Interdisciplinarity, Systems Thinking, and Teaching with the UN SDGs
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## RESOURCE LINK

*Sustainability: Designing Interdisciplinary Opportunities for Teaching*
https://www.surveymonkey.com/r/JRF7PFN
**Please fill in the short survey to download the web version of the workbook. You will be contacted by email every two years to solicit feedback. This project has been selected by the Clinton Global Initiative University to be presented on the global stage and biannual benchmarking is required for subsequent follow-up. The feedback received will also drive revisions made to new editions in 2019 and 2021. Thank you in advance.**

This guide will assist in showing cross-curricular opportunities for discussions, projects and learning communities. Seven seemingly unrelated courses to illustrate how sustainability shows up throughout college curriculum and how they are interconnected: geology, computer science, U.S. government, business management and engineering.

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Although several papers have been written about the importance of incorporating sustainability into college curriculum, barriers still exist. For instance, Robert Van Wynsberghe and Janet Lynn Moore note in their paper "UN Decade on Education for Sustainable Development (UNDESD): Enabling Sustainability in Higher Education," "…one barrier to creating sustainability programming that supports this social movement at the university level is the disciplinary structure of the institution. Many students and faculty work within a specific discipline of study and see little need to engage outside their own discipline."[1]

Another paper, Janet Moore's survey of barriers to sustainability education, says that "A longstanding argument against interdisciplinary undergraduate programs is that it would be 'better' for students to get disciplinary training first. Many faculty members suggested that it is important for students to start with a disciplinary foundation and wait until later on in their schooling to deconstruct that foundation."[2] Wouldn't it be advantageous for students in a community college setting to have been exposed to cross-discipline theories and discussions prior to transferring to a four-year institution as juniors who lack this background? More importantly, those students who complete only their associate's degree will not have the opportunity to learn how sustainability crosses over several disciplines through systems thinking.

But, what is systems thinking? According to Donella H. Meadows,

> A system is a set of things – people, cells, molecules, or whatever – interconnected in such a way that they produce their own pattern of behavior over time. The system may be buffeted, constricted, triggered, or driven by outside forces. But the system's response to these forces is characteristic of itself, and that response is seldom simple in the real world.[3]

**In other words, a system is a set of things that may not seem related at first glance, but as students are encouraged to widen their view to take in more information, the broadening scope will increase the number of interrelations and impacts available for students to think more critically about a situation.**

In his paper "Critical Thinking and Systems Thinking: Towards a Critical Literacy for Systems Thinking in Practice," Martin Reynolds summarizes by saying,

> …systems thinking is indeed interdisciplinary, but coupled with more explicit attention to critical thinking, systems thinking provides for a transdisciplinary engagement; one that transcends conventional disciplinary silos. The critical literacy embodied in such transdisciplinarity is manifest in a framework of systems thinking in practice. The notion of systems thinking in practice derives from a critical systems perspective constituting three activities associated with three entities – (i) a framework for understanding complex interrelationships in the real world context of change and uncertainty, (ii) a framework for practice when engaging with different perspectives amongst people involved and affected in the contexts of interest, and (iii) a composite framework for responsibility acknowledging the limiting and integral features of framing understanding and framing practice in the conceptual world of ideas and tools.[4]

How can systems thinking be implemented in higher education? Meadows continues, "systems thinking is a critical tool in addressing the many environmental, political, social, and economic challenges we face around the world. Systems, big or small, can behave in similar ways and understanding those ways is perhaps our best hope for making lasting change on many levels."[5]

John A. Cassell and Thomas Nelson make the case for systems thinking in the classroom when speaking to the problem of students understanding of civic engagement:

> They call upon educators to create a new type of citizenry by helping students to see patterns and connections, raise questions, and act on knowledge for the benefit of the world around them. Ultimately, teachers must help students develop as citizen stewards, able to grasp and promote concepts of healthy ecological and social systems. As Orr puts it, educators must teach students the ways in which they are part of the natural world and help them gain an understanding of self and a mastery of their personhood so as to use knowledge well in the world, for the benefit of the world.[6]

We also need to teach more broadly and cooperatively:

> This will include emotional and social intelligence which…allow us to connect, feel empathy, and see situations from the perspectives of others. It will also involve the active use of ecological intelligence that serves to support the extension of this sense of connectedness to all life on Earth so as to develop the ability to see complex patterns in interconnectedness, cycles and limitations of which humanity is a vital part.[7]

Colleges have come up with some creative ideas for teaching in an interdisciplinary fashion, including learning communities and team-taught courses, but workload issues and other administrative barriers have held up the penetration of these course models and faculty remain stymied in terms of how to really teach in an interdisciplinary way. There is a lot of interest in teaching "systems thinking" as the new "critical thinking," but no clear agreement on what systems thinking looks like as a learning outcome or a pedagogical strategy. However, a simple intervention could change how we teach, how we organize our research, and how we build community partnerships.

## UN Sustainable Development Goals

At Mountain View College, we're introducing sustainability to students and faculty through the UN Sustainable Development Goals, 17 intertwined goals that can be used to illustrate and highlight situations so that students can visualize the "systems" that are all around them.


If this is your first time seeing this dynamic quilt of global strategic goals, welcome. You can learn more about each goal by hovering and clicking on each goal at http://sustainabledevelopment.un.org/sdgs.[8] Many resources and information about the SDGs exist, but briefly, they are a "set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030."[9]

So, let's apply the SDGs to an interdisciplinary case study of Volkswagen TDI. As you read the following interdisciplinary case study, think about a) how this issue fits with your discipline or a course you teach and b) which of the SDGs does it violate? (The easy ones are 1, 3, 6, 8, 9, 11, 12, 13, 14, 15, 16. Choices made by Volkswagen to cheat air emissions tests easily violates 11 of the 17 goals. That's 64.7%.)

Keep in mind that no society, business or community can reasonably be in non-violation of all the SDGs. It's about using these goals to work toward a more sustainable future for all.

## CASE STUDY – VOLKSWAGEN TDI

The Volkswagen scandal that was uncovered in September of 2015 is a sustainability issue that affects millions of people, even those who don't own one of the VW cars implicated in the scandal. Here's what happened:

Since 2009, Volkswagen had touted its "clean diesel" technology on its TDI models as an alternative to hybrid or electric vehicles. Consumers liked the cars because they boasted diesel performance while creating less pollution than a typical diesel. But VW cheated. What they promised consumers turned out to be very expensive, so they instead installed "defeat devices" to trick the computers used in annual

emissions testing. But when driving, the defeat device would switch off and the car would be a pollution-generating, diesel-fueled vehicle.[10]

In the test mode, the cars are fully compliant with all federal emissions levels. But when driving normally, the computer switches to a separate mode – significantly changing the fuel pressure, injection timing, exhaust-gas recirculation, and, in models with AdBlue, the amount of urea fluid sprayed into the exhaust. While this mode likely delivers higher mileage and power, it also permits heavier nitrogen-oxide emissions (NOx) – a smog-forming pollutant linked to lung cancer – up to 40 times higher than the federal limit. That doesn't mean every TDI is pumping 40 times as much NOx as it should. Some cars may emit just a few times over the limit, depending on driving style and load.[11]

Consumers who bought the cars specifically for the "clean diesel" technology were furious. They had paid a premium price for something that the car only did while hooked up to a computer once a year. Volkswagen also sells cars under the Audi and Porsche brands, so there are twelve models that are affected. Volkswagen is buying back cars or if the consumer decides to keep the car, compensating them for diminished resale value. In addition, the affected models are no longer for sale, even the ones on used car lots.

So, how is this a sustainability issue? Let's break it down:

***Economic Responsibility:*** Volkswagen lied to its customers. Since 2009, it sold cars under three brands and marketed the TDI models as "clean diesel." Since they were caught, the company has not only a tarnished reputation, but is facing millions of dollars of fines from all the countries where these cars were sold, but they are also having to pay out billions of dollars to its duped customers. "Pending approval from U.S. District Court Judge Charles Breyer on July 26, Volkswagen will mail notifications to all current affected owners and lessees of 2.0-liter cars informing them of the $10 billion buyback program, as detailed on June 28."[12] Since production has been stopped, looking downstream, this affects the dealerships that sell the cars. It also affects the factories that build the cars and the manufacturers of the parts that go into the cars. This scandal has far-reaching economic repercussions.

***Environmental Resilience:*** Consumers who bought the TDI models thought they were buying a reliable car with the benefits of a diesel engine – higher mileage and more power – that would be offset by low-emission technology. Instead, as stated above, the cars generated heavier nitrogen-oxide (NOx) emissions, possibly up to 40 times the federal limit. Since NOx is a greenhouse gas, that affects everyone. According to the Environmental Protection Agency (EPA), "Nitrous oxide molecules stay in the atmosphere for an average of 114 years before being removed by a sink or destroyed through chemical reactions. The impact of 1 pound of N2O on warming the atmosphere is almost 300 times that of 1 pound of carbon dioxide."[13]

*Note:* Here is where the lines between environmental and social begin to blur, overlap and intersect. Ozone pollution has both environmental and social impacts, so it is difficult to talk about one without the other.

Unlike the Houston-Galveston-Brazoria (HGB) and Beaumont–Port Arthur (BPA) areas, where industrial point sources account for a greater proportion of the total nitrogen oxide ($NO_X$) emissions in the area, point sources account for only about one-tenth of the total $NO_X$ emissions in the Dallas-Fort Worth (DFW) area. The majority of $NO_X$ emissions in the DFW area come from on-road mobile sources (cars and trucks) and non-road mobile sources (such as construction equipment, aircraft, and locomotives).[14]

Locally, the Dallas/Fort Worth region – Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties – has been in nonattainment for air quality and ground-level ozone

since 1992.[15] Although the air quality has been progressively getting better, the EPA keeps raising the bar until our air quality is deemed acceptable according to federal regulations.

Ozone is created when nitrogen oxide (NOx), carbon monoxide (CO) and volatile organic compounds (VOCs) combine with very hot temperatures. Ozone season in the DFW region is March 1 through October 31. This timeframe is based on when the area is most likely to experience high levels of ozone.

So, what are the health impacts of ozone? According to the American Lung Association, ozone is the most widespread pollutant in the U.S. and one of the most dangerous. It can lead to premature death, immediate breathing problems and cardiovascular problems. And the five groups most affected by high quantities of ozone are: 1) children and teens; 2) anyone 65 and older; 3) people who work or exercise outdoors; 4) people with existing lung diseases, such as asthma, COPD, emphysema, chronic bronchitis; and 5) people with cardiovascular disease.[16]

Then there are the environmental impacts of greenhouse gases and their contribution to global warming and climate change that need to be discussed, specifically when it comes to health issues. In June 2016, the World Health Organization (WHO) released a fact sheet that states, "The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between US$ 2–4 billion/year by 2030."[17]

We must also note that air pollution comes back down with rain to contaminate our water, soil and food supply.

***Social Justice:*** Back to the Volkswagen debacle, you have to also consider the factory workers who build the cars, the dealerships and their salespeople and the manufacturers of VW parts. Plus, this is a global brand that has factories in Europe, North America, South America, Asia and Africa. In Puebla, Mexico, the Volkswagen plant accounts for 25% of the state's gross domestic product and although workers weren't immediately laid off, overtime work was stopped.[18]

In addition, the shareholders of Volkswagen have seen a loss in their stock value. On October 28, 2015, VW reported a "loss of $1.83 billion in the third quarter." The latest news, on June 28, 2016, VW agreed to "settlements that could total as much as $15.3 billion to resolve environmental and customer claims from the scandal."[19]

The Volkswagen TDI case study can be interpreted through the lens of many college courses, such as:
Technology: Can the technology be designed to reduce emissions in diesel vehicles?

Economics: Is it economically feasible to create such a device and what are the economic consequences when you're caught cheating?
Ethics: What are the ethical implications for what Volkswagen did and then tried to cover up?
Business supply chain: How were other businesses in Volkswagen's supply chain affected by the scandal?
Environmental science: How do vehicle emissions affect the environment?
Marketing: How was the scandal handled by Volkswagen's marketing department? What could have been done differently?
Chemistry: What is the science behind diesel emissions and the creation of ozone?
Engineering: How could an emission reduction device be designed?
Computer science: How did the computerized defeat device work?
Health: What are the long-term health consequences of Volkswagen's malpractice?
Government: How should governments regulate claims made by manufacturers? How should governments punish manufacturers who make false claims that have global consequences?

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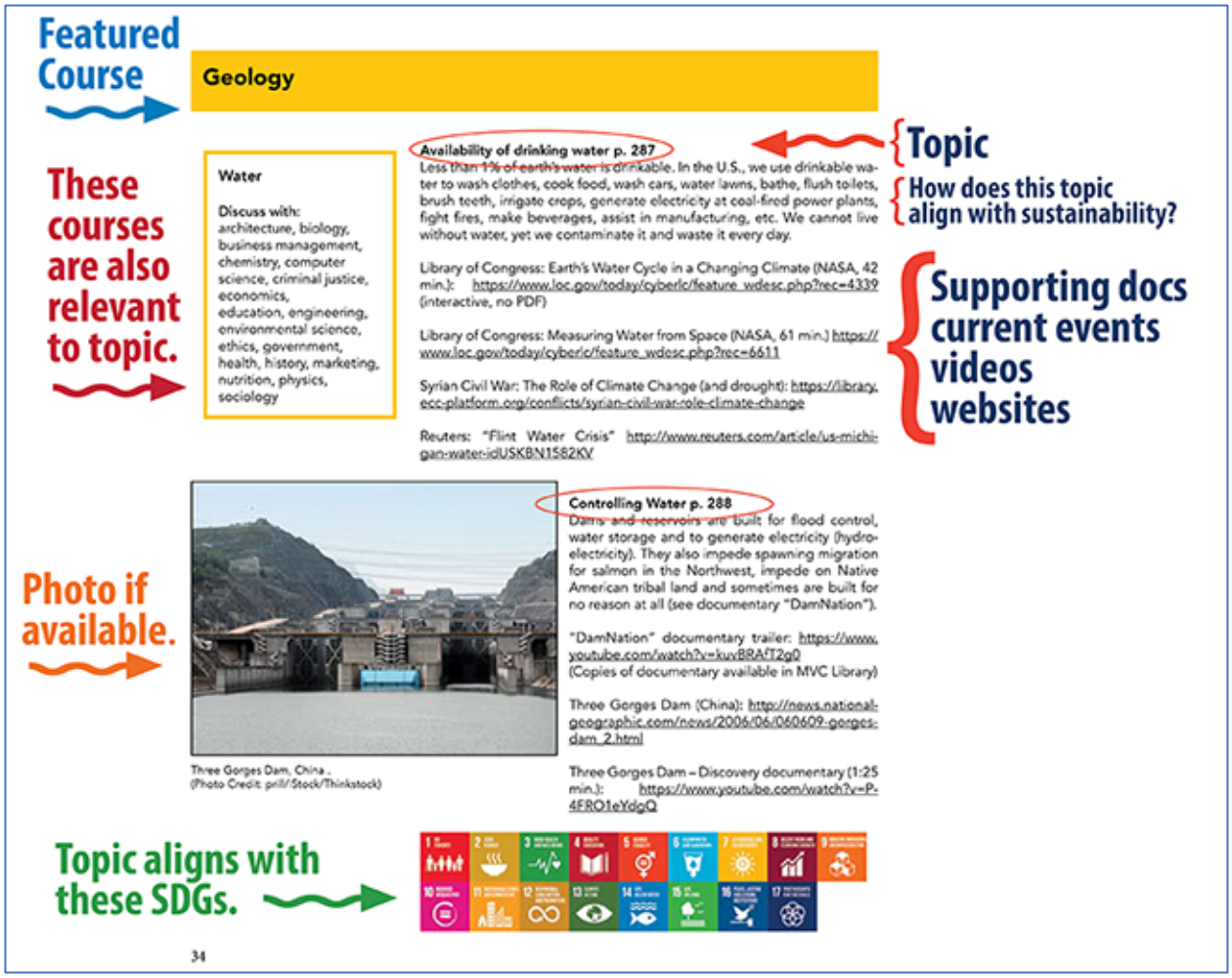

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**Endnotes**

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