

PAPER

Co-Creating a Learning Community: Teaching Sustainability in Higher Education

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ABSTRACT

This study explores the emergence of a distinctive learning-community aspect of teaching sustainability. It uses action nets to describe major contributions shaping a learning community about sustainability. The results describe how the growing learning community of research, externally funded projects, teaching strategies, students, NGOs, and regional industry is framed within a sociotechnical network of actants and identifies events exposing the transitions in the making. Based on the findings, we discuss lessons learned from the co-creation, increasing the awareness of mechanisms involved in gaining (and regaining) support needed to create the new approach to teaching sustainability. The learning community mirrors, in many ways, the systemic nature of sustainability and sustainable development. It also introduces the uncertainty and ambiguity inherent in the transitions. It was easier than anticipated to mobilize resources, but the connections between the different contributions are also delicate, and we experience the learning community as something like fresh produce—something we must create and recreate continuously.

KEYWORDS

teaching sustainability, learning communities, action nets

1 INTRODUCTION

Sustainability challenges the traditional way of teaching and learning in higher education [1]. Part of this may be because it is relatively new to many academic disciplines, but it is also due to a general lack of common definitions and understandings. Sustainability, sustainable development, and sustainable innovation are all concepts that are systemic in nature [2–5]. Sustainability introduces numerous wicked problems, without simple answers given in advance, one set path to success, or a fixed solution. It suggests that resolving these challenges requires a different approach to teaching. The question then becomes how to do this.

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How do we approach this question? That is a matter of perspective. It is possible to take the viewpoint of the teacher, the student, the curriculum, the textbook, the IT infrastructure, or different external stakeholders/the industry. Sustainability, though, suggests that we connect with others, communicating that no one single stakeholder have the knowledge or means to address the complexities and wickedness of sustainability. We must seek help to find the answers. This approach to teaching sustainability is about handling uncertainty [6], being humble [7], and asking good questions [8]; we must think together with other stakeholders, go outside the textbook and outside the classroom, and accept that no teacher or textbook has the answers alone.

2 THEORY

In this section, we explore the theoretical lenses and learning models adopted in our approach to teaching sustainability in higher education based on our fundamental belief that a learning community co-created by multiple stakeholders with different agendas conforms to a multi-perspective beneficial symbiosis environment that improves the learning experience significantly. At the same time, it also strengthens and continuously improves both the curriculum and the teacher's understanding of the different topics due to the constantly challenging and interactive nature of symbiosis environments. The most dominant theories we have adopted are briefly but clearly explained in the next sections.

Sociotechnical systems (STS) have come a long way since Eric Trist and Ken Bamforth's paper in 1951 [9] explored the core principles of STS, and scientists have previously used its core principles for theory and knowledge construction trying to push the borders of pedagogical paradigms [10]. Our belief is that the core principles of STS are essential in teaching sustainability due to the holistic nature of sustainability that requires a life cycle assessment (LCA) approach defined by ISO 14040 [11], where sub-optimisation is to be avoided.

Actor-network theory (ANT), although rooted in science and technology ANT, is now also used in other science studies. We believe that, in terms of teaching sustainability topics, it is of utmost importance to be able to conduct analyses across the normal borders that separate organisations and individuals. Therefore, we consider ANT a useful and beneficial methodology for generating actor networks with human and nonhuman actors and their relationships to facilitate and strengthen the holistic perspective.

The concepts of co-creation and design thinking have also previously been used by other scientists to explore, develop, and adopt project-based learning models by a group of international students from different cultures and backgrounds while working on projects with a real-world client [12]. This is similar to what we have archived within our GreenBizz project and aligns with the principle of inclusion and that differences are a strength that we can build upon. Finally, it also supports our action research methodology, one of our core research approaches.

We chose the core principles of problem-based learning (PBL) combined with cooperative learning groups where the focus was student centered, using open-ended problem solving as the main activity on the empirical real-world cases and facilitation as the preferred interaction method between the students and the teacher.

3 METHOD

In this study, we explore one year (2022) of teaching sustainability in a growing learning community [13] of research, externally funded projects, traditional teaching, students, NGOs, and regional industry.

This study employs the action net model [14, 15] to describe different contributions to the learning network based on experiences from the innovation and project leadership (IPL) program at Østfold University College. The methodological framework is guided by recognized concepts such as radical indeterminacy and generalized symmetry [16–18].

Researchers challenged stakeholders in writing a short memo describing how they engaged and contributed to the teaching on sustainability in this unique case. This approach is in line with the perspective taken and guides our research towards agency. The goal is to focus on how we address the co-creating and how a learning community, including what traditionally is viewed as external stakeholders, move teaching sustainability.

Together they produce a relational network based on actions identified in the memos. The relational network is used to describe and discuss the co-creation of the learning community and increase the awareness towards mechanisms involved in gaining (and regaining) the contributions in a learning community on sustainability.

4 RESULTS

4.1 The bachelor programme on IPL

The bachelor program is an interdisciplinary leadership education that focuses on operative skills and problem-solving applying knowledge and skills within key subjects, theories and methods within IPL. The students will lead change processes where sustainability becomes an increasingly important theme, and sustainability therefore is involved in all subjects throughout the study. The collaboration between students and companies and organizations is an essential part of the course. The students are involved and engaged in many different activities and contexts internally and externally, where they must pitch their ideas, activities, and projects. The degree's organizational form is central to providing the professional and personal competence that is important for creating new graduates who initiate, carry out, and implement innovations and projects within and/or across different types of organizations. It also provides knowledge and skills in navigating and mastering professional, social, and humane challenges in complex contexts—such as the world today.

Sustainability is introduced to become a general part of the mindset and actions of the students when reading theory, practicing methods, or doing projects. Students are combining theory and practice by reading and analyzing major plans, strategies and goals and translating them into concrete actions in projects in public and private enterprises. This project-based learning approach, turning big ideas down to actions that make students into change agents creating commitment, confidence, and credibility in the process. The program changes over time based on input from students, teachers, and the needs of the outside world. This way, study plans and subjects are continuing to be relevant, and sustainability is emerging as a fundamental aspect of our education.

4.2 The Interreg Greenbizz project

The European Union Interreg program finances cross border projects that stimulates cooperation between countries inside the union. These projects can last for up to 3 years, and partners from both commercial and public sector can participate.

The Greenbizz project lasted for 3 years, and the first three partners were Aarhus University, Chalmers University, and Østfold University College. Chalmers University was later replaced by Halmstad University when Chalmers University went into financial problems and had to cancel all projects.

This network was important for strengthening academic cooperation. It created a new Scandinavian research network, because it hosted 6 PhD candidates who had a common purpose to work on the green transition. The PhD candidates, guided by professors and supported by students, had to help 60 commercial companies reduce their CO2 emissions and develop new green business plans.

4.3 Strategy of cooperation with the private and public sectors

External collaborations have been developed with business associations, clusters, and stakeholder organizations, and with individual companies, organizations, and people. These collaborations appear as fundamental for the study program to achieve work relevance and research-based teaching. As training arenas for students, in joint workshops and in research projects, various real-life problems and relationships are explored and potentially solved. Examples are student projects with the company, guest lectures, company visits, organizing joint workshops (as the lighthouse week), application design, and research collaboration. Each year, the collaboration extend collaboration with over 100 businesses.

Emerging action nets occur, at times stabilizing around the concrete action being cooperated on. This can be action nets connected to guest lectures and company visits, changing to closer collaboration on student projects, and then changing again to more complex cooperation, such as research with several actors. Resulting in the program getting more entangled in society and students and researchers are connected to real-life situations. Thus, achieving work life relevance and a research-based education for both students and teachers/researchers.

4.4 PhD research fellow on LCA

The current urgency in the world to reduce climate change will influence business in many ways in the coming years. There is a need for improving existing business models and developing new ones. Methods to estimate the impact on environment from different business models will be important to support this development. LCA has been a tool to calculate environmental impacts of products, companies, and systems for several years. There are varied standards and methods developed for LCA, but the complexity is a challenge for small and medium enterprises. Hence, there is a need for exploring new ways of applying LCA to develop new business models.

The work of the PhD candidate started with action case study as part of the Greenbizz-project. This project involved working with 20 small and medium sized companies in Viken region Norway and which has little experience with LCA from before.

The research part of the PhD started with finding simplified ways to apply LCA to a general business model. The research literature suggested new approach to LCA for business models, where impacts in term of profit was assessed. In practice, the companies were, however, more interested in LCA in terms of the customer perspective. The focus further was then to apply LCA with business model on several cases to further develop the methodology.

4.5 PhD research fellow on Sustainable Business Models

In Autumn 2021 Østfold University College enrolled a PhD research fellow within the field of Business Models (BM), more specifically Sustainable Business Models (SBM) / Green Business Models (GBM). She supervised student teams, taught specific classes in GBM in courses like Sustainable Innovation, bringing contemporary literature, models, and findings in the making to the learning community.

Phase 1 – Greenbizz: Participate in the Greenbizz project, which constitutes the last year of the three-year Interreg project with 20 businesses in Norway, Sweden, and Denmark. The PhD student explored business modelling for Norwegian businesses together with another PhD student in the field of LCA.

Phase 2 – Literature review part 1 (current phase): The objective is to identify sustainable, green, and circular BM-types and corresponding synonyms that can be used as conceptual framework.

Phase 3 – Literature review part 2: The aim is to identify BM-type actions categorised into different BM elements. This will lead to an overview of the degree to which BM-types and BM-type actions are in the literature streams of sustainable, green, and circular BMs.

Phase 4 – Case studies: To verify and further develop the findings in phase 2 and phase 3, the aim of the final phase is to put the developed sustainable, green, and circular conceptual framework in an empirical context using multiple case studies from the Greenbizz project (Phase 1).

This position was financed by the Interreg Greenbizz project and is part of the PhD program at Aarhus University. The PhD research fellow run workshops and supervise students, part of the Bachelor Innovation and Project Leadership program, thus connecting state of the art research with teaching sustainability.

4.6 The river reborn bachelor thesis project

A student team of four worked full-time from January to June 2022 developing a concept for the reuse of decommissioned leisure boats in the new production of rotationally molded products. These types of boats are transported out of the country and burned without any form of economic or environmental gain. During the thesis work, they expanded their network from the client producing the boats to companies with world-class expertise in molding, compounding, pulverizing, testing and chemicals, also connecting to a research project offering expertise in business models and LCA. For the first time in Norway, a new boat of this type was produced from reused materials.

The client company is becoming more oriented toward sustainability thinking, both from market changes and more general interest. The students' work and ideas led to the emergence of an action net around the reuse of rotationally molded leisure boats, including several companies based on their deliverance of high expertise and access to tools and methods for different parts of the process. The action net contributed to an acceleration of the project and led to better quality than expected. The students' learning far exceeded what was expected at the start at the same time as they made contacts with several interesting companies, and thus potential employers. In the frame of a thesis work, the students are creating a path to a sustainable project, combining theory and practice, working on including excellent partners and ending with a new sustainable process and product.

4.7 Sustainathon 2022

The start-up week at Department of Engineering 2022 introduced the cross-disciplinary Sustainathon with participating students from different engineering programs and innovation and project management. Sustainathon 2022 represented the first initial steps towards knowledge, skills, and competences necessary in the green shift, challenging the old mindset and emphasizing systems thinking, creativity and working in teams of experts.

The Sustainathon introduces the question on how we can create value and welfare like it is illustrated in the United Nations sustainable development goals (UNSDG), but without increasing the energy demand and related CO₂ emissions. Sustainathon thus mobilizes global trends and discourses and what the International Energy Agency (IEA) refers to previous research [19] as the decoupling of gross domestic product (GDP), total primary energy demand (TPED) and emissions (CO₂). It is student active learning embedded in global discourses, allowing for exploring sustainability in a playful setting.

4.8 The Biomimicry-festival

Fall 2022 students met at Storesand, inside the Ytre-Hvaler national park, a 354 km² marine national park in Norway, of islands, coastline, cliffs, kelp forests, eelgrass beds and corals. The arena for the biomimicry festival celebrating nature's own sustainable, renewable, circular and energy-efficient solutions, all based on millions of years of natural selection, makes the fact that the living organism exists an example of sustainability. The festival is a requirement in the course on Sustainable innovation.

The Biomimicry-festival introduces nature as the teacher and laboratory for sustainable innovation. It mobilizes the national park center and competences (employees), equipment, methods and experiences as resources and citizens in the sustainability learning community. All the natural models like the shore crab, kelp, the ant lion, the swallowtail butterfly, numerous examples of symbioses and behaviors are all resources for new designs, materials, structures, and systems for us to learn from. It is research-based and student-active learning allowing for exploring a wide array of paths to new sustainable and circular ideas and solutions.

4.9 The where the river meets the sea workshop 2022

How can we collaborate better across organizational boundaries, finding solutions to the environmental challenges facing the Oslofjord? Students from the innovation and project management program led the workshop, that was part of the official Lighthouse Workshop and The National Science Week in Norway September 2022. The workshop builds on the search conference [20] method. In short, the intention is to combine the exploration of the challenges we are meeting developing a shared vision, and co-create solutions, strategies and measures to get there [21]. It is about breaking with traditional silos, allowing everyone to participate on equal terms.

Where the river meets the sea Workshop creates a heterogeneous arena of stakeholders on sustainability, including academia in students and researchers, NGO's like Oceanscape, The River and Ocean Environmental Foundation, the organization Bevar mørket, Keep Norway Beautiful, Rent a Biologist, Norwegian

Sailing Federation, public organizations like the Ytre Hvaler National Park, Water area Glomma South, Viken county municipality, Hvaler Municipality, industry partners like Pronofa, Storm Østers, and Visit Fredrikstad Hvaler. The Workshop represents a systemic approach to sustainability in both how we understand the problem and how we develop actions, strategies, and measures.

4.10 The 9R-festival on redesign

Fall 2022, students collaborated with the company RE:inventar AS developing prototypes for more circular and scalable solutions extending furniture lifespan, expanding the area of use and in other ways creating new and sustainable values across the value chain. The project was based on redesigning 500 disposed cabinets from a public office. At the 9R festival, the students presented the prototypes and discussed the circularity of the solutions. The project and exhibition are requirements in the course on Sustainable innovation.

The 9R festival strengthens teaching sustainability as something going beyond the classroom and textbooks. Teaching sustainability is entangled and connected to research in the industry network part of Interreg Greenbizz, and conceptual models like 9R [22]), value creation with an industry client (RE:inventar AS), cross-disciplinary design using tools and methods from other courses, and student active learning in the practical work on prototypes from simple drawings and cardboard models to 3D-printed and manually crafted models. It was for real, and RE:inventar AS presented some of the models for a big customer just days after the festival!

4.11 Useless SB

Student enterprise is a non-profit organization established for training purposes. It is a course requirement in Student enterprise (10 ECTS).

Useless SB is one of the student enterprises established fall 2022. The Useless pitch is as follows: Did you know that 4.2 million tons of usable materials end up in recycling stations in Norway every year? We want to use waste from side streams and give it new value by recreating it as a stylish interior. We are Useless! What makes our product relevant is the increasing focus on the circular economy and responsible use of materials has led to sustainable interiors moving from being a trend to a requirement. We also see a constant need for consumers to show their position via their home. We take material that is considered “Useless” and give it a new value in a new function. We have developed the first prototype that uses a tire to make a puff. All the materials in this prototype are resources that would normally be thrown away and energy recovered. The circular economy is the future economy.

As the climate change is on the agenda throughout the society, it also is a clear expectation that this topic will be implemented in higher education. Sustainability offers a wide range of approaches for the students to discuss and to explore in the course Student enterprise (10 ECTS) and entrepreneurship. In the subject creativity and entrepreneurship, the students were divided in groups, which were challenged to choose one of the UN’s sustainable development goals and then by using various creativity methods provide innovative solutions in order to meet the chosen goal. Further in our entrepreneurship program, the various start-ups led by the students have integrated sustainability in their business models by focusing on low emission production and the circular economy as a guideline.

4.12 Green Innovation Camps

Using external funding to promote internationalization and making international training arenas. International projects are used to send students abroad to work with companies making their business models more sustainable. In the work, they experience other understandings of sustainability as they apply the learned framework in these companies. The training arenas are moved from local companies to companies with other cultures and other understandings of sustainability.

The Green Innovations Camps, which, in 2022, were part of the subjects Innovation and Development of Green Business Models and financed by the project Greenbizz, connect our students with students and professionals from other countries. By learning a multi-business innovation framework and applying it to companies' sustainability needs in another country, they experience how sustainability is emphasized and understood in other ways in different cultures and countries. Simultaneously, the action connects ongoing education and research projects, and secure research-based teaching.

To support and structure the company's transition toward green business models, the students was introduced to the Greenbizz SME process framework originally based on Theory by U [23] with some small changes to make it suitable to facilitate the green transition for small, medium-sized organizations.

4.13 Building bridges 2022

November 2022, first year students are tasked with building a bridge over the 25 meters wide Buerbekken stream, outside the nearby town Sarpsborg. From Monday to Thursday the students get the rules, design the bridge, get sponsors for materials and tools, build the bridge, walk the bridge, disassemble the bridge and make sure the materials are reused as much as possible. The rules are given Monday morning, specifying that the process and most materials for the bridge must be environmentally friendly, as in reused materials and there being a plan for reuse afterwards, i.e., circularity. The project is mandatory in the subject Project Leadership.

The building of bridges inspires the students to not always look for the economic and labor-friendly simple solution. In a very material sense, the project challenges them to think on how acting environmentally better when addressing new problems is a real possibility. The process perspective introduces them to environmental questions in their teams, but also in meeting sponsors from the construction industry and building warehouses. In this way, the team members bring the discussion about reuse and circularity out of the classroom and into the regional business society.

4.14 PhD research fellow supervising students on Sustainable Business Models

In the spring of 2022, first-year bachelor students in IPL participated in the six-week "Sustainable Business Models" project. Businesses in the local area were invited to learn a methodology for developing sustainable business models by having the students visit several times, for either improving existing business models or starting development of new sustainable business models. The businesses had to contribute with access to managers and employees who explain how they work, describe the current business model(s) and be willing to identify possible improvements. Eleven businesses accepted the invitation and 44 bachelor students participated in the

project. They were grouped into 11 project groups, all with a project leader that had participated in the “Green Innovation Camps” in Denmark and had knowledge of the Multi Business Innovation framework methodology [24], which is the agreed framework to use in this project. A PhD fellow from the Interreg Greenbizz project was coordinating the project, introducing the businesses to the project groups, and preparing the students professionally for the work. The first meeting was about understanding the existing business model, and in the second and third, presenting and discussing potential new sustainable business models with the company. Through guidance from the PhD candidate, the students achieved a high degree of learning and access to new, up-to-date knowledge in the area.

5 DISCUSSION

This is an experimental study from a single year and a single bachelor program, and a limited number of stakeholders inviting both methodological, conceptual, and analytical discussions, and further exploration.

We acknowledge the possible bias of any interpretation including that of the memos presented. We do not argue that it constitutes unambiguously support for any grand theory, but we do argue that it provides a shared experience that can be discussed and assessed from different perspectives. The narratives are understood as arenas for reflections, and may be read and interpreted in an iterative process creating individual, organizational, and project feedback loops.

This study asked how to teach sustainability in higher education. Our perspective builds on an understanding of sustainability as systemic in nature and challenging us to go beyond the textbook and the classroom. The results describe 14 different initiatives from 2022 of teaching sustainability in one study programme (Table 1).

Table 1. Summary of initiatives

Memo	Contributions	Constituting	Comment
3.1	Connecting global trends with regional value creation in project-based learning	The IPL study plan	Accumulative effect on the green shift and sustainability
3.2	Increasing the research-based foundation, and economic leeway	The Interreg Greenbizz project	2019–2022
3.3	Entangling teaching in regional public and private industry	Regional worklife	Increased demand
3.4	Increasing the research-based foundation, and human resources available	The LCA PhD research fellow	Going beyond the Interreg Greenbizz project
3.5	Increasing the research-based foundation, and human resources available	The GBM PhD research fellow	Going beyond the Interreg Greenbizz project
3.6	Creating value for industry and employability for students	The bachelor thesis projects	Sustainability not the only topic of interest
3.7	Broadening the underpinning in cross-disciplinary projects part of the start-up week	Sustainathon	First time 2022

(Continued)

Table 1. Summary of initiatives (*Continued*)

Memo	Contributions	Constituting	Comment
3.8	Mobilizing national interests, and regional and natural resources on environment	The biomimicry festival	Part of the National science week for the last three years
3.9	Activating the quadruple helix cluster on sustainability	The river meets the sea workshop	Part of the lighthouse project for the last five years
3.10	Creating value for industry and employability for students	The 9R-festival on redesigning furniture	Going into the company portfolio
3.11	Creating value and potential for start-ups	Student enterprises	Top national ranking over several years
3.12	Expanding the classroom to include Scandinavian companies' shopfloors, joining students from other universities	Green innovation camps	Funded by the Interreg Greenbizz project
3.13	Turning project leadership training into a laboratory for sustainability	The project leadership course requirement	Student initiative
3.14	Supervising students and running green business model innovation workshops	The LCA and GBM PhD research fellows	Contemporary models and development available

The contributions identified in Table 1 describe initiatives of connecting the study program to other stakeholders and arenas not necessary directly linked to traditional teaching. They represent contributions going beyond the textbook, classroom, and campus as the boundaries of teaching sustainability for bachelor students. This is notable in increasing the research-based foundation (Memo 3.2, 3.4, 3.5, 3.14) entangling human resources, methods, and tools (Memo 3.14) from active research projects in the teaching and at the same time using students (Memo 3.12) in the research projects. The second notable theme is the partnership between students and private and public businesses (Memo 3.3), creating value (Memo 3.6, 3.10, 3.11) for start-ups and businesses and creating employability for the students. It is also notable in how teaching is mobilizing and activating a quadruple helix cluster on sustainability including national interests (Memo 3.8), public and private businesses, NGO's, and academia (Memo 3.9).

The different contributions individually represent little new. It is going from ad-hoc initiatives to a coherent study model, connecting global trends with regional value creation in project-based learning supported in the formal study plan (Memo 3.1, 3.7, 3.14), that represents what can be understood as a new coherent approach to learning.

Some preliminary lessons learned include:

- Appreciating teaching sustainability as a socio-technical network of resources, nature, research, projects, and more
- Opening the economic, environmental, and social dimensions of sustainability
- Increasing available resources beyond the limitations of the classroom, textbooks, and theoretical knowledge
- Building employability in the meeting with research, projects, and businesses
- Rethinking sustainability as a mean for competitiveness
- Co-creating a learning community on sustainability is easier than expected
- Building student centered learning is an effect of co-creating the learning community

This study covers one year of co-creating a learning community on sustainability. It proved easier than anticipated to mobilize resources, but the bounds connecting the different contributions are also delicate and we experience the learning community as something like fresh produce—something we must create and recreate continuously. The learning community described thus represents a snapshot of the learning network.

The analysis suggests that teaching sustainability is a result of emergent and innovative processes, employing varying activities and concepts, created through the co-creation of the learning community. Actors emerge through the different actions [14], mobilizing new actions, in a form of experimentation, which in turn develops and strengthens the learning community.

The university, industry, NGO's, projects, literature, research, students, and others co-create a learning community on sustainability. The learning community mirrors the systemic nature of sustainability and sustainable development. It also introduces the uncertainty and ambiguity inherent in wicked problems. The tensions and renegotiations between the different stakeholders in the learning community transforms the teaching of sustainability in changing directions and into something different from the original program. The bachelor program then appears more like an emerging and changing organization than a static organization as described in the syllabus.

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