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# Ten Simple Rules for Incorporating the UN Sustainable Development Goals (SDGs) into Environmental and Natural Science Courses

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**Abstract:** In 2015, the United Nations (UN) established 17 Sustainable Development Goals (SDGs) to combat poverty, inequality, and climate change. Recently, integrating these goals into higher education curricula has emerged as essential for fostering positive environmental and civic engagement. Challenges persist, particularly the prioritization of social and economic concerns over eco-centered principles and ecopedagogy. Education must emphasize the politics of environmental issues, advocating sustainable practices that benefit both humans and nonhuman species. This article proposes ten simple rules for incorporating the SDGs into undergraduate courses in ecology, evolution, and environmental science. We conducted a literature review, analyzing 940 publications from 2014 to 2024 using ISI Web of Science and Google Scholar. We focused on fields like Green Sustainable Science and Technology and Environmental Education to identify the best practices for integrating SDGs. Our findings link pedagogical successes to the SDGs, facilitating effective educational strategies. For practical sustainability education, students must grasp the interplay between the environment and societal elements such as diversity, justice, and resilience. Connecting course topics to the SDGs offers a powerful framework for teaching undergraduates about complex environmental challenges. Our research highlights a novel approach to embedding SDGs in environmental education, promoting critical thinking and literacy across various settings.

**Keywords:** sustainable development goal (SDG); science education; environment; sustainability; ten simple rules



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## 1. Introduction

Global change presents a far-reaching set of implications for humanity and the planet. Social, environmental, and economic issues of global change must be addressed to work to solve these multifaceted challenges. SDGs are a framework of 17 goals, 169 targets, and 300 indicators that build on the success of other target- and indicator-based frameworks [1] that aim to plan and program sustainable development at the national, regional, and international levels. The goals offer convergence between the three dimensions of sustainable development—social, economic, and environmental. In addition to their governmental/institutional aspect [2], SDGs are heavily used in policy planning [3–5]. To a much lesser extent, SDGs are directly used in teaching [6,7]. Students should actively engage in addressing SDG-related issues in addition to learning and reflecting on these objectives [8]. Incorporating SDGs into teaching is a crucial strategy that will enable students to appreciate and understand the importance of a sustainable, lasting future on the planet that must combine economic, environmental, and technological growth alongside human population increases [9–11]. Higher education must lead the way in teaching sustainable practices and enhancing the ways that sustainability is viewed, taught, modeled, and applied in classrooms at many levels [12]. Hence, we propose ten simple rules that synthesize some of the best practices and recommendations developed for teaching to enable incorporation into university-level course offerings in environmental and natural sciences [13–15]. Over

the last seven years, we have explored these rules in three upper-year courses. First, we reviewed the literature for the best practices in connecting the SDGs to higher education. Then, we developed these simple rules by brainstorming some of the pedagogical success we have used over the last seven years of teaching to effectively teach environmental topics and connect them to SDGs and the best practices. We then narrowed down our brainstorming into 10 simple rules and connected them to the relevant SDGs publications. Our study aims to provide educators with straightforward steps for incorporating the SDGs into higher education curricula, especially those that may be new to the topic, rather than serving as a critical review.

## 2. Methodology and Results

### *2.1. Literature Review*

We reviewed the literature to obtain studies on approaches used to incorporate the SDGs into higher learning education. To this end, we conducted review using the terms sustainability* and higher education* and SDGs*, in addition to sustainability* and SDGs* and environmental* science* and education* as two searches in ISI Web of Science (WoS) [16]. The searches were performed in the beginning quarter of 2024. Additionally, we conducted supplemental searches in book chapters and Google Scholar to validate the publication coverage of WoS. This process resulted in a total of 940 publications, and once duplicates were removed, they spanned the years 2014–2024. From the remaining publications, we screened the abstracts or summaries to select studies that belong to the following categories of WoS: Green Sustainable Science and Technology, Environmental Studies, Environmental Science, and Education and Education Research. These categories were chosen based on the number of publications, record counts on WoS, publication impact, and relevance to the pedagogical successes we have had in higher education environmental and natural sciences courses. We then reviewed the full text of these studies to select the best practices. The full-text articles included in this study were chosen based on relevance to the brainstormed ideas and rules outlined in subsequent sections.

### *2.2. Pedagogical Success and SDGs*

We brainstormed some of the pedagogical successes we have used in the last seven years in courses including Current Topics in Environmental Biology, Biology for Environmental Management, and Experimental Design. We used reading, assignments, discussions, and many other common components of teaching, including, but not limited to, posters, infographics, and oral presentations. We then obtained the 17 goals, 169 targets, and 300 indicators of indicators using a Google Scholar search. Topics in the course were directly related to plastic pollution and life below water (SDG 14), climate change and extreme weather (SDG 13), consumerism and shopping (SDG 12), sustainable green infrastructure (SDG 11), desertification and land fragmentation (SDG 15), and Canada's energy policy (SDG 7). Finally, we developed these simple rules by connecting the pedagogical success of the last seven years of teaching to the obtained SDGs and best practices. We tested the ten rules in class and adjusted them based on in-class experiences and student feedback.

### *2.3. Findings and Outcomes*

#### 2.3.1. Rule 1: Introduce the UN SDGs Early in Course Offerings

Introduce the purpose of the 17 UN SDGs as near to the beginning of the course offering as possible. Explain that the purpose of this global framework is "a shared blueprint for peace and prosperity for people and the planet, now and into the future" (United Nations, 2024). Explain the three pillars of sustainability, namely social, economic, and environmental, in addition to discussing the five principles of sustainable development:

- Conservation of the ecosystem or the environment;
- Conservation of biodiversity of the planet;
- Sustainable development of the society;
- Conservation of human resources;

- Population control and management.

In course offerings, a slide with the 17 goals was always provided in the first lecture to prompt students to think about each lecture topic while relating it to the SDGs. The pillars of sustainability are first introduced and continuously referred to in every lecture in the context of the lecture topic. Effective teaching linking the US SDGs to the course outline should incorporate these pillars and principles. Throughout the course, students should have the opportunity to explore these pillars and principles through discussion, or whatever form of pedagogy and practice is best suited to the specific course offering. If a summative evaluation is to be used to assess competency associated with the SDGs, an explanation of this should be included as well.

#### 2.3.2. Rule 2: Ensure Some of Your Learning Outcomes and Course Objectives Incorporate the UN SDGs into Course Outlines and Teaching Materials

Oftentimes, the course outline or syllabus describes and clarifies the learning outcomes of the course. This is a great place to link the learning outcomes to either the SGDS goals, targets, or indicators. For instance, in the courses we taught with SDGs, if the course assessment included formal syntheses such as a meta-analysis, systematic review, data synthesis, or critically reading environmental science peer-reviewed journal publications, this formal synthesis can be an extensive literature review based on the keyword searches of one or multiple of the 17 SDGs goals on various databases. Typically, the first one or two lectures are spent teaching students how to use university databases to access scholarly sources. The difference between primary, secondary, tertiary, and grey literature is discussed such that student can select the correct source for their project or assignment. Students are taught how to effectively select the right scholarly database and how to filter results by year, author, topic, etc. Then, students can write an extensive review based on one or multiple SDGs. Wherever possible, work examples or publications that both directly and indirectly explore the SDGs should be provided. There are numerous educational publications and texts to support instructor development and planning in this area, which include students' learning outcomes (LOs) [6,17]. Furthermore, there are also specific education resources for LOs for sustainable development in higher education [18,19].

#### 2.3.3. Rule 3: Assign Students Formative and/or Summative Work That Encourages Them to Summarize and Critically Appraise a Set of Target Indicators

Formative assessments are those that usually carry no grade and are low stakes, whereas summative assessments are used to evaluate student learning at the end of an instructional unit by comparison against a standard [20]. Students can use scientific tools such as bibliometric resources to create syntheses that link research to action, management, and policy in both formative and summative work. Bibliometric resources such as IOS, Web of Science (WoS), Google Scholar, or PubMed compile the literature and citations from various resources based on keyword searches. The use of such resources will encourage students to use evidence-informed principles through published research to develop linkages with SDGs and sustainability in general [14]. One can also introduce the PRISMA diagram [21] as we do in our teachings to properly outline the screening and excluding mechanisms of studies based on relevance to the target indicators as used in systematic reviews. This is to standardize the screening and selection criteria of scholarly sources. This also ensures that all students are on the same page regarding the proper way of choosing sources. The research process supporting SDGs is as important as the research in appreciating the complexity of implementing the SDGs. Thus, students should be encouraged to reflect or show how they are evaluated and used evidence using critical research skills, in addition to developing literate environmental citizenship.

#### 2.3.4. Rule 4: Link Goals to Local Issues

Discuss the SDGs concerning regional, municipal, and issues in the city. Connect local plans to existing global goals. For example, you can connect global goals such as tackling

climate change (SDG 13) and ensuring local food security to existing local efforts such as "nature-based solutions" including green roofs that help combat the heat island effect and can be used for urban crop production (SDG 2). In this way, you can demonstrate how a goal or indicator directly relates to efforts being taken locally. Many universities have sustainable development plans as well [18,22] because they also face challenges such as sustainable transportation (SDG 11) and waste management (SDG 12). For instance, at York University, Toronto, ON, the institution where we taught these courses, the organization Regenesis focuses on "a more sustainable future" through advocacy and local services [23]. They offer programs where you can buy second-hand bikes, and they focus on environmental education, ecotraining, and circular economy. Through education, they are aspiring for youth as leaders in creating effective environmental solutions, many of which are linked to the UN SDGs.

#### 2.3.5. Rule 5: Ensure Summative Assignments Promote Connection to SDGS

Summative assignments may use "hands-on and minds-on" methods to make practical work meaningful for students [24]. Since summative assignments generally include an evaluation, by incorporating SDGs into assessment rubrics as a criterion, you can better promote the connection of the goals to each assignment. For example, an assignment centered on explaining the cause of an environmental issue and its effects can be a great way to help explain one or more of these goals. By adding the SDGs to the assessment rubric, students are encouraged not only to learn about them but also to educate their peers on the topic creatively and engagingly. We have achieved this numerous times in oral presentations by ensuring a proportion of the presentation (for instance 5 min of a 20 min presentation) centers around connecting the assignment to the SDGs and the indicators. This is an effective method for recognizing the importance of SDGs and connecting them to broader ecological topics. In this way, students teach their peers about their chosen topics and relate to the broader context of the SDGs. This is crucial because students typically prioritize summative assessments due to their significant impact. Feedback from these assessments can serve as valuable formative guidance for both students and faculty in shaping their efforts and activities in future courses [25].

#### 2.3.6. Rule 6: Select Readings That Can Be Linked to SDGs Directly and Indirectly

Select primary, secondary, and tertiary research articles that identify and articulate the broader significance of their research topic, specifically in the context of SDGs. Some journals and databases have adopted the SDG framework to classify and organize their content [26]. Keywords and indicators can also be used to retrieve studies that contain relevant information for SDGs. Quantitative research on Sustainable Development Goals (SDGs) predominantly relies on global-scale databases offered by entities such as the United Nations, the World Bank Group (WBG), and the collaboration between Bertelsmann Stiftung and the Sustainable Development Solutions Network (BE-SDSN) [26]. These can also be used for research in university/college course offerings. For every topic of interest, you not only can search the pertinent keywords, but you can also add the keyword of SDG to find studies that incorporate both. Selecting readings that directly and indirectly link to SDGs can illustrate or contextualize the impact of research.

#### 2.3.7. Rule 7: Invite Local and International Stakeholders Who Are Working to Address SDGs

Experts from organizations can inspire students to help create a more socially and environmentally sustainable planet. You can invite expert speakers from conservation authorities, city planners, forest and landscape planners for the university, and regional conservation companies. For example, in our courses, we invited speakers from the clean energy sector to discuss affordable and green solutions that aim to address one more of the SDGs. In our case, the expert was from an institution with expertise in energy, such as the Ontario Energy Network, or an expert educator on the topic of urbanization and green infrastructure. Furthermore, we also had guests with expertise in wildlife and climate

change who expanded their niche research topics to include big ideas that incorporate the SDGs to educate students. Local speakers help illustrate how individuals or organizations are prioritizing and promoting sustainability in the community. Some business programs invite alumni from the sustainability sector to give talks as guest speakers [27]. This can also be applied to natural and environmental sciences as well. Some universities have virtual conference series that host international speakers in different areas of sustainability to reimagine higher education in an era of global uncertainty [28].

#### 2.3.8. Rule 8: Encourage Students to Get Involved with SDG Efforts Outside of the Classroom

Inspire students to network outside of the classroom to learn more about SDGs [29]. Encourage them to review and even contact internships, employment opportunities, volunteer opportunities, and research opportunities that are likely in place at some if not many for motivated students. This can be a component of a summative or formative evaluation. We encouraged students to use directories that many cities and municipalities offer to find different ways to get involved with initiatives using keyword searches pertinent to sustainability and the environment [30,31]. Through this website, students can further filter their searchers by organization, location, and category. Additionally, they can also get involved with non-profit organizations situated on the York University campus or other campuses as many universities have environmental groups and clubs that students can support [23,32]. Partnership and involvement between students and environmental organizations are crucial in the promotion and implementation of the SDGs.

#### 2.3.9. Rule 9: Explore and Promote Innovation in Solutions for SDGs Relevant to the Topic of the Course

Create a course offering such that the capstone project is a start-up competition for the UN SDGs. The project team utilized the SDGs as a reference point to examine successful methods for corporate leaders to participate in social and environmental justice. Students also explored tactics for developing upcoming business models and solutions that integrate the SDGs [33]. The team engaged in research emphasizing the competitive analysis of innovative organizations and studying cases of entities actively making tangible contributions to the SDGs. In all three course offerings, students collected data from long-term federated data repositories, analyzed the data, and applied a theoretical framework that can then be applied to commercialization or entrepreneurial endeavors [34]. Students were encouraged to combine ecological/environmental data obtained from one source with socioeconomic data from another source to address difficult problems. The project holds significance for industry collaboration and gaining a thorough comprehension of the SDGs within a business framework. Many participants developed an awareness of their own capacity to take sustainable actions in the future.

#### 2.3.10. Rule 10: Bring It Home Individually: Discussion, Comics, Writing, and Infographics

Encourage students to consider the most relevant goals to the specifics of their lives and challenges. Develop actionable, individual goals that link to the UN SDGs or specific indicators for at least one goal. Utilizing scientific infographics is an excellent way to elucidate intricate subjects without overwhelming the reader [35]. As a visual aid, they prove to be successful in conveying overarching concepts to a non-specialized audience. In our course offerings, we had an infographic assignment where students had to choose an environmental issue related to one of the topics in the course outline. One of the evaluation criteria was how the infographic includes the effects of the environmental issue described in relation to the SDGs and what possible solutions to the environmental problem it reveals using the SDG targets. In the experimental design course, visuals were used to illustrate salient design principles about the implications of SDGs. Infographics present environmental issues with their possible effects and solutions in an organized and engaging manner. Using an infographic, students can pick an SDG and create an infographic to communicate an issue, the solutions to the issue, and the stakeholders in a creative, eye-

catching manner. The ultimate goal is to create infographics that can raise awareness, with a focus on specific targets, indicators, and communities [36]. Students can also create scientific comics—one of the simplest and most effective methods for communicating ideas [37]. A comic is typically an illustration that utilizes metaphor or storytelling to effectively convey an idea to a wide audience [37]. While comics frequently incorporate humor, their narratives can also be purely informational or address serious topics such as the SDGs and their target indicators. Comics can educate and engage groups that other media cannot. Infographics and comics may be used alongside class discussions and writings to better promote an in-depth understanding of the SDGs.

## 3. Discussion

The UN SDGs directly is of course fantastic and a strong form of using education to promote social good. Nonetheless, it may not be reasonable or appropriate to do so in many course offerings. The UN SDGs do not necessarily have to be front-and-center in a course to serve as a useful pedagogical tool. In courses such as economics, math, entrepreneurship, or even some life and natural sciences, the goals can be used as implications, synthesis opportunities, incubators, or even means to frame specific course content into a lens of sustainability and justice (European University Association). Indirect use as a society scaffolding or heuristic is still powerful. Encouraging students to practice the ideas of ethical ecology by interpreting their place in the biotic community and adjusting their actions accordingly is key to a sustainable future [38]. How free market capitalism, innovation strategies, and finance link to global sustainability are legitimate and crucial questions that all students and people need to be asking [34]. The UN high-level SDGs, even without a deeper dive into the target indicators in courses, can provide concepts, ideas, visuals, and vocabulary that broaden the value and practicality of skills and learning outcomes in a very diverse set of [12]. It is important nonetheless to frame the proposed ideas with some of the criticism and challenges described in the environmental education literature. Assuming that economic development can be easily separated from resource use, "inclusive" or "sustainable" growth is meant to address many of the issues raised by the SDGs [39]. However, the sustainability-through-growth paradigm's current dominance has made things worse by putting more strain on natural resources and increasing inequality, which has exacerbated social tensions, climate change, and the loss of biodiversity [39]. Education for sustainable development (ESD) often combines sustainability with neoliberal ideas of economic growth [40,41]. While development usually refers to the industrial and economic sectors, sustainability refers not just to natural resources but also to the existence and well-being of all living things in a finite world. Growth driven by resource demand worsens environmental problems by increasing overpopulation, overconsumption, and overproduction [42]. Teaching and learning about a sustainable future through UNESCO can sometimes stress social and economic priorities over ecophilosophical principles [43]. However, even with these limitations, the proposed rules can move forward the need for literacy and critical thinking by applying alternatives of sustainable education to the rules [39]. For instance, students can apply Rule 4 to this challenge by getting involved in non-profit organizations whose aim is not centered around sustainable growth for the economy but instead sustainability and a better earth for all organisms. Ecological citizenship education seeks to liberate humans and nonhuman beings by exposing the ethical and pragmatic limits of the concept of sustainable development [44]. Researchers, educators, and experts have begun to recommend an ecocentric pedagogy and an eco-centered education to prioritize environmental protection and care by critically teaching the politics of environmental issues [44]. "Ecocentric education" is focused on ecological values in environmental education for sustainable development [45] and aims to support ecopedagogy (an education based on ecological views) that supports an "earth democracy" aiming to promote the rights of all living things [46]. Students can use visual aids, such as infographics (Rule 10), to illustrate the scope of an environmental issue and its effects and highlight possible eco-centric solutions.

Moreover, alternatives to SDGs include Indigenous education, empowerment, and liberation [39]. Because of its diversity of thought and perspective on the integration of the material and spiritual, nature and culture, and the human person and other forms of life, Indigenous knowledge has a significant contribution to society [47]. The absence of this integrated vision in Western society is detrimental to the sustainable development process. Thus, students should be encouraged to include articles by Indigenous scholars and expert views on Indigenous topics of nature in summative evaluations alongside other scholarly work and the SDG framework (Rules 2 and 5). Technology will not necessarily save us but can also be a challenge to sustainable development. Technological literacy in the context of sustainability must also be included. In a political, economic, and educational context, digital literacy is a critical empowering factor as both personal and professional life grow more technologically oriented [48]. Consequently, bridging the digital divide and promoting sustainable development require digital literacy. Having said that, though technology can help with certain problems, including the climate crisis, it cannot solve capitalism's structural and historical roots or our contemporary problems on its own [49]. Our ingrained faith in technological advancement in the context of sustainability may be keeping us from realizing how serious some environmental degradation issues can be [50]. We encourage students to use Rules 2, 6, 8, and 10 to work toward increasing digital literacy by using scholarly and federated databases to promote sustainability but simultaneously question how current and future technologies serve our main objective of inhabiting this planet alongside other earthlings. It is inescapable that global change will continue to impact all dimensions of life, and thus, most courses can embrace even simple connections to sustainability.

## 4. Implications and Future Directions

While teaching the UN SDGs directly is effective, it is not always feasible for every course. SDGs can still be valuable as indirect tools to frame course content around sustainability and justice. Encouraging students to engage with ethical ecology and understand the connections between economic activities and global sustainability is essential. Despite some criticisms of the current sustainability paradigm, incorporating SDGs can enhance critical thinking and literacy in a diverse educational context; however, obstacles to fulfilling the expected results are still prevalent. Our experience in courses, including Current Topics in Environmental Biology, Biology for Environmental Management, and Experimental Design, showed that because university courses are already packed with the required content, we struggled to align existing course objectives with the SDG principles and frameworks without overhauling the syllabus at times. Moreover, while some students were motivated by sustainability topics, others saw them as unrelated to their primary area of study. Thus, occasionally, we found it difficult to generate widespread interest across diverse student populations. Lastly, inviting guest speakers required a certain degree of logistical and financial resources that we occasionally lacked. These difficulties imply that while incorporating SDGs into university curricula is beneficial, it necessitates thorough preparation, institutional backing, and contextual adaptation.

While our study provides ten simple rules for incorporating the SDGs into higher education, there are several ways the future exploration of these rules can be enhanced. For instance, future research should focus on evaluating the long-term impact of embedding the SDGs in course curricula. Longitudinal studies could assess how student engagement with SDGs translates into sustainable practices in their personal and professional lives post-graduation. Furthermore, emerging digital tools and platforms for teaching, such as virtual reality and artificial intelligence, could enhance experiential learning in sustainability. Future research could examine how these tools can be leveraged to simulate real-world challenges and promote active problem-solving related to the SDGs. Additionally, as the manuscript acknowledges the importance of Indigenous knowledge, future studies could explore more in-depth approaches to integrating Indigenous perspectives on sustainability into the classroom. This could include collaborative projects with Indigenous communities

or the inclusion of traditional ecological knowledge in course content by Indigenous land custodians. By addressing these areas, educators may increase the efficacy of sustainability teaching and make sure that students are not only aware of the SDGs but are also equipped to take action to address environmental issues throughout the world.

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