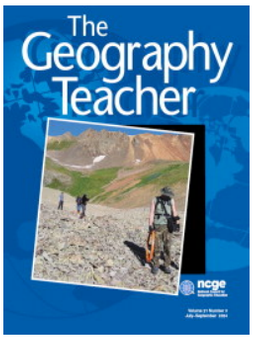


The Geography Teacher

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rget20

Using the Chesapeake Bay to Learn Climate Change

Michael Allen, Jamie Young, Lydia Grote, Anna Simon, Shelly Carter, Michele Sullivan, Gretchen Maxwell, Gabrielle Hurst & Jennifer Whytlaw

To cite this article: Michael Allen, Jamie Young, Lydia Grote, Anna Simon, Shelly Carter, Michele Sullivan, Gretchen Maxwell, Gabrielle Hurst & Jennifer Whytlaw (11 Nov 2024): Using the Chesapeake Bay to Learn Climate Change, The Geography Teacher, DOI: 10.1080/19338341.2024.2413514

To link to this article: https://doi.org/10.1080/19338341.2024.2413514

Published online: 11 Nov 2024.

THE GEOGRAPHY TEACHER
https://doi.org/10.1080/19338341.2024.2413514

Routledge
Taylor & Francis Group

LESSON PLAN

Using the Chesapeake Bay to Learn Climate Change

Michael Allen[a], Jamie Young[b], Lydia Grote[c], Anna Simon[d], Shelly Carter[e], Michele Sullivan[f], Gretchen Maxwell[g], Gabrielle Hurst[h], and Jennifer Whytlaw[i]

[a]Department of Geography and Environmental Planning, Towson University, Towson, Maryland, USA; [b]Old Donation School, Virginia Beach City Public Schools, Virginia Beach, Virginia, USA; [c]James River High School, Chesterfield County Public Schools, Midlothian, Virginia, USA; [d]AECOM, Virginia Beach, Virginia, USA; [e]Central Elementary, Rockbridge County Public Schools, Lexington, Virginia, USA; [f]Mantua Elementary School, Fairfax County Public Schools, Fairfax, Virginia, USA; [g]Westlawn Elementary School, Fairfax County Public Schools, Falls Church, Virginia, USA; [h]W.T. Cooke Elementary School, Virginia Beach Public Schools, Virginia Beach, Virginia, USA; [i]Department of Political Science and Geography, Old Dominion University, Norfolk, Virginia, USA

The State of Climate Education

Studies have indicated climate literacy remains low across the U.S. K–12 system, with Virginia receiving a failing grade in 2020 (NCSE 2020). As of 2020, Virginia was one of only six states that had not adopted Next Generation Science Standards (NGSS) or the National Research Council (NRC) framework for K–12 Science Education Framework (NCSE 2020).

While a few states have or are in the process of adopting climate-related standards, it remains unclear how the issue will manifest in the classroom (State of New Jersey Department of Education 2020; Monk 2022; Maryland State Department of Education 2023; Michigan House 2023; Branch 2023; U.S. Congress 2024). "A few state standards promote the false narrative that the existence, cause, and seriousness of climate change are a matter of debate among climate scientists" (NCSE 2020). For decades, various stakeholders have aimed to influence science curriculum, with the fossil fuel industry intentionally casting doubt on the causes of and consensus surrounding anthropogenic climate change (Supran and Oreskes 2017; Supran, Rahmstorf, and Oreskes 2023). Researchers found that many state science standards did one or more of the following:

1) Promoted a false narrative,
2) Failed to address climate change directly in the classroom,
3) Muddied the scientific consensus on climate change, and
4) Missed opportunities to inspire hope (NCSE 2020).

In August 2023, the Florida Department of Education approved the adoption of PragerU resources to teach social science. PragerU is a U.S. nonprofit "focused on changing minds through the creative use of digital media" (PragerU 2023). A variety of climate-denying videos exist in their portal, elevating common scientific myths surrounding the causes and consequences of anthropogenic climate change (Waldman 2023; Shepherd 2013). Concerns persist that other states will follow suit, resulting in increased confusion about climate facts.

Given these obstacles, high demand for climate literacy exists within the K–12 system, but working with Virginia educators reveals that many lack the content knowledge or teaching resources to effectively communicate the science, present the risks, or offer solutions to address the climate crisis (NCSE 2020). Educators also need professional education about climate change, as many have never had a course on the topic (Bloom 2021; Plutzer et al. 2016; Henderson and Drewes 2020; Lehtonen, Salonen, and Cantell 2019). Up-to-date teaching resources and easy-to-understand case studies on the topic may strengthen one's ability to integrate the topic into and across curricula.

While some states offer location-specific resources for climate change education (NOAA 2022; Rutgers University 2022), no repository for many other states, including Virginia, currently exists. The Virginia Geographic Alliance (VGA 2024) is a nonprofit organization that promotes geo-literacy by providing effective professional development programs that enhance the teaching and learning of geography and supports climate change literacy. Geography offers an opportunity to bridge the gap between social studies and natural and environmental science content.

Chesapeake Bay Climate Institute

The Virginia Geographic Alliance's Chesapeake Bay Climate Institute addresses intersectional climate concerns including rising seas, saltwater intrusion, species migration, and infrastructure challenges (USGCRP 2023). Research indicates that local, active experiences have a significant impact on learning (Morris 2020). Place-based learning is interdisciplinary, situating people and places and drawing on the interconnection with nature (Woodhouse and Knapp 2000). Since 2019, the Virginia Geographic Alliance has supported professional development programs aimed at increasing climate literacy, introducing participants to the issue of climate change through guest lectures, hands-on outdoor learning opportunities, and visualization techniques. The multi-day institute culminates with a field experience to Tangier Island, a historic Bay community on the front lines of

CONTACT Michael Allen mallen@towson.edu Department of Geography and Environmental Planning, Towson University, Towson, MD, USA.

anthropogenic climate change that will likely become one of the first sites of U.S. climate refugees (Scientific American 2015).

The intentional decision to immerse educators in situ, with the Chesapeake Bay, enhances educators' sense of place and connection to academic content. As a result, the knowledge and skills are transferable and replicated with respective learning communities and classrooms. This place-based connection to content provides personal context and connection to concepts taught in the classroom, deepening teachers' understanding of climate issues and enabling them to foster a connection between their students and the Bay.

Climate education encompasses many complex dimensions, drawing on all forms of educational techniques (Stevenson et al. 2020; Fauville et al. 2020; Rooney-Varga et al. 2020) across all disciplines and grade levels. The experience at the institute on Virginia's Eastern Shore created opportunities for participants to talk with individuals and communities on the front line of climate change, fostering critical thinking and personal connections and allowing learners to better understand complex concepts, develop problem-solving skills, and cultivate a sense of agency while considering impacts and solutions (Morris 2020).

Educators from divergent disciplinary backgrounds, including Earth Science, Environmental Science, Human Geography, History, Mathematics, Chemistry, Special Education, Ecology, Communications, Graphic Design, Political Science, English, and Music, have participated, brainstorming and developing lessons relevant to their student populations and standards of learning. Cross-disciplinary collaboration has provided fruitful discussion related to teaching climate change across subject areas and grade levels. Interlocking climate change to various disciplinary content areas has enabled educators and students to better understand how the climate crisis affects so many aspects of society.

The experience also fosters creativity, as educators grapple with teaching climate change while avoiding the term. For example, in a history class, students may focus the climate discussion on redlining, the Dust Bowl, or the Little Ice Age (Plumer and Popovich 2020; Hoffman, Shandas, and Pendleton 2020; NOAA 2018; Mann 2002). Marine biologists may focus on how ecosystems adapt or evolve in the face of environmental change (NOAA 2019). Business curricula may focus on how extreme events impact economic well-being or infrastructure investments (NCEI 2022; Deloitte 2022; Allen and Allen 2019; Sanderson and O'Neill 2020; Hsiang et al. 2017). Participants used the geo-literacy framework to design classroom activities, and three lessons are presented as part of this symposium:

- Climate Change and Animal Habitat: Investigating the Chesapeake Bay
- Analyzing the Effect of Impervious Surfaces on Flooding
- Dissolved Oxygen and Climate Change

The Geo-Literacy Framework

The geo-literacy framework aims to build geographic literacy through the three I's: Interactions, Interconnections, and Implications. Understanding the dynamic physical and cultural forces that interact across our world, geo-literacy is essential for addressing the challenges of the 21st century. The National Geographic Society Geo-Inquiry Process is a five-step method designed to address a local issue (National Geographic Society 2017). Students first formulate a question (Ask). The question must be linked with a local issue. Students then collect data (Collect); data may be qualitative or quantitative, formal or informal. The next steps of the Geo-Inquiry Process are Visualize and Create. Depending on the grade level, students may draw mental maps or use ArcGIS to help organize and communicate their data. The final stage is important: Action. Students use the new knowledge to develop some type of action or project (Oberle 2020; Schell, Mohan, and The Instructional Materials and Professional Development Committee 2013).

Expanding Beyond the Chesapeake Bay

While exploration often centers on places far away, local exploration significantly impacts the learning environment, scaling information to the region, nation, and world. What one person sees is only part of the story (Meinig 1979), and local, place-based exploration empowers participants to ask questions, develop new and challenge old hypotheses, explore novel information, and form new perspectives (Krakowka 2012; Mehta and Fine 2019; Jose, Patrick, and Moseley 2017; Bliss 2016). The Chesapeake Bay Climate Institute integrated the social and environmental science context, while also allowing for the development of curricula for a variety of other content areas.

Often, individuals discuss climate as *there and their* issues.

There Issue: Pakistani flooding occurred *over there.*

Their Issue: The heat wave in the Pacific northwest really impacted *those* people.

Local storytelling creates empathy while inspiring people to act (Bennett 2013). Through the local exploration at the Chesapeake Bay Climate Institute, geographic inquiry contextualizes climate stories as neither *there* nor *their* but rather here in the Chesapeake Bay, and today. Such linkages can be expanded to larger scales. Estuaries all around the world are experiencing similar impacts of acidification and habitat modification. People who live in coastal environments—whether Miami, Tangier Island, or Bangladesh—experience flooding, erosion, and future retreat. Scaling knowledge provides an avenue for educators to discuss climate change as both there and here, us and them, together. Such discourse empowers learners to think about the topic of climate change within disciplinary silos but also integrate across curricula. The issue of climate change does not need to be a distant topic; the Chesapeake Bay Climate Institute contextualizes the causes, impacts, and solutions for participants.

Conclusion

Integration is needed in science education, where standards of learning often compartmentalize topics without consideration for how other course material beyond the original, narrow scope may intersect with other disciplines. The lack of integration across science and "non-science" courses is problematic yet offers opportunity. Addressing and solving the climate crisis requires integrated approaches across disciplinary silos and localized, compelling experiences empower stakeholders to take climate action. Climate change is ultimately about people—our

communities, health, economies, lived experiences—coping with a warming planet, preparing for the next storm, and reducing greenhouse gasses in the atmosphere (Kwauk and Winthrop 2021; Project Drawdown 2022). Through local experiential learning, educators may increase climate knowledge and analytical skills and share these experiences with their local communities and student populations. Climate change is not a *there* or *their* issue, and we hope that the learning materials establish examples through which educators may integrate the topic of climate change into curriculum.

Acknowledgements

This review provides examples of teacher lessons developed at the Chesapeake Bay Climate Institute. We thank the Virginia Geographic Alliance, which supported this project. A special thanks goes to Dr. Georgeanne Hribar, who offered geospatial expertise; to the two Grosvenor Fellows, Judith Painter and Becky Schnekser; and to our Virginia Institute of Marine Science and Tangier Island partners for adding valuable, global perspective. We would like to personally thank all of the participants for sharing their knowledge and making the VGA Chesapeake Bay Climate Institute an incredible experience. We also would like to acknowledge the reviewers and editor for valuable contributions. Finally, we thank Dr. Don Zeigler, one of the founding members of the Virginia Geographic Alliance, for serving as a mentor. Don, who passed away in 2023, joined us on Tangier Island for our institutes. His memory inspires us to improve geographic literacy in the Chesapeake Bay watershed.

Disclosure Statement

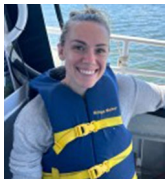
No potential conflict of interest was reported by the author(s).

Notes on Contributors

Michael Allen, PhD, is an Assistant Professor of Climatology within the Department of Geography and Environmental Planning at Towson University. He previously served as co-coordinator of the Virginia Geographic Alliance and Geography Program Director at Old Dominion University. In addition to having interests in geographic literacy and climate education, Dr. Allen explores the intersection of weather, climate, and human health. In 2023, he was a U.S. Fulbright Scholar in Serbia.

Jamie Young is a National Geographic–Certified Educator and Geo-Inquiry Ambassador and has more than 20 years of teaching experience in public schools/college. She taught Earth Science for 19 years, and she exposed her students to experiential, place-based learning. She is presently a STEAM educator at Old Donation School in Virginia Beach, Virginia. She integrates climate issues into her coding and engineering design activities. An active member of the Virginia Geographic Alliance, Jamie has both a BS in Criminal Justice and Political Science and a master's degree in Education.

Lydia Grote is a Google-Certified Educator and National Science Foundation Robert Noyce Scholar. With more than 5 years of teaching experience in formal and informal K–12 education settings, Lydia works to further high-quality teaching in underserved areas. She most recently taught oceanography and environmental science at James River High School in Chesterfield County, Virginia. Lydia is a graduate of The College of William & Mary with a BS in biology and marine science and an MA in Education, with a specialization in curriculum and instruction in secondary science.



Anna Simon is presently a Geologist II at AECOM in Virginia Beach, Virginia. She previously was a science educator at Renaissance Academy in Virginia Beach, Virginia, for five years. As an alternative education teacher, Anna exposed her students to the community around them through local field trips and scientific inquiry. Anna earned a BS in Geology from Marshall University and a master's degree in Oceanography from the University of Rhode Island.

Shelly Carter, an elementary school educator for more than 10 years, currently teaches preschool in Rockbridge County, Virginia. With a passion for social emotional learning and integrating students' well-being with all academic learning, she incorporates outdoor learning experiences into her curriculum. Shelly earned both a BBA and MAT from James Madison University.

Michele Sullivan incorporates aspects of the natural world into her lessons and emphasizes outdoor learning. For more than 10 years, Michele has been a fifth-grade teacher with Fairfax County Public Schools. As an Eco Teams Leader for Mantua Elementary School, Michele works with students to plant trees on campus and install native, pollinator species in the bioretention facilities. Michele earned a BA in Quantitative Economics from Stanford University and an MBA from the University of Virginia's Darden School of Business.

Gretchen Maxwell is an Advanced Academic Resource Teacher in Fairfax County, Virginia. A career-switcher, she wanted to implement change by encouraging and advocating for the students in her neighborhood Title 1 school, Westlawn Elementary. She is the daughter, sister, and mother of scientists and loves nothing more than using different pathways to expose students to new experiences outside. Gretchen earned her MS in gifted education from Arkansas State University.

Gabrielle Hurst is a K–6 Gifted Resource Educator in the Virginia Beach City Public School System and Virginia Master Naturalist. These experiences help her incorporate citizen science activities into the classroom. For the last 15 years, her experience has included serving as a classroom instruction for third and fifth grade, a sixth-grade Advanced Life Science teacher, and a Gifted Resource Teacher assisting grades K–5. She also oversees school garden projects and helps students learn about organic growing, composting, and sustainable acts. Gabrielle earned a BBA in accounting and an MS in Education from Old Dominion University.

Jennifer Whytlaw, PhD, GISP, is an Assistant Professor of Applied GIS in the Department of Political Science and Geography at Old Dominion University. Her research focuses on utilizing geospatial analyses and visualizations to understand how environmental hazard events influence personal understanding of vulnerabilities within communities.

ORCID

Michael Allen http://orcid.org/0000-0002-8897-3901
Jennifer Whytlaw http://orcid.org/0000-0002-1612-8805

References

Allen, M. J., and T. R. Allen. 2019. Precipitation trends across the Commonwealth of Virginia (1947–2016). *Virginia Journal of Science* 70 (1):4.

Bennett, T. 2013. *The power of storytelling: The art of influential communication*. Verb Technology, In. ISBN: 13-978-1936631087.

Bliss, L. A. 2016. Phenomenological research: Inquiry to understand the meanings of people's experiences. *International Journal of Adult*

Vocational Education and Technology 7 (3):14–26. doi: 10.4018/IJAVET.2016070102.
Bloom, A. 2021. With great care, climate change is in the classroom. The Nature Conservancy. https://www.nature.org/en-us/about-us/who-we-are/how-we-work/youth-engagement/climate-change-education-us/.
Branch, G. 2023. Climate change in a Michigan environmental literacy bill. National Center for Science Education. https://ncse.ngo/climate-change-michigan-environmental-literacy-bill.
Deloitte. 2022. Inaction on climate change could cost the US economy $14.5 trillion by 2070. Deloitte Report. https://www2.deloitte.com/us/en/pages/about-deloitte/articles/press-releases/deloitte-reportinaction-on-climate-change-could-cost-the-us-economy-trillions-by-2070.html.
Fauville, G., A. C. M. Queiroz, and J. N. Bailenson. 2020. Virtual reality as a promising tool to promote climate change awareness, In *Technology and Health: Promoting Attitude and Behavior Change*, ed. Y. Kim and H. Song 91–108. Elsevier https://doi.org/10.1016/B978-0-12-816958-2.00005-8.
Henderson, J., and A. Drewes. 2020. Teaching climate change in the United States. In *Teaching climate change in the United States*, ed. J. Henderson and A. Drewes, 1–10. London: Routledge https://doi.org/10.4324/9780367179496.
Hoffman, J. S., V. Shandas, and N. Pendleton. 2020. The effects of historical housing policies on resident exposure to intra-urban heat: A study of 108 US urban areas. *Climate* 8 (1):12. doi: 10.3390/cli8010012.
Hsiang, S., R. Kopp, A. Jina, J. Rising, M. Delgado, S. Mohan, D. J. Rasmussen, R. Muir-Wood, P. Wilson, M. Oppenheimer, et al. 2017. Estimating economic damage from climate change in the United States. *Science* 356 (6345):1362–9. doi: 10.1126/science.aal4369.
Krakowka, A. R. 2012. Field trips as valuable learning experiences in geography courses. *Journal of Geography* 111 (6):236–44. doi: 10.1080/00221341.2012.707674.
Kwauk, C., and R. Winthrop. 2021. Unleashing the Creativity of Teachers and Students to Combat Climate Change: An Opportunity for Global Leadership. Brookings Institute. https://policycommons.net/artifacts/4143605/unleashing-the-creativity-of-teachers-and-students-to-combat-climate-change/4952736/.
Lehtonen, A., A. O. Salonen, and H. Cantell. 2019. Climate change education: A new approach for a world of wicked problems. In *Sustainability, human well-being, and the future of education*, ed. J. W. Cook, 339–74. Cham: Palgrave Macmillan.
Mann, M. E. 2002. Little ice age. In *Encyclopedia of global environmental change*, ed. M. S. MacCracken and J. S. Perry, Vol. 1, 504–509. New York: Wiley.
Maryland State Department of Education. 2023. Environmental literacy standards framework. https://marylandpublicschools.org/programs/Documents/Environmental/EnvironmentalLiteracyFramework.pdf.
Mehta, J., and S. Fine. 2019. *In search of deeper learning: The quest to remake the American high school*. Cambridge, MA: Harvard University Press.
Michigan House. 2023. Environmental Literacy Task Force. Legislative Analysis. https://www.legislature.mi.gov/documents/2023-2024/billanalysis/House/pdf/2023-HLA-4961-F8B2B51B.pdf.
Meinig, D. W. 1979. The beholding eye: Ten versions of the same scene. In *The interpretation of ordinary landscapes: Geographical essays*, ed. D. W. Meining, 33–48. New York: Oxford University Press.
Monk, G. 2022. Connecticut schools will soon be required to teach climate change. Here's why. *Hartford Courant*. https://www.courant.com/news/connecticut/hc-news-connecticut-education-climate-change-20220519-plxqwpyykbh5hkw6tz3iczcjca-story.html.
Morris, T. H. 2020. Experiential learning–A systematic review and revision of Kolb's model. *Interactive Learning Environments*. 28(8): 1064–1077. doi: 10.1177/1046878119890643.
National Center for Science Education (NCSE). 2020. Making the grade? How state public school science standards address climate change. https://climategrades.org/MakingTheGradeReport.pdf.
National Geographic Society. 2017. *The geo-inquiry process: Educator guide*. Washington, DC: National Geographic Society.
NCEI. 2022. Billion-dollar weather and climate disasters. National Centers for Environmental Information. https://www.ncei.noaa.gov/access/billions/.
NOAA. 2018. Models warn of dustier summers in U.S. Southwest and Southern Plains, but Northern Plains may see fewer dust storms year round. https://www.climate.gov/news-features/featured-images/models-warn-dustier-summers-us-southwest-and-southern-plains-northern.
NOAA. 2019. New study: Climate change to shift many fish species north. https://www.fisheries.noaa.gov/feature-story/new-study-climate-change-shift-many-fish-species-north.
NOAA. 2022. Teaching climate. https://www.climate.gov/teaching.
Oberle, A. 2020. Advancing students' abilities through the geo-inquiry process. *Journal of Geography* 119 (2):43–54. doi: 10.1080/00221341.2019.1698641.
Plumer, B., and N. Popovich. 2020. How decades of racist housing policy left neighborhoods sweltering. *The New York Times*. https://www.nytimes.com/interactive/2020/08/24/climate/racism-redlining-cities-global-warming.html
Plutzer, E., M. McCaffrey, A. L. Hannah, J. Rosenau, M. Berbeco, and A. H. Reid. 2016. Climate confusion among US teachers. *Science* 351 (6274):664–5. doi: 10.1126/science.aab3907.
PragerU. 2023. What is PragerU?, https://www.prageru.com/.
Project Drawdown. 2022. Solutions. https://drawdown.org/.
Rooney-Varga, J. N., F. Kapmeier, J. D. Sterman, A. P. Jones, M. Putko, and K. Rath. 2020. The climate action simulation. *Simulation & Gaming*, 51(2), 114–140. doi: 10.1177/1046878119890643.
Rutgers University. 2022. NJ Climate Change Resource Center. Rutgers Climate Institute. https://njclimateresourcecenter.rutgers.edu/.
Sanderson, B. M., and B. C. O'Neill. 2020. Assessing the costs of historical inaction on climate change. *Scientific Reports* 10 (1):1–12. doi: 10.1038/s41598-020-66275-4.
Schell, E. M., A. Mohan, and The Instructional Materials and Professional Development Committee. 2013. Road map for 21st century geographic education: Instructional materials and professional development. *The Geography Teacher*, 10(1), 6–14. doi: 10.1080/19338341.2012.758597.
Scientific American. 2015. Virginia Islanders could be U.S. first climate change refugees. https://www.scientificamerican.com/article/virginia-islanders-could-be-u-s-first-climate-change-refugees/.
Shepherd, M. 2013. Slaying the "zombies" of climate science. TEDx Talks. https://www.youtube.com/watch?v=O019WPJ2Kjs.
Stevenson, K. T., D. F. Lawson, M. N. Peterson, and S. Binner. 2020. Empowering children to change hearts and minds on climate change against all odds. In *Teaching Climate Change in the United States*, ed. J. Henderson and A. Drewes, 11–28. London: Routledge. ISBN: 9780367179496.
Supran, G., and N. Oreskes. 2017. Assessing ExxonMobil's climate change communications (1977–2014). *Environmental Research Letters* 12 (8):084019. doi: 10.1088/1748-9326/aa815f.
Supran, G., S. Rahmstorf, and N. Oreskes. 2023. Assessing ExxonMobil's global warming projections. *Science* 379 (6628):eabk0063. doi: 10.1126/science.abk0063.
State of New Jersey Department of Education. 2020. 2020 New Jersey Student Learning Standards. https://www.nj.gov/education/cccs/2020/.
U.S. Congress. 2024. Climate Change Education Act, S.4117. https://www.congress.gov/bill/118th-congress/senate-bill/4117.
USGCRP. 2023. *Fifth National Climate Assessment*. A. R. Crimmins, C. W. Avery, D. R. Easterling, K. E. Kunkel, B. C. Stewart, and T. K. Maycock, eds. Washington, DC: U.S. Global Change Research Program. doi: 10.7930/NCA5.2023.
Virginia Geographic Alliance (VGA). 2024. Professional learning opportunities. https://www.vageo.org/plo.
Waldman, S. 2023. DeSantis's Florida approves climate-denial videos in schools. *Scientific American*. https://www.scientificamerican.com/article/desantiss-florida-approves-climate-denial-videos-in-schools/.
Woodhouse, J. L., and C. E. Knapp. 2000. *Place-based curriculum and instruction: Outdoor and environmental education approaches*. ERIC Digest: ED448012.