyomissing) and 26 faculty responded to the survey, with nine faculty identifying as science teachers. The survey was viewed 112 times and a 61.9% completion rate with 42 respondents starting the survey with 16 respondents dropping out of the survey. This survey was conducted during the COVID-19 pandemic, which likely factored into the low response rate as teachers shifted to online modality and may have been fatigued from the virtual learning process. While the data set is minimal, the opportunity to study how climate change information is discussed in the classroom can still be presented. While this study only encompasses one of

the 67 counties in Pennsylvania, responses from a majority rural county with a large urban center (Reading) can be informative as to the status of this key social and environmental issue in high school classrooms. Responses from the Common Core (CC) and Science (S) teacher subset provides additional insight as to whether science teachers, presumably more knowledgeable in climate science, contrast with other common core teacher backgrounds in essential fields like mathematics, English, and social studies. Mathematics was included in this analysis due to the quantitative nature of climate model projections and rates of warming that are reported widely. English was considered due to the communicative nature of conveying information to a broad audience in both verbal and oral presentations. With climate change affecting government responses, economic-related issues, and geographical ramifications, social studies educators were solicited.

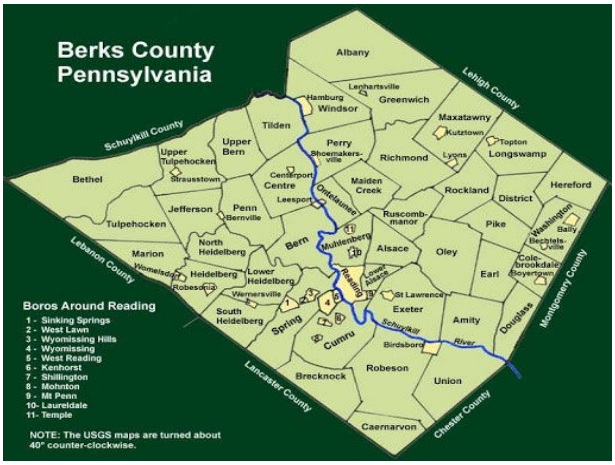

Figure 2. Berks County townships and boroughs.

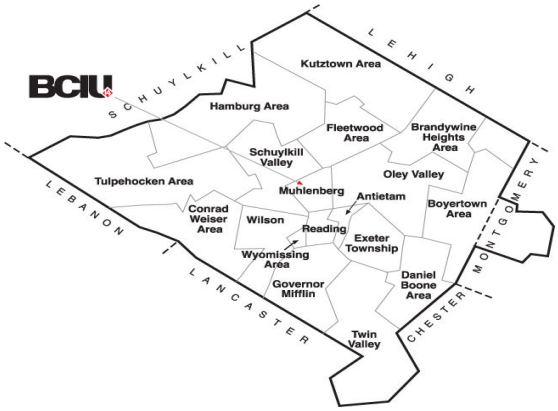

Figure 3: Berks County public school districts.

Questions to be asked were presented to the Institutional Review Board for feedback and appropriateness. Questions on the survey pertained to general background information on each respondent such as highest degree earned and in what year, how many years of the respondent has taught, the subject the respondent teaches, the number of students in a typical classroom, and how many classes does the respondent typically teach in a day. Respondents were asked to rate their knowledge on different climate topics as either extremely knowledgeable, knowledgeable, neither knowledgeable nor unknowledgeable, unknowledgeable, or extremely unknowledgeable (Table 1). Likert scale questions were posed to the respondents asking questions on whether they strongly agree, agree, neutral, disagree, or strongly disagree with environmental questions (Table 2). A five-question true and false section asking whether a respondent is aware of current environmental issues, keeps up to date on science through various news outlets, coal is contributing to greenhouse gas emissions, there is a great interest from the respondent's students in climate change, and whether the respondent discusses climate change in the classroom. Respondents were also asked to rank different environmental issues from 1-10, with 1 being their most concerning issue. These included: habitat loss, deforestation, pollution, overpopulation, climate change, loss of biodiversity, ocean acidification, forest fires, desertification, extreme weather (not shown). These responses provided a dataset that the authors were able to analyze and report initial findings regarding teaching philosophies and presentation of climate change in Berks County high school classrooms.

RESULTS

Common Core Teachers

Within the surveys, most respondents were certified to teach science (32.14%) followed by social studies (25%), language arts (21.43%) and math (17.86%). Within the science cohort, responses were scattered across Biology (26.09%), General Science (17.39%), Chemistry (17.39%), Earth and Space (4.35%), and Environmental Education (4.35%). Responders' highest degree earned was overwhelmingly a master's degree (88.46%), consistent with Pennsylvania state requirements for high school instructors. The year of degree earned was highest during the 2006-2010 period, with 26.92% responders graduating during that 5-year interval. Instructors had generally taught

between 11-20 years (38.46%), they normally teach 21-30 students (84.62%) and typically hold 4-6 classes a day (53.85%). From the respondents, climate change was rated the chief environmental concern by the respondents followed by pollution and habitat loss while desertification, ocean acidification, and forest fires ranked low on the list of concerns.

Table 1. Self-assessment of respondent knowledge in various climate issues. Common core (CC) faculty (n=26) are given toward the left of the column and science (S) faculty (n=9) are given toward the right of the column.

	Extremely unknowledgeable		**Slightly unknowledgeable**		**Neither**		**Slightly knowledgeable**		**Extremely knowledgeable**	
	CC	**S**	**CC**	**S**	**CC**	**S**	**CC**	**S**	**CC**	**S**
Greenhouse gases	1	1	2	1	1	0	16	3	6	4
Deforestation	2	2	4	1	2	0	13	2	5	4
Ocean Acidification	4	2	8	1	3	1	8	2	3	3
Ocean Currents	4	3	6	1	3	1	11	2	2	2
Dead Zones	6	3	7	0	2	0	9	4	2	2
Floods	3	2	3	1	3	1	15	3	2	2
Desertification	5	2	5	1	3	0	11	4	2	2
Hurricanes	2	2	2	1	3	1	16	4	3	1
Weather Patterns	3	2	1	1	4	1	16	4	2	1
Forest Fires	2	2	3	1	3	1	15	4	3	1
Climate Change	2	2	0	0	1	0	18	3	5	4

Responses for Likert scale questions are given in Table 2. Results indicate that respondents have a strong sense of environmental stewardship and hope that their students share that sentiment. Faculty respondents were asked to gauge their students' adeptness to learn. These numbers were high with 18 respondents believing that their students enjoyed learning on contemporary environmental issues. All respondents agreed that natural cycles can affect the climate while a robust 21 respondents strongly agreed that humans had an impact on the changing climate. Many respondents believed that America was too dependent on fossil fuels with 13 respondents agreeing and 11 respondents exhibiting in strong agreement. Despite a wide acknowledgement of the reliance on fossil fuel from the responders, mixed results emerged on whether the respondents believe the United States utilizes a good amount of renewable energy. The amount of agreement nearly matched the amount of disagreement suggesting that this topic may require additional resources to faculty to understand this issue more thoroughly. Respondents would like to see more renewable energy options in the energy portfolio of the United States with nearly 17 respondents strongly agreeing with that statement. This question dovetailed into 11 respondents believing that other countries are more advanced than the United States in the renewable energy market. Respondents generally agreed, but to various degrees, that climate change will affect all countries. The strongest response came from whether climate change would affect their communities (24 respondents agree or strongly agree) and that climate change would affect them or their family (22 respondents agree or strongly agree).

Faculty openness towards discussing climate change in the classroom was assessed. These responses appeared muted as 10 respondents agreed they felt comfortable with speaking on climate change while 7 respondents identified with strong agreement in speaking on climate change. This could be from potential reprisal or fear of job security especially in a school district that may not share the same stance. When respondents were asked to evaluate whether the school district grants such freedom or whether the district shared their views, respondents tended to disagree or feel neutral toward that view. It is possible that the school district stance has not been made to faculty and the prospect of speaking of an issue that can be perceived as controversial may be intimidating to faculty. Based on one response from a participant, there could be an ethical issue as the comment stated: "Being an educator does not give me the right to simply use my classroom for my own interests or agenda". Another responder added: "I do not believe it is appropriate for a classroom teacher to express political viewpoints to students. There are too many educators that inflict their personal opinions onto students". Within the series of true and false questions, faculty answered consistent with current climate science literature states suggesting that faculty are well-informed on the scientific knowledge revolving around climate change. However, invigorating their students to care about climate change appears to be a hurdle as approximately half of the respondents identified students as having a great interest in learning about climate change.

Science Teachers

When examining the science faculty subset, all respondents possessed a Masters in their subject area and the majority received their degree in three 5-year cohorts: 1991-1995, 1996-2000, or 2016-2020.

Table 2. Likert scale questions and the responses. Common core (CC) faculty (n=26) are given toward the left of the column and science (S) faculty (n=9) are given toward the right of the column.

Question	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		I Don't Know	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1 - I care about our planet							7	2	19	7		
2 - I want the younger generations to care about our planet							8	3	18	6		
3 - Students are interested in environmental issues that are happening today					7	3	18	5	1	1		
4 - Humans have an impact on how the climate will change in the future			1	1		1	4	7	21			
5 - America is dependent on fossil fuels					2	1	13	3	11	5		
6 - America utilizes a good amount of renewable energy sources			8	6	9	2	6		1	1	2	
7 - America needs more renewable choices for energy					2	2	7	1	17	6		
8 - Other countries are more advanced than America when it comes to renewable energy sources	1	1			4	1	9	3	11	4	1	
9 - Climate change will affect all countries							8	3	18	6		
10 - Climate change will affect America							10	3	16	6		
11 - Climate change will affect my community					2		14	5	10	4		
12 - Climate change will affect me and my family			1		3		12	5	10	4		
13 - I feel comfortable speaking to my students about the changing climate			7	1	2		10	4	7	4		
14 - My school system supports my views			1		8	5	4	1	5	2	8	1
15 - My school system has very different views than I do	3	3	4	1	7	4	1		1		10	1
16 - The colleagues in my department share the same opinion about the environment as I do			1		3	1	8	4	6	4	8	
17 - I have the freedom to talk about what I want within my class	1		7	2	4	1	10	3	4	2		

Responses given by this group were increased toward positive environmental stances and behaviors. 78% strongly agree that they care about our planet, while 67% strongly agreed they wanted the younger generations to care about our planet. When asked to gauge their students' interest in learning, 67% agreed that their students enjoyed general learning and that their students were interested specifically in environmental issues that are happening today.

Science teachers appeared more willing to discuss climate change in the classroom as 88% agreed to some extent that they feel comfortable speaking to their students about climate change. This subset firmly believed their colleagues share the same opinions of the environment as 88% agreed. The same tendency of uncertainty regarding administration or the school district having the same stance appeared in this survey.

All science teachers answered that carbon dioxide was a greenhouse gas. However, only 78% of the teachers said that the burning of fossil fuels was the main driver of climate change. 56% of the respondents agreed that there was a great interest among students in climate change and almost all (89%) chose to talk about climate change in their classroom.

CONCLUSION

Responding high school teachers in Berks County Pennsylvania care about the environment and teach anthropogenic climate change to their students throughout their classes. Respondents are generally well informed on climate issues and aim to instill elements of climate stewardship into their students. Respondents would consider themselves knowledgeable in many issues that pertain to climate change suggesting that educators are prepared to teach these issues. The results do not suggest interference from administration, school boards or any general censorship of climate change related material within Berks County high school classrooms. The science faculty subset tends to exhibit stronger convictions toward climate related questions than their peers in mathematics, social studies, or English and the hardships climate change poses to their communities and abroad. Furthermore, concerns regarding the ethical nature of speaking based on personal beliefs or the weight of a political issue were cited as obstacles in teaching climate change to a student population. One issue that arises is the perceived lack of communication between faculty and administrators as a significant issue making faculty uncertain whether they may speak freely on a perceived controversial topic that could jeopardize their job security or potential safety.

The authors would encourage dialogues between administration and faculty on the augmentation of climate science to the curriculum and have safeguards from reprisal when discussing this issue in the classroom. Additional support from the state would likely embolden faculty to feel confident speaking toward such a critical and topical issue. Efforts to increase the robustness of the data must be made to solidify these preliminary findings. The lack of respondents is likely a culmination of the COVID pandemic and the migration to online modality, administration not wanting to burden their overworked faculty during this unprecedented time or overlooking the request for an undergraduate research study soliciting a survey to their faculty. However, it is our belief that trends from additional schools will yield similar results as presented within this study.

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