V. Delta Internship Project: Using Teaching-as-Research to Explore the Effect of Mass Media on Student Climate Literacy

a. Introduction

The "Teaching-as-Research" Delta pillar refers to conducting a research project in order to better understand and subsequently improve the quality of the educational experience for students. This can include research related to (but not limited to) testing out alternative methods of teaching, altering the curriculum for a course, starting up a new course, and even simply testing out a new assignment or assessment tool for measuring student understanding of course material. With one of the core principles of my teaching philosophy being the improvement of climate literacy of students, I conducted a teaching-as-research project for my Delta Internship requirement that investigated how mass media sources affect student climate literacy. Specifically, the study focuses on how students critically analyze climate science data and the effect of mass media information on their critical thinking ability. This study is described below.

b. Summative Report

The Effect of Mass Media on Student Climate Literacy and Critical Analysis of Climate Science Data

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1. Introduction

With the potential for major global climate change within the next century, it is important to educate those not associated with the scientific field of climate science, or the "public," about climate science and the potential impacts that climate change has on human society. This is necessary regardless of whether or not one believes in the potential hazards of a rapidly changing climate, because heeding such warnings could lead to negative societal consequences. An improvement in societal "climate literacy," or one's understanding of climate science knowledge, is one way to lead to correct decisions about handling such consequences (Bord et al 2000).

There are a variety of methods that are used to attempt to improve public climate literacy. Bord et al (2000) and McCaffrey and Buhr (2008) suggest that climate literacy is best improved in the academic setting (i.e., class/course incorporating textbooks, academic journal articles, and other scholarly resources). However, most people will likely never take a course on climate change. People in this category will most likely obtain any information tied to climate science from "mass media" sources. While online sources are the primary source of science information for the general public (NSF, 2014), newspaper articles, non-academic journals, magazines (both science and non-science based), television, radio and/or "word-of-mouth" (i.e.: talking with friends, etc...) are other sources of information.

There are a few problems with obtaining climate science information purely from mass media. One issue is that the goal of mass media sources is tied to the idea of an "Attention Economy" defined by Ungar (2000). The idea is that the public wants information as soon as possible, but does not want information to be too complex (Gowda et al 1997). Society is structured around "conversational" information, or that which requires minimal explanation. Academic articles, which can be complex, do not suit well in such an economy. Thus, people who use resources well suited for an "Attention Economy" will only obtain limited information

about complex topics such as global climate change. Thus, such persons are not provided all of the details on climate change, and are potentially misinformed about climate change. This can lead to low climate literacy.

Along with this, mass media sources tend to inform the public about current issues that can lead to immediate consequence in society and/or one's personal life (tied to the "Attention Economy" of Ungar 2000). Therefore, issues such as Global Climate Change, while threatening to society, may not be considered as threatening to the public in the short term compared to human disease (i.e.: cancer, heart disease) and disasters such as damaging weather events and even air pollution (Table 2 of Bord et al 2000). Hence, the public does not feel the need to understand the details behind Global Climate Change outside of being aware of such an event.

From this, it seems that using mass media sources to learn more about climate change may not be the best way to improve climate literacy due to the existence of biases and misconceptions within such sources. However, since the public utilizes such resources primarily to obtain scientific information, it is important as a scientific educator to understand how students interpret information from these sources as well as whether or not students are able to critically analyze and identify misconceptions that arise from such sources. This is especially true for students enrolled within a climate science course. For example, if students use misconceptions disseminated by mass media in developing their understanding of the Earth's climate system, then this would make eliminating those misconceptions as well as teaching students the factual information about climate science much more difficult. It is this concern as an educator that motivates our study.

Our study investigates the effects of mass media on student climate literacy, specifically addressing the following research question: *"Are students enrolled within climate science courses able to critically analyze information from mass media such that they do not adopt misconceptions from mass media within their own understanding of climate science?"* The rest of this study is outlined as follows: Section 2 discusses the methodology we use in investigating our research question, Section 3 provides results from our study, and Section 4 concludes the study, including further discussion on the results from Section 3.

2. Methodology

Courses and Participants for Study

We explore our research question within two UW-Madison introductory atmospheric science courses taught between 2013-2014: 1) the introductory course "Weather and Climate" (WC) course taught in the traditional "in-classroom" manner, focusing on a general overview of weather and climate science, and 2) an online course titled "Climate and Climate Change" (CCC) which focuses on understanding climate science information from the recent Intergovernmental Panel on Climate Change (IPCC) assessment reports. The CCC course specifically focuses on climate science, where students dissect information contained within the Intergovernmental Panel on Climate Changes' assessment reports, which contains observational and model data demonstrating changes in Earth's climate. On the other hand, the weather and climate focuses an overview of the field of atmospheric science, and while some of the lectures discuss climate change, there is less emphasis on this topic relative to the "Climate and Climate Change" course.

Students that were enrolled in either the CCC course during the Spring 2013 or Fall 2014 semester, or the WC course during the Spring 2013 or 2014 semesters were eligible to participate in this study. The courses have no prerequisites, and thus the sample of students that participate include a variety of knowledge backgrounds regarding understanding and interest in climate science. Students were not required to participate within this study, however students that did participate in full were offered extra credit points towards their grade. Given these requirements, there were 46 participants from the CCC course and 29 participants from the WC course (i.e., N = 46 +29 = 75 participants).

Volunteer participants from each course completed a two-week course activity that consisted of a pre-test, series of short readings and a post-test. The pre/post-test asked participants to interpret a plot portraying changes in yearly and globally (or Northern Hemisphere) averaged temperature, stating whether or not global climate change was occurring and will/will not continue to occur (Appendix A). The readings chosen were articles from mass media sources that were biased towards content stating that global climate change was not occurring (Appendix B).

Climate Literacy Reading Activity

Volunteer participants were asked to complete a brief pre- and post-test as well as read three mass media articles related to content on the pre- and post-test. During the first week of this study, participants completed the pre-test shown in Appendix A. The pre-test asked volunteers to analyze a time series of annually averaged global average temperature over a 70-year period (Fig. 1 in Appendix A). The figure included observational data up to 2012, and then model forecast data showed the projected global average temperature trend up to 2020. After analyzing the data on this figure, participants were asked to respond to one multiple-choice question regarding their perspective on whether or not global climate change was occurring on Earth given the data they analyzed. A short answer question followed asking participants to explain their response to the multiple choice question as well as cite any resources that were used in helping them arrive at their answer.

After completing the pre-test, participants were then asked during the second week of the study to read three articles on climate science. These articles were posted on the course websites for both courses, as all participants from the courses had online access to the course website. The majority of images were removed from the articles, along with the authors and sources where the articles came from. Only key figures pertaining to the article were kept (except for one photo that was not removed unintentionally, though this photo did not pertain to any of the discussion on climate change in that particular article).

The readings that were assigned to participants discussed the interpretation of the data that participants analyzed on the pre-test from points of view that suggested that global warming had “halted” or “slowed-down” given the trends in this data. Topics of discussion within the articles included quotes from various scientists, discussion on the validity of climate models as well as choosing a short period of time in the data to draw a conclusion, and the potential negative effects that may exist within the European economy due to the trend in global average temperature rising at a lesser rate than predicted. In short, the articles present arguments that suggest that the prediction of the rate at which global average temperatures would rise are too high and thus not as accurate as initially predicted.

While the articles are correct in stating that the trend in global average temperature has decreased over the past two decades, the reasoning used to explain this slowdown along with the conclusion that global warming (or global climate change) has "halted" is incorrect. For example, while the global average temperature rate of increase has slowed, there is a lot of evidence, including both within observational data as well as climate model forecasts that suggest that global climate change is occurring and will continue to occur (e.g., see textbooks such as Mann and Kump (2008) and Kitchen (2013), for example). Furthermore, the articles tend to jump to subjective discussion criticizing the source of the plot of global average temperature, implying that the organization "quietly" released this information in order to avoid backlash about what is really occurring regarding global warming (see Article 1 in Appendix B, for example). The criticisms highlighted by the articles regarding the plot of global average temperature are examples of mass media utilizing minimal scientific information to make a subjective point regarding global warming and/or global climate change despite scientific consensus on the occurrence of global climate change. Given that the plot of global average temperature should be interpreted with ease by students within the CCC and WC courses based on what they have learned along with the biases and misconceptions within the selected mass media articles, the articles appeared to be a reasonable choice for this study.

Upon reading these articles during the second week of the study, participants concluded the study by completing a post-test. The post-test was the exact same test as the pre-test (Appendix A), as the goal of the post-test was to assess whether or not participants' perspective on global climate change had remained the same or changed after reading the articles. Finally, after the end of the second week of the study, participants (as well as students in both courses) were asked to participate in a discussion of either the study itself or the climate science articles as a group. In the CCC course, this was done via a forum discussion on the course forum boards. In the WC course, a one-hour discussion section period was used to have a discussion on the material within the climate science articles. This allowed for participants in the study to discuss their thoughts on both the articles and the study itself, as well as allowed students in the course to join the discussion and discuss how the articles affected their perspective on global climate change.

While the activity is to be completed individually, participants were given permission to discuss the articles with other members of the group he or she was assigned to. This is done in order to allow for participants to discuss and subsequently learn via discussion about the reading content. This in turn gives participants the opportunity to learn from each other. Furthermore, all articles were available for each student to read to allow for students to educate themselves about the climate science topic of interest and thus improve his or her climate literacy.

To make sure that students would provide individual responses for all questions, a disclaimer was placed in the activity directions stating that each participant should provide individual responses whether or not they discussed the material with others. While this may not have been an issue provided that the participants were not allowed to discuss the readings amongst each other, this is an educational study, and the primary purpose of this course is to inform and improve the climate literacy of the students as much as possible.

The climate literacy reading activity serves as an excellent opportunity for both participants and non-participating students to improve their critical reading and analytical skills, as well as improve climate literacy with respect to a particular climate science topic (in this case, changes in annually averaged global average temperature). Thus, this activity provides an educational opportunity for those who participate while simultaneously providing an opportunity

for a researcher (such as myself) to gain insight into how well students are able to both retain climate science information from the climate science literature along with determine what information is the most accurate. Both of these skills help to comprise one's climate literacy.

3. Results

Multiple-Choice Responses – Pre- and Post-Tests

Figure 1 shows the total number of participants selecting each of the four multiple-choice responses on both the pre- and post-tests for the CCC (Fig. 1a) and WC (Fig. 1b) courses. We find that in both courses, participants predominantly selected the "global climate change is occurring and will continue to occur" response on the pre-test (Fig. 1a), with 97.8% (89.7%) of students choosing this response in the CCC (WC) course. However, on the post-test, only 78.3% (48.3%) of students chose this response, with the other 21.7% (51.7%) choosing either "not sure" or one of the two responses that expressed doubt in global climate change occurring in the present and/or in the future. These results show that after reading the climate science articles during the second week of the climate reading activity, the total number of participants that agreed with both the occurrence of global climate change in the past as well as present and future declined, suggesting that the articles did affect participant perspective on this issue.

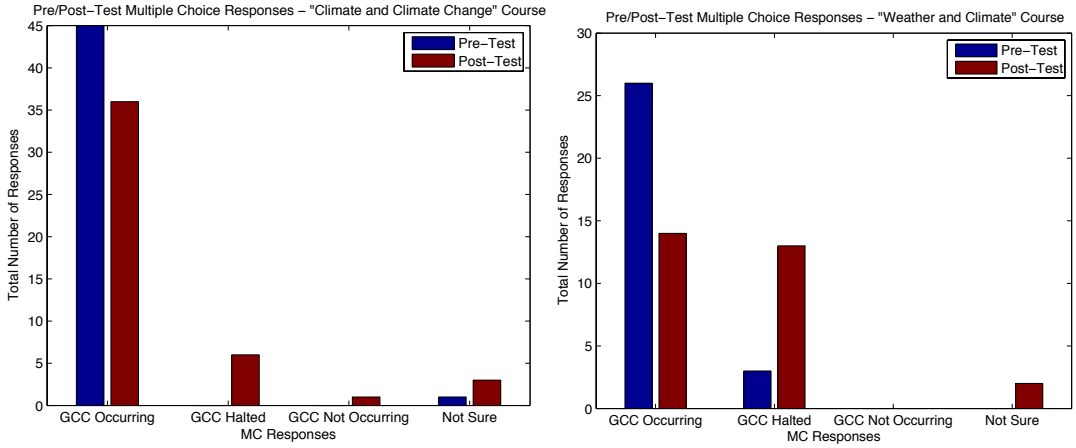

Figure 1: a) Number of responses to Q2 on the pre-test (blue bars) and post-tests (red-bars) for the online "Climate and Climate Change" course, and b) Same as Figure 1a but for the traditionally taught "Weather and Climate" course.

To more specifically investigate which responses participants changed their answers to between the pre- and post-tests, Table 1 shows the number of participants that changed their response between the tests as well as how many of those students changed their response from the "pro-global climate change" multiple choice answer (i.e., "global climate change is occurring and will continue to occur) to one of the other answers expressing "doubt" in global climate change (i.e., "global climate change was occurring but has halted/stopped," "global climate change is not occurring and was never occurring nor will it occur in the future," or "not sure"). Of the students that changed their response in either the CCC or WC courses, all but one student in each class changed their response from a "pro-global climate change" response in the pre-test to a response expressing "doubt" in climate change on the post-test. This suggests that the bias in the articles towards expressing uncertainty in global climate change based on the perceived

"halt" in increasing global average temperature may have influenced how participants interpreted their analysis and understanding of the data presented to them on the pre- and post-tests.

	Did not change response between pre- and post-tests	Changed from "pro-global climate change" response to response expressing doubt	Changed from response expressing doubt to "pro-global climate change" response
Climate and Climate Change	35 (76.1%)	10 (21.7%)	1 (2.17%)
Weather and Climate	15 (51.7%)	13 (44.8%)	1 (3.45%)

Table 1: Number of participants that changed/did not change their multiple choice response between the pre- and post-test. The percent of total participants responding is included in parentheses next to each value.

Short Answer Responses to Pre- and Post-Tests

While the multiple choice question results provide initial insight with respect to whether or not participants changed their responses after reading the climate science articles, these results do not provide any insight regarding the thought process behind why participants changed their responses. Answering this question (or at least gaining some insight into possible reasons for response changes) is essential in better understanding how student critical thinking is affected by content within mass media articles.

To explore this topic, we qualitatively investigate the short answer responses provided by participants in the last question of the pre- and post-test. Table 2 shows a selected list of participant responses to this question, including participants from both the CCC and WC courses. The selected responses in Table 2 were chosen such that at least one response from each class included a participant selecting "Global Climate Change is occurring and will continue to occur" on both the pre- and post-tests, and the other participant responded with this response on either the pre- or post-test, but selected a different response on the post- or pre-test.

First, we consider the responses where participants initially selected the first multiple-choice response on the pre-test but switched responses on the post-test (i.e., all participants with a "1" after the hyphen in their ID). With respect to the pre-test short answer responses, the majority of the participant responses included discussion on how he or she used background knowledge, course material, and/or their understanding of interpreting graphical data to conclude that global climate change was occurring given the figure in the pre-test. The participants cited that there was a clear increase in annually averaged global average temperature over the 70-year period. All participants referenced that this was consistent with that they were learning in class and even from other course experiences (e.g., WS14-1). One participant did mention that there might be a possibility that this study would reveal some sort of "trick" about what was happening with global climate change, expressing caution with respect to the data they were analyzing despite not having read the climate science articles up to this point yet in the study.

An analysis of the post-test responses of these four participants shows that, overall, the climate science articles did not change their perspective on global climate change. For example, participant CF14-1 expressed that their reasoning did not change despite reading the articles, citing that course content and their background knowledge led them to selecting the same multiple-choice response on the post-test. CS13-1 mentioned that they had "read too many

articles" that suggested the opposite of the interpretation provided by the climate science articles their responses, stating that their own interpretation of the data along with background knowledge led them to choosing the same response on the post-test.

While many students did not change their response from the "pro-climate change" response between the pre- and post-test, some student short answer responses showed that the articles may have had some effect on how the participants analyzed the global average temperature plot the second time. For example, while participant WS13-1 expressed that "Although it is true in the last 15 years there has been a halt/stop to the trend of global warming, there is still no denying that over the past 130 years the temperature has been increasing," they also mentioned that "Since the weather climate models have to account for so many variable that go into the climate of our planet it is hard to say how precise scientist can be." The participant acknowledged the slowing trend in the increase in global average temperature, but seemed to imply that it is too difficult to deny climate change due to the trends over a long period of time. However, they expressed some doubt in the precision of scientists regarding global climate change, which was not initially expressed in their pre-test short answer response.

With respect to those participants that changed their response between pre- and post-tests from the "pro-climate change" response to a response that expressed "doubt" in climate change, it is clear within their short answer responses that the climate science articles had an effect on participant analysis of the figure from the pre- and post-tests. For example, participant CF14-2 directly quoted one of the articles as evidence of the slowdown in the increase in global average temperature, stating thus that global climate change was slowing down. This is despite the fact that the course the participant was enrolled in stressed the importance of using multiple sources of observational data to solidify an argument about whether or not global climate change is occurring and will continue to occur. Participant WS13-2 also cites the articles, saying that the data is "skewed" and actually suggest halting of global climate change. CS13-2 discusses how the articles lead readers into believing that climate change is a "hoax," and along with this statement had selected on the post-test the response stating that "Global Climate Change is not occurring and was never occurring nor will it occur in the future." In all three cases, the participants appeared to take the evidence presented in these articles as "truth" in the description of whether or not global climate change was occurring and/or will continue to occur.

Interestingly, there was one participant (WS14-2 in Table 2) that changed their response between the pre-test and post-test from a response reflecting "doubt" in climate change to the "pro-climate change" response. Within their short answer question response on the pre-test, the participant identifies the trend over the last two decades of the rate of increase in global average temperature declining, and states that they used their own abilities in interpreting data to come to this conclusion. However, in the post-test short answer response, the participant changed their answer based on the articles they read as well as what they had learned from a course activity. Given that the articles leaned towards suggesting a halt in warming global average temperature, it may be possible that the course activity made the participant more aware of the scientific consensus on global climate change, and thus their response on the multiple-choice question changed.

Participant ID and MC Responses	Pre-Test Short Answer Response	Post-Test Short Answer Response
CF14-1 (Pro/Pro)	(a) I choose the response that "global climate change is occurring and will continue to occur" for several reasons. One reason is due to the fact that the Figure shown to us represents that over almost the last century that global annual temperatures have continued to increase. This tells me that something is causing these temperatures to increase and having learned from past readings and this course alone we know that global climate change is a huge factor that is causing temperature increases seen across the globe. I also chose this statement because the is clear that global climate change is occurring all around us with more severe storms, increased ice melt, severe drought, etc seen in different areas. We have also learned that global climate change will continue to occur unless we, as humans, take action and responsibility to reduce CO2 levels in our atmosphere and oceans to help better the future impact of our environment. / / (b) When analyzing the figure I reflected back on information learned from Week 5: "Observations of Climate Change". In this unit we looked at several data sets of direct observations to analysis climate change in our environment in several different aspects. Articles read from the IPCC I believe also provided incite in reading the figure presented as well as the online activity we completed in Week 13 unit.	(a) I choose the response "Global Climate Change is occurring and will continue to occur" because of the same reasoning's that I did last week. Throughout my past experiences of doing research on global climate change, observing current global climate change in Wisconsin, seeing disasters happen around the world because of the result of global climate change, and AOS 102 course to show that global climate change is occurring and will continue to occur with some variability. One way to decrease the effects of climate change is by reducing the amount of CO2 released into the atmosphere decreasing our carbon footprint. / / (b) Resources that I utilized in choosing this response was content explored in AOS102, such as week 5 content looking at observations of climate change, and week 11 content on mitigating climate change. As well as information from our textbook (Kitchen) that provided even more solid information on global climate change and its patterns, and readings that we had done by the IPCC. The media articles read for this activity did not change my decision because they explained how the Met Office has altered and published false results before, it was published quietly, and the fact that it has not been thoroughly scrutinized yet are all red flags to me not to believe in what the Met Office says about global climate change having stopped for the last 15 years.
CF14-2	a) I chose this response because,	a) Combined with the information

(Pro/Doubt #2)	according to the figure 1, there is high confidence of the rise of global annual temperature. / b) According to the knowledge that I got from this course, both natural causes (radiative forcing, volcanic eruptions, and etc.) and anthropogenic causes (GHG emissions, CO2 emissions, and etc.) have been encouraging global temperature to be higher than before. This trend is expected to continue if we not cut down GHG/CO2 emissions and so on.	that I got from the article, global climate change is on its way to slow down. Based on the data from the article, "over the next five years temperatures will be 0.43 degrees above the 1971-2000 average" which is a 20 percent of reduction. Based on the article, MET Office confirms that the global warming has stopped already. / b) MET Office article, "Global warming has stalled since 1998: UK Met office"
CS13-1 (Pro/Pro)	I choose the response global climate change is occurring and will continue to occur because as you can observe the line line is most definitely increasing. And it will most likely continue to increase by the looks of the thick blue line because the peak on the blue line is tied for the highest point overall. It does not seem likely that this increasing would stop since it has been increasing for over 50 years. / / I used my background knowledge of climate change. As well as all the readings from this course. This course has focused a lot on the changing of the climate so all of those readings were very helpful in making my selection.	I choose this answer because even though the articles we were given to read were about how climate change is no longer happening my opinion on the subject matter did not change. I choose to pick that climate change is occurring and will continue to occur because it is and based on the graph the temperature has been increasing. / / I read the three articles we were assigned from class but my background knowledge and past knowledge lead me to believe other things then what the articles were saying. I just think I have read way to many articles saying the opposite of what Met office reported.
CS13-2 (Pro/Doubt #3)	Given the data from the past and the upcoming projections of the future it appears to steadily increase over time. The only thing that makes me hesitate is that is cannot predict what effect the changes society has made to lessen global warming effects. It also shows that scientists can only say this with abut a 10-30% confidence rating. Throughout everything we have read and graphs we have looked at there is no doubt that global	Based on the articles given to us this week in preparation for this question I would be led to believe that global climate change is not occurring and was never occurring nor will it occur in the future. The Uk Mets office would lead us to believe that global warming has not occurred for over the past 15 years. Climate models are incomplete and we cannot understand them to their full extent and what affects they have on oceans, ecosystems or atmospheres.

	warming is occurring and will continue to occur, it is just a matter of to what magnitude.	They lead us to believe that this is just a government hoax that allows us to charge nation extra money and taxes to cover the programs intended at targeting this global warming
WS13-1 (Pro/Pro)	a) I choose that Global Climate Change is occurring and will continue to occur because the chart indicates that since 1950 the temperature difference has continued to increase. It is clear indicator that this trend will continue because the data is observed over many decades and shows that although seasonal temperature differences are occurring there is a larger scale incident of increasing temperature difference in the bigger scheme. Also I said it will continue to occur because their is no evidence that would break the current trend. / b) From the climate change presentations that were given in AOS 101 discussion this trend of increasing temperature difference had been presented multiple times. Furthermore, I have been aware of this information from the general media that their is a correlation between higher emissions and a significant climate change. That being said, this reminded me most of reading presented in discussion and lecture of AOS 101 about CO2 emissions and the temperature differences related to it.	a) Although it is true in the last 15 years there has been a halt/stop to the trend of global warming, there is still no denying that over the past 130 years the temperature has been increasing. However, it must be noted that the intensity of which there is global warming has in the past been largely exaggerated by researchers and the media. Since the weather climate models have to account for so many variable that go into the climate of our planet it is hard to say how precise scientist can be. Furthermore, the necessity to account fully for man made and natural causes needs to be interpreted better in order to come to a reasonable conclusion. Despite this stoppage, which can be seen as too short of a time to make any accurate predictions, there is a clear affect that CO2 has on the environment and the ocean saturation of this CO2. / / b) I used the 3 articles that were given to me to read prior to this portion. I particularly took to the second article because it didn't discount for the changes that man was creating in the environment. Instead, it took into account the highly variable nature of the world's climate and that it may not be as drastic as predicted by some scientists. This gives a good prespective on drawing on the new data of 0 increase while still accepting old data of a stead increase. I also used background knowledge on this topic when taking into account CO2 and its affects on

		the environment.
WS13-2 (Pro/Doubt #2)	The graph looks to be increasing in terms of temperature over time. This was also mentioned in class. Professor Martin talked about increasing temperatures.	Due to the reading, it seems like there has been a lot of evidence that suggests global climate change has halted or stopped. The readings suggests that there has been no real warming for the past decade. It seems like the articles are suggesting that the data are skewed and out of proportion.
WS14-1 (Pro/Pro)	I am guessing that there is some sort of trick question here... Well, my understanding is due mainly to media such as news broadcasts and websites. I feel like it has been thrust upon us so hard that climate change is this huge deal and that if we do not fix our issues with pollution and such, that we will destroy the planet. I believe climate change was a bigger deal in the 1990's. We learned in class, as well as I have previous knowledge from other classes, about how destructive Freon was to the environment. Without Freon, I don't think climate change is as dramatic as it was. I also took an environmental conservation class where we learned about how climate change is affecting the world and such. I will be sort of surprised if the twist at this end of this project is that climate change never existed and the media has fed us lies all along...	I still believe that global warming is occurring. The three articles all referenced the same article as their only source saying that global warming has halted. Only having one source to come to conclusions upon I do not believe is very good science. It takes a lot more than one article to prove to me that something is true. However, the graph above is also from the Met Office. I find it strange that they have created a graph that shows continuing significant temperature increase, yet the article denies this. However, the graph is only from one location. Maybe this location has more significant temperature increases than other place. Still, I do continue to believe that global warming does exist and is still occurring to some extent.
WS14-2 (Doubt #2/Pro)	I chose the answer above for question two because the chart shows a clear fluctuation in global annual temperature leading up to 2020. At around 2010, it seems to be flattening out which led me to believe that this climate change is coming to a halt. I used simple background knowledge on how to interpret a line graph for the problem, and didn't take into	I chose the response based on my knowledge of analyzing graphs. There is a clear increase in temperature difference from 1950-2010, so the decision as to which answer was correct came down to A or B. According to all of the articles posted, climate change is continuing to occur and at rapid paces, which made me choose option A. / In class today, we did a climate change

	account any science-specific information or knowledge.	activity and learned of various changes in the global climate. However, we did learn strategies of mitigation to counter these changes. Overall, the climate change as of now is continuing and only we can prevent it from getting worse through mitigation. There will be a constant battle over the next few years as to the correct way to handle our current climate situation on Earth.

Table 2: Selected participant responses to the short answer question on the pre- and post-tests (middle and right columns, respectively) from both the CCC and WC courses. The identification for each participant is chosen such that the first letter represents what course the participant enrolled in (e.g., "C" = CCC, "W" = WC), the second along with the two-digit number representing the semester (e.g., "S14" = Spring 2014 semester), and finally the digit after the hyphen representing whether the participant responded on both tests with the "pro-climate change" response ("-1" on the end) or responded with two different choices ("-2" on the end). See text for more details.

4. Discussion and Conclusions

The goal of our study was to determine the effects of information disseminated by mass media on student critical analysis of climate science information, including determining whether or not the climate literacy of students enrolled within a climate science course was affected by misconceptions within mass media articles. Our motivation was based on the idea that as climate science educators, we are interested in understanding how mass media biases affect student understanding and interpretation of climate science information and how this affects student ability to understand the climate science material taught to them within a climate science course. We focus on the impact of climate science information disseminated by mass media given that the majority of members comprising the general public obtain science information primarily from online mass media sources.

We explore our research question (see Section 1) by constructing and implementing a climate science reading activity within two University of Wisconsin – Madison Department of Atmospheric and Oceanic Sciences courses, both holding no prerequisites with respect to what students should know prior to enrolling within each course. Participants chosen for this study were students that volunteered to participate. Participants were required to complete a short pre-test during the first week of the study regarding their thoughts on global climate change based on a graph showing trends in annually averaged global average temperature, and during the second week, participants read three articles about the graph they analyzed, completing a post-test upon completion of these articles within the same week.

Prior to reading the three mass media articles, it is clear that nearly all of the participants (i.e., 71 of 75) selected the only "pro-climate change" response available to them in the multiple-choice question on the pre-test, which stated that "global climate change is occurring and will continue to occur." Participants arrived at this choice given the data presented to them along with citing prior knowledge and course material within many of the short answer responses; this holds true for both the CCC and WC courses. After reading the articles and completing the post-test, however, the results in each course diverge from each other. For example, while the

majority of participants in the CCC course still responded with the "pro-climate change" response on the post-test (i.e., 35 of 46 participants), just over half of participants responded with this choice in the WC course (i.e., 15 of 29 participants).

Regardless of whether or not participants changed their responses on the multiple-choice question between the pre- and post-tests, qualitative analysis of the short-answer responses provided reveal that participants' analysis of the time series of global average temperature included consideration of the information provided by the mass media articles. For the randomly selected participants shown in Table 2 that selected the "pro-climate change" multiple-choice response on the post-test, participants chose their answer based on their background knowledge and/or course material (especially for those participants enrolled in the CCC course), with one of the participants even stating that it was "strange" that the articles denied what the graph was showing on the pre- and post-tests (i.e., participant WS14-1). As for the "-2" participants, it is clear (from those responses shown in Table 2 at least) that the articles had an effect on their responses. All participants cited the readings in their post-test short answer response, suggesting that the information in these articles influenced their decision. The final participant listed is still an interesting case, as the participant changed their response from a response "doubting" global climate change to the "pro-climate change" response, yet referenced the articles in their explanation.

One reason why a higher percentage of students in the WC course changed their response to a response expressing "doubt" with respect to global climate change on the post-test may have been due to differences in instruction regarding climate science between the CCC and WC courses. For example, in the CCC course, the instructors focused on educating students solely on climate science material, discussing observations and climate model data supporting the idea that global climate change is occurring and is likely due to anthropogenic (i.e., human-induced) forcing. On the other hand, the WC course was a survey course covering various topics related to weather and climate in general. While students did attend a couple of lectures that focused on climate change and specifically discuss climate science for two weeks during discussion section, the course did not exclusively discuss climate science. Therefore, students in the CCC course had more practice with critically analyzing climate science information compared to students in the WC course, which may have led to more students changing their responses to express "doubt" in global climate change on the post-test despite analyzing the exact same data on both tests. The results in Fig. 1 as well as Table 2 seem to support this claim, but further and more detailed investigation of this claim is likely required given the simplicity of this study.

While this study utilized a short pre- and post-test along with three articles that were purposely selected based on their biases relative to the time series provided in the tests, this study has revealed some interesting insight as to the potential effects of mass media information on student perception of global climate change. In revisiting our research question, it appears that students in both the CCC and WC courses were well equipped to critically analyze both the data on the tests as well as within the articles, but that students were still vulnerable to believing the information presented to them in the mass media articles, even if it presented information that was not consistent with the climate science field. Given that this had much less an effect on student perception of global climate change in the CCC course, this study seems to initially suggest that it is important for climate science educators to both help students critically analyze climate science material as well as show them a significant amount of data showing the agreement in the climate science field on global climate change. Without educating students substantially about the facts surrounding global climate change, students may be more vulnerable

to taking information from mass media as "truth" despite the misconceptions and biases that exist within these sources. Furthermore, while not specifically explored in this study, it may also be important to teach students about the biases and misconceptions that are present within mass media in order to help raise awareness of these issues and improve student ability to identify false scientific information. This is a topic that would be very interesting to investigate as future work and may also be beneficial for properly educating students about climate science.

5. References

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