

Scientists Warn of Rising Oceans From Polar Melt
Analysis of the Tenets of Nature of Science and Nature of Math

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Abstract

This paper explores a New York Times article published in May of 2014 concerning the study of the rise of ocean levels as a prime example of a resource that helps students understand the Nature of Science and the Nature of Math. The New York Times article, authored by Gillis and Chang, is first compared to two articles that outline the tenets of the Nature of Science (NOS). These tenets are applied based on The Next Generation Science Standards (NGSS) and by a Renee Schwatz article published in October, 2007 entitled “Whats in a Word” (WiaW). The New York Times article is then compared to two articles concerning the Nature of Mathematics (NOM). The first NOM article is by the American Association for the Advancement of Science (AAAS) and the second is a NGSS Appendix that outlines connections to standards in science and math. This paper examines the New York Times article on rising oceans in relation to the research articles to suggest that Gillis and Chang have provided a substantial example of the type of next generation resource posited in the NOS and NOM tenets to increase students’ understanding of the subjects.

Scientists Warn of Rising Oceans From Polar Melt

Analysis of the Tenets of Nature of Science and Nature of Math

The May 12, 2014 article in the New York Times by Justin Gillis and Kenneth Chang reports on scientists' warnings of rising oceans as a result of the melting of the West Antarctic ice sheet. Through the use of textual explanations of this occurrence in our environment, the authors provide a student of science and math with the data and the conclusions of teams of scientists from 1978 through the present. This article provides an educator with a resource that touches upon each of the eight major themes described in the Nature of Science Matrix documented by NGSS.

The first tenet of the Nature of Science Matrix is, "Science Investigations Use a Variety of Methods" (Next Generation Science Standards, 2013). The New York Times article provides the reader with the conclusions of two groups of scientists. Gillis and Chang state, "Two scientific papers released on Monday by the journals *Science* and *Geophysical Research Letters* came to similar conclusions by different means" (Gillis & Chang, 2014). One paper published by the University of California, employed satellite images and air measurements. There is an active link within the article that displays the actual report for the student to view. The second paper mentioned in the article utilizes computer modeling with measurements of ice flow to substantiate their findings. While the full report requires a subscription to *Science Magazine*, the student can view the abstract if the study.

The second tenet of NOS is, "Scientific Knowledge is Based on Empirical Evidence" (Next Generation Science Standards, 2013). This article provides access to files through active links including graphs and animations that reveal data from the study in 1978 and

the studies in 2014. The data can be analyzed to show evidence of the actual decline of the polar ice cap. Students can visit the NASA Ozone Hole Watch webpage to view daily maps of the Antarctic pole, records of the largest ozone hole, and animations of the daily progression of the ozone hole (NASA Goddard Space Flight Center, 2014).

The third tenet of NOS is well covered in this New York Times article. It is evident that the study of the polar ice cap is open to revision in light of new evidence. An active link to the IPCC Website provides access to the Fifth Assessment Report by this organization that states, “The Fifth Assessment Report (AR5) provides a clear and up to date view of the current state of scientific knowledge relevant to climate change” (IPCC, 2014). A link to a 1978 article by J.H. Mercer of the Institute of Polar Studies is provided within the New York Times article. Students can read, “If the global consumption of fossil fuels continues to grow at its present rate, atmospheric CO₂ content will double in about 50 years” (Mercer, 1978). This can be compared to a collection of satellite images annotated in the recent report issued by the University of California team. This collection shows the years of 1992, 1994, 1996 and 2000. It is startling to see the gradual regression of the polar ice cap that was predicted in the 1978 study by Mercer.

Dr. Rignot, the team leader of the University of California team, is quoted in the New York Times article as stating, “Today we present observational evidence that a large sector of the West Antarctic ice sheet has gone into irreversible retreat,” Dr. Rignot said in the NASA news conference. “It has passed the point of no return” (Gillis & Chang, 2014). This substantiates the fourth tenet of the Nature of Science Matrix which states that “Theories are explanations for observable phenomena” (NGSS, 2013).

Science is a way of knowing is the fifth tenet of NOS (NGSS, 2013). In the Schwartz article (WiaW), a distinction is made between data vs. evidence. “Evidence is a product of data interpretation, not the data itself” (Schwartz, 2007). We are presented with a wide variety of data in the New York Times article documented by two teams taking different approaches and reaching the same conclusion. Students can readily observe that all of the data gathered reached independent, yet identical conclusions.

The sixth tenet, “Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future” give the two groups of scientists the ability to consider powerful winds as the cause of the melting. “Scientists said the ice sheet was not melting because of warmer air temperatures, but rather because relatively warm water that occurs naturally in the depths of the ocean was being pulled to the surface by an intensification, over the past several decades, of the powerful winds that encircle Antarctica” (Gillis & Chang, 2014).

The Schwartz article (WiaW) suggests that traditional use of data to “prove” conclusions does not take into account the seventh tenet, Science is a Human Endeavor. Schwartz states, “This view does not acknowledge creativity, inference, or tentativeness as characteristics of science” (Schwartz, 2007). The article recommends that students move away from the mindset of one scientific method and accept that there are many approaches that can be taken. The New York Times article comments that, “The two teams worked independently, preparing papers that were to be published within days of each other. After it was learned that their results were similar, the teams and their journals agreed to release the findings on the same day” (Gillis & Chang, 2014). The teacher can use this example to substantiate that two groups of scientists used

two different approaches and cooperated with one another to publish their findings simultaneously.

The final tenet of NOS is that, “Not all questions can be answered by science” (NGSS, 2013). In the scientists’ analysis of the evidence of the melting of the West Antarctica ice sheet, the New York Times article reports, “The rise of the sea is likely to continue to be relatively slow for the rest of the 21st century, the scientists added, but in the more distant future it may accelerate markedly, potentially throwing society into crisis” (Gillis & Chang, 2014). The scientists cannot answer whether or not society will be thrown into a crisis. They can only report their conclusions on the evidence provided by the data. Governments and organizations must act upon laws and human habits based on the reports.

The NGSS Connections to the Common Core State Standards for Mathematics (Appendix L) addresses the need to reinforce the math by applying concepts to the study of science. The Connections document states, “Such tools can also be better understood, and more securely mastered, by applying them in a variety of contexts.” This document also posits, “During the middle school and high school years, students develop a number of powerful quantitative tools, from rates and proportional relationships, to basic algebra and functions, to basic statistics and probability “ (NGSS, 2013) It has been my observation, however, that students might be presented with the quantitative tools, but they do not know where to begin to apply them. If it is true that, “Mathematics is the chief language of science” (American Association for the Advancement of Science, 2014), as stated by the Science for All Americans website, then improvements must be made to instruct students in realizing where we begin to apply mathematical analysis to science topics. The New York Times article presents a significant

amount of data with the resulting graphs and analysis. The student of science and math can benefit from this reporting in two ways. First, this is evidence of how scientists are currently studying real world problems to formulate evidence of natural phenomena. The scientists are leading by example to our budding scientists. The creative and resourceful teacher will use the data provided in the article to guide the students in preparing their own explanations of the evidence. The article presents over three decades of data that provide fertile ground for mathematical studies.

Conclusions and Further Study

The Gillis and Chang article provides a wealth of information to help students understand the Nature of Science and the Nature of Mathematics. Since the Western Antarctic ice sheet is in an irreversible decline, future scientific and mathematical studies must point to measuring the increasing height of oceans and the depletion of coast lines. Students can draw conclusions and follow the progression of scientific and mathematical studies toward the domino effect of not heeding the warnings published from 1978 through the present.

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