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An Introduction to Sustainability Education

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This paper, in part, is an executive summary of the literature review in the author's dissertation submitted to the University of Wisconsin - Stevens Point in August 2020 and the author's work as a postdoctoral associate at the MIT Environmental Solutions Initiative. For complete discussion of relevant and cited literature, research methods, findings, and conclusions, please see the full dissertation: Potter-Nelson, E.M. (2020). Sustainability Literacy Competencies in Coursework for Preservice Teacher Preparation. [Doctoral dissertation, University of Wisconsin - Stevens Point]. Minds@UW.

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Introduction

In the fall of 2018, the Intergovernmental Panel on Climate Change (IPCC) released *Global Warming of 1.5° An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, in which the effects of global warming are discussed in detail. The report (2018) states that as of today the overall temperature of the planet has risen 1.0°C from pre-industrial levels, and will continue to rise to or above 1.5°C no later than 2050. While the impact of climate change varies, its effect on livelihoods and economic growth, human and ecological health, and food and water security are already being felt and will compound over time. Extreme weather events such as heat waves and heavy rainfall will impact more areas around the planet with greater frequency and intensity, leading to more devastating impacts (IPCC, 2018). Due to the interconnected nature of life, these events have had and will continue to have ripple effects into the social, ecological, economical, and political aspects of life on Earth. The 2018 IPCC report is dire. And follow up reports continue to acknowledge that little can currently be done to avoid reaching a 1.5°C raise in temperature from pre-industrial levels.

However, swift, deliberate, and dramatic changes in how people live and act could potentially curtail a rise in temperature of 2.0°C or higher, which scientists say would cause catastrophic changes to the Earth (IPCC, 2018). For the first time, in the lifetime of many, the changes that have been talked about for decades, which seemed so distant, will become the stark reality for people, many of whom will live through the consequences of actions that were not their own (Wray, 2022).

Although the IPCC report is ominous, there are still opportunities to stave off the grimmest realities in favor of a more sustainable world.

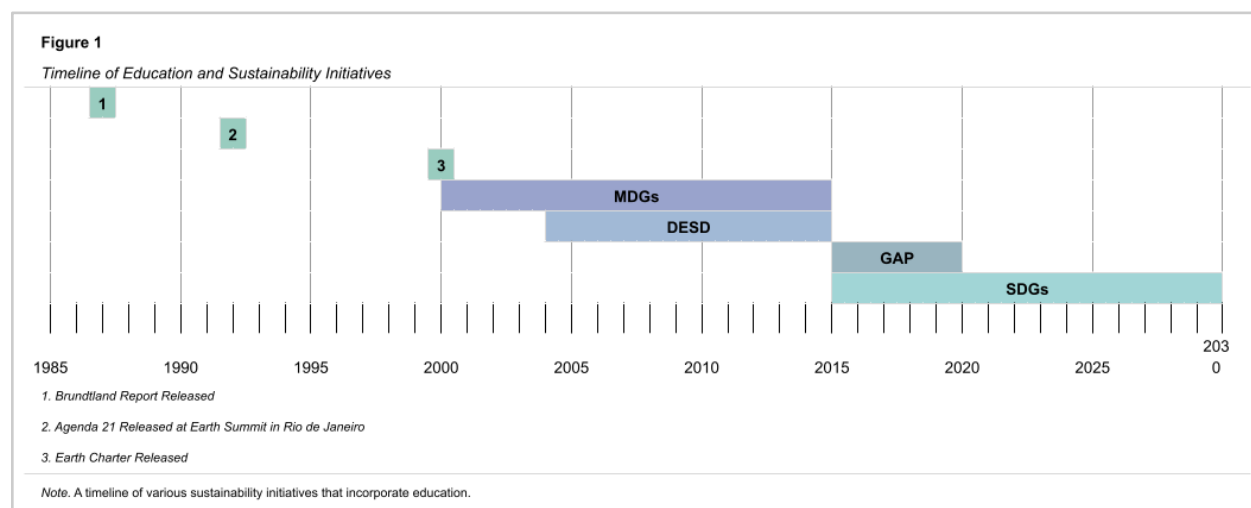
One of these opportunities is through education. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) has identified teachers and instructors of all students at all levels as “powerful change agents” who are at the forefront of revisioning a sustainable education system (UNESCO, 2017). Throughout history, education in the United States has been leveraged to address societal concerns, leading teachers, educators, and instructors to teach students about norms and key concepts that society finds important (Darling-Hammond, 2006; Orr, 2004; Sterling, 2011). As society faces the multi-faceted implications of global climate change, there is a need to foster a sustainability literate population with the knowledge, skills and dispositions to live sustainably, now and in the future. Fostering a sustainability literate society will involve “education of a different kind” that looks to curtail current unsustainable behaviors deeply embedded in the education system, including but not limited to the content taught, the pedagogy used by instructors, and the systems of injustice that permeate deep into existing structures, so that all learners have the opportunity to become sustainability literate (Bransford et al., 2005; Cortese, 2003; Lange, 2018; Nolet, 2009; Orr, 2004; Sterling, 2011).

To address the topics of sustainability education and sustainability literacy, this paper is structured in five parts. Part One explores the history of sustainability education. Part Two addresses key sustainability literacy competencies and groups these key competencies into five categories which can assist instructors in identifying leverage points within their own

curriculum for change. Part Three shares a framework that organizes the sustainability literacy competencies and other categories for instructors to use in their own practice. Part Four addresses specific instructional practices that support student learning and sustainability education. Finally, Part Five presents concrete ways that instructors can begin to move their instruction into supporting sustainability and sustainability literacy.

1 Positioning Sustainability Education

In 1987, the World Commission on Environment and Development (WCED) released a report entitled *Our Common Future*. Known colloquially as the Brundtland Report, it outlined a foundation for sustainability, and ultimately sustainability education. First, the Brundtland Report provided what many currently use as their definition of sustainability, where people live in a way to meet their needs without compromising the needs of future generations. Second, the Brundtland Report identified that sustainability is more than just an environmental way of knowing by addressing the interconnectedness between environment, economic and social perspectives. Finally, it addressed education as a means to accomplish sustainability initiatives (Nolet, 2015). Building from this initial starting place, there have been a number of different global initiatives - starting at various times and sometimes overlapping - that address some combination of sustainability and education (Figure 1).



After the release of the Brundtland Report, the United Nations held their first *Conference on Environment and Development*, often referred to as the Earth Summit, in Rio de Janeiro in 1992. Attendees were tasked with producing a blueprint for sustainable development that encompassed environmental, social and economic impacts. One of the main results of the conference was *Agenda 21*, which outlined ways to lessen human impacts during development (United Nations Conference on Environment and Development, 1993). Conversations also took place to create a document that would articulate the complex vision of sustainability outlined in the Brundtland Report. However, consensus on this document could not be reached due to the political climate of the time. (Nolet, 2015). Though consensus was not reached, the writing process continued on what would be known as the Earth Charter, with conscious efforts to include people from all walks of life, while also referencing and building from a variety of

sources in broad fields from international law instruments to NGO documents. Particular efforts were made to incorporate the voices of those who have been historically marginalized (Nolet, 2015). In 2000, eight years after initial conversations, the Earth Charter was released. The Earth Charter articulated a global vision for, and steps necessary to accomplish a sustainable future (Earth Charter Commission, 2000; Earth Charter Initiative, n.d.; Nolet, 2015). The Earth Charter identified 16 principles with 61 support principles that outlined a bold vision for a sustainable future.

Refining the principles in *Agenda 21*, led directly to development of the Millennium Development Goals (MDGs). The MDGs were enacted by the United Nations at the turn of the millennium as a way to end worldwide extreme poverty with a focus on development. The MDGs consisted of eight goals. Education and sustainability were both represented as part of goals 2 and 7, respectively. In 2015, at the completion of the MDGs, then Secretary General of the United Nations, Ban Ki-Moon, identified the MDGs as a success in moving toward eliminating extreme poverty but also stated that there was more work to be done (UN, 2015).

The completion of the MDGs led into the creation of the Sustainable Development Goals (SDGs). In 2015 the United Nations General Assembly adopted the *2030 Agenda for Sustainable Development* which outlined 17 Sustainable Development Goals (SDGs) that strive to create a sustainable future for all. The goals are far reaching, covering broad topics that embrace a broad definition of sustainability through incorporating the environment, social and economic perspectives. “Quality Education” holds a unique place as the fourth SDG because even though it is its own goal, it has also been identified as the way in which the other goals will be achieved (UNESCO, 2017). With the SDGs coming to a close in 2030, progress has been made towards the targets and indicators of each goal. Unfortunately, the COVID-19 pandemic has shifted or even stalled some areas of progress; in terms of SDG 4, the COVID-19 pandemic has exacerbated the fragile nature of an already stressed education system.

While the MDGs and SDGs set clear targets and indicators in education for sustainable development, other initiatives have also occurred, overlapping their tenure with a continued and deliberate focus on sustainability and education. Following the release of the MDGs, the United Nations Decade of Education for Sustainable Development (DESD) began in 2005 and concluded in 2014. The goal of the DESD was to bring together different agencies, organizations and governmental entities to intentionally bring sustainable development into education (UNESCO, 2014b). During the first half the DESD was focused on bringing awareness of sustainable development into education and of education into sustainable development. However, after the World Conference in 2009, the DESD shifted past just awareness, focusing on deliberate integration of education for sustainable development by focusing on topics of climate change, biodiversity and disaster risk reduction (UNESCO, 2014b). Upon its completion, the DESD increased awareness of education for sustainable development but there was still a need for improving and evaluating the work that had been completed. This led the DESD to inform aspects of the aforementioned SDGs, but also led directly into the Global Action Program on Education for Sustainable Development (GAP on ESD) (UNESCO, 2014a; UNESCO 2014b).

The GAP on ESD continued the work of the DESD of bringing sustainable development into education and education into sustainable development. By identifying five priority action areas - advancing policy, transforming learning and training environments, building capacities of

educators and trainers, empowering and mobilizing youth and accelerating sustainable solutions at local levels - the GAP on ESD used a strategic focus for achieving their objectives and goals and advancing education work on the SDGs (UNESCO, 2014a; UNESCO, 2014b).

The various global initiatives, goals and documents looking at sustainability and education echo each other, fundamentally calling for a radical change in how people think and act (UNESCO, 2017). Scholars are also calling for a transformed education system to provide people with the knowledge, skills and dispositions necessary to thrive during our ever changing world (Bransford et al., 2005; Cortese, 2003; Lange, 2018; Nolet, 2009; Orr, 2004; Sterling, 2011). Orr (2004) asserted:

But there are better reasons to reform education, which have to do with the rapid decline in habitability of the earth. The kind of discipline-centric education that enabled us to industrialize the earth will not necessarily help us heal the damage caused by industrialization (p. 2).

While many of these initiatives and goals have a finite timeline, the ultimate goal of revisioning the education system can and will outlive these timelines, helping people to navigate the dramatic changes in climate. As Lange (2018, p. 2) shared, "...sustainability education is a profound act of hope in the future."

1.1 *Situating Terminology*

Up to this point, the terms *sustainability*, *sustainability education*, and *education for sustainable development* have been used interchangeably at the neglect of their complex relationships and nuanced meanings. Situating these words is important because it provides additional context in a world of sustain-a-babble, where the word *sustainability* has so many meanings that one could argue it is meaningless (Lange, 2018).

Since the 1980's, the word *sustainability* has gained traction both academically and colloquially leading to its current definition being fluid, which often leads to confusion about what is actually meant when used (Birdsall, 2014; Lange, 2018). Recognizing there are nuances, many academically still reference the Brundtland Report (WCED, 1987) for their definition of sustainability, namely, that sustainability is a way to meet current needs without jeopardizing the needs of future generations. Ultimately this concept of sustainability, which incorporated environmental, social and economic perspectives, evolved into the idea of sustainable development at the Earth Summit in 1992 (Lange, 2018).

There has been much trepidation about the use of *sustainability* and even more so about *sustainable development*. Sauv  (1998) finds the use of the word *sustainability* irresponsible and trendy. In addition, there is continued concern about the word *sustainable development* because it conveys unlimited growth, which runs counter to the ideals of sustainability and some argue that there is an implied positivity to the word (Lange, 2018; Mappin & Johnson, 2005; Orr, 1992; Wals & Jickling, 2002). Many environmental educators have also voiced their concern in the shift of using *sustainability education* to define their work because they do not agree that environmental education and sustainability education are the same (Wals & Jickling, 2002). Environmental education has often been taught as a discrete topic within science courses or its

own course, focused solely on the environment (Feinstein & Kirchgasler, 2015; Mappin & Johnson, 2005). However environmental education has recently worked to include broader topics such as behavioral, personal, and social change, aligning more with a broader course that could be viewed as sustainability. Yet, many still question if environmental education fully aligns with the overall goals of sustainability and education (Cole, 2007; Mappin & Johnson, 2005; Nolet, 2009).

While these words are important and signify nuanced meanings, in the midst of a global climate crisis, one could argue that finding commonality towards action is more important. When all of the nuances are removed, all of these words work towards changing systems, including the education system (Cole, 2007; Orr, 2004; Sterling, 2011). Wals & Jickling (2002) even argue that as understanding of sustainability evolves and changes, it should be viewed as the pathway to changing education systems.

1.2 *The Call for Education of a Different Kind*

Education has often been viewed as the pathway to facilitate societal reforms. But as E.F. Schumacher addressed in the mid-1990's, "The volume of education has increased and continues to increase, yet so do pollution, exhaustion of resources, and the dangers of ecological catastrophe. If still more education is to save us, it would have to be *education of a different kind*." (Sterling, 2011). Orr (2004, p.8) echoed Schumacher by stating, "It is not education, but education of a certain kind, that will save us." Orr argues that changing education alone won't lead to greater sustainability; there needs to be a deliberateness that occurs as a way to facilitate growth to a more sustainable society. While acknowledging that the current education system is unsustainable, Sterling, and others agree that the change in education systems needs to be towards increasing the sustainability literacy of learners (Lange, 2018; Nolet, 2009; Orr 2004; Sterling, 2011).

Even more than just increasing the sustainability literacy of learners, there is an emphasis on the need to increase the sustainability literacy of *all* learners (UN, 2015). This shifts the conversation away from educating some students - often in highly privileged, financially wealthy communities - to providing equitable education experiences for all students. Recent curriculum standards in the United States have moved towards embracing this ideal, by articulating a need of "all standards for all students," indicating that the standards would be achieved by all students and not just those students with high academic ability (NGSS Lead States, 2013). For many this appears to align with the goals of public education in the United States by providing education to all students, however, in practice, this is far from the truth. There are long standing systemic concerns, centered in colonialization and inequity that must be addressed and dismantled before public education in the United States truly meets the needs of all learners (Alim & Paris, 2017; Freire, 2018; Grande, 2015; Holmes & González, 2017; hooks, 1994; Ladson-Billings, 1998). A pluralistic approach to education encourages a use of critical thinking around these deeply ingrained approaches (Everett, 2008; Kowasch & Lippe, 2019).

If the goal is a sustainability literate populace, then the current methods that are being used in education will not lead to this goal (Nolet, 2009; Orr, 2004; Sterling, 2010). In the current vein of positivistic teaching, a teacher cannot just tell their students about the environmental damage that is being done and expect there to be a change in the behavior of their students. Teachers

need to foster experiences that create lasting change by encouraging learners to shift their paradigms (Cranton, 2016; Sterling, 2011). Paradigms are synonymous with world views and are viewed as societal beliefs about how the world functions (Meadows, 2008; O’Sullivan 1999). While potentially unsettling for the learner to experience, a paradigm shift can have a profound impact on the learner as they question and grapple with deeply held beliefs about how the world operates (Cranton, 2016; Meadows, 2008). While impactful for the learner, shifting paradigms are incredibly challenging, with transcending paradigms being the most difficult shift for a learner to achieve (Meadows, 2008). However, once achieved a change in paradigms can have the most profound impact on changing a system than any other change (Meadows, 2008).

Sterling (2011) addressed these types of paradigm shifts in sustainability through the lens of transformative learning experiences, where the learner has the opportunity to make an epistemological shift, as first-order, second-order, and third-order learning. In first-order learning the learner is involved in a change in thinking, second-order learning results in a shift in behavior and third-order learner results in an epistemological shift. These can also be viewed as education *about* sustainability, education *for* sustainability and education *as* sustainability respectfully (Weiss et al., 2021). Reflected over the current education system, much of the learning occurs at a first-order level or education *about* sustainability, where the focus is on knowledge transfer and students learn about sustainability (Cortese, 2003; Everett, 2008; Sterling, 2011; Weiss et al. 2021). While there is a time and a place for knowledge transfer, if the goal is deeper-level thinking, which ultimately leads to transformation, this will not occur with first-order learning because learners are not having the opportunity to think, reflect, or engage with change. By creating deep learning experiences where students can engage in participatory, active, and experiential learning, teachers are opening the potential for students to experience transformative changes. These changes will encourage a shift to education *as* sustainability where education has been intentionally redesigned to incorporate and foster sustainability (Weiss et al. 2021). A discussion will follow that provides guidance on competencies, or the knowledge, skills and dispositions that one should acquire to be considered sustainability literate.

1.3 *The Broader Aims of Teaching*

As one starts to think about the role of teaching and educating students as changing their worldviews, part of the discussions naturally turns to question how that goal differs from indoctrination. Teaching is a moral and technical activity (Darling-Hammond, 2006). Liston & Zeichner (1987) state, “...education is construed as a social practice, one which depends on the honest, just, and courageous actions of teachers and is focused on developing intellectually and moral autonomous, compassionate, and caring students” (p. 8). Yet, it is important to note that while teaching is a moral activity, being a moral agent or moral model is different from being a moral activist (Campbell, 2014). Teachers need to be aware of how their actions—from teaching, to selecting curriculum and educational tools, to interactions with students—convey varying messages to their students (Campbell, 2014). These decisions are often referred to as the *hidden curriculum* which are not explicitly spoken lessons that students learn, but unspoken ideals and agendas that get passed onto students based on decisions that are made by teachers (Greenwood, 2010; Kahn, 2010; Liston & Zeichner, 1988; McIntosh, 1989). Teachers need to remember that students are always watching, observing, and learning from the smallest

interactions that teachers have with students who are late to class, to the larger decisions about the curricular materials that are being selected (M. Clough, personal communication, 2006).

What is crucial in the delineation between moral agent and moral activist is that teachers cannot expect others to conform to their own personal belief system (Campbell, 2014). Kowash & Lippe (2019) address this careful navigation in educational sustainability by stating, “We advocate a sustainability frame of mind, which does not promote certain ‘answers’, but an effective democratic participation in classroom discussions and societal development” (p. 12). This aligns with what Liston & Zeichner (1987) advocated for, which includes an understanding of the current moral and political structure in schools and curriculum. This means that instructors need to find ways in their curriculum to help students see and understand the moral and ethical implications of what they are learning or in this case about sustainability (Gore & Zeichner, 1991).

2 Sustainability Literacy Competencies

As outlined in Part One, there is a need for the individuals to become sustainability literate. Sustainability literacy encompasses the knowledge, skills, dispositions, and values necessary for one to actively live sustainably (Stibbe & Luna, 2009). This extends learning about sustainability past just knowing the words to being engaged in thinking about, problem solving, and acting towards sustainability. To accomplish this, there is a need to identify specific competencies that one must be proficient in to be considered sustainability literate. While arguably reductionistic, identifying concrete metrics provides instructors of all students, at any grade level, with concrete goals and allows for them to better infuse sustainability into existing curricular materials. Identifying specific competencies and subsequent learning goals has the potential to lead people into thinking that sustainability is an add-on to the current curriculum or one more thing to cover (Nolet, 2009). This could not be further from the truth. Sustainability encompasses topics in every content area due to the interconnected nature of the environmental, social, and economic perspectives. This leads to a natural segue of holistic integration in any content area, where instructors are encouraged to rethink how they teach their courses both in the pedagogy used and the content that is covered (Cranton, 2016; Widhalm, 2011).

Similar to the conversation around defining the word *sustainability*, similar conversations exist in the education community around terminology that defines what students should know and be able to do. A sampling of the terminology used throughout sustainability education literature and in practice in school settings includes standards, learning outcomes, competencies, learning targets, knowledge, skills, objectives, and themes (Baartman et al., 2007; Bransford et al., 2005; Nolet, 2009; Sipos et al., 2008; Warren et al., 2014; Wiek et al., 2011). Adding to the confusion, these words often have conflicting meanings that vary from institution to institution, and sometimes even from department to department (Wiek et al., 2011).

In this paper, competencies will refer to the knowledge, skills and/or dispositions needed to complete a task or solve a problem (Baartman et al., 2008; Wiet et al., 2011). Competencies can be broad and general - such as creative or critical thinking - or they can be more specific to a content area (Wiek et al., 2011). Learning outcomes are the tangible measurements of the

competencies that will show when understanding has been achieved (Sipos et al., 2008; Wiek et al., 2011). While the decision has been made to use these terms in this way, this does not mean that the other terms are invalid. Teachers, instructors, students, lesson designers, and others who work in education use these words interchangeably, often with similar outcomes for student learning.

Sustainability scholars are striving to reach consensus on the specific competencies that, when mastered, will identify if someone is sustainability literate. However, there is still not a field-wide consensus on a specific set of competencies (Brundiars, et al., 2021). Instead there are numerous lists - some broad and far-reaching - that identify a range of content, specific skills, and how the content should be taught. The lists range from a few competencies (such as Howlett et al. (2016) who wants learners to have an interdisciplinary approach, critical thinking and reflective thinking), while others are much longer, containing 10 or more competencies (such as Lozano et al. (2017) who list 12 specific competencies ranging from critical thinking and analysis to strategic action to systems thinking, and anticipatory thinking). Some scholars have even provided lists more specific to teachers and instructors. Nolet (2009) identified nine different sustainability literacy competencies for preservice teachers and Bürgener & Barth (2018) identified that teachers need to have content knowledge, pedagogical content knowledge, along with managing and monitoring student learning. In working to reach consensus, Brundiars et al. (2021) brought together 14 international sustainability education experts, using a Delphi study to work toward an agreed upon framework.

On the surface it appears that these lists are different with the various lengths, focus groups, and specifications. However, there are more similarities than differences. Many of these lists take their foundation in the Brundtland Report recognizing that sustainability incorporates environmental, social and economic perspectives while also acknowledging the importance of meeting current needs without compromising the needs of future generations (Nolet, 2009; Tilbury, 2011; WCED, 1987).

Diving deeper within the specificities of these lists, five main categories of competencies emerged, building from the initial four that the author identified in their research (Potter-Nelson, 2020). These five categories are as follows:

- sustainability knowledge,
- systems thinking,
- social justice,
- futures thinking, and
- active citizenship.

What is unique is that this group of sustainability literacy competency categories provides a link to existing education frameworks, without the creation of new standards (Nolet, 2015). This allows instructors, at any instructional level, to build learning experiences that support their existing curricular goals that also addresses at least one of these sustainability literacy competency categories. The key is to identify these places, also known as leverage points, within the existing curriculum that support the intentional introduction of sustainability content (Nolet, 2015). What follows in this paper are explanations of each of these competency categories.

2.1 *Sustainability Knowledge*

The first competency category is sustainability knowledge, which introduces the learner to a broad, general knowledge of sustainability (Christie et al., 2013; Cortese, 2003; Foley et al., 2017; Mintz & Tal, 2014; Sipos et al., 2008; Wiek et al., 2011). Those with an intricate understanding of sustainability knowledge may wonder why it is included specifically on the list, especially given that sustainability knowledge is integral to all of the other competencies. Yet, to truly teach about sustainability, one has to be knowledgeable about the topic to begin to understand how to intentionally integrate it within and throughout the curriculum. Without this understanding, there is a lack of depth and connections, leading to an incomplete, or potentially even incorrect, picture for students (Christie et al., 2013; Cortese, 2003; Sipos et al., 2008; Widhalm, 2011).

This category was established as a way to provide a base understanding of sustainability. This includes knowing and applying a definition of sustainability. In addition, Cortese (2003, p.17) outlined topics that often aren't included in higher education but could and should be, to encompass an understanding of sustainability. This list includes topics such as: resources are exhaustible, humans are a part of nature, and that technological developments may not solve many of society's problems.

2.2 *Systems Thinking*

A goal of sustainability is to understand the interconnected nature of the world, including how the tangible and intangible behave and interact together. Meadows (2008) defined a system as, "an interconnected set of elements that is coherently organized in a way that achieves something" (p. 11). Systems thinking counters reductionist thinking by recognizing that a system is greater than the sum of its parts and focuses on understanding the components and interactions of these components in a system (Capra & Luisi, 2016; Meadows, 2008). Meadows (2008) further stated, "Systems surprise us because our minds like to think about single causes neatly producing single events ... But we live in a world in which many causes routinely come together to produce many effects." Due to the interconnectedness of a system, changing it can be difficult and near impossible (p. 100). Wiek et al. (2011) provided a way to pragmatically move systems thinking past the knowledge of systems, which includes an understanding of feedback loops, cause-effect chains, and tipping points, to deliberately address how systems interact across and within class and domains. The goal in a sustainable society is to focus on the impact a change in a system can have throughout other systems.

2.3 *Social Justice*

The Brundtland Report, the SDGs, and the Earth Charter all highlight the importance of social justice in becoming more sustainability literate. All three documents make the explicit connections between social, economic and environmental perspectives, even as environmental agencies and others continue to focus solely on the environment, negating the complex interconnectedness of all three areas. Nolet (2009) identifies the lack of interconnected thinking as a systemic issue where the voices and viewpoints of a few outweigh the voices and viewpoints of people from different backgrounds. Holmes & González (2017) added to this by identifying

that the problem with Western education may be Western education itself, because it fails to holistically incorporate the voices of all participants, amongst other concerns.

Diving deeper, the United Nations through the SDGs and other initiatives have clearly articulated a need for education systems to be inclusive, equitable, and ultimately socially just. Public education in the United States has a stated focus on *education for all* but arguably has not been achieved due to deeply embedded systems that support and propagate unfair and unjust practices (Alim & Paris, 2017; Grande, 2015; Holmes & González, 2017; UNESCO, 2016). Focusing on asset-based pedagogies which look at the assets students bring to the classroom instead of their deficits is one way to begin embracing a more just way of teaching (Alim & Paris, 2017).

2.4 *Futures Thinking*

Futures thinking, also called anticipatory thinking, intergenerational thinking, or long-term thinking, encourages people to envision the future, decades from now, instead of just a few years from now (Frisk & Larson, 2011; Nolet, 2009; Wiek et al., 2011). If the goal of sustainability is to meet the needs of the present without compromising the needs of the future, there is an inherent need to address how decisions made today will propagate out to future generations (Frisk & Larson, 2011). In conjunction with systems thinking, there is a need to identify how current decisions will impact systems in the future and anticipate how to curtail any potential unintended or harmful consequences that may occur (Frisk & Larson, 2011). There is also a need for futures thinking to combat the “all hope is lost vision” of the future that is commonly portrayed in the news and on social media, providing younger generations with agency in advocating for a future that is sustainable (Wray, 2022).

2.5 *Active Citizenship*

Active citizenship situates the learner as a participant in their community and asks them to apply what they are learning about sustainability to benefit their community. Communities can be thought of as small or large, depending on the context for the learner and engagement can take a variety of different forms from place-based learning approaches where learners engage with the local community to more active involvement through civic engagement or even activism. Many of the competency lists have competencies that touch on active citizenship through competencies such as *global citizenship* (Nolet, 2009) to *interpersonal competence* (Brundiers et al., 2021; Wiek et al., 2011). Essentially, the idea behind this is once a learner has sustainability knowledge, what are they going to do with that information. Cortese (2003) argued that higher education institutes (HEI) should help foster civic engagement with their students and that HEI have a responsibility to benefit their local communities.

3 Sustainability Literacy Framework

A framework was developed to assist in identifying where the above categories are present within existing curricular materials. The framework provides guidance to instructors as they work to identify and ultimately utilize the places where their course materials may already address topics in sustainability. From here, once those leverage points are identified, small

changes may need to be made to further amplify and support the intentional inclusion of sustainability. The framework is located in Appendix A.

In the framework, criteria were established for each sustainability literacy category (i.e. sustainability knowledge, systems thinking, social justice, futures thinking, and active citizenship) that would distinguish one category from the other. Beyond the unique criteria, key words and citations to the literature were also identified to further assist in the identification of each category. When utilizing the framework, one would look at the overall assignment or material collected and identify the goal of the assignment. Then, using the criteria on the framework, one would identify which category was most prevalent in the assignment. It should be noted that the criteria on the framework is not a checklist and an assignment or lesson material does not need to meet all of the identified criteria to be classified in that category.

The framework also provides instructors with access to the sustainable development goals, MIT's learning goals for their environment and sustainability minor, and sustainable instructional approaches (which will be discussed in detail in Part Four). The framework is based on research conducted by Potter-Nelson (2020) where the current iteration of the framework was modified and used in the Sustainability and Climate Change Across Learning Environments Project (SCALES). As part of the SCALES project almost 400 instructional materials from MIT OpenCourseWare were classified with the framework for inclusion in the SCALES project so that instructors of high school and postsecondary students could search for sustainability instructional materials based on the provided criteria.

4 Sustainability Instructional Approaches

There is importance in categorizing the content of courses to identify leverage points so that instructors can be intentional in their integration of sustainability topics during their courses. However, there is an ever-growing body of research which indicates that how instruction is delivered is almost as important as the content that is being taught (Widhalm, 2011). In the guise of sustainability, Widhalm (2011) encouraged educators to make sure that the methods they use in teaching mirror the information they are teaching to students. This encourages instructors to transition traditional methods of teaching towards more hands-on, student-centered approaches. Instead of lecturing students about their community or through a complex science topic, students should be engaged in place-based learning, where they interact with their community or engage in learning about the complex science topic through a hands-on lab experience.

Many instructors teach the way that they were taught, often using a positivist approach which directly challenges the lessons they are sharing about sustainability (Christie et al., 2013; Mintz & Tal, 2018). A positivist approach to teaching assumes that there are absolute truths which are objective, progressing linearly, where a postpositivist approach assumes that knowledge is subjective and socially constructed (Christie et al., 2013; Littledyke & Manolas, 2010). To fully support sustainability in the classroom instructors need to utilize a postpositivist approach which supports the students in transformative learning, where they begin to adjust and shift their paradigms (Christie et al., 2013; Mintz & Tal, 2018; Sipos et al., 2008; Widhalm, 2011). This means shifting instruction so that it is student-centered, active, hands-on, interdisciplinary, and

intentionally connects students to the real-world (Christie et al., 2013). Activities like role playing, group discussions from a variety of viewpoints, stimulus activities, debates, critical instances, case studies, critical reading, problem-based learning, and fieldwork support a postpositivist approach to teaching (Christie et al., 2013; Cotton and Winter, 2010). It should be noted that these techniques usually require more initial preparation by the instructor, they typically allow learners to engage more deeply in the material (Cotton and Winter, 2010).

More broadly, Nolet (2015) has identified five different instructional approaches that support education for sustainability in the classroom. These practices are student-centered, active, and encourage learners to build skills that will be useful outside of the classroom (Nolet, 2015). In reflecting on these approaches a sixth approach was added in recognition of the need to further create equitable, decolonized education systems (Grande, 2015; Orr, 2004, Lange, 2018, Nolet, 2015; Sterling, 2011). These six approaches (included on the framework in Appendix A) are:

- collaborative, small group learning,
- inquiry-based learning,
- experiential learning,
- service learning,
- place-based learning, and
- culturally sustained learning.

4.1 Collaborative, Small Group Learning

Collaborative, small group learning can occur in a variety of different education settings with students of any age. The collaborative experience can also vary in length from short activities that last a few minutes to longer projects that take considerable time. Ultimately, collaborative, small group learning builds from constructivist and social learning theories as learners work together, collaboratively, to process ideas and course content through active discussions with other members of the group. Nolet (2015) shared that collaborative, small group learning can take place with as few as two students to as many of six students with the reminder that there are diminishing returns as groups get larger, because fewer students are able to participate.

As with all of these approaches, collaborative, small group learning, involves deliberate decisions from the instructor, prior to learners engaging in the learning activity. The instructor needs to identify the parameters for the group learning activity, including group size, how the group will determine their success, and any outcomes or deliverables the group will need to produce. The instructor may also need to assist groups in learning how to work collaboratively. This type of scaffolding often requires more deliberate interactions and modeling early in course as the instructor shares their expectations. As learners gain confidence and skill in small group learning the instructor will naturally provide less support. Finally, while learners are participating in collaborative, small group learning the instructor needs to be actively observing and listening to group interactions. The instructor does not need to be intrusive when they observe these interactions, but observing allows the instructor to determine if additional instructional or student support is needed. (Nolet, 2015)

4.2 *Inquiry-Based Learning*

Inquiry-based learning involves learners engaging in authentic, self-directed learning. In an ideal setting, the instructor would serve as a facilitator for the student(s) who follows their own inquiry into finding the answer to a question, finishing a project, designing something, or advancing their learning with a concrete end point. In more guided inquiry experiences the instructor will identify certain parameters for the student, like the initial parameters, and students then follow a line of inquiry tied to those specific parameters. Inquiry-based learning can take place as an individual activity or with students in a small group.

A focus of inquiry-based learning is having learners engage in authentic, real-world experiences. Often these experiences can be found in project-based, problem-based and design-based learning, where students work on a project, solve a problem or design a solution. Having these types of experiences can serve as motivation for students because they serve an identified need, often in the community, for students (Nolet, 2015).

Inquiry-based learning requires deliberate scaffolding from the instructor throughout the experience and the course. Students, especially older students, who have years of education experience, often struggle with the open nature of inquiry-based learning. This is to be expected when students rarely get the opportunity to engage in inquiry-based learning experiences. To support students, instructors can provide additional parameters, ask deliberate questions, and work to engage students in understanding the expectations for the experience to help them build confidence and understanding (Nolet, 2015).

4.3 *Experiential Learning*

Experiential learning provides students with direct learning experiences. Through experiential learning students are not necessarily regurgitating a set of skills, but are instead applying their knowledge and skills, with the potential for broader, transformative changes. Instructors select at least one authentic experience for students and then serve as the facilitator when the experience is occurring. As the facilitator, instructors help guide students through the experience by asking questions and supporting students as needed (Nolet, 2015).

Experiential learning is closely associated with nontraditional learning environments such as Girl Scouts, Boy Scouts and 4-H. In addition experiential learning is a key component to Montessori and Reggio Emilia approaches to teaching and learning. While experiential learning has historically been done in nontraditional learning environments, it is an exciting way to expand the traditional classroom to engage students in real world learning (Nolet, 2015).

4.4 *Service Learning*

Service learning experiences have students engage in learning through intentional community-based service, where both the learner and the community benefit from the interaction. While experiential in nature, service learning also has components of inquiry-based learning where the learner is more than just an extra set of hands, contributing reciprocally in the community partnership. Extensively researched, service learning has a role in elementary, secondary and post-secondary institutions and naturally segues with sustainability education where learners

are given the opportunity to think critically and interact with complex, real-world situations (Nolet, 2015).

While service learning experiences can and will vary greatly, there are key characteristics within each experience. These key characteristics have learners learn more about the community they will serve, plan their service to benefit the community, conduct the act of service, reflect on the outcomes and have a recognition with the community. (Nolet, 2015)

4.5 *Place-based Learning*

While place-based learning incorporates aspects of inquiry-based learning, experiential learning, and service learning, it is different because the learner directly interacts with their local community. The learner asks questions, seeks answers, and works to develop solutions to locally based issues. By engaging with the local community, the learner has the opportunity to have a transformative experience as they engage with real world, interconnected concerns in their community.

Similar to experiential learning the instructor serves as the facilitator for these experiences, often offering a prompt, field trip, guest speaker or other experience to get students thinking. Instructors then ask their learners open-ended questions to encourage critical reflection, and then support students as they engage more deeply with their community.

4.6 *Culturally Sustained Learning*

Building from culturally responsive and culturally relevant pedagogies, culturally sustaining pedagogies work to affirm learners' cultural backgrounds *and* find ways to sustain them in the education system (Alim & Paris, 2017; Paris, 2012). Through culturally sustained learning experiences students not only foster and support their culture in the classroom, but also have the space to question practices that are repressive and regressive (Alim & Paris, 2017).

In culturally sustained learning instructors create spaces that support learners both through the materials they use to teach and the practices that they use within the classroom. Instructors can reflect on what is being taught in their course, the hidden curriculum that is used, who has access to knowledge, and the voices that are neglected in the process. In auditing course materials instructors are often able to identify a lopsidedness in the materials they use and are encouraged to use more diverse materials. In addition, instructors can shift their teaching practices to focus on asset-based practices that view students' with assets instead of deficits (Alim & Paris, 2017; Ladson-Billings, 1995a; Paris, 2012; Paris & Alim, 2014). Ladson-Billings (1995b) encouraged instructors to integrate education into the culture of students and their community instead of what is typically done where culture is inserted into education.

5 **In Practice**

Instructors at all levels face an overburdened curriculum with little time to cover one more topic (Falkenberg & Babiuk, 2014). In addition, there are increasing demands placed on instructors at all levels (Darling-Hammond, 2006; Falkenberg & Babiuk, 2014). Our goal is not to have

instructors start their planning from scratch, but rather, to modify existing materials and practices to more holistically support sustainability.

So, what does this look like in practice? The above sections highlighted two different places where an instructor could begin to think about changing their instruction: the content that is taught or the method that is used to teach the content. Similar to many things in the sustainability movement, there is no right or wrong place to start, as long as the instructor makes a decision to start somewhere. An instructor could identify small changes that they could make in an existing lesson that more intentionally addresses sustainability topics with their students. Or, an instructor could modify an existing lesson to be more student-centered by changing a lecture into a group project or by taking students on a field trip to center student learning in the local community. Both of these methods are small changes that embrace and encourage changes towards a more sustainable approach in teaching.

Teaching is a complex activity and instructors need to know their students, the content that they are teaching, and how to teach that content (Darling-Hammond, 2006). Sustainability should not be viewed as an add-on to the existing curricula that is being taught, but instead integrated into what is being taught (Nolet, 2015). For some instructors this may encourage a return to the instructional planning process that has become second nature for them. To assist in this process, a guide, *Rethinking Instruction for Sustainability*, has been created that prompts instructors to think about some of the key aspects of their lessons (Appendix B). Borrowing heavily from the Understanding by Design (UbD) work of Grant Wiggins and Jay McTighe, this guide utilizes a modified backwards design approach where the instructor is asked to think about the end learning goals of the activity and build learning experiences that support the goals of the lesson.

The guide is designed to be self-explanatory, walking instructors through identifying a lesson, identifying how they want to shift that lesson and then reconstructing the lesson so that it embodies sustainability. While this process may seem cumbersome, many of the steps ultimately become second nature.

6 Summary

We have presented information in this paper about the history of sustainability education, sustainability literacy competencies, a sustainability literacy framework, guidance on sustainability instructional practices and a guide to assist instructors in moving their instruction to embrace sustainability.

Ultimately, there is a clearly articulated need to develop a sustainability literate populace. However, doing so will call into question deeply held societal beliefs and norms, including how people are educated. In moving to embrace sustainability literacy, instructors at all levels can begin making small changes to their instruction either through the content that is covered or through their instructional approaches. This helps to ensure that sustainability is addressed, regardless of content area and so that it doesn't become an add on to an already full curriculum.

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8 Appendix A: Framework for Identifying Sustainability Leverage Points in Education

8.1 Rationale for the Framework

The purpose of this framework is to identify the prevalence of key sustainability categories and other important sustainability criteria in academic coursework. The rationale for this is two-fold. First, it serves as a way to identify leverage points where instructors can intentionally infuse sustainability into their coursework without dramatic changes to the content that is being taught. Second, this intentional inclusion of sustainability in coursework further addresses the identified need to create a sustainability literate populace (Orr, 2004; Sterling, 2011). This framework was used to code MIT undergraduate course materials, undergoing several iterations as it evolved to become more encompassing.

8.2 Components of the Framework

The second iteration of the framework evaluates coursework in the following areas:

- Categories of Sustainability Competencies
- Sustainable Development Goals
- MIT's Learning Goals for the Environment & Sustainability Minor
- Sustainability Instructional Approaches

8.2.1 Categories of Sustainability Competencies

In sustainability education there are numerous different competency lists that address the knowledge, skills and/or dispositions that a person should have if they are to be considered sustainability literate (Bertschy, Künzli, & Lehmann, 2013; Brundiers et al., 2021; Cole, 2007; Cotton & Winter, 2007; Nolet, 2009; Nolet 2016; Roth, 1992; Sipos et al., 2008; Tilbury, 2011; Warren et. al., 2014; Wiek et al., 2011). After a thorough review of these lists, five main categories of competencies emerged from the sustainability literature. These five categories serve as the foundation for the first part of the framework. These categories are:

- Sustainability Knowledge
- Systems Thinking
- Social Justice
- Futures Thinking
- Active Citizenship

8.2.2 Sustainable Development Goals

Building from a number of different documents and initiatives, the *Sustainable Development Goals* (SDG), developed by the United Nations, outline an ambitious set of objectives in 17 different goal areas that work towards achieving worldwide sustainability (UN General Assembly, 2015). The goal areas addressed in the SDGs are wide reaching, embodying the

articulation in the *Our Common Futures* report that sustainability lives at the intersection of social, environmental, and economic interactions (WCED, 1987).

8.2.3 *MIT's Learning Goals for the Environment and Sustainability Minor*

While similar to (1) Categories of Sustainability Competencies above, these are specific to the MIT community. MIT has an established Environment and Sustainability Minor for undergraduate students in any major. The minor is designed to provide students with interdisciplinary knowledge and real-world experiences to equip them in solving the wicked problems facing society. In completing the coursework required for the minor, students will have achieved learning outcomes in seven categories:

- Systems Thinking
- Sustainable Design
- “Manus”
- Know your Planet
- Social Context
- Ethical Decision-Making
- Impactful Communication

8.2.4 *Sustainability Instructional Approaches*

Researchers have identified how sustainability content is delivered is as important as the content itself (Christie et al., 2013; Mintz & Tal, 2018; Nolet, 2016; Redman, Wiek & Redman, 2018; Sipos et al., 2008; Widhalm, 2011). Identifying which instructional practices are used can assist instructors in moving to more of a postpositivist instructional model, making sure the “message matches the material.” All of these experiences are learner-centered, where the instructor serves as the facilitator of the experience, instead of the direct deliverer of content. In addition, all of these approaches all have their origins of constructivism, where students construct their understanding by interacting with their prior knowledge. Finally, all of these approaches encourage applications of learning outside the walls of the classroom. The sustainability instructional approaches are as follows:

- Collaborative, small group learning
- Inquiry-based learning
- Experiential learning
- Service learning
- Place-based learning
- Culturally Sustained learning

8.3 *Using the Framework*

Assignment and course materials are considered and coded as an entire document. After reading over the course material, the evaluator considers the following questions:

- What is this trying to teach about?
- What is the main focus of this material?

These two broad questions will help guide evaluators in coding the material, as sometimes an assignment may address a variety of topics. After brief reflection on these questions, the evaluator will work their way through each of the four components of the framework, applying criteria for all categories. The tables below provide details on how categories are defined in some detail.

Please note that the framework is designed as a guide and not a checklist. The course material does not need to meet all listed criteria to be coded for that category. If an item meets the criteria for two or more categories, the item is coded to the category with which it meets more of the criteria. If the item meets both categories equally, context should be considered, determining which category there is more alignment.

Table 1: Categories of Sustainability Competencies

	Sustainability Knowledge	Systems Thinking	Social Justice	Futures Thinking	Active Citizenship	Content Knowledge
Rationale	Sustainability knowledge is an emergent paradigm that addresses the interconnection of environmental, social and economic perspectives. In instructional materials this builds past the tradition of an environmental or ecological way of knowing, embracing interplay between the social and economic perspectives.	Traditionally there is a desire to simplify systems; to focus on the parts instead of the whole. Systems thinking encourages a return to thinking about the whole and its connections with other parts of the system. Systems thinking looks at the links between all of the systems and how one decision affects another system.	Social justice and equity is a crucial step in achieving sustainability with a clearly articulated need to provide equitable and inclusive opportunities to all. In many cases working toward social justice requires an acknowledgement of and action towards dismantling the deeply embedded systems that support and perpetuate inequality.	Often called anticipatory thinking or intergenerational thinking, <i>futures thinking</i> encourages instructors and learners to think about how current choices will influence the long-term future. Activities like forecasting and backcasting encourages reflecting on how current decisions impact future generations.	Active citizenship positions the learner to connect what they are learning to either their local place or as a global citizen. Active citizenship encourages the connections between content and positive action within the defined community.	A first step in rethinking teaching and curriculum to be more sustainability focused is to build instruction around examples within the content area. The goal is to build an understanding of the content that does not focus students on the impact of the knowledge being taught.
Criteria	<ul style="list-style-type: none"> Builds capacity for greater understanding of sustainability through environmental, social, human health, and/or economic perspectives Explicit connection to course content and sustainability perspectives 	<ul style="list-style-type: none"> Emphasizes how the content being taught is part of a larger system Encourages explanations or thinking about how the “part” is connected to the whole Incorporates at least two out of the three perspectives of sustainability: environmental, social and economic 	<ul style="list-style-type: none"> Recognizes diversity within the context of the course material(s). Focus is on equity and identifying existing social barriers that may prevent equity. Equity can be broad from equitable distribution of resources to gender-equity in decision making. 	<ul style="list-style-type: none"> Emphasizes how choices now will impact future generations, 150+ years from now (Nolet, 2009). Focus is on meeting current needs without jeopardizing the needs of future generations (WCED, 1987). Could use forecasting or backcasting to draw connections between here and then (Frisk & Larson, 2011). 	<ul style="list-style-type: none"> Emphasizes involvement in local and/or global community Involves learning about local and/or global community and ties content back to local/global community Learning and/or action about governments, policies, laws, norms, etc <i>A reading or a lecture likely will not be active citizenship because students are not acting</i> 	<ul style="list-style-type: none"> Uses environmental, social, and/or economic perspectives solely to build content knowledge disconnected from the other competencies listed.
Key Words	Sustainability; Environmental Education, Ecological; Interdisciplinary	Integrated; linked; causal; leverage points; emergence; causes; silos	Equity; Equality; Just/Justice; Barriers; Race; Racism; Gender; Pluralism; culturally responsive; culturally relevant; culturally sustaining	Forecasting; visioning; backcasting; intergenerational; collective change	worldview; place-based; community; citizenship; policy;	Varies based on content being covered
Authors	Foley et. al., 2017; Hakovirta and Denuwara, 2020; Mintz & Tal, 2014; Nolet, 2009; Rieckmann, 2012; WCED, 1987; Yavetz et. al., 2009	Cabrera & Cabrera, 2015; Capra & Luisi, 2016; Cortese, 2003; Frisk & Larson, 2011; Meadows, 2008; Nolet, 2009; Wheeler et. al., 2008; Yavetz et. al., 2009	Alim & Paris, 2017; Grande, 2015; Holmes & González, 2017; Earth Charter Commission, 2000; Nolet, 2009; Santone, 2019; Thompson et. al., 2003;	Brundier et. al., 2020; Foley et. al., 2017; Frisk & Larson, 2011; Lozano et. al., 2020; Merritt et. al.; UNECE, 2011; Wiek et. al., 2011	Brundiers et. al., 2020; Cortese, 2003; Gibson, 2006; Frisk & Larson, 2011; Lozano et. al., 2017; Nolet, 2009; Sipsos et. al, 2008; Wheeler et. al., 2008; Wiek et. al., 2008	Content specific authors

Table 2: Sustainable Development Goals

SDG	Goal	Overview	Target for SDG
1	No Poverty	End Poverty in all its forms everywhere.	<ul style="list-style-type: none"> 1.1 - Eradicate extreme poverty 1.2 - reduce poverty by at least 50% 1.3 - Implement nationally appropriate social protection systems 1.4 - Ensure equal rights to economic resources, basic services, property, inheritance, natural resources, technology and financial services 1.5 - Build resilience to climate-related extreme events and other economic, social and environmental disasters 1.A - Ensure significant mobilization of resources to end poverty in all its dimensions 1.B - Create policy frameworks to support investment in poverty eradication actions
2	Zero Hunger	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	<ul style="list-style-type: none"> 2.1 - End hunger and ensure access to safe, nutritious and sufficient food all year round 2.2 - End all forms of malnutrition 2.3 - Double the agricultural productivity and incomes of small-scale food producers 2.4 - Ensure sustainable food production systems and implement resilient agricultural practices 2.5 - Maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species 2.A - Increase investment in rural infrastructure, agricultural research and extension services, technology and plant and livestock gene banks 2.B - Correct and prevent trade restrictions and distortions in world agricultural markets 2.C - Adopt measures to ensure the proper functioning of food commodity markets.
3	Good Health and Well-Being	Ensure healthy lives and promote well-being for all at all ages	<ul style="list-style-type: none"> 3.1 - Reduce the global maternal mortality ratio 3.2 - End preventable deaths of newborns and children under 5 years of age 3.3 - End the epidemics of AIDS, tuberculosis, malaria and other communicable diseases 3.4 - Reduce mortality from non-communicable diseases and promote mental health and well-being 3.5 - Prevent and treat substance abuse 3.6 - Halve the number of deaths and injuries from road traffic accidents. 3.7 - Ensure universal access to sexual and reproductive health-care services 3.8 - Achieve universal health coverage 3.9 - Reduce death and illness from hazardous chemicals and pollution 3.A - Implement the World Health Organization Framework Convention on Tobacco Control 3.B - Support research, development and access of vaccines and medicines 3.C - Increase health financing and the recruitment, development, training and retention of the health workforce in developing countries 3.D - Strengthen the capacity of all countries for early warning, risk reduction and management of health risks.
4	Quality Education	Ensure healthy lives and promote well-being for all at all ages	<ul style="list-style-type: none"> 4.1 - Ensure that all complete free, equitable and quality primary and secondary education 4.2 - Ensure that all have access to quality early childhood development and care 4.3 - Ensure equal access for all to affordable post-secondary education 4.4 - Increase the number of people with skills for employment 4.5 - Eliminate all barriers to education 4.6 - Ensure universal literacy and numeracy 4.7 - Ensure that all learners have knowledge and skills to promote sustainable development 4.A - Build and upgrade inclusive and safe schools 4.B - Expand higher education scholarships for developing countries 4.C - Increase the supply of qualified teachers

5	Gender Equality	Achieve gender equality and empower all women and girls	<ul style="list-style-type: none"> 5.1 - End discrimination against women and girls 5.2 - Eliminate violence against and exploitation of women and girls 5.3 - Eliminate forced marriages and genital mutilation 5.4 - Value unpaid care and promote shared domestic responsibilities 5.5 - Ensure full participation in leadership and decision-making 5.6 - Universal access to reproductive rights and health 5.A - Give women equal rights to economic resources, property ownership and financial services 5.B - Promote empowered women through technology 5.C - Adopt and strengthen legislation for gender equity and empowerment
6	Clean Water & Sanitation	Ensure availability and sustainable management of water and sanitation for all	<ul style="list-style-type: none"> 6.1 - Achieve universal access to safe and affordable drinking water 6.2 - Achieve access to sanitation for all, ending open defecation 6.3 - Improve water quality, wastewater treatment and safe reuse 6.4 - Increase water-use efficiency and ensure freshwater supplies 6.5 - Implement water management 6.6 - Protect and restore water-related ecosystems 6.A - Expand water and sanitation support to developing countries 6.B - Support local engagement in water and sanitation management
7	Affordable & Clean Energy	Ensure access to affordable, reliable, sustainable and modern energy for all	<ul style="list-style-type: none"> 7.1 - Ensure universal access to modern energy 7.2 - Increase percentage of renewable energy 7.3 - Double improvement in energy efficiency 7.A - Promote access, technology and investments in clean energy 7.B - Expand and upgrade energy services for developing countries
8	Decent Work & Economic Growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	<ul style="list-style-type: none"> 8.1 - Sustainable economic growth 8.2 - Diversity, innovate and update for economic productivity 8.3 - Promote policies to support job creation and growing enterprises 8.4 - Improve resource efficiency in consumption and production 8.5 - Achieve full employment and decent work with equal pay 8.6 - Promote youth employment, education and training 8.7 - End modern slavery, trafficking, and child labour 8.8 - Protect labor rights and promote safe working environments 8.9 - Promote beneficial and sustainable tourism 8.10 - Universal access to banking, insurance and financial services 8.A - Increase aid for trade support 8.B - Develop a global youth employment strategy
9	Industry, Innovation & Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	<ul style="list-style-type: none"> 9.1 - Develop sustainable, resilient and inclusive infrastructures 9.2 - Promote inclusive and sustainable industrialization 9.3 - Increase access to financial services and markets 9.4 - Upgrade all industries and infrastructures for sustainability 9.5 - Enhance research and upgrade industrial technologies 9.A - Facilitate sustainable infrastructure development for developing countries 9.B - Support domestic technology development and industrial diversification 9.C - Universal access to information and communications technology

10	Reduced Inequalities	Reduce inequality within and among countries	<p>10.1 - Reduce income inequalities 10.2 - Promote universal social, economic and political inclusion 10.3 - Ensure equal opportunities and end discrimination 10.4 - Adopt fiscal and social policies that promote equality 10.5 - Improve regulation of global financial markets and institutions 10.6 - Enhance representation for developing countries in financial institutions 10.7 - Responsible and well-managed migration policies 10.A - Special and differential treatment for developing countries 10.B - Encourage development assistance and investment in least developed countries 10.C - Reduce translation costs for migrant remittances</p>
11	Sustainable Cities & Communities	Make cities and human settlements inclusive, safe, resilient and sustainable	<p>11.1 - Ensure access to adequate, safe and affordable housing and basic services 11.2 - Provide access to safe, affordable, accessible, and sustainable transport systems 11.3 - Enhance inclusive and sustainable urbanization 11.4 - Protect the world’s cultural and natural heritage 11.5 - Reduce the adverse effects of natural disasters 11.6 - Reduce the environmental impacts of cities 11.7 - Provide access to safe and inclusive green and public spaces 11.A - Support strong national and regional development planning 11.B - Implement policies for inclusion, resource efficiency and disaster risk reduction 11.C - Support least developed countries in sustainable and resilient building</p>
12	Responsible Consumption & Production	Ensure sustainable consumption and production patterns	<p>12.1 - Implement the 10-year sustainable consumption and production framework 12.2 - Sustainable management and use of natural resources 12.3 - Halve global per capita food waste 12.4 - Achieve responsible management of chemicals and waste 12.5 - Substantially reduce water generation 12.6 - Encourage companies to adopt sustainable practices and sustainability reporting 12.7 - Promote sustainable public procurement practices 12.8 - Promote universal understanding of sustainable lifestyles 12.A - Support developing countries’ scientific and technological capacity for sustainable consumption and production 12.B - Develop and implement tools to monitor sustainable tourism 12.C - Remove market distortions that encourage wasteful consumption</p>
13	Climate Action	Take urgent action to combat climate change and its impacts	<p>13.1 - Strengthen resilience and adaptive capacity to climate-related disasters 13.2 - Integrate climate change measures into national policies, strategies and planning 13.3 - Build knowledge and capacity to meet climate change 13.A - Implement the UN Framework Convention on Climate Change 13.B - Promote mechanisms to raise capacity for planning and management</p>
14	Life Below Water	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	<p>14.1 - Reduce marine pollution 14.2 - Sustainably manage, protect, and restore marine and coastal ecosystems 14.3 - Minimize and address the impacts of ocean acidification 14.4 - Regulate harvesting, end overfishing and implement science-based management plans 14.5 - Conserve at least 10% of coastal and marine areas 14.6 - End subsidies contributing to overfishing 14.7 - Increase the economic benefits from sustainable use of marine resources 14.A - Increase scientific knowledge, research and technology for ocean health 14.B - Support small scale fishers 14.C - Implement and enforce international sea law</p>

15	Life on Land	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	<p>15.1 - Ensure conservation, restoration and sustainable use of terrestrial and freshwater ecosystems</p> <p>15.2 - End deforestation and restore degraded forests</p> <p>15.3 - End desertification and restore degraded land</p> <p>15.4 - Ensure conservation of mountain ecosystems</p> <p>15.5 - Protect biodiversity and natural habitats</p> <p>15.6 - Protect access to genetic resources and fair sharing of the benefits</p> <p>15.7 - Eliminate poaching and trafficking of protected species</p> <p>15.8 - Prevent invasive alien species on land and in water ecosystems</p> <p>15.9 - Integrate ecosystems and biodiversity in governmental planning</p> <p>15.A - Increase financial resources to conserve and sustainably use ecosystem and biodiversity</p> <p>15.B - Finance and incentivize sustainable forest management</p> <p>15.C - Combat global poaching and trafficking</p>
16	Peace, Justice & Strong Institutions	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	<p>16.1 - Reduce all forms of violence everywhere</p> <p>16.2 - Protect children from abuse, exploitation, trafficking and violence</p> <p>16.3 - Promote the rule of law and ensure equal access to justice</p> <p>16.4 - Combat organized crime and illicit financial arms flows</p> <p>16.5 - Substantially reduce corruption and bribery</p> <p>16.6 - Develop effective ,accountable and transparent institutions</p> <p>16.7 - Ensure responsive, inclusive, participatory and representative decision-making</p> <p>16.8 - Strengthen the participation in global governance</p> <p>16.9 - Provide universal legal identity</p> <p>16.10 - Ensure public access to information and protect fundamental freedoms</p> <p>16.A - Strengthen national institutions to prevent violence and combat terrorism and crime</p> <p>16.B - Promote and enforce non-discriminatory laws and policies</p>
17	Partnerships for the Goals	Strengthen the means of implementation and revitalize the global partnership for sustainable development	<p>17.1 - Strengthen domestic resource mobilization</p> <p>17.2 - Implement all development assistance commitments</p> <p>17.3 - Mobilize financial resources for developing countries</p> <p>17.4 - Assist developing countries in attaining debt sustainability</p> <p>17.5 - Invest in least-developed countries</p> <p>17.6 - Enhance knowledge sharing and cooperation for access to science, technology and innovation</p> <p>17.7 - Promote sustainable technologies to developing countries</p> <p>17.8 - Strengthen the science, technology and innovation capacity for least-developed countries</p> <p>17.9 - Enhance SDG capacity</p> <p>17.10 - Promote a universal trading systems under the WTO</p> <p>17.11 - Increase the exports of developing countries</p> <p>17.12 - Remove trade barriers for least-developed countries</p> <p>17.13 - Enhance global macroeconomic stability</p> <p>17.14 - Enhance policy coherence for sustainable development</p> <p>17.15 - Respect national leadership to implement policies for sustainable development goals</p> <p>17.16 - Enhance the global partnership for sustainable development</p> <p>17.17 - Encourage effective partnerships</p> <p>17.18 - Enhance availability of reliable data</p> <p>17.19 - Further develop measurements of progress</p>

Table 3: MIT Learning Goals

Category	Description
Systems Thinking	Foster a holistic, systems thinking approach to see the interconnections between environment, economics and society at different scales (individual and collective; local, regional, national, international, global)
Sustainable Design ¹	Cultivate sustainable design skills to envision and design viable solutions and transition pathways
“Manus” ¹	Engage in project-based, experiential learning to apply problem solving strategies to current and emerging environment and sustainability challenges
Know your Planet ²	Understand the physics, chemistry and/or biology of Earth, its climate and its ecosystems
Social Context ³	Understand the significance of political, historical, economic and cultural factors in order to translate, localize and implement environmental solutions to a particular social context
Ethical Decision-Making	Develop the ability to reconcile competing values and goals in support of effective, ethical decision-making, recognizing the effects of philosophical, cognitive and sociological factors in decision-making by individuals and institutions
Impactful Communication	Build communication skills to motivate and collaborate with diverse and/or conflicting constituencies

¹ While “Sustainable Design” and “Manus” are similar, the distinguishing factor is that “manus” has students actively engaged in a hands-on, experiential learning project for a real-world problem; they often go to a place or physically create something. “Sustainable Design” often represented discussions, readings, or other ways of fostering design skills.

² “Know your Planet” addresses high-level content knowledge where students are learning about their planet to further their understanding of sustainability.

³ “Social Context” often involves curricula that looks at a direct impact on people and/or policy decisions and discussions.

Table 4: Sustainability Instructional Approaches

	Collaborative, Small Group Learning	Inquiry-based Learning	Experiential Learning	Service Learning	Place-based Learning	Culturally Sustained Learning	Other ⁴
Description	Working in groups of 2-6 students engage in a learning experience where the initial parameters are defined by the instructor.	Inquiry-based learning involves the student engaging in authentic, self-directed learning. Often inquiry-based learning is collaborative. Ideally the instructor is the facilitator of the learning experiences. In more guided inquiry experiences the instructor sets initial parameters and students follow a line of inquiry tied to the parameters.	Experiential learning experiences provide students with direct experiences, accompanied with a critical reflection. Instructors often select the experiences for students, but then serve as the facilitator when the experience is occurring. These experiences are often conducted in informal education settings and with clubs and organizations, but also have a place in the formal setting.	Service learning experiences have students engage in learning through community-based service, where both the learner and the community benefit from the interaction. While experiential in nature, service learning also has components of inquiry-based learning because the learner is more than just an extra set of hands, contributing reciprocally in the community partnership.	Place-based learning involves learners interacting with their local community. With components of inquiry-based learning, experiential learning and/or service learning, place-based learning encourages the learner to ask questions about the local place which could touch on environmental issues, economic issues or issues of social equity.	Culturally sustaining learning not only affirms students' cultural backgrounds, but finds ways to sustain them through their education. Culturally sustaining learning should take place throughout all of the types of learning, however to guarantee that it occurs, it is identified as its own approach.	There are multiple other approaches to teaching students. If the lesson or the materials do not fit one of the already mentioned categories, the lesson will be marked as other.
Examples	<ul style="list-style-type: none"> • Think-Pair-Share • Jigsaws • Numbered Heads Together • Roundtable • Discussions 	<ul style="list-style-type: none"> • Project-based learning • Problem-based learning • Design-based learning • Laboratories 	<ul style="list-style-type: none"> • Field Trips • Field Work • Internships • Hands-on lessons • Laboratories 	<ul style="list-style-type: none"> • Experiences vary greatly 	<ul style="list-style-type: none"> • Field Trip • Guest Speaker • Primary source document from Community • Question about the Community 	<ul style="list-style-type: none"> • Reflection on one's own cultural lens • Addressing biases in systems • Utilization of students' culture to guide instruction • Hip Hop Pedagogy 	Varies

⁴ Depending on an instructor's goals for their coursework they may use a variety of different instructional approaches. These approaches may or may not align with what are considered best practices in sustainability education. In the case that they are not one of the already listed, the category of *Other* was created to support the variety of instructional approaches that are issued in teaching students.

9 Appendix B: Rethinking Instruction for Sustainability

Online access for this template is available at <https://bit.ly/3ySkzpZ>

The following prompts are designed to help you revise a selected learning experience (e.g. a lesson, activity, unit, course, continuing education experience, professional development) to be more sustainable. You are not required to answer all of the questions but space is provided below each prompt for you to be deliberate in your process.

Reflect on the original learning experience that you'd like to revise.

What did students do? What did the instructor do? What evidence for learning did students share?

Will you modify the content of the learning experience or the instructional approach you are using?

*If you are changing the **content of the learning experience** this likely means that you will be modifying some type of your lessons to be more focused on sustainability. This means that you would change the content of the lesson to focus more on sustainability in one of the following areas: sustainability knowledge; systems thinking; social justice; futures thinking; and/or active citizenship.*

*If you are changing the **instructional approach** this likely means that you will modify how the content is delivered, moving towards a postpositivistic approach. This means that your modified lesson will likely embrace one of these instructional approaches: collaborative, small group learning; inquiry-based learning; experiential learning; service learning; place-based learning and/or culturally sustained learning.*

Which category of sustainability literacy competency OR sustainability instructional approach would you like the new learning experience to embody?

Content of Learning

- *Sustainability Knowledge*
- *Systems Thinking*
- *Social Justice*
- *Futures Thinking*
- *Active Citizenship*

Instructional Approach

- *Collaborative, Small Group Learning*
- *Inquiry-Based Learning*
- *Experiential Learning*
- *Service Learning*
- *Place-Based Learning*
- *Culturally Sustained Learning*

What are your goals for students in this learning experience?

What content standards, course objectives, program objectives or learning outcomes will this experience address?

What do you want students to understand at the end of this learning experience?

What are the big ideas? What specific understandings about them are desired? What misunderstandings could be predicted?

What do you want students to know and be able to do by the end of their learning experience?

What knowledge and skills will students acquire as a result of this experience?

Students will know...

Students will be able to...

What is an essential question that could encompass the broad learning goals of this lesson?

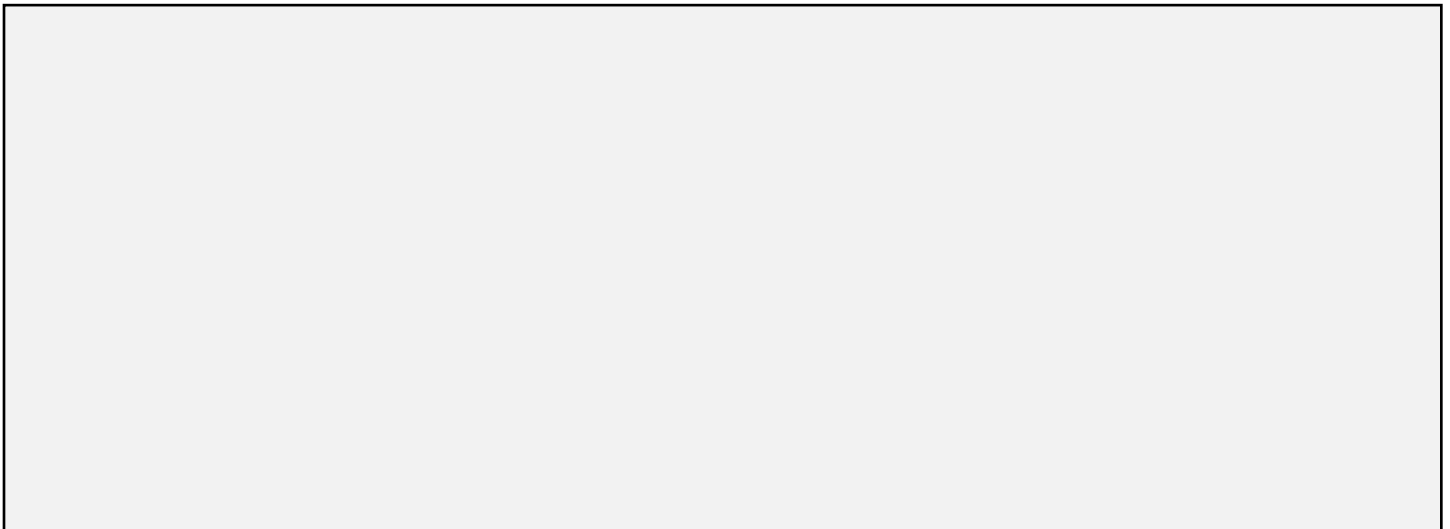
Essential questions are questions that engage learners in the learning experience by helping them work to identify the goals of the lesson. Some instructors prefer to state the learning objectives of a lesson or complete the sentence “Students will be able to...” as a way to help guide students into what they are learning in their learning experience.

How will students show their understanding of the material?

What authentic performance tasks will students complete and how will it be assessed? What other evidence (quizzes, tests, papers, homework, journals) will students use to demonstrate their understanding of the material?

**What learning experiences and instruction will enable students to achieve the desired results?**

How will the lesson or series of lessons move forward? What will the instructor need to do? What will students do?



Please also create any instructional materials that students may need during this instruction. Will you need to create a rubric? A worksheet? An outline of expectations? A list of resources?