Abstract

The scientific community has reached a consensus about the occurrence of global climate change and its anthropogenic causes. This is an issue that will require the public support and political leadership in order to enact mitigation strategies. University students, as young, educated members of the American public, are both current voters and highly invested in our future. This research focuses on undergraduate students at two universities in order to examine their understanding of climate change science. Surveys (n=853, completed=465) were conducted to determine the students' level of climate change knowledge and how students' mental models compare to the scientific model. A Knowledge Score was generated for each student based on his or her responses. It was found that, overall, students continue to hold misconceptions about the causes of climate change and frequently confuse climate change with other environmental issues, most notably, ozone depletion. This research shows that students in science majors and environmental groups are more likely to have mental models of climate change that closely match the scientific model, and that environmental group membership is a greater determinant of climate change knowledge than enrollment in a science major.

Student Understanding of Climate Change: Influences of college major and environmental group membership on undergraduate survey knowledge scores

Introduction

The scientific community has reached a consensus about the occurrence of global climate change and its anthropogenic causes. Outside of this community, however, there continues to be considerable debate and confusion surrounding the topic. Several studies have been conducted since the early 1990s on public understanding of climate change. Studies conducted by Kempton et al and Bostrom et al found that in the 1990s, members of the general public frequently held inaccurate mental and cultural models regarding the processes of climate change. Participants in these studies had often gathered misinformation and combined multiple environmental problems into their cultural models of climate change. Since the 1990s, climate change discussion and science have both advanced, however the level of public understanding has not noticeably done so. Both the study done by the Yale Project on Climate Change Communication in 2010 (Leiserowitz et. al.) and a retest of Bostrom et al's 1994 study, done in 2010 by Reynolds et al, revealed very few changes in the cultural models of the American public. The findings again included persistent confusion between climate change and other environmental issues such as ozone depletion.

This research narrows the focus of previous studies by examining the mental and cultural models of undergraduate students. These young, educated members of the American public are an important population. As voters, they are capable of contributing to political and social change in the present, and they also represent the future leaders and thinkers of the country. Their understanding of this extremely urgent issue is critical to the future of our global climate. In addition, understanding the cultural models of students in higher education will help us to inform policy and communication strategies for this important issue, and to identify ways in which it can be improved. In this study, students were sampled and surveyed from two public, Mid-Atlantic universities (n=853, completed=465) and Knowledge Scores for these students were generated based on their responses. This research aims to provide insight into student understanding of an important, contentious and socially relevant issue and to examine the mental models held by young, educated citizens.

American Environmental Values and Scientific Understanding

In their book *Environmental Values in American Culture*, Kempton, Boster and Hartley conduct semi-structured interviews and surveys to understand American cultural models of the environment, and of specific issues like climate change. Kempton et al define a cultural model or mental model as "a simplified representation of the world that allows one to interpret observations, generate novel inferences, and solve problems." (1995: 10) In other words, a mental model is

a set of guidelines or even an imaginary map each individual builds for his or herself about any particular subject through which he or she can run scenarios, analyze information, and come up with conclusions. A further examination of the literature on mental models and their implications can be found in the next section of this literature review.

In *Environmental Values in American Culture*, the authors review the cultural models, values and beliefs of their informants in regards to the environment in general. Interview subjects express both their environmental concern and their perception of how environmental problems have come about. In Kempton Boster and Hartley's fourth chapter, "Cultural Models of Weather and the Atmosphere," the authors closely examine their informants' cultural models of climate change (or as it was more commonly called in 1995, the greenhouse effect). Overall, they find that the responses of their laypersons do not correspond to scientific models. One of their hypotheses for this phenomenon was that the greenhouse effect was a relatively new concept at the time. The authors describe ways in which informants modeled climate change that are based upon models for previously existing concepts, all of which deviate from scientific understanding of climate change. Some of these concepts include greenhouse gases as pollution or the "pollution model," ozone depletion or the "ozone depletion model."

A 2010 study done by the Yale Project on Climate Change Communication reveals some similar results to the Kempton et al studies (Leiserowitz et al 2010). In the Yale study, 2,030 adult members of the American public were surveyed on their knowledge of climate change and were given "grades" (A-F) on their performance. A large majority of those surveyed received Bs, Cs and Ds on their knowledge, with the largest proportion scoring Cs and only 2% earning and A. Majorities of the adults surveyed had heard of the "greenhouse effect" and could correctly identify carbon dioxide as a greenhouse gas, but most did not know how great the increase in carbon dioxide in the atmosphere has been since 1850. A majority of Americans were found to correctly understand that burning of fossil fuels contributes to climate change, but the study also finds that "majorities of Americans… incorrectly believe that the hole in the ozone layer, toxic wastes, aerosol spray cans, volcanic eruptions, the sun, and acid rain contribute to global warming." (2010: 11) The results of their understanding could be seen in the solutions the respondents listed, which for large majorities included both correct (reducing driving, switching to renewable energy sources, etc.) and incorrect (reducing toxic waste, banning aerosol spray cans, etc.) solutions.

The Yale study also documents the pervasiveness of climate skeptic arguments in the American publics' understanding of climate change. Many of those surveyed did not believe that scientists can predict future weather or that computer models are reliable. A third stated that they did not believe that humans cause climate change. More than half of the respondents said that they don't know if climate change is happening or that they don't believe it to be happening at all. Over one third said that there is much disagreement among scientists about whether or not climate change is happening. The respondents listed television, printed media and the Internet as their main sources of information about climate change, and a large majority stated that they needed more and better information on the subject

(Leiserowitz et al 2010).

Overall, the literature shows strong environmental values in the American public, especially since the 1970s. It also reveals a lack of scientific understanding of the processes of more complex environmental issues like climate change, the consequences of which tend to be misinformation on the possible effects and severity of the issue, and the adoption of ineffective mitigation actions, as well as possibly weakened support for governmental initiative on the issue.

Mental Models

Mental models are an extremely important component of this study, as they are one of the tools by which students' understanding will be described and measured. Mental models, also called cultural models or cognitive models, come from a sub-field of anthropology known as cognitive anthropology. D'Andrade defines cognitive models as a "small-scale model" of external reality and our own possible actions that we carry around in our heads. It "consists of an interrelated set of elements which fit together to represent something" and this model is used to reason or to calculate by mentally manipulating its parts to solve a problem (1995: 151). Mental models appear not just in cognitive anthropology but also in the wider field of cognitive science. Within this field, the use of mental models for human reasoning is a common theme. It is theorized that "people do not reason using abstract rules, but rather they construct and combine mental models and generate inferences consistent with those models." (Bly and Rumelhart 1999: 156) We can "run" our mental models to come up with conclusions or solutions to a problem. Since mental models are constructions of human thought, they often include simplifying assumptions (Mudditt 1996). People are normally logical, but there may be flaws or missing information in the models they have formed. Errors in conclusions, therefore, will likely not be random, but will instead correspond with gaps or errors in mental models. Studies show that mental models, complete with gaps or distortions, can be passed on, taught and transferred (Bly and Rumelhard 1999).

Mental models are not only seen as agents of reasoning, but also are linked to motivation and action. D'Andrade, in an essay from the book *Human Motives and Cultural Models,* describes mental models as having a "motivational force" because they describe the world, set forth both conscious and unconscious goals, and elicit desires (1992:23-44). Holland and Quinn specifically address how mental models motivate behavior, expressing that the basis of mental models' directive force is in the authority and expertise with which they are invested and within the "intrinsic persuasiveness" the models hold for us (1987:9). Indeed, the influence of mental models on the actions and perceptions of their holders can be seen in a variety of studies. The examples range from people's interactions with their thermostat settings, which is influenced by one of two mental models informants hold for how the thermostat works (Kempton 1987) to the actions and beliefs of college women regarding the innate or learned nature of sexuality and romance (Holland and Skinner 1987) (Holland and Quinn 1987). As has been done in these previous studies, this research will use student survey responses to partially reconstruct and

examine the mental models of students on climate change. The finding from multiple studies that mental models influence behavior reinforces the need to understand how student mental models compare to the scientific model of climate change.

Research Questions

1. What levels of knowledge and cultural models do undergraduate students at these two universities hold to explain climate change and how do their models compare to the scientific model of climate change?
2. How do the students' knowledge of climate change, as defined by the Knowledge Score, differ between students in climate-related science majors, students belonging to environmental groups, and students in neither category?

Design and Methodology

The cultural anthropology methodology of this research contains elements of both ethnography and grounded theory and is based upon the work done by Kempton, Boster and Hartley in their 1995 study. The authors conducted semi-structured interviews of members of the general public. The ideas, reasoning and mental models expressed in these interviews were then used to construct survey statements to be administered to a larger population. This methodology, which is also outlined in Bernard 2002, allows the researcher to test the existence of the mental models seen in semi-structured interviews across a larger population. The mixed methods analysis of Kempton et al's data included the examination of interview quotations and survey responses to reconstruct the mental models of the intended population regarding climate change. This methodology was replicated in the present research. Prior to the development of the survey instrument, a pilot study was conducted consisting of semi-structured interviews of 18 university students. Semi-structured interviews include a pre-determined set of questions, but the interviewer is able to ask further questions and probe for more complete answers, depending on how the informants respond (e.g. Agar 1980). Transcripts of these semi-structured interviews were reviewed, and the mental models of these informants were reconstructed from the lines of reasoning displayed. The comments and arguments representative of the informant mental models observed were condensed into one-sentence statements on the Survey of Student Understanding of Climate Change.

Upperclassmen were selected for the survey, as these students have spent three or four years studying their individual majors and therefore better represent the influence that a student's major may have on their understanding of climate change. The universities assisted with the selection of a representative sample, and the survey was conducted online using Qualtrics survey software. A total of 853 students took the survey, with 465 students from the two universities completing the entire survey. For the comparison of climate-related science majors and non-

science majors, a selection of majors was made including majors relating to environmental science and policy, chemistry, biology, and geology.

This subset of the survey was chosen as its analysis effectively captures and represents the overarching themes and mental models seen throughout the entire body of research. The Knowledge Variables include both correct and incorrect statements about the mechanisms of climate change, as well as the actions that can be taken to prevent or mitigate climate change. With the chosen survey methodology, and in a socio-scientific issue such as climate change, the socio components cannot be completely separated from the science. The survey Knowledge Variables also involve those socio components most closely associated with the scientific model and that can be coded as correct and incorrect in comparison with the scientific model. The socio aspects of these Knowledge Variables are most clearly represented in statements dealing with scientific certainty and government action. For a complete list of the Knowledge Variables on the Survey, see Appendix I.

For the analysis of the Knowledge Variables, a "Knowledge Score" was generated based on students' agreement and disagreement with both correct and incorrect statements. One point was assigned for agreement with a correct statement and one point was signed for disagreement with an incorrect statement. All other responses received no points. Only the answers of the 465 students who completed the survey in its entirety were included in the calculation of the Knowledge Score (Scale=0-35). The mean Knowledge Scores of science and non-science students were compared using a t-test, as were the mean knowledge scores of environmental group members and students not belonging to an environmental group. One-Way and Two-Way Analysis of Variance was used to compare mean Knowledge Scores between the four Core Groups (1. Science major and Environmental group 2. Non-Science major and Environmental group 3. Science major and Non-environmental group 4. Non-science major and Non-environmental group*)* and to analyze the influence of major and environmental group on the scores.

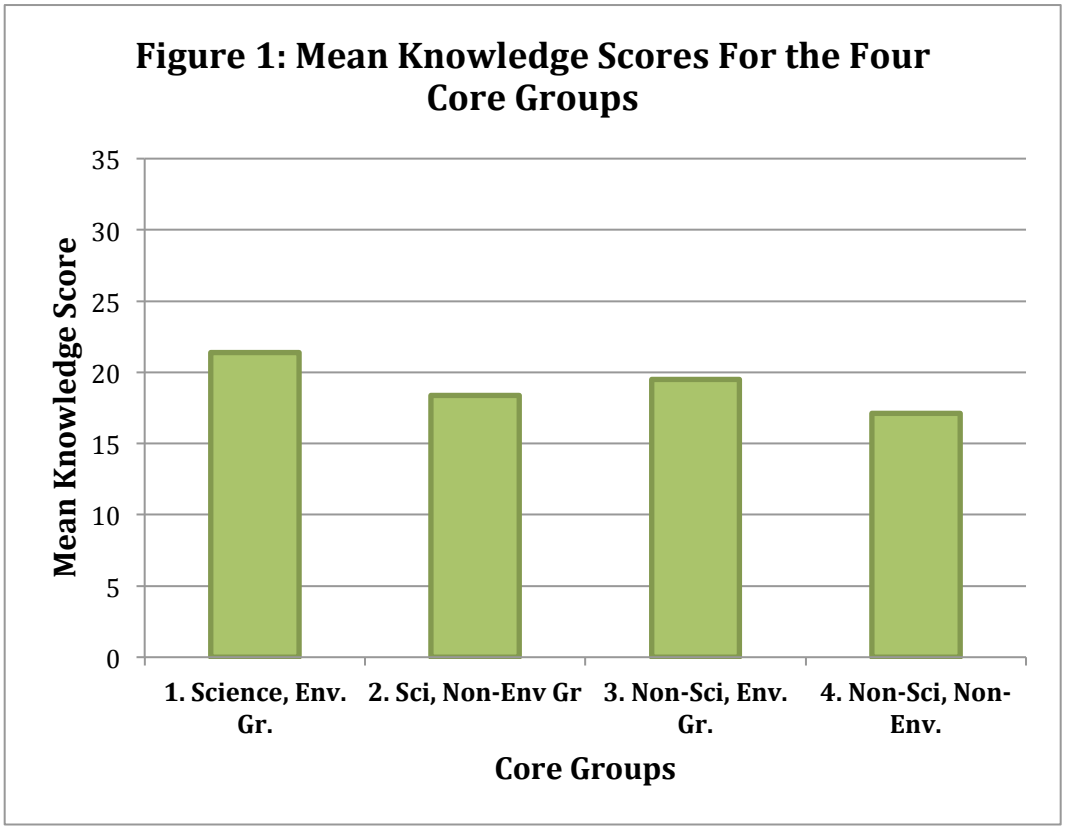
In addition to the calculation and analysis of the Knowledge Scores, the descriptive statistics of individual statements of interest on the survey were examined in order to gain a better understanding of students' mental models of climate change. Specifically, student agreement and disagreement with statements similar to the scientific model, and statements confusing climate change with ozone depletion were analyzed. Ozone depletion was chosen as an interesting example of an environmental issue students frequently confuse with climate change.

Results and Analysis

The creation of the Knowledge Score allowed for the overall knowledge of the students to be measured and the levels of knowledge of specific groups of students to be compared. The Knowledge Score variable was created by summing the "Knowledge Variables" in the survey. Incomplete surveys were excluded from

this analysis, as their scores skewed the results. The Knowledge Score was calculated on a scale of 0 to 35 for the 465 students who were included in this analysis. The mean score of the students from both universities was 17.84 with a standard deviation of 5.40. The highest score received was a 35 and the lowest was a 0.

Descriptive statistics were performed to compare different groups of students based on their science education and their environmental group membership. In an independent samples t-test, the mean Knowledge Score of the science majors was found to be significantly higher (m=19.60, sd=5.98) than the mean Knowledge Score of the non-science majors (m=17.43, sd=5.19), (t(448)=3.46, p<.05). The mean Knowledge Score of environmental group students was significantly higher (m=20.11, sd=5.04) than the mean Knowledge Score of the non-environmental group students (m=17.36, sd=5.35), (t(456)=4.44, p<.05).



In order to examine the effects of both environmental group membership and science major, a 2 (Environmental Group Membership) X 2 (Science Major) between-subjects factorial ANOVA was calculated comparing the Knowledge Scores of the students. Environmental group membership and science major were each shown to have significant main effects. The Core Groups and their corresponding mean scores are as follows: 1. Science major and Environmental group (*m=21.38)*, 2. Non-Science major and Environmental group (*m=19.5*), 3. Science major and Non-environmental group *(m=18.36)*, 4. Non-science major and Non-environmental group (*m=17.13).* A significant difference was found between the groups F(3, 447) =

9.60, $p<.05$) and post hoc analysis shows that environmental group membership is a greater indicator of a high Knowledge Score than belonging to a science major.

Specific statements from the survey were of particular interest in re-creating student's mental models of climate change. The statements found in this first set are examples of statements matching the scientific model, a predetermined definition of which can be found in Appendix II. The response percentages for some of the survey statements matching the scientific model of climate change can be seen in Table 1:

Table 1: University Student Responses to Survey Statements Matching the Scientific Model of Climate Change

Item	Agree	Neither	Disagree	N
2.10 Scientists are highly certain that humans are definitely the cause of current, rapid climate change	53.2%	29.0%	17.8%	682
2.23 Burning fossil fuels releases carbon dioxide into the atmosphere, which traps heat and causes climate change	77.0%	19.6%	3.3%	566

In the responses to statement 2.10, more than half of the respondents understand the scientific certainty that exists about climate change, but almost 30% of the students are unsure about the scientific agreement, and almost 20% do not agree that there is scientific agreement. These results show some confusion with the scientific model, although some of this confusion may be attributed to the strong wording of the statement, taken directly from an interview transcript. The agreement of 77% of the respondents with statement 2.23, explaining how the burning of fossil fuels contributes to climate change shows that when presented with the correct mechanisms of climate change, a majority of students can identify them.

Despite the high number of responses showing understanding of the role of fossil fuels in climate change, several statements dealing with the confusion of climate change with other environmental issues show that student mental models do not necessarily match the scientific model. Some of the statements dealing with the confusion of climate change and ozone depletion are seen in Table 2:

Table 2: University Student Responses to Survey Statements Confusing Climate Change with Ozone Depletion

Item	Agree	Neither	Disagree	N
2.11 Climate change is happening because we are depleting the ozone layer, and that lets in more heat from the sun.	43.0%	26.9%	30.1%	672
2.16 Greenhouse gases make the hole in the ozone layer worse	54.8%	23.2%	21.9%	633
2.36 I can help prevent climate change by not buying or using aerosol cans	50.1%	28.7%	21.1%	505

The percentages of agreement with these statements indicate that there is a great deal of confusion in students' mental models between climate change and ozone

depletion. The student responses were relatively split on statement 2.11, but a majority agree that depletion of the ozone layer causes climate change. Statement 2.16 describes a different line of reasoning regarding the mechanisms of climate change. This incorporates new information and a frequently used term, greenhouse gases, with the older model of climate change having to do with ozone depletion. More than half of the respondents agreed that greenhouse gases contribute to the hole in the ozone layer. This combination of correct and incorrect information is a more common element of student mental models. When running through their mental models to find conclusions and solutions, half of the respondents agree with 2.36 and mistakenly believe that limiting their use of aerosol cans will help to prevent climate change.

Conclusions

In the overall student population at the two universities represented in this study, the examined elements of student mental models show some basic understanding of the scientific processes of climate change. However, students also show a great deal of confusion between climate change and the ozone depletion. This confusion of issues is seen not only in students' understanding of the causes of climate change, but also in their understanding of the solutions and actions to be taken for climate change. These findings indicate that there are gaps and misconceptions in students' mental models that need to be addressed through education or other means in order to insure that college undergraduates are able to best tackle this serious issue.

In terms of the level of knowledge of the general student body at these two universities, the mean Knowledge Score falls at 17.84, just slightly over 50% on the scale of 0-35. In order for students to contribute meaningfully to climate change mitigation and adaptation, they will need to have a greater understanding than this Knowledge Score shows they currently have. Predictably, when looking at different groups of students, those belonging to the selected science majors are shown to have a higher level of knowledge than those students not belonging to science majors. The finding that those students belonging to environmental groups score higher on the Knowledge Score scale than those not belonging to such groups is similarly unsurprising. What is highly interesting, however, is that environmental group membership is a greater indicator of climate change knowledge (as defined by the Knowledge Score) than enrollment in a science major.

This research does not cover how these students reached this higher level of knowledge, or what causes students in environmental groups to have a greater understanding. It is possible that these findings could be attributed to the education and information students receive from environmental groups, but it seems unlikely that environmental groups are better sources of information than science classes. Students in both a climate science-related major and an environmental group have the highest mean knowledge scores. Another possible explanation for the differences in scores could be that students' greater understanding is a function of a higher level of interest and concern for climate change which is manifested in the

students' choice of major and environmental group participation. This theory could also explain why environmental group membership is a greater predictor of high Knowledge Score than enrollment in a science major. Further study of the information covered in specific classes and disseminated through environmental groups, as well as in students' motives in choosing college majors and belonging to an environmental group would be needed to test this theory.

In either case, these findings indicate that members of the American public in higher education, voters and future leaders for the country, are not receiving or retaining adequate information to make informed decisions about climate change. In order for students to contribute meaningfully to climate change mitigation and adaptation, they will likely need to have a greater understanding than this study shows they currently have. This indicates a need for more effective communication and political action on this issue.

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Appendix I

Knowledge Variables

Correct Statements

Q2.10 Scientists are highly certain that humans are definitely the cause of the current, rapid climate change.

Q2.12 Climate change is caused by the greenhouse effect.

Q2.18 Climate change is caused by an increased amount of gases like carbon dioxide and methane in the atmosphere.

Q2.23 Burning fossil fuels releases carbon dioxide into the atmosphere, which traps heat and causes climate change.

Q2.25 Even though it's sometimes debated, I feel that its pretty well documented that humans have released too much carbon dioxide into the atmosphere.

Q2.27 I've heard that driving less and using bicycles and public transportation are ways to reduce climate change.

Q2.30 The best way to deal with climate change would be to reduce or eliminate carbon-based fuel sources.

Q2.31 Individuals can give political support to clean energy initiatives to help deal with climate change.

Q2.32 The government could tax carbon emissions or introduce a system of cap and trade in an effort to reduce climate change.

Q2.37 Individuals can reduce climate change by not buying gas-guzzling cars and instead maybe owning a more fuel-efficient car or a hybrid.

Q2.38 The U.S. government could start dealing with climate change by signing the Kyoto Protocol.

Q2.40 We need to change our transportation system, like creating more public transportation, in order to make a big impact on reducing climate change.

Q2.42 I've heard that using efficient light bulbs, turning off electric appliances and insulating my house are all ways I can reduce my contribution to climate change.

Q2.43 The government could put more resources into developing alternative and renewable sources of energy in order to reduce climate change.

Q2.68 I think that it's generally pretty well accepted that climate change is occurring.

Q2.74 Even if the science isn't clear to me, I still think it's better to act and be safe rather than sorry.

Q2.75 It's hard for scientists to be certain about anything, but I think the patterns and trends that they're seeing in climate change have them pretty convinced.

Incorrect Statements

Q2.9 I think that climate change concerns are exaggerated more than the science supports.

Q2.11 Climate change is happening because we are depleting the ozone layer, and that lets in more heat from the sun.

Q2.14 Gas and chemical emissions from our cars deplete the ozone and cause climate change.

Q2.15 Toxic pollution in the atmosphere causes climate change.

Q2.16 Greenhouse gases make the hole in the ozone layer worse.

Q2.19 Climate change involves magnetic field and fluctuations in the sun, and other things beyond our control, and those things are bigger factors than greenhouse gas emissions.

Q2.20 Natural things like volcanoes and water vapor have more of an impact on climate change than human actions.

Q2.21 Climate change happens because we release chemicals from aerosol cans into the atmosphere.

Q2.22 Nuclear power plants create pollution that contributes to climate change.

Q2.34 As a college student, my actions don't affect the environment or climate change that much, but when I am doing bigger things, like owning a home, that's when my decisions will matter.

Q2.35 The government can reduce climate change by regulating toxic pollution.

Q2.36 I can help prevent climate change by not buying or using aerosol cans.

Q2.39 Cutting down on waste and pollution will help stop the melting of the ice caps.

Q2.44 Recycling is essential to reducing climate change because it keeps plastics out of landfills and reduces production.

Q2.62 From my sources I've learned that too much emphasis is put on the human element of climate change, rather than the natural elements.

Q2.69 I think that scientists are certain that the climate is changing, but not about who or what is responsible.

Q2.70 The climate has changed a lot in the past, so I think we might be making too big of a deal about how it's changing now.

Q2.73 I don't think that climate change is the most pressing environmental issue we face today, and I think that it gets too much press.

Appendix II

Climate science model

The climate science model consists of four main parts: 1. the physical mechanisms and effects of climate change, 2. the anthropogenic sources and causes of climate change, 3. the scientific consensus on the occurrence and anthropogenic causes of climate change and 4. the severity and urgency of climate change as an issue. Student understanding and mental models will be compared to each of these four parts of the model, and references to completeness of a student's mental model denote the inclusion of all four of these parts.

The climate science model of the physical mechanism of climate change to which the interview and survey data will be compared is a simplified version of the one held by scientists. It is simplified in that it is only as complex as the most informed layperson would actually be able to produce; it is not at a level that would be found in a scientific presentation or science journal article. The model is as follows: The most important cause of climate change, or global warming, is the greenhouse effect. The greenhouse effect is the phenomenon in which greenhouse gases, including carbon dioxide and methane, trap heat within the earth's atmosphere, heating the surface and lower atmospheric levels. This warming will have many effects, including severe weather, the melting of polar ice caps, and sea level rise.

The second part of the climate science model deals with the causes of climate change. Again the version to which students' mental models will be compared is simplified from the scientific model. Although there is natural variation in the earth's climate, climate is changing today at a rate with few precedents in geological history. This change is due to human emissions of much faster rates of carbon dioxide and other greenhouse gases into the atmosphere. The main sources of these

emissions are from the burning of carbon-based fossil fuels for electricity, home fuel use (e.g. for heating.) industrial uses and transportation. Humans have increased the greenhouse gas concentrations in the atmosphere since the industrial revolution from 280 ppm to 385 ppm.

The third part of the climate science model states that there is a high level of scientific consensus on both the occurrence of climate change and on its anthropogenic causes. That is, the scientific community is reasonably in consensus; there is not a "controversy." The scientific consensus was reviewed in Chapter 2 of this dissertation.

The fourth part of the climate science model deals with the urgency of climate change. Climatologists maintain that climate change will cause very substantial fluctuations, similar in magnitude to those from one geological age to another. Such changes lead to mass extinctions, change in sea level, and other shifts that would cause serious problems for our planet and for human civilization. Furthermore, because climate change has inertia at higher levels of GHG, we commit the planet to dramatic climate change and its consequences. One could argue that a belief in the urgency of the issue is in part a problem of values, e.g. whether minimizing species extinction or minimizing disruptions to the next generation are moral imperatives. This dissertation includes them as part of the "scientific model" because much of the urgency derives from straightforward science comprehension of the scope, rapidity, and difficulty in shifting of climate change. In comparing interview and survey data to this part of the climate science model, the urgency aspect of climate change is evaluated on whether or not a respondent's answers or comments give weight to the need to act or the criticality of the issue of climate change.

Climate action model

The climate action model specifies which actions, including both individual and governmental actions, will reduce, slow down, or prevent anthropogenic climate change forcing. That is, the final and most important assessment of an informant's understanding of climate change is the informant's ability to identify actions that can be taken to deal with the issue. There are many different approaches to how to deal with climate change, and policy choices will be deemed "correct" simply by the fact that the intention is to address the specific causes of climate change. Therefore the climate action model covers a wide range of activities and policies.

Individual actions that can be taken to deal with climate change include lifestyle changes to reduce the use of carbon-based fuel sources (ex: home energy conservation, use of public transportation, reduced personal gasoline vehicle use, etc.) and political support for climate change policies. Specific policies and governmental actions that are included in the climate action model can be numerous, including but not limited to: carbon taxing, implementing cap and trade, the U.S. signing of the Kyoto Protocol or other international agreement with similar goals, furthering economic incentives for renewable resources, ending subsidies on fossil fuels, supporting infrastructure for renewable integration, creating stricter regulations on the automobile industry, and improving public transportation. Ineffective, misguided, or counterproductive actions or policies are not included in the climate action model, examples of which include encouraging recycling or banning ocean dumping, neither of which deal directly with climate change, or banning CFCs in aerosol cans, which again has little influence on climate change and has already been done in the United States. The climate action model includes any individual, group, or political action supported by the climate science model. The interview and survey data and the mental models revealed in this data will be

evaluated with both the climate science model and the climate policy model, defined above, as a reference.