

*Discussion*

# Entry points to integrating sustainability in education

Birgit R. Krogstie<sup>1</sup>

<sup>1</sup> Department of Computer Science, NTNU, Norway

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**Sammendrag:** There is a need to incorporate sustainability in higher education, including the MNT fields. How to achieve a meaningful integration of sustainability in our courses and study programs is however a challenge. By considering this challenge from the perspectives of society and work life we identify a set of entry points for educators to work on the integration of sustainability in their courses. We invite discussion about the relevance of these entry points and about ideas as well as hindrances for such integration to happen in real life educational contexts.

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Nøkkelord:

Sustainability, sustainability education, transformative education, sustainability competencies, employability

## 1.1 Introduction

A look at Norwegian universities' strategies is sufficient to recognize the current need to incorporate sustainability in all areas of higher education. As universities and university colleges we need to be sustainable as organizations, and more crucially: We need to provide education that helps our students get the right competence to actively take part in handling the great sustainability challenges.

The expectation that educators must somehow integrate sustainability in their courses is often met by frustration and resignation: "My curriculum is already packed!", "My course is not about sustainability!", "Are we supposed to teach social science?", "What is meant by sustainability anyway?" and so on. Sustainability may end up being reluctantly added to the lecture plan, typically at the end, to "tick off" that it has been addressed.

The issue of how to meaningfully integrate sustainability in various types of courses and study programs, accordingly, is challenging and worth discussing across the fields represented at the MNT conference.

The research question addressed in this work is: How can we achieve a meaningful integration of sustainability in education? To approach an answer we draw on research literature as well as the authors' experience from working with the integration of sustainability in Computing education over several years.

## 2 Sustainability

Regarding the concept of sustainability, there are various definitions, models and taxonomies. The definition of *sustainable development* from the Brundtland commission is well established: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987).

The UN has translated sustainable development into a set of 17 sustainable development goals (SDGs) <https://sdgs.un.org/goals>. These goals with subgoals cover the needs humanity needs to address to achieve a sustainable future. Another range of models of sustainability include the environment, society and economy as main constituent areas. The three areas are often depicted in a Venn diagram, and sometimes in a layered fashion ("wedding cake") where the environment/biosphere is the foundation, society builds on this, and economy on top is based on a working society.

Another key reference model for sustainability outlines the planetary boundaries within which humanity can continue to develop and thrive – if we manage to stop overshooting them (Rockström et al. 2009). The doughnut model of economics (Raworth 2022) locates the viable area for human activity outside the boundaries of a social foundation (inner part of the doughnut) while inside the planetary boundaries.

### 3 Including sustainability in education

There are many stakeholders involved in higher education with legitimate roles and interests in making education successful. In what follows we address the integration of sustainability in education by taking the perspectives first of society, then of work life. The resulting entry points indicate some directions for educators' work to integrate sustainability in education. To illustrate our points, we include some references to computing education.

#### 3.1 The needs of society

Due to the scale of the challenges related to sustainability on a societal level, the ability of the population to understand and act upon sustainability challenges is critical. This has implications also for higher education. Here we will focus on three aspects: The need for basic knowledge about sustainability challenges, the need for a vocabulary (terms, models) to communicate about sustainability, and the need for competence to actually make a change in society.

For universities to be able to address sustainability issues on a more advanced level (which we will get back to in the next section), there is a need for basic knowledge and sufficient vocabulary. These two go hand in hand: insight about types of sustainability challenges and concrete cases needs to be expressed in suitable language and at the same time gives meaning to vocabulary and models that otherwise may be perceived as rather abstract. Regarding basic vocabulary, we pointed to some relevant sources in the Introduction chapter. Regarding sustainability challenges, it is not trivial to say what should be regarded as "common knowledge". Available knowledge is constantly changing and expanding as technology, research, events and discussions evolve, including debates of a political nature with arguments about priorities, likelihood of scenarios and the truthfulness of scientific findings. For instance, arguably, it might be regarded as basic knowledge that access to clean water for everyone is one of the UN SDGs. Given the growing use of AI, it could also be considered basic knowledge that AI usage (especially that of generative AI) has a huge impact on clean water consumption, potentially contributing to water shortage. As users of AI and future professionals making decisions on use of AI in various contexts, then, our students need to have this knowledge. Another type of basic knowledge is more on a meta level: sustainability issues frequently involve dilemmas that cannot be solved without concessions and compromise. Our students will be taking part in discussions involving such dilemmas.

Upon entering higher education, students today have more awareness of sustainability than students only a few years ago, provided through primary and secondary education. Formal learning at school is accompanied by a flood of information from social media and other channels, resulting in insight but potentially also confusion and a need to keep it all at distance. At the higher education level we need to make sure we create a common ground for the students on sustainability, helping

some catch up on vocabulary and knowledge that others already have, and lifting the perspective to challenges taken on through the expertise gained in higher education. By taking a broad perspective on sustainability it is possible to cover diverse types of challenges matching the diversity of students' chosen fields of study.

Many have argued that a dedicated introductory level course on sustainability is ideal for this purpose. Another option is to modify existing introductory level courses (e.g. on society, ethics,..) to make sustainability a main topic there.

Whether or not there is a dedicated course addressing the basics of sustainability, the use of a shared set of terms and models should be promoted. If teaching staff across various courses actively use the same vocabulary, it demonstrates to the students a commitment to sustainability. We should reach beyond referring to the SDGs, which often ends up as a superficial exercise. To achieve this, culture building among teaching staff for discussing sustainability is essential, which suggests a degree of formal and informal learning activity e.g. through seminars and workshops.

Many voices in society call for fundamental change to the way society works, e.g. with respect to technology, economy, and government. This suggests educational approaches aiming for transformation (Aboytes & Barth, 2020; Sterling, 2010; Yacek, 2020). *Transformative education* involves “[. . .] learning that transforms problematic frames of reference – sets of fixed assumptions and expectations (habits of mind, meaning perspectives, mindsets) – to make them more inclusive, discriminating, open, reflective, and emotionally able to change (Mezirov, 2003) p.58. As educators we need to consider to what extent our courses should aim for students to acquire competence defined by existing practices and when it is more appropriate to have students *question* these practices. While many existing courses involve problem solving and innovative solutions, a transformative take is to require a student project to make a real impact on the world outside the university, e.g. by developing solutions in collaboration with neighbourhoods or non-profit organizations. Importantly, having students go beyond existing practices and solutions does not imply that the teacher should prescribe what is the right approach or solution. In light of the different traditions for sustainability teaching: fact-based, normative, and critical/pluralistic (Öhman & Östman, 2019), transformative education belongs to the latter tradition: Students should be active participants in defining even what sustainability means.

### 3.2 The needs of work life

Work practices in the areas we prepare our students for are rapidly evolving. Within various disciplines and professions, there is a need for knowledge and skills to address sustainability-related challenges.

Sustainability accountability and reporting are increasingly required. Candidates from technology-oriented study programs frequently start working in consultancy companies whose clients expect the company to be able to deliver solutions according to certain standards. The Corporate Sustainability Reporting Directive (CSRD) (European Union, 2022) is an important example; from the fiscal year of 2024, large enterprises in Norway

must report based on CSRD. The company might also have developed their own guidelines and standards with respect to sustainability. As employers, companies seek candidates who are able to actively consider and report on sustainability in their work.

Relatedly, there is the development of sustainability awareness within the core practice of the various disciplines. In Software engineering (SE), the need to integrate sustainability throughout work process has spurred the development of tools and frameworks (König et al., 2024; Lago et al., 2024). In SE education, to give our students relevant experience they should practice use of the same state-of-the-art tools and frameworks. This means educators also need to be updated on the relevant tools and their appropriate integration in the work process (e.g., in the case of Software engineering, in agile development). Also, curricula need to be developed to support the learning process.

As an example, at NTNU there is ongoing research on how to integrate sustainability analysis in Human-Computer Interaction (HCI) courses. In a large introductory course the Sustainability Awareness Framework (SusAF) (Duboc et al., 2019; Penzenstadler et al., 2018) is applied. The students develop a sustainability analysis diagram (SusAD) in addition to the other design artifacts, which benefits learning about HCI design practice as well as sustainability. A research publication from this work is currently under review.

A simplified SusAD diagram, taken from another course, is shown in Figure 1. The technology under analysis is a website for a housing cooperative, and the students have identified sustainability effects related to the cooperative's car charging solution.

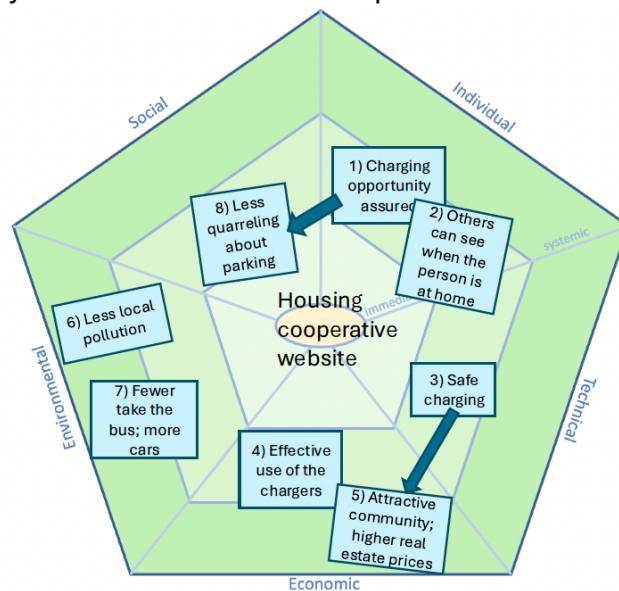


Figure 1: Example of a sustainability analysis diagram; simplified

Finally, it is useful to consider the competences regarded as particularly useful for working with sustainability challenges. Key competences for sustainability (Redman & Wiek, 2021; Wiek et al., 2011) include e.g. critical thinking, teamworking, systems thinking and future thinking. These are competencies typically asked for by employers (e.g. (Lundberg, Gunhild M. et al., 2018)). Also, they are competencies developed in many existing courses, in particular advanced courses based on project-based learning. To

integrate sustainability in education, thus, an important thing to ask, is: What do we already have in our current courses, and what needs to be added to help students gain the full set of sustainability competencies through their study program. Frameworks such as the CDIO Optional Standard for sustainable development (Rosén et al., 2021) can be helpful to address this systematically.

## 4 Questions for discussion

Sustainability is an area that can easily lead to a feeling that things are going in the wrong direction while our actions mean little. As educators we are however in a privileged position: We can make a difference to the learning and engagement of those who will be out there grappling with the sustainability challenges. Seeing examples of how this can be done, how to actively engage students in learning activity to address sustainability challenges, is valuable.

Continued experience exchange and knowledge building among educators in the area of sustainability in education is therefore essential. We need to share frustrations and ideas and get inspiration from colleagues. This should be done within disciplines, but also across disciplines (e.g. within engineering education, STEM education, and in higher education more widely).

As a starting point for discussion at the MNT conference, this work has briefly addressed some entry points into the integration of sustainability in education, assuming there are many similarities across the M, N and T. Questions to discuss include:

- Are the issues and proposed entry points relevant across the fields targeted by the conference?
- What are the most important hindrances to achieving integration of sustainability in education in our various fields and specific courses?
- What are good ideas for how to achieve such integration in practice?

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