Active Learning in Sustainability Teaching

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BACKGROUND

Societies are increasingly faced with the need to address global sustainability challenges, such as climate change, resource depletion or chemical pollution, to name but a few. Immediate reductions in the environmental footprint of human activities are therefore necessary. To do so, tools that allow for quantifying sustainability and guiding management actions associated with decisions and policies taken by stakeholders in industry and authorities should be systematically used.

The awareness of these challenges and needs is a key point in the education of future engineers. When entering the labour market and due to their influence as builders of tomorrow's societies, they must (1) know what sustainability is and how their decisions as engineers can affect sustainability, (2) be aware that there are methods and tools to assess the sustainability of their decisions, and (3) for those specialized in innovation and technology development, understand the principles of sustainability assessment and be able to apply tools for quantitative sustainability assessment.

However, how to optimise the teaching to increase the student learning and thus achieve these objectives? We posit that active learning has a central role to play, and we aim to explore opportunities for active learning in different course settings.

EXPLANATIONS

Teaching quantitative sustainability aspects implies specific challenges as the learning relates to (1) background knowledge about sustainability across its various dimensions, (2) the standardised assessment methodologies (e.g. EC, 2010; ISO, 2006) and their applications, and (3) the (further) development of these methodologies. Three levels of learning have thus been defined, each covering the entire ranges of the Bloom's taxonomy but with different emphasis (Bloom, 1984; Olsen, 2010):

1. LEVEL 1 "basics and principles of sustainability assessment in engineering": Teaching of methods and tools for sustainability assessment targeted at different technological domains, providing a background knowledge to students pursuing a career in various technical fields (Bloom's level I-VI – with emphasis on levels I-IV – Know, Comprehend, Apply and Analyze)
2. LEVEL 2 "advanced application of quantitative sustainability assessment methods in engineering": In-depth education for the students aiming to work with the development of technical solutions and therefore wishing to acquire in-depth knowledge of the tools available to assess sustainability of technologies (Bloom's level I-VI with emphasis on levels III-VI – Apply, Analyze, Synthesize, Evaluate)
3. LEVEL 3 "expert training in developing quantitative sustainability assessment methods in engineering": Specialized teaching and education of principles and methods for quantitative sustainability assessment targeted at the student pursuing a professional career within this field (Bloom's level I-VI with emphasis on levels III-VI – Apply, Analyze, Synthesize, Evaluate, Create)

Because of the technical level of the standardised assessment methodologies, hands-on practice must be an essential part of the learning. A number of methods for implementing active learning in this context have been elaborated and tried out, such as conducting case studies by the students in collaboration with companies (e.g. Hauschild et al. 2012) and the use of peer-assessments that can accommodate large classes (e.g. Edström and Kuttenkeuler, 2014; Christiansen, 2015).

SET-UP

The programme will include introductory presentations to provide a background on the objectives of the session and provide a brief, non-exhaustive overview of existing active learning tools. It will be followed by a workshop session, which will aim at outlining complementary "active learning tools", thus contributing to building an "active learning toolbox" dedicated to quantitative sustainability teaching. A detailed programme is proposed below.

Time	**Activity**
0-5 minutes	Introduction, objectives and expected outcomes
5-20 minutes	3 key presentations, describing current use of "active learning tools" (invited speakers)
20-65 minutes	"Hands-on" workshop session with groups of 3-4 (number of groups conditioned by number of participants). Each will be assigned one of the three learning levels, with a "blank course archetype" as support. The aim of the workshop will thus be for the participants to start from those "course archetypes", and elaborate and discuss suggestions on how to use and implement active learning/teaching.
65-90 min.	Wrap-up of "hands-on" workshop session and plenum discussion

EXPECTED OUTCOMES

The expected outcomes are an "active learning toolbox", gathering a number of tools dedicated to sustainability teaching and usable at different learning levels. They should cover all course elements, from lecturing, assessment, project work. This tool box will be made available to all participants following the workshop, e.g. it is intended to be used to refine existing courses at the Technical University of Denmark.

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