

Preparing Students for A Sustainable World: Earth Science and the Sustainable Development Goals

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Abstract: Incorporating the Sustainable Development Goals (SDGs) into elementary education empowers students to address global challenges. The American Geosciences Institute, along with teachers experienced in integrating the SDGs into instruction, share strategies for that integration. These include selecting SDGs that align with curriculum and fostering engagement and motivation for action. By empowering students to address global challenges, educators cultivate informed and conscientious citizens with the empathy and agency to effect positive change. Through practical examples and reflections from educators, this article underscores the importance of SDG-focused education in nurturing socially responsible individuals equipped to tackle complex global issues.

Earth science is vital for addressing many challenges the world faces. From mitigating the effects of natural phenomena like earthquakes and tornadoes to addressing the potential effects of human activities such as mining and logging on environmental integrity, and especially as people respond to climate change, earth science helps people understand what is happening around them through the lenses of science and systems thinking. In what follows we describe ways that by bringing the United Nations Sustainable Development Goals (SDGs) into instruction in earth science and other subjects, educators can empower young people to take meaningful action so that they, their families, and their communities are better able to make decisions about current and future challenges and opportunities.

The SDGs were adopted by the member countries of the United Nations in 2015 as part of the “2030 Agenda for Sustainable Development.” The 17 SDGs serve as a global call to action around issues such as poverty, clean water and sanitation, quality education, addressing climate change, and others (see Figure 1 to view all the SDGs). Each of these goals has a role to play in creating and maintaining sustainable lifestyles and communities, where sustainability is defined as humanity having the ability to “ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (Imperatives, 1987, p. 16).

Strategies for Introducing the SDGs

The recognition that youth empowerment is a key to sustainable development has led to an emphasis in many parts of the world on finding ways to teach students about the SDGs from a young age.

Organizations such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO),

World's Largest Lesson, Science on Stage, Asia Society, and others are actively encouraging and facilitating the incorporation of the SDGs into teaching by providing resources for educators to use in their teaching.



Figure 1 The 17 SDGs. Learn more about them, including the Targets and Indicators, at <http://www.sdgs.un.org>

At the American Geosciences Institute (AGI), we are committed to promoting the SDGs and working with teachers to explore ways to include these goals in their instruction. AGI has been identifying and sharing a variety of resources that simultaneously address the SDGs, the Next Generation Science Standards (NGSS), and other standards. In collaboration with several teachers, we have also been investigating specific strategies for introducing the SDGs through workshops presented at conferences, summer academies, and webinars. The emphasis has been on finding and/or developing approaches that allow the SDGs to provide context and meaningful applications of learning, rather than as additions to existing curriculum requirements. In fact, the teachers we have worked with find that the SDGs are very compatible with the NGSS and to specific state standards.

The results of our collaborations have been encouraging in that the teachers report observing more engaged discussions, increased global awareness, and heightened student motivation for learning content and, importantly, for taking action, as illustrated by these statements from teachers:

- “Incorporating the SDGs has added relevance, authenticity, and critical thinking opportunities for my students. This has led to a noticeable increase in student engagement and motivation.”
- “Incorporating the SDGs makes more well-rounded and concerned students. They begin to see the world from a smaller and more impactful perspective. Our learners know that they can make a difference now, at their age. As a result, it is my hope that we develop more productive citizens

for our communities, our environment, and our world because they understand that making a difference takes one person at a time implementing change.”

- “[Including SDGs in instruction] also promotes higher order thinking by requiring students to view problems from multiple perspectives and realizing that actions that may positively contribute towards one goal may negatively impact another. At a young age, students are able to describe the complexity of real-world issues so that they may better mitigate these issues in the future.”

Some of the strategies for introducing students to the SDGs that teachers have found successful include:

- Creating bulletin boards of the SDGs to which students can add ideas throughout the year.
- Asking students to brainstorm what they consider to be the most pressing issues societies face, then introducing the SDGs so students can compare their ideas to what those goals indicate are areas to be addressed.
- Reading stories and comics to introduce and discuss relevant SDGs in a relatable and engaging way.

Teachers took different approaches regarding which specific SDGs to work with, but generally chose a limited number for focused attention. For example, a teacher in Alaska introduced her students to three SDGs at the beginning of the school year. She created posters for these SDGs and hung them around the room, asking students to contribute relevant information from what they had learned throughout the year (Figure 2). This visual and interactive approach serves as a continuous prompt, encouraging students to discuss the SDGs on a regular basis to connect them to their learning and encouraging them to extend their learning in new and meaningful directions.

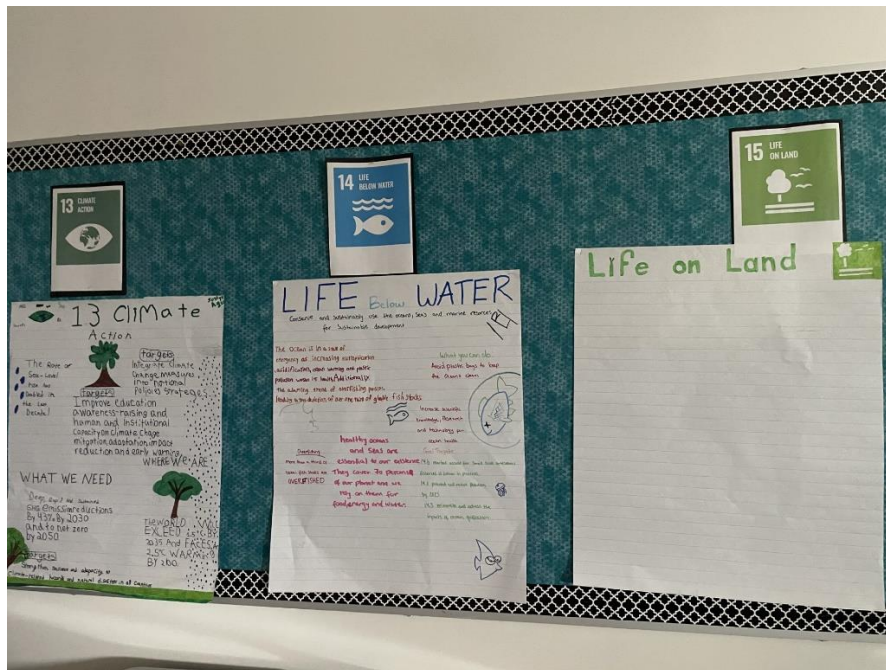


Figure 2 Fifth-grade students learned about SDGs 13, 14, and 15, and added information, comments, and ideas as they connected those SDGs to science lessons throughout the year.

At times throughout the year, she introduced an additional SDG to her students that the class had not yet considered, but that related well to what was being studied. She then created a new poster and dedicated time to discussing the new SDG before asking the students to consider ways to link it to what they are learning and their prior knowledge.

Strategies for Incorporating the SDGs

Teachers report that some grade level science content relates more readily to specific SDGs than others. For example, third-grade students may be addressing the NGSS dimension of identifying evidence to support claims that certain natural events—like weather hazards—have an impact on humans (3-ESS3-1). This ties directly into SDG 11 (Sustainable Cities and Communities), particularly its focus on making cities and human settlements inclusive, safe, resilient, and sustainable. By exploring SDG 11 along with the science standard relevant to natural events, students are likely to remain engaged and retain information better while also developing a practical understanding of how their learning can directly contribute to building safer and more sustainable communities, including their own.

To support teachers in identifying which SDGs may relate to the earth science concepts they are teaching, AGI has developed a table correlating the SDGs with NGSS Disciplinary Core Ideas (DCIs) (Figure 3). This resource serves as a valuable tool for curriculum planning, enabling teachers to seamlessly integrate SDGs into their instruction. At the same time, it is important to point out that the SDG tiles provide a broad indication of what each SDG is about, but there is much more to know about them. Each SDG has specific Targets and Indicators, that detail targetable actions toward the goal. For example, in fifth grade, students may be exploring the availability of water, and specifically freshwater (5-ESS2-2), which connects broadly to SDG 6 (Clean Water and Sanitation). By delving into the Targets and Indicators, educators can enhance students' comprehension and engagement with the content. For example:

- Target 6.1: Achieve universal and equitable access to safe and affordable drinking water for all.
- Target 6.4: Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity.
- Target 6.6: Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.

These more specific elements can help students gain insight into the broader global efforts to address water-related challenges and understand the significance of sustainable water management practices.

Especially for elementary teachers who often teach across subjects, it is worth noting that the SDGs also connect well to social studies, language arts, and other subjects in addition to science. For example, one teacher reported she has her students read stories and connect the information to both content standards and the SDGs. Other ideas include having students design media to communicate about the SDGs related to art standards, and in mathematics classes students can consider data about SDGs such as the data provided by the USGS Vizlab. Including age-appropriate data can help students begin to understand the Indicators for each SDG Target. Connections with social studies are also apparent – one teacher will be leading a professional development workshop for her colleagues on strategies to

incorporate the SDGs into both science and social studies curricula, promoting interdisciplinary learning and a holistic understanding of global challenges.

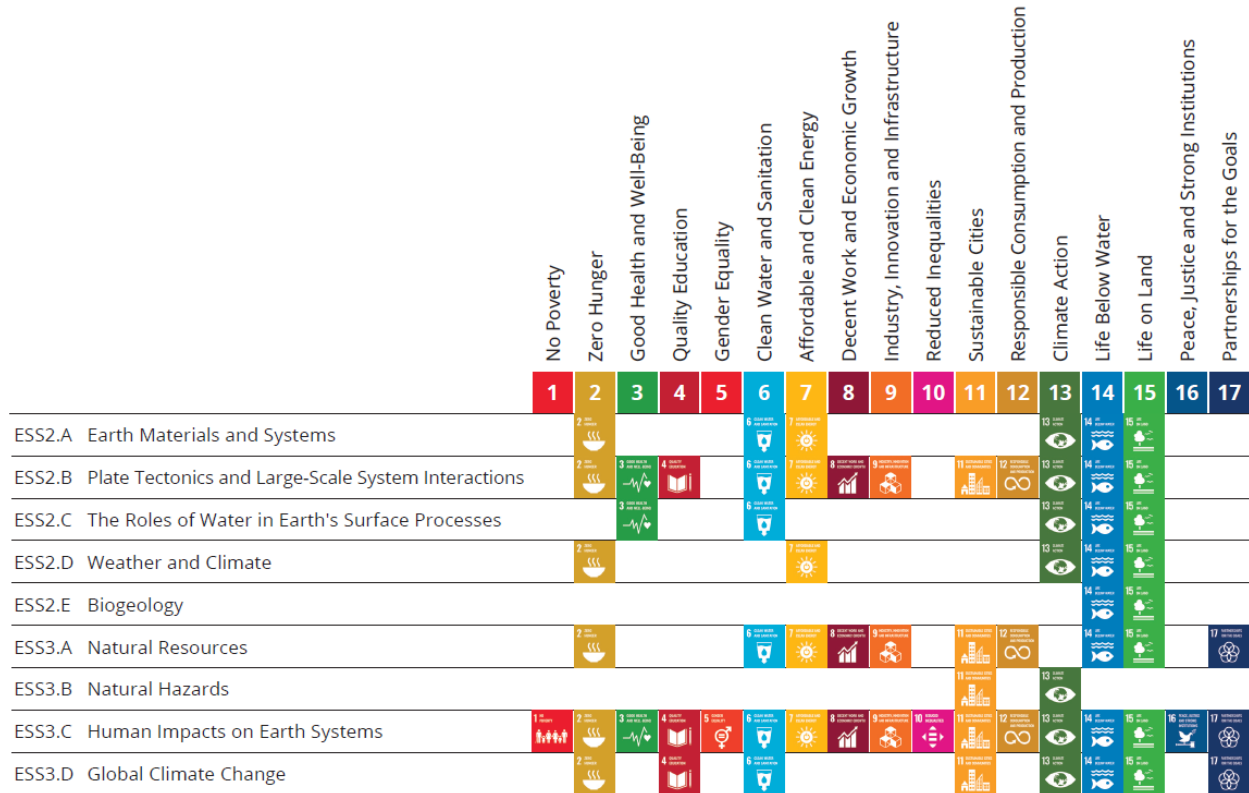


Figure 3: Alignment of the SDGs to the Earth-Space Science DCIs from NGSS. The content of the DCIs was compared with the Targets and Indicators of each SDG to assess for overlap. Reproduced with permission from Mossa et al., 2022.

Taking Action

An important aspect of incorporating the SDGs into elementary education is supporting students in taking action, often by contributing to progress in their community. One elementary teacher in Georgia asked students to consider sustainability at the end of the year and relate it to the content the class had learned. Students were asked to consider one SDG they found relevant and generate ideas for how they or other elementary school students could contribute to it. Some of the student responses included:

- “Don’t take long showers. Don’t use a bunch of water when you wash dishes, wash your hands, wash vegetables, and more!”
- “You can pick up trash and help the community. You shouldn’t litter because it’s bad for the animals and they could eat it and die.”
- “So here is my plan...make a water silo that will filter rain...”

As might be expected, some of the ideas are more attainable by elementary students than others. For example, one student developed a plan for a hydropower wheel that also filters water (Figure 4A) in

order to address SDG 6 (Clean Water and Sanitation) and 7 (Affordable and Clean Energy). While the idea is not something that could likely be implemented by elementary students, it demonstrated the student's understanding of science concepts and how they apply to the SDGs. Such ideas allow teachers to connect lessons to engineering design processes, the larger civic context in which solutions are implemented, and related careers.

On the other hand, some ideas hold potential for direct action by students. Another student came up with a plan to reduce food waste, addressing SDG 12 (Responsible Consumption and Production – Target 12.3), as seen in Figure 4B. As the class considered the plan, the teacher encouraged the students to act. They identified an extra crate in the classroom, created a sign for it, and placed it in their school cafeteria (Figure 5). The "Don't Waste Your Food" initiative asks students to place any extra packaged food items or drinks into the crate for collection. The items in the crate are then checked by the teacher, and when possible, distributed to students who attend the school's aftercare program. The teacher said, "Since the implementation of this initiative, those aftercare students have voiced how grateful they are for the snacks they are given. It also models for students how they can be resourceful and be responsible by reducing their wastefulness... My students are excited that they are able to help one another and the environment. One student said, 'I didn't think that something so simple could actually make a difference.'" This statement indicates the role empathy plays as a theme across action for sustainable development, fostering social-emotional learning and a deeper connection to community and environmental stewardship.

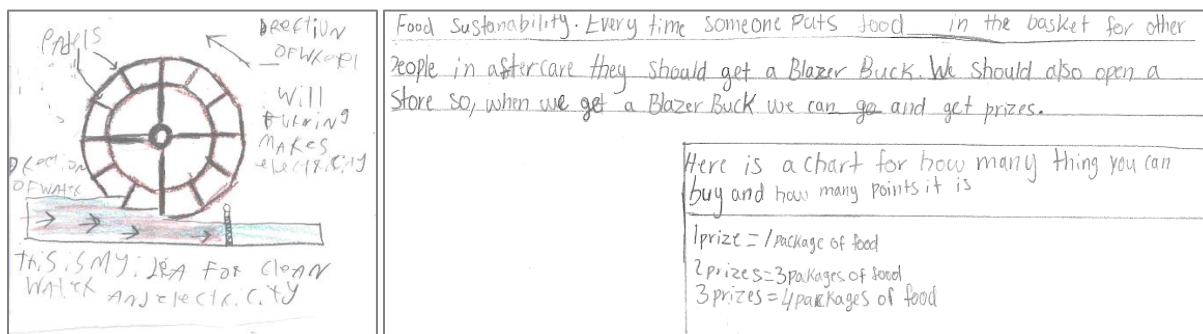


Figure 4: Ideas given by two student ideas when asked to make connections between the SDGs and content learned throughout the school year, and how they or other students could contribute towards SDG progress.

Education for the Future

Incorporating the Sustainable Development Goals (SDGs) into curricula is about nurturing students who are equipped and inspired to address the complex challenges and opportunities today and in the future. By embedding these global goals into their teaching, educators provide students with practice analyzing situations and applying their learning in ways that emphasize sustainability, equity, and environmental integrity. Such integration is especially well aligned with earth science topics, but it can support standards across the elementary curriculum.

One teacher's reflection captures the essence of this approach: "It has been an invaluable experience for my students. I believe that by exposing them to these SDGs in 5th grade, they will become more informed and conscious citizens. They will begin to make changes to their interactions with the environment and people around them that may have needs they can provide." This statement highlights the transformative impact of SDG-focused education—students not only learn about global issues but also develop the empathy and agency needed to make a difference.



Figure 5: Fifth-grade students planned and implemented a “Don’t Waste Your Food” initiative in which untouched food was saved and redistributed to students in an afterschool program to address food waste and SDG 12, Target 12.3.

Author’s Note

AGI will continue to facilitate the integration of the SDGs into various subjects, particularly in the earth sciences, through workshops, developing curricula, and celebrating sustainability as we did in Earth Science Week 2022 (<http://www.earthsciweek.org/resources/2022>). Geoscience educational resources related to the SDGs that AGI has developed and compiled are available on AGI’s Geoscience for Sustainability website (www.americangeosciences.org/sustainability).

References

- Imperatives, S. (1987). Report of the World Commission on Environment and Development: Our common future. Accessed Feb, 10(42,427).
- Mossa, L., Brase, L., & Tobler, B. Table 1. Alignment of the SDGs to the earth-space science disciplinary core ideas (DCIs) from NGSS. In Camphire, G., Mossa, L., & Brase, L., (2022). Science for sustainability: Earth Science Week 2022. *The Earth Scientist*, XXXIX (2), 5-7.

Online Resources

<https://sdgs.un.org/2030agenda>

<https://www.un.org/en/desa/four-things-you-need-know-about-youth-and-sdgs>

<https://www.unesco.org/en/education>

<https://worldslargestlesson.globalgoals.org/>

<https://www.science-on-stage.eu/act-now-sdg>

<https://asiasociety.org/education/projects-organized-un-sustainable-development-goal>

<https://www.americangeosciences.org/sustainability/>

<https://labs.waterdata.usgs.gov/visualizations/index.html#/>