

The Demise of the Knowledge–Action Gap in Climate Change Education

Margaret E. Mooney, Cathy Middlecamp, Jonathan Martin, and Steve A. Ackerman

ABSTRACT: Advances in science literacy documented in an undergraduate course on Climate and Climate Change at the University of Wisconsin–Madison (UW) in 2020 raised the question: Does the new climate knowledge translate into behavior change? Traditionally a “knowledge–action gap” has undermined educators’ efforts to galvanize actions toward mitigating climate change. Through a survey focused on carbon footprint and civic engagement and testimonials gleaned from students’ capstone elevator speeches, this study presents an encouraging update on young adults’ response to the climate crisis. By comparing responses to a similar survey distributed to UW students in another undergraduate course in 2021, we show that the course focused on Climate and Climate Change motivated behavior modifications that lighten the carbon footprint to a greater degree than a traditional introductory meteorology course.

KEYWORDS: Climate Change; Education

<https://doi.org/10.1175/BAMS-D-21-0256.1>

Corresponding author: Margaret E. Mooney, margaret.mooney@ssec.wisc.edu

In final form 1 July 2022

©2022 American Meteorological Society

For information regarding reuse of this content and general copyright information, consult the [AMS Copyright Policy](#).

AFFILIATIONS: **Mooney**—Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin–Madison, Madison, Wisconsin; **Middlecamp**—Nelson Institute for Environmental Studies, University of Wisconsin–Madison, Madison, Wisconsin; **Martin**—Department of Atmospheric and Oceanic Sciences, University of Wisconsin–Madison, Madison, Wisconsin; **Ackerman**—Cooperative Institute for Meteorological Satellite Studies, and Department of Atmospheric and Oceanic Sciences, University of Wisconsin–Madison, Madison, Wisconsin

Knowledge that galvanizes a greater good amplifies knowledge gains. Some examples include medical research that leads to cancer cures (McDowell et al. 2019), mRNA advances and vaccinations (Pardi et al. 2018), mathematics that facilitates space exploration (Shetterly 2018), or the revolutionary impact of *Silent Spring*—Rachel Carson’s science treatise on the adverse effects of pesticides—which energized the environmental movement during the 1960s (Carson and Darling 1962). This article investigates behavior change in undergraduate students at the University of Wisconsin–Madison inspired, at least in part, by knowledge gains regarding the science of climate change.

The University of Wisconsin–Madison (UW) has offered an online course on Climate and Climate Change (AOS 102) to undergraduates since 2013. Course content is designed to convey the physical science behind climate change. It has also evolved to include attributes toward a certificate in sustainability at the UW. By course completion, students should be able to do the following:

- 1) Analyze causes of and solutions to the sustainability challenge of lowering global temperatures, especially in terms of the Intergovernmental Panel on Climate Change (IPCC) future scenarios.
- 2) Describe the social, economic, and environmental dimensions of climate change from local and international perspectives and be able to identify trade-offs, biases, and interrelationships at an undergraduate level.
- 3) Apply sustainability principles and/or frameworks to address the challenge of climate change, climate justice, and health inequities related to air quality and other environmental degradations resulting from carbon pollution.

Advances in climate literacy among students from AOS 102 were recently documented by comparing pre- and postcourse surveys on knowledge gains of cohorts from 2018 and 2019 (Dzambo et al. 2020). But did the new knowledge translate into new actions for these students? In an effort to assess behavior change resulting from the class, another survey was distributed to cohorts from 2018, 2019, 2020, and 2021, asking whether the course had influenced their carbon footprint related behaviors. Out of 221 students who received the survey link after completing the course, 71 students participated, for a 32% response rate. Eighty-one percent of those students reported increased actions to reduce their personal carbon footprint as a result of taking the UW class on Climate and Climate Change, pointing to the mitigation potential of education (Cordero et al. 2020). A majority of students also credited the course with increasing their confidence and ease discussing climate change with family and friends and inspiring them to become more civically engaged. A vast majority (93%) indicated their commitment to vote in the next election.

These survey results are impressive, but could factors other than the 8-week course be influencing young adults? This article delves deeper into undergraduates' motivation to address the climate crisis through the lens of current literature and additional insights gleaned from firsthand testimonials from the UW students who took the online Climate and Climate Change course in 2020 and 2021.

The knowledge–action gap

Social science research has long pointed to a “knowledge–action gap” around climate change where sharing the science does not significantly influence behaviors, opinions, or actions (Knutti 2019). In fact, some audiences dig deeper into preexisting notions. Advancing climate literacy or knowledge regarding climate change rarely inspired action. To bridge the knowledge–action gap, climate educators were encouraged to create place-based content (Schweizer et al. 2013) highlighting changes to nearby environmental assets or cherished places and pastimes, and to frame their message (Nisbet 2009) to establish common ground to connect with intended audiences. In a recent systematic review to identify effective climate change education strategies, personally relevant and meaningful information was revealed as a common top theme (Monroe 2019).

Student testimonials on climate change

Our experience from teaching AOS 102 for nearly a decade suggests that young adults come to the science of climate change with a different perspective from undergraduates 10 or 20 years ago. They do not have to connect to Wisconsin or the Great Lakes to want to protect the environment in this region and beyond. Their common ground is our common humanity on Earth. As one student, Ree, said in her capstone elevator speech during the summer of 2020: “We were brought up and educated in a time when it was being discovered that climate change was a huge issue ... I think there is some hope for us because as we move into positions of power ... we have a brand new viewpoint about how the environment works and how much we should care about it - and what we need to do.”

Indeed, a recent Gallup poll (Reinhart 2018) found that the extent to which Americans take global warming seriously differs by age, with adults under age 35 typically much more engaged than those 55 and older. The generation gap was especially apparent in the belief that global warming will pose a serious threat in one's own lifetime. This and other polls (Tyson and Kennedy 2020) also identified partisan divides when it comes to addressing climate change. Kiara from AOS 102 advises, “Regardless of what party you belong to politically – Republicans or Democrats – you should try to learn about the science behind climate change and what it could do to affect you ... if everyone in the whole world or even just the United States would take small steps to reduce their carbon footprint and reduce their pollution we could make great strides in slowing or stopping climate change” (Fig. 1).

The range of future scenarios for today's undergraduate students is significant in terms of air quality, water availability, weather-related risks and losses, and health; furthermore, disproportionate burden will be shouldered by the world's poorest and most marginalized communities (IPCC 2014, 2021). Awareness of impacts on vulnerable populations is critical for equitable strategies for responding to climate change (EPA 2021). Perhaps not surprisingly, the topic of climate justice loomed large for UW students in AOS 102, sparked in part by the Black Lives Matter (BLM) movement during the summer of 2020. Many weaved BLM, racial disparities, and other social justice issues into their weekly discussion forum posts. While the course taught science and sustainability, the students typically took a wider holistic approach to discussing the climate crisis in the United States, pointing to redlining and other historically discriminatory practices as part of the problem while listing food deserts, degraded air quality, and higher numbers of COVID-19 cases as related injustices.

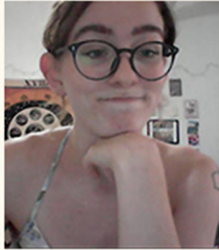


CLIMATE CHANGE ELEVATOR SPEECHES, 2021 & 2020

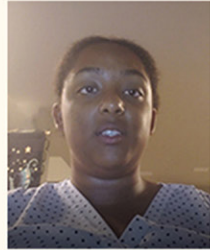
Students who take *Climate and Climate Change* (AOS 102) at the University of Wisconsin-Madison are tasked to create an "elevator speech" for the last week of class imagining they're on an elevator and someone asks "what do you think about climate change?" With less than 2 minutes to respond, here are some thoughtful responses from 2021 and 2020.



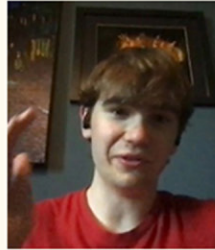
[Jenna, 2021](#)



[Lillian, 2021](#)



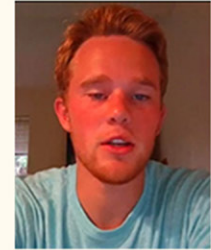
[Ashley, 2021](#)



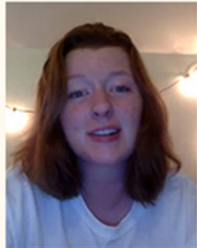
[Zach, 2021](#)



[Payten, 2021](#)



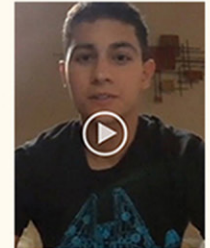
[Gabriel, 2021](#)



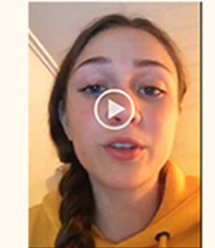
[Brenna, 2021](#)



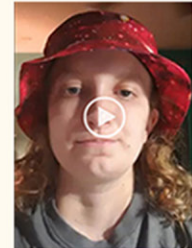
[Ree, 2020](#)



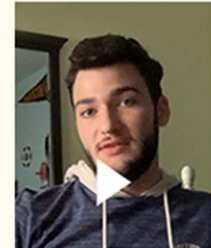
[Nic, 2020](#)



[Kora, 2020](#)



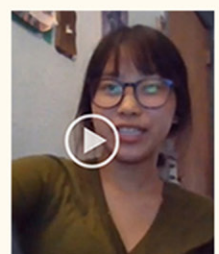
[Kiara, 2020](#)



[Josh, 2020](#)



[Connor, 2020](#)



[Maleee, 2020](#)



[Paige, 2020](#)



[Matthew, 2020](#)



[Damitu, 2020](#)



[Frank, 2020](#)

Learn more about AOS 102 from the [Bulletin of the American Meteorological Society \(BAMS\)](#).

Fig. 1. UW Climate Change Elevator Speeches online (with permission) at <https://cimss.ssec.wisc.edu/education/AOS102/>.

Most undergraduates are keenly aware that policies and actions undertaken in this decade will influence societal and environmental outcomes over the remainder of their lives, and thus have huge incentive to take action on climate change. To quote Frank from the summer of 2020: "I think simply, climate change is the single greatest existential threat that humanity has and will continue to face throughout the 21st century... the science is in ... I don't know how to make this any clearer than we need to start actually addressing this issue like it will be the end of humanity, because quite frankly it will be." And Connor: "Climate change is the largest threat humanity has ever faced. We're in the midst of a pandemic, we've been through wars, this is the biggest threat. I think it's a heart issue... renewable energy is a mostly untapped industry in America – if we switch to it now we're going to have so many new jobs opening up... I think sacrificing certain wasteful practices is worth it if we get more jobs, cleaner air and water, a better future and (begin) correcting environmental injustices."

Many are frustrated, per Lillian from summer 2021: “I think that it’s messed up that corporations get to pollute our earth and get away it ... I agree that I should be consciously thinking about my carbon footprint ... however, that doesn’t really matter in the grand scheme of things when billionaires can take private jets and apparently now play space cowboy and essentially erase whatever hard work any individuals do to limit their emissions within a matter of minutes.” Gabriel (2021) invokes humility: “Climate Change is the issue to end all issues ... I think it really depends on humility as a race, as a human race, as a species, that we’re just one of so many other species on this planet and, we should not be destroying it.”

Comparing carbon footprint data from two different AOS classes

In an effort to explore the degree to which new knowledge from AOS 102 motivated undergraduates to reduce their carbon footprint, we distributed nearly identical survey questions to another UW undergraduate course in the Department of Atmospheric and Oceanic Sciences (AOS) during the spring of 2021. AOS 100, or Weather and Climate, is the current version of the introductory meteorology course offered at the UW since AOS was founded as the Meteorology Department in 1948. It is a 12-week course taught in a large lecture hall with enrollment capped at 380 students. The course description follows:

AOS 100: Weather & Climate (3 credits) Nature and variability of wind, temperature, cloud and precipitation. Storm system, fronts, thunderstorms, tornadoes and their prediction. Air composition and pollution. Global winds, seasonal changes, climate and climatic change. Discussion session will include weather map analysis and basic quantitative lab exercises.

AOS 102 on Climate and Climate Change debuted in 2013. It is offered online during the 8-week summer semester and capped at 90 students. The course description follows:

AOS 102: Climate and Climate Change (3 credits) This course describes the basic climate principles governing the climate system. It describes the climate and climate variability at present, climate evolution in the past, and the projected climate change into the future. The scientific principles underlying the natural and anthropogenic greenhouse effect and climate model forecasts are elucidated.

Three hundred and forty eight students who enrolled in the spring 2021 offering of AOS 100 Weather and Climate received the carbon footprint survey toward the end of the semester while still taking the class. Two hundred and seventy-four responded for a 79% response rate. They earned 1 point (out of 100) toward their final grade for taking the survey. Conversely, students from AOS 102 Climate and Climate Change received the survey after completing the course and without incentivization. A third (34%) took AOS 102 in 2018 and 2019, and responded to the survey in 2020, up to 2 years after completing the Climate and Climate Change course. The other two-thirds responded during the fall semesters of 2020 and 2021, several weeks after the end of the summer semester when they took the class. The AOS 102 survey was distributed to 221 students and 71 responded for a 32% response rate. However, students who graduated and left the UW would not have received the survey link so the actual response rate is likely a little higher.

The questions in both surveys were worded the same, but revised for students in Weather and Climate to omit reference to the AOS 102 course on Climate and Climate Change. For example, the transportation question posed to AOS 102 students was as follows:

Please indicate the extent that taking Climate and Climate Change has motivated you to drive less by car pooling, taking public transport, walking or biking (response choices: not at all, somewhat, a great deal)

The same question was posed to AOS 100 Weather and Climate students as follows:

Please indicate the extent that you try to drive less by car pooling, taking public transport, walking or biking (response choices: not at all, somewhat, a great deal)

Table 1 summarizes student responses from both surveys. Across all categories and responses, AOS 102 students who took Climate and Climate Change indicated greater behavior change a clear majority of the time. Perhaps the most striking difference was in communicating climate change (*How often do you currently discuss topics related to climate and climate change with others?*), with AOS 102 Climate and Climate Change students being nearly 5 times more likely than AOS 100 Weather and Climate students to discuss climate change “as often as possible.” And according to climate scientist Dr. Katharine Hayhoe in her 2018 Ted Talk, the most important thing we can do to fight climate change is talk about it (Hayhoe 2021).

Maylee from AOS 102 voiced similar sentiment in 2020: “There’s so much information and it all seems so overwhelming. But I feel like the first place to start making a change is to start having conversations like these and educating yourself on this topic.”

Looking solely at AOS 100 Weather and Climate survey responses it should be noted that students indicated modifying behaviors to reduce carbon footprint either “somewhat” or “a great deal” 74% of the time. This is noteworthy. While less than the 81% of AOS 102 Climate and Climate Change students who reported reducing carbon footprint, these results show that a majority of UW undergraduates surveyed are modifying personal behaviors to mitigate climate change, a hopeful scenario for humanity. No doubt guidance around sustainability practices prominent on most college campuses is making a difference. For example, the UW Office of Sustainability routinely promotes sustainable lifestyle practices that

Table 1. University of Wisconsin–Madison undergraduate survey responses.

UW-Madison undergraduate carbon footprint survey responses		
Topic/behavior	AOS 102 (n = 71/221)	AOS 100 (n = 274/348)
	Climate and climate change	Weather and climate
Shifting diets toward plant-based meals		
Somewhat + a great deal	77%	49%
A great deal	37%	16%
Eliminating food waste		
Somewhat + a great deal	85%	88%
A great deal	37%	32%
Reducing automobile travel		
Somewhat + a great deal	86%	87%
A great deal	31%	26%
Reducing air travel		
Somewhat + a great deal	62%	57%
A great deal	20%	24%
Reducing energy and water usage		
Somewhat + a great deal	94%	87%
A great deal	51%	27%
Sustainable purchasing		
Somewhat + a great deal	85%	71%
A great deal	38%	14%
Civic engagement		
Somewhat + a great deal	63%	69%
A great deal	17%	12%
Likelihood of voting		
Very likely + 100% likely	93%	87%
100% likely	77%	64%
Communicating climate change		
Only if someone else brings it up	6%	20%
Very rarely	6%	18%
Occasionally	65%	58%
As often as possible	23%	5%

prioritize responsibility to people and the planet. It is also likely that social media stories promoting youth climate activism (Sabherwal et al. 2021) contributes to a sense of efficacy and call to action among undergraduate students.

Conclusions

In this paper, we present evidence documenting that an undergraduate course focused on Climate and Climate Change (AOS 102) can better galvanize actions to address the climate crisis than a traditional introductory meteorology course. Not only did the UW students who completed AOS 102 indicate greater behavior change a majority of the time, one-third reported behaviors that reduce carbon footprint a year or two after taking the course. Thus, our data suggest that behavior modifications attributed to knowledge gains in the class can become lasting lifestyle choices. In our study, some inherent bias is likely since the students sampled are science-interested individuals invested in the subject area. However, both AOS courses featured in this study are offered for nonmajors, and thus reach lower-division undergraduates considering a wide range of careers and futures. Testimonials from AOS 102 students and reported behavior modifications are inspirational and impactful.

We also present findings from recent publications and student quotations documenting incentives young people have to lighten carbon footprint and mitigate climate change. These incentives catalyze knowledge into action. Future research in this area would benefit from pre- and postcourse surveys rather than querying students just once. Multiyear surveys could provide further insight on the longevity of students' behavior modifications.

Based on the evidence collected via survey response and capstone elevator speeches, students who take the AOS 102 undergraduate course on Climate and Climate Change at the University of Wisconsin–Madison are heralding the demise of the knowledge–action gap in climate education. Their actions include 1) talking about climate change, 2) increased civic engagement, and 3) making lifestyle changes to reduce carbon footprint.

Acknowledgments. The authors thank Andrew Dzambo for documenting advances in climate literacy by analyzing two years of pre- and postcourse student survey data from AOS 102 thereby laying the groundwork for this exploration of behavior change and civic engagement based on knowledge gains.

Data availability statement. Datasets analyzed for this study include survey responses (displayed in Table 1) and student quotations from capstone elevator speeches available online and posted with permission at <https://cimss.ssec.wisc.edu/education/AOS102/>.

References

- Carson, R., and L. Darling, 1962: *Silent Spring*. Houghton Mifflin, 368 pp.
- Cordero, E. C., D. Centeno, and A. M. Todd, 2020: The role of climate change education on individual lifetime carbon emissions. *PLOS ONE*, **15**, e0206266, <https://doi.org/10.1371/journal.pone.0206266>.
- Dzambo, A. M., M. Mooney, Z. Handlos, S. Lindstrom, Y. Hang, and S. A. Ackerman, 2020: An interactive online course in climate and climate change: Advancing climate literacy for non-atmospheric science majors. *Bull. Amer. Meteor.*, **101**, E1697–E1708, <https://doi.org/10.1175/BAMS-D-19-0271.1>.
- EPA, 2021: Climate change and social vulnerability in the United States: A focus on six impacts. U.S. Environmental Protection Agency Rep. EPA 430-R-21-003, 101 pp., www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf.
- Hayhoe, K., 2021: *Saving Us*. Simon and Schuster, 320 pp.
- IPCC, 2014: *Climate Change 2014: Synthesis Report*. R. K. Pachauri and L. A. Meyer, Eds., IPCC, 151 pp.
- , 2021: Summary for policymakers. *Climate Change 2021: The Physical Science Basis*, V. Masson-Delmotte et al., Eds., IPCC, 40 pp., www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf.
- Knutti, R., 2019: Closing the knowledge-action gap in climate change. *One Earth*, **1**, 21–23, <https://doi.org/10.1016/j.oneear.2019.09.001>.
- McDowell, S., S. L. Rausch, and K. Simmons, 2019: Cancer research insights from the latest decade, 2010 to 2020. American Cancer Society Research, www.cancer.org/latest-news/cancer-research-insights-from-the-latest-decade-2010-to-2020.html.
- Monroe, M. C., R. R. Plate, A. Oxarart, A. Bowers, and W. A. Chaves, 2019: Identifying effective climate change education strategies: A systematic review of the research. *Environ. Educ. Res.*, **25**, 791–812, <https://doi.org/10.1080/13504622.2017.1360842>.
- Nisbet, M. C., 2009: Communicating climate change: Why frames matter for public engagement. *Environ. Sci. Policy Sustain. Dev.*, **51**, 12–23, <https://doi.org/10.3200/ENVT.51.2.12-23>.
- Pardi, N., M. J. Hogan, F. W. Porter, and D. Weissman, 2018: mRNA vaccines—A new era in vaccinology. *Nat. Rev. Drug Discovery*, **17**, 261–279, <https://doi.org/10.1038/nrd.2017.243>.
- Reinhart, R. J., 2018: Global warming age gap: Younger Americans most worried. Gallup, <https://news.gallup.com/poll/234314/global-warming-age-gap-younger-americans-worried.aspx>.
- Sabherwal, A., and Coauthors, 2021: The Greta Thunberg effect: Familiarity with Greta Thunberg predicts intentions to engage in climate activism in the United States. *J. Appl. Soc. Psychol.*, **51**, 321–333, <https://doi.org/10.1111/jasp.12737>.
- Schweizer, S., S. Davis, and J. L. Thompson, 2013: Changing the conversation about climate change: A theoretical framework for place-based climate change engagement. *Environ. Commun.*, **7**, 42–62, <https://doi.org/10.1080/17524032.2012.753634>.
- Shetterly, M. L., 2018: *Hidden Figures*. HarperCollins, 384 pp.
- Tyson, A., and B. Kennedy, 2020: Two-thirds of Americans think government should do more on climate. Pew Research Center, www.pewresearch.org/science/2020/06/23/two-thirds-of-americans-think-government-should-do-more-on-climate/.