# A New Vision of Sustainability in Earth Science Education

Following the culmination of an ambitious Earth science education initiative, scientists and educators met to prioritize ways in which education about Earth can foster sustainable societies.



Portland State University students enjoy the fresh air on the ecoroof of the Native American Student and Community Center. Public spaces that incorporate environmental sustainability features increase community awareness of environmental issues and encourage conversations about sustainable practices. Credit: <u>Portland State University</u>, <u>CC BY-NC-SA 2.0</u>

By <u>Lisa A. Gilbert</u>, Rachel Teasdale, and <u>Cathryn A. Manduca</u> **O** 30 June 2020

How can we structure our societies to live and prosper within the boundaries that ecological limits impose? The geosciences can—and should—play a strong role in studying, communicating, and finding solutions to modern societal challenges, not the least of which is building sustainable societies.

Human demands on the Earth system—through natural resource use and urbanization, for example have put at risk our ability to live sustainably on our planet, while Earth hazards like storms and earthquakes exacerbate societal inequities. A public that is <u>geoscience literate</u>

(https://nagt.org/nagt/teaching\_resources/literacies.html) and a geoscience workforce that can provide scientific knowledge, systems thinking, and skill in interdisciplinary problem solving are of paramount importance for addressing societal grand challenges (http://www.agiweb.org/gap/criticalneeds/) in environmental sustainability. Thus, it is vital that Earth scientists and educators collaborate to ensure a steady supply of geoscientists [e.g., *Wilson* (https://www.americangeosciences.org/workforce/reports/status-report), 2018] and Earth-literate graduates, to improve upon the lack of diversity within the geoscience workforce [e.g., *Bernard and Cooperdeck* (https://doi.org/10.1038/s41561-018-0116-6), 2018], and to prepare scientists to collaborate with a variety of community groups and institutions that help educate the public at large.

InTeGrate was a major nationwide effort by academic institutions and employers to meet evolving needs for the geoscience workforce and to increase societal capacity to use geoscience knowledge to live successfully, sustainably, and justly on Earth.

Working toward these goals, one recently completed initiative, called Interdisciplinary Teaching about Earth for a Sustainable Future (InTeGrate (https://serc.carleton.edu/integrate/index.html))—which involved more than 110,000 students at more than 1,000 institutions of higher education—set out to revolutionize how Earth education is perceived as well as practiced. InTeGrate was a major nationwide effort (https://serc.carleton.edu/integrate/about/index.html) by academic institutions and employers [e.g., *Summa et al.* (https://doi.org/10.1130/GSATG342GW.1), 2017] to meet evolving needs (https://eos.org/agu-news/stem-supports-67-of-u-s-jobs) for the geoscience workforce [e.g., *Gosselin et al.* (https://doi.org/10.1007/978-3-030-03273-9), 2019] and to increase societal capacity to use geoscience knowledge to live successfully, sustainably, and justly on Earth.

Outcomes of the InTeGrate project support teaching geoscience in the context of resource and environmental issues across the undergraduate curriculum. These efforts include not only students planning a career in the geosciences but also the large majority of students who do not major in the geosciences, students from groups that are <u>historically underrepresented (https://eos.org/opinions/promoting-racial-diversity-in-geoscience-through-transparency)</u> in the geosciences, and future teachers.

The end of the InTeGrate initiative in 2019 provided a logical opportunity for the geoscience community to self-assess and redirect itself toward a new vision in educating future geoscientists and the public to

encourage moves toward sustainable societies. Last October, 80 leaders in education and sustainability from across the United States gathered to map out that new community vision.

## Earth Education for Sustainable Societies

During its 7-year run, <u>InTeGrate projects (https://serc.carleton.edu/integrate/about/project\_products.html)</u> developed and implemented teaching materials in and beyond the geosciences, supported development and evaluation of new models for incorporating geoscience throughout the curriculum, and provided professional development opportunities involving more than 4,600 faculty from all 50 U.S. states, Puerto Rico, India, and Micronesia.

The peer-reviewed teaching materials, program models, and continuing professional development opportunities that resulted from InTeGrate are freely available on an expansive and well-organized <u>web</u> <u>portal (https://serc.carleton.edu/integrate/index.html)</u>. These resources provide a foundation for continuing critical work within broader science, technology, engineering, and mathematics (STEM) learning ecosystems. They have become even more relevant amid the recent rapid shifts to remote teaching this past spring and with recent announcements by many institutions of higher education that most or all classes will be online in the fall.

As InTeGrate drew to a close, the project team recognized that the progress in sustainability efforts to which the program had contributed could continue if opportunities initiated through InTeGrate were bridged with new initiatives and more diverse groups. This realization spurred our idea to gather educators and scientists with relevant expertise (within and outside the InTeGrate community) in July 2019 at a forum at Tennessee State University during the <u>Earth Educators' Rendezvous</u> (<u>https://serc.carleton.edu/earth\_rendezvous/2019/index.html</u>) to discuss ways that scientists, educators, and leaders can increase awareness and implementation of sustainability education.



Participants at the 2019 Earth Education for Sustainable Societies (EESS) workshop discuss their vision of Earth education for a sustainable future. Credit: <u>Andrew Haveles</u> (<u>https://serc.carleton.edu/details/images/232619.html</u>), Carleton College, <u>CC BY-NC-SA 3.0</u> (<u>https://creativecommons.org/licenses/by-nc-sa/3.0/</u>)

The ideas we gathered at the forum then framed discussions at the Earth Education for Sustainable Societies (<u>EESS (https://serc.carleton.edu/integrate/workshops/sust\_societies/index.html</u>)) workshop at Carleton College in Minnesota last October. The EESS workshop assembled representatives from many parts of the larger STEM learning ecosystem to develop a common vision and prioritize efforts to achieve it.

InTeGrate programs focused on undergraduate education and related faculty development. However, at the EESS workshop, we sought to include educators and emerging leaders from kindergarten through 12th grade instruction, higher education, and informal learning environments, along with educators in government agencies that support scientific data collection and student and public outreach. All of these communities have ideas and perspectives to contribute to the development of a community vision: In gathering a variety of groups together, we saw an opportunity for participants to initiate collaborative activities in support of that vision.

Workshop participants began writing a freshwater literacy document and developing a guide to teaching about energy. They also set to work establishing a framework for student-stakeholder environmental participatory action, organizing a forum for integrating difficult conversations about sustainability into Earth science classes, and beginning many other collaborative projects.

#### **Charting a New Path**

A goal of the workshop was to build teams that could initiate and advance new projects and capitalize on the resources, community, and expertise developed through InTeGrate and the work of this expanded pool of participants. The outcomes of the workshop provide insight for Earth and space scientists into the ways that a wide range of educators are thinking about Earth education for a sustainable future.

"Earth education for sustainable societies engages all learners and empowers communities to develop relationships and solutions for environmental resilience."

In the 2 months leading up to the EESS workshop, participants engaged in two webinars, and they shared essays. During the webinars, InTeGrate-developed materials and approaches, which were largely focused on higher education, were used to catalyze discussions of innovative new initiatives to tie

together Earth education for sustainable societies for all learners, from preschoolers to retired adults. Participants' essays on designing the future of Earth education for sustainable societies provided a forum for sharing ideas and further helped participants to arrive at EESS ready to collaborate. Such engagement helped familiarize participants with lessons learned from InTeGrate and also with each other's work in advance of the workshop.

Workshop activities during the EESS meeting, as well as multiple rounds of input following the meeting, led to participants converging on a shared vision statement: "Earth education for sustainable societies engages all learners and empowers communities to develop relationships and solutions for environmental resilience."

Participants agreed that this statement recognizes the urgency for change. They also agreed that future work must build support for individual action and collective action at local to global scales and must also involve opportunities for lifelong learning that are accessible, meaningful, and equitable. Their vision also focuses on increasing Earth literacy, systems thinking, and interdisciplinary expertise and data, and it stresses the need to embrace values, experiences, and wisdom from diverse cultures. All these factors contributed to a <u>strategic framework</u>

(<u>https://serc.carleton.edu/integrate/workshops/sust\_societies/vision\_statement.html</u>) to guide future activities that will help achieve this vision.

In addition to developing the shared vision, participants developed a list of <u>priority work areas</u> (<u>https://serc.carleton.edu/integrate/workshops/sust\_societies/priority\_areas.html</u>) and self-selected working groups to initiate efforts to address these areas. Some of the priority work areas include strengthening capacity for the following:

place-based learning: learning that is grounded in understanding a local environment, culture, and history

developing collaborations across disciplines and institutions for supporting multigenerational learning developing strategies to support community action, including building educator expertise to work with communities

building capacity to discuss such difficult topics as increasing diversity, equity, and inclusion (DEI) in sustainability

empowering students to act through activities in which they develop solutions or engage in activities that result in change

#### Working Across the Educational Ecosystem

Workshop participants were particularly interested in projects that explore Earth education in the context of local environments and that incorporate issues of importance to the local community. For

example, projects that create support for students to make digital content will increase their awareness of sustainability issues where they live. Key to this approach is integrating geoscience learning with concepts from other disciplines, including the social sciences, which offers the opportunity to work across different parts of the educational ecosystem.

Participants also agreed about the importance of recognizing that priority work areas must be addressed in ways that include and engage learners from diverse backgrounds, including from different ethnicities, races, genders, ages, and geographic areas of the United States. For example, learning activities should be designed to highlight and model ideas of DEI by first ensuring diversity among participants and decision-makers and by amplifying many <u>voices and perspectives (https://eos.org/articles/forum-explores-motivating-different-people-about-climate-change)</u>.

Activities that value DEI can also include opportunities for discussion among large and small groups that provide opportunities for all participants to contribute. These ideas were practiced as well as discussed during the EESS workshop, resulting in a call by participants for educational activities that embrace the values, experiences, and wisdoms of diverse cultures, recognizing that solutions must be driven by the communities involved.

## **Connecting and Engaging**

There is no shortage of opportunities to "connect and engage with society to enhance the well-being of our communities and preserve the health of our planet."

There is no shortage of opportunities to participate in Earth education for sustainable societies and to <u>follow the lead of AGU (https://www.agu.org/Share-and-Advocate/Share)</u> in advocating for Earth science education to "connect and engage with society to enhance the well-being of our communities and preserve the health of our planet."

Scientists can put their expertise to use for education and societal action by working with communities as well as formal and informal educators to engage students in exploring and developing new solutions for environmental resilience. In doing so, the priority work areas identified by EESS participants can be used to guide researchers in ways to <u>partner with communities (https://eos.org/opinions/partnerships-drive-science-to-action-across-the-agu-community)</u> so their scientific results have optimal value to society.

AGU and other Earth science organizations, such as the U.S. Geological Survey (USGS), the Geological Society of America, the American Meteorological Society, and the National Association of Geoscience Teachers (NAGT), offer opportunities for broader outreach, including internships and workshops. Examples include AGU's <u>Thriving Earth Exchange (https://thrivingearthexchange.org/)</u>, the USGS <u>Science to Action Fellowship (https://www.usgs.gov/land-resources/climate-adaptation-science-centers/science/science-action-</u> <u>fellowship?qt-science\_center\_objects=o#qt-science\_center\_objects</u>), and NAGT's <u>2020 Earth Educators' Rendezvous</u> (<u>https://serc.carleton.edu/earth\_rendezvous/2020/index.html</u>)workshops and working groups, all of which are opportunities for researchers to broaden the reach of their scientific discoveries through outreach to K– 16 educators, informal educators, and policy makers.

Developing partnerships among these groups can also provide opportunities for substantive broader impacts (e.g., helping educators to obtain National Science Foundation (NSF) awards to develop more comprehensive programming). In addition to training future scientists to conduct rigorous research, scientists can design research projects that incorporate the EESS vision by adapting portions of the priority work areas presented here.

Novel and meaningful partnerships can have far-reaching impacts on educating students and the public about action related to developing sustainable societies. By engaging our communities in scientifically grounded activities that may include data collection (community science), sustainable problem solving, and long-term planning, we build a geoscience workforce, a scientifically literate public, and a scientific community able to collectively create a sustainable future.

#### Acknowledgments

Funding was provided by NSF award 1933699. The EESS Workshop was coconvened by the authors and Felicia Davis (Clark Atlanta University), Mintesinot Jiru (Coppin State University), Rory McFadden (Gustavus Adolphus College), Hannah Scherer (Virginia Polytechnic Institute and State University), and Margie Turin (Columbia University).

## References

Bernard, R. E., and E. H. G. Cooperdeck (2018), No progress on diversity in 40 years, *Nat. Geosci., 11*, 292–295, <a href="https://doi.org/10.1038/s41561-018-0116-6">https://doi.org/10.1038/s41561-018-0116-6</a>).

Gosselin, D.C., A. E. Egger, and J. J. Taber (Eds.) (2019), *Interdisciplinary Teaching About Earth and the Environment for a Sustainable Future*, Springer, Cham, Switzerland, <u>https://doi.org/10.1007/978-3-030-03273-9</u> (<u>https://doi.org/10.1007/978-3-030-03273-9</u>).

Summa, L., C. Keane, and S. Mosher (2017), Meeting changing workforce needs in geoscience with new thinking about undergraduate education, *GSA Today*, *27*(9), 60–61, <u>https://doi.org/10.1130/GSATG342GW.1</u> (<u>https://doi.org/10.1130/GSATG342GW.1</u>).

Wilson, C. (2018), *Status of the Geoscience Workforce*, Am. Geosci. Inst., Alexandria, Va., <u>www.americangeosciences.org/workforce/reports/status-report</u>

(http://www.americangeosciences.org/workforce/reports/status-report).

### **Author Information**

Lisa A. Gilbert (<u>Igilbert@williams.edu (mailto:Igilbert@williams.edu</u>)), Geosciences Department and Williams-Mystic, Williams College, Williamstown, Mass.; Rachel Teasdale, Department of Geological and Environmental Sciences, California State University, Chico; and Cathryn A. Manduca, Science Education Resource Center, Carleton College, Northfield, Minn.

**Citation:** Gilbert, L. A., R. Teasdale, and C. A. Manduca (2020), A new vision of sustainability in Earth science education, *Eos, 101,* <u>https://doi.org/10.1029/2020EO146424</u>. Published on 30 June 2020.

Text © 2020. The authors. <u>CC BY-NC-ND 3.0</u>

Except where otherwise noted, images are subject to copyright. Any reuse without express permission from the copyright owner is prohibited.