Daria Podmetina & Ellen Saltevo

Chapter 23. Innovation and Technology for Sustainable Future

23.1. COURSE SUMMARY

Table 23–1

Audience and level of studies	Students (Master)	
Group size	≤ 25	
Course duration	7 weeks	
Credits	3 ECTS	
Workload	Presence: 28h Self-study: 50h	Total: 78h
Contents/primary topics	• Disruptive technologies • Sustainable Development Goals (SDGs) • Design, management, impact assessment, implementation and envisioned development trajectories of innovations in the context of sustainability	
Main course objectives	• Understanding the major causes, impacts and interconnectedness of key environmental and social challenges occurring in socio-economical systems • Identifying the potential and challenges of science and engineering-driven solutions in solving sustainability problems • Analysing potential solutions critically and collaboratively creating alternative visions for a more sustainable future	
Main teaching approaches	• Active learning • Collaborative learning • Inter-/transdisciplinary learning	
Main teaching methods	• Arts-based teaching and learning • Vision-building exercise • In-class role play	
Learning environment	Virtual classroom (online learning) Synchronous (interaction in real-time) and non-synchronous learning (interaction in different times)	

Link to Sustainable Development Goals	SDG 1 | No Poverty | End poverty in all its forms everywhere SDG 2 | Zero Hunger | End hunger, achieve food security and improved nutrition and promote sustainable agriculture. SDG 3 | Good Health and Well-being | Ensure healthy lives and promote well-being for all at all ages SDG 4 | Quality Education | Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all SDG 5 | Gender Equality | Achieve gender equality and empower all women and girls SDG 6 | Clean Water and Sanitation | Ensure availability and sustainable management of water and sanitation for all SDG 7 | Affordable and Clean Energy | Ensure access to affordable, reliable, sustainable and clean energy for all SDG 8 | Decent Work and Economic Growth | Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all SDG 9 | Industry, Innovation and Infrastructure | Build infrastructure, promote inclusive and sustainable industrialization and foster innovation SDG 10 | Reduced Inequalities | Reduce inequality within and among countries SDG 11 | Sustainable Cities and Communities | Make cities and human settlements inclusive, safe, resilient and sustainable SDG 12 | Responsible Consumption and Production | Ensure sustainable consumption and production patterns SDG 13 | Climate Action | Take urgent action to combat climate change and its impacts SDG 14 | Life below Water | Conserve and sustainably use the oceans, seas and marine resources for sustainable development SDG 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 SDG 16 | Peace, Justice and 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 SDG 17 | Partnerships for the Goals | Strengthen the implementation and revitalize the global partnership for sustainable development

Table 23–2

Impact assessment	(None) Low/ Medium/ High	Explanation
1. Degree of student participation / activeness	High	Students are expected to actively engage in course activities in the form of multiple seminar, workshop and individual assignments, as well as the main course project, while the teacher acts merely in the role of a facilitator.
2. Degree of student collaboration / group work	High	Most course activities are in the form of group work where students are expected to convey their arguments, see the perspectives of others, and try to find a common ground, as well as work together towards a common goal.

Impact assessment	(None) Low/ Medium/ High	Explanation
3. Degree of student emotional involvement	Medium	Students are expected to articulate their own feelings and thoughts about sustainability, as well adopt the role of others and try to empathise and find arguments from their point-of-view in relation to sustainability.
4. Degree of inter-/trans-disciplinarity	High	Sustainability is addressed throughout the course as a wicked problem embedded in complex systems in need of inter-/transdisciplinary approaches. The course applies knowledge from business, engineering, arts, design, sustainability sciences and social sciences to accumulate a holistic understanding of sustainability that students can employ in their main course project.
5. Degree of student (self-) reflection	Low	Students are expected to self-reflect on one's own role as business experts, engineers and innovators through capabilities, possibilities, and restrictions throughout the course in the exercises and in the main course assignment.
6. Degree of experience of real-life situations	Medium	Case examples are utilised as a baseline for analysis and discussion in seminar assignments, and guest lecturers from industry are included to ensure the practical implementation and understanding of the topics.
7. Degree of nature-related experiences	(None)	Course is carried out in an online classroom environment.
8. Degree of stakeholder integration	Medium	Sustainability is introduced as a largely normative issue with differing values and goals attached to it by different stakeholders whose views students are expected to reflect in seminar and individual assignments, as well as in the main course project.
9. Degree of integration between theory and practice	Medium	Lectures available online are used throughout the course for brief transfers of knowledge about the main theories and concepts that will act as a baseline for applied learning for the main course project, where students are expected to envision and evaluate the development trajectories of existing disruptive technological innovations in the context of sustainability.

23.2. COURSE INTRODUCTION

It is widely acknowledged that innovation is a key element in the global pursuit of sustainable development. This means shifting from the traditional innovation logic of merely finding economic applications for inventions in pursuit of limitless economic growth (Schumpeter, 1912) towards sustainability-oriented innovation – developing solutions to existing global problems in order to create and realise social and environmental value, as well as economic returns (Adamset al., 2015) or responsible innovation (Stilgoe et al., 2020; Owen et al., 2013).

Sustainability is understood as a wicked problem (Rittel & Webber, 1973) with multiple "hard to identify" root causes that impact various stakeholders and that are deeply intertwined with other issues. Thus, determining appropriate solutions is difficult and determining the sustainable nature of an innovation calls for a wide lens of inspection. Sustainable change is deeply entrenched in socio-technical systems emphasising the role of technological innovation that is fundamentally linked to societal constructs that need to co-evolve with it (Geels, 2010).

The course *Innovation and Technology for a Sustainable Future* is designed to improve understanding of the role innovation and technology play in sustainable development and how it is translated into engineering (Jansen, 2008) and business management education (Wankel & Stoner, 2009) — the primary target audience for this course. This course goes beyond techno-utopianism and promotes a critical approach to technological innovation development in the context of sustainability. By the end of the course, students should be able to understand the challenges, benefits, and potential of developing engineering-driven solutions to sustainability problems; to evaluate the impacts of innovations and to forecast possible development trajectories for the future; and begin to create solutions to solve the complexities that relate to their adaptation as part of larger socio-technical and economic systems.

The course is delivered in an online format. Key theoretical and factual knowledge is transferred through short, pre-recorded lectures, expert interviews and recommended independent readings available for each week of the course on the learning platform. The main theoretical concepts discussed are disruptive technologies, design and management of sustainability-oriented/responsible innovations, impact assessment and stakeholder analysis, ethical issues related to sustainability and technological development, system change and transitions, as well as future studies.

Students are expected to get familiar with each lecture and the recommended materials at the beginning of the week, to be able to build upon the newly acquired knowledge in seminar sessions and in preparation of individual assignments at the end of each week. Key learnings are put to the test in individual assignments and seminar sessions with exercises utilising theatre-based teaching methods that leave room for different interpretations and perspectives to be debated. There are no right or wrong answers. The aim is merely to enable students to find multiple possible pathways towards a more sustainable future and inspire them to act as change agents themselves.

During each week, students will also participate in film making workshops. Film making workshops will aid students in preparing for their main course project, where they are expected to employ their learnings throughout the course in examining a specific technology in the context of a specific United

Nation's (UN) (2015) Sustainable Development Goal (SDG) and create their own visions of the future in the form of a short film.

23.3. LEARNING OBJECTIVES

Table 23–3

Learning objective dimension (UNESCO, 2017)	Operationalization	Competency referred to (Rieckmann, 2018)
Cognitive	Students learn to describe and recognise the key environmental and social challenges that occur in a variety of socio-economic systems and understand their causes, impacts and interconnectedness.	Systems thinking competency
	Students learn to analyse the inherent complexities that relate to sustainable technological development and implementation in business and society.	
	Students learn to evaluate and decide between multiple possible pathways towards solutions of grand challenges	Anticipatory competency
	Students learn to identify the potential, as well as risks and challenges, of science and engineering-driven solutions for sustainability problems.	
	Students learn to question what can be deemed as sustainable or responsible through the exploration of differing perspectives, opinions, and norms.	Critical thinking competency
Socio-emotional	Students learn to deal with the uncertainty of what they don't know and to build on it by turning the unknown into an exploration of probable, plausible and unexpected versions of the future.	Anticipatory and systems thinking competency
	Students learn how to respect, reflect, and learn from the perspectives of others, as well as to create collaborative understanding and action.	Collaboration competency
Behavioural	Students learn to create their own visions of the future and communicate them to others.	Anticipatory competency
	Students learn to build evidence and take part in the sustainability discourse through scientific argumentation, class discussions and debates, written reports, and presentations.	Critical thinking competency

23.4. COURSE OUTLINE

Table 23–4

Structure		Session Focus	Homework
Week 1	Session 1 (2 h)	Introduction to the course and methods used. Introduction to short film making.	Getting acquainted with the course contents, schedule and teaching methods. Reading through the requirements for the main course project*. Making groups and choosing topics for the main course project.
	Session 2 (2 h)	Introduction to key concepts: SDGs and disruptive technologies for the future.	
Week 2	Session 3 (2 h)	Workshop: short film making (project development). Sustainable innovation and design • Responsible innovation • Design thinking	Getting familiar with the chosen topic (specific SDG, technology, and context).
	Session 4 (2 h)	Seminar: Stakeholder roleplay*.	
Week 3	Session 5 (2 h)	Workshop: short film making (pre-production). Sustainability impact awareness, assessment and tools – examples from the ICT industry.	Working on the main course project: written report (part 1) and short film (project development).
	Session 6 (2 h)	Seminar: ICT is the backbone of almost any solution we have for the future – but how sustainable is any software? • Case example: bitcoin	
Week 4	Session 7 (2 h)	Workshop: short film making (production) Sustainable systems and transitions • Sustainability transitions • Socio-technical systems and the multi-level perspective	Working on the main course project: written report (part 2) and short film (pre-production).
	Session 8 (2 h)	Individual assignment: socio-technical system change and sustainable transitions require co-operative effort – what elements are needed for change? • Case example: mobility as a service (MaaS)	
Week 5	Session 9 (2 h)	Workshop: short film making (post-production) Ethics of technological innovation and sustainable development.	Working on the main course project: written report (part 3) and short film (production).
	Session 10 (2 h)	Individual assignment: collective story writing*. • Case example: artificial intelligence (AI)	

Structure		Session Focus	Homework
Week 6	Session 11 (2 h)	Seminar: Futures studies in practice – examples from the consulting industry.	Working on the main course project: short film (post-production).
	Session 12 (2 h)	No activities for this week. Students will work on the main course project.	
Week 7	Session 13 (4 h)	Visions for the future: students will present their short films followed by a joint discussion in class about each topic and the overall role of technology and innovation in sustainable development.	Peer evaluation of short films. Group members evaluate each others' performance within the group throughout the main course project.

*See further instructions from subchapter "Exercises".

23.5. TEACHING APPROACHES AND METHODS

The course combines aspects of active, collaborativeand inter-/transdisciplinary learning as its core teaching approaches. This combinatory pedagogical approach is critical in flipping the role of the student from a listener and subject learner of Science, Technology, Engineering and Math (STEM) to an active participant of group learning activities and designer of collaborative learning spaces together with other students and teachers.

Active learning is used throughout the course to enable students to take charge of their own level of engagement and input in assignments, as well as in the organization of the main course assignment, while teachers act in the role of facilitators. Collaborative learning is used to enable student interaction in small teams while working on common assignments. Inter- and transdisciplinary learning is used to gain a holistic view of the integrated issues of innovation and technology development in the context of sustainability by applying principles from multiple fields of study, such as business, engineering, arts and design, sustainability sciences and social sciences, and analysing their compounded effect throughout the course, and especially with the main course project.

With the implementation of these approaches, the students need to process, evaluate, and reflect the theoretical materials provided by the teachers with different backgrounds on several aspects of the same topic and synthetise a creative project in collaboration with other students, reflecting the learning of the theoretical materials put through the prism of individual and group backgrounds and perspectives. Such participatory and collaborative pedagogies can boost self-reflection in addition to active learning, leading to the development of more sustainable habits, minds, and lifestyles (Mezirow, 2000; Giangrande et al., 2019; Ayers et al., 2020). There is theoretical evidence that pedagogical freedom, teachers' skills, university support and favourable infrastructure are needed to enable inter/transdisciplinary, active and collaborative learning (Moore et al., 2005). The development of this course benefitted from such resources available. With a general transformational focus on sustainability, students and teachers are advised to keep an open mind and to be up for a challenge (Sipos at al., 2008). Moreover, "sustainability education implies the benefits of fully integrative, active, collaborative, and applied approaches to sustainability-oriented curriculum development and teaching—approaches that can directly involve students in learning and practicing transdisciplinary engagement in service to sustainability" (Evans, 2019, p. 20). As highlighted by UNESCO (in Sipos et al., 2008), creative practices in addition to proactive and collaborative learning practices are key in developing "transdisciplinary understandings" in sustainability education.

Following the need to develop a variety of skills, arts-based teaching and learning, and more specifically theatre-based learning, was selected as the dominant method used in this course. Adding arts-based teaching and learning is how a traditional STEM course is transformed into a STEAM (Science, Technology, Engineering, Arts, and Mathematics) course. STEAM is a specific teaching-learning methodology and transdisciplinary method aiming to develop "transversal knowledge, in which the contents of each of these branches is not taught or learned in isolation, but rather is imparted in an interdisciplinary way that ensures contextualized and meaningful learning" (Moaveni & Chou, 2016). Moreover, the combination of art and science increases "creativity, critical thinking, cooperative learning and develop[s] problem-solving skills" (Chien & Chu, 2018), gaining students the skills that will help them in their future work life (employability skills) in an active way (Yakman, 2008; Yakman & Lee, 2012; Chien &Chu, 2018; Stehle & Peters-Burton, 2019; Perignat & Katz-Buonincontro, 2019).

Art-based teaching also allows for uncertainty and sense-making of complex situations through creativity (Nissley, 2010), especially useful for the exploration of innovation in an increasingly complex world faced by the wicked problems of sustainability. As noted by Ødegaard (2002), "theatre" and "theory" have similar etymological underpinnings, and both refer to ways of viewing the world and extracting truth from it – eluding a natural interconnection between the two. Therefore, the use of theatre-based methods in science education can be understood as an alternative route towards the truth. To utilise this connection, improvisation, narrative development, drama production and acting performance are used in assignments and in the main course project to develop wider and more nuanced insights into technological innovation development in the context of sustainability than strict science-based methods could deliver. Theatre-based methods of teaching facilitate the understanding of difficult concepts, develop expression capacity, inter-personal communication and empathy, as well as provide a suitable frame for exploring future scenarios (McSharry & Jones, 2000; Nissley, 2002).

Vision building and in-class roleplay are specific approaches embedded in the theatre-based methodology. Vision building is used to synthesise the main course learnings and apply them into the creation of docufiction stories about plausible future scenarios as the main course project. Docufiction is a cinematographic term that relies on the factual basis of a documentary but adds a dramatic flair and fiction to provoke new ideas and challenge perspectives (Rhodes & Springer, 2005). The infusion of fiction not only makes learning more interesting, but it is also a necessary approach to understanding the future, the key literacy competence of the 21st century (Miller, 2018), as "there are no facts or evidence from the future (we create the future as we experience it) – we should be thinking about futures in terms of different (--) perspectives, frames of references and images" (UNDP, 2018, 8).

In-class role play is used to broaden and reflect one's perspectives by assuming the improvised role of another in a structured way (rules) within a theoretical or conceptual frame to increase contextual and personal understanding (Ødegaard, 2007). Role-play has also been found to be highly effective in developing students' soft skills and empathy (Bearmanet al., 2015).

23.6. EXERCISES

Stakeholder roleplay for Disruptive Innovations

The main goal of this exercise is to enable the students to expand their viewpoints by stepping into the role of another person through roleplay. The exercise is intended to increase emotional and knowledge-based understanding of the importance of including and mitigating all stakeholder perspectives in the development and implementation of responsible innovations. This exercise is carried out in groups and conducted early in the course for students to get acquainted with theatre-based methods used throughout the course.

The students are given a range of technological innovations that are viewed as disruptive (e.g., platform economy, lab grown meat, biofuels, or robotics and automation). In relation to each innovation, some stakeholder roles which are expected to experience differing impacts on the further implementation of the innovation are determined. The groups will choose topics on which to focus, and within each group assign individual stakeholder roles. The students will continue to search information about the topic and the role of their individual stakeholder. The students will discuss the gathered information in the group to be able to prepare and compose fact-based, but imagination driven, identities and perspectives for each stakeholder.

Finally, each group will proceed to present their topic in class in the form of a dialogue held by all the members of the group acting in the role of their individual stakeholder. Each stakeholder will deliver their own view of the topic and mirror this perspective in relation to other stakeholder views. Afterwards, the audience is tasked to identify the main controversies that exist in the stakeholder views in relation to the topic and to think collectively how they could possibly be mitigated.

Fact Based Future Fiction

This exercise acts as the main course project and is worked throughout the course in groups of four to five students. The main goal of this exercise is to enable the students to summarise and implement the main course learnings by comprising a holistic understanding of a specific sustainability problem and analysing a possible technological solution for it withstanding all related complexities, uncertainties, differences in perspectives and conflicts by processing it in a structured way and translating it into a form that can be convincingly conveyed to others.

The students construct a topic for the project by selecting a sustainability issue from one of the 17 SDGs (UN, 2015) along with a disruptive future technology to explore their compounded impact in a specific context. An overview of disruptive future technologies by Diamandis and Kotler (2022), including quantum computing, artificial intelligence, robotics and automation, material science and nanotechnology, biotechnology, networks and sensors (IoT), augmented and virtual reality (immersive technologies), blockchain, and 3D printing, as a reference point is provided. To illustrate, a possible topic could be "enhancing peace and justice (SDG 16) through immersive technologies (augmented and virtual reality) in peace-tech (context)".

First, students are tasked to delve deeper into the SDG (what are the main issues behind the goal and their contributing factors) and the more specific context chosen (how do these issues manifest in the specific context). Second, they investigate how the chosen technology or technologies could be applied in this specific context to aid in solving the underlying problems and drive forward the SDG's fulfilment. Third, they conduct a holistic impact assessment and an examination of the solution's development trajectory. This will act as knowledge-based background research for the development of a storyline.

Second, the key findings of the research will be formulated into an interesting storyline and produced into a short film with a duration of 15 minutes maximum. By building a storyline, the students are forced to include not only detached factual perspectives of technological and economic analysis, but also more personal and emotional perspectives in order to go beyond what is known, into what should and could be to build visions for the future. To help structure the film, the students are suggested to follow the typical five-step dramatic scheme (Pavis 1998):

1. *Introduction of the setting and the underlying problem*: what is the sustainability problem?
2. *Evolving action:* what is the rising proposed solution?
3. *Collision or climax:* how does the proposed solution affect stakeholders, surrounding systems and structures, and does it create possible conflicts?
4. *Last twist in the form of surprising events:* is there a possibility of unintended consequences or other risks, ethical or cultural considerations?
5. *Resolution:* what the does the future look like?

To ensure the successful transfer of facts into future fiction, expert instructions and workshops for drama and film making are made available to the students throughout the course.

Collective Story Writing

What is the value of technological development and innovation? Is this value intrinsic or extrinsic, i.e., context dependent or not? If related to context, then the value of the innovation is dependent on its use for the general good or bad. But is the definition and distinction of good and bad relative or universal? Also, do good intentions matter if the outcome is ultimately bad?

This thought process above illustrates a brief and simplified extract of the many ethical considerations related to assessing technological innovations in the context of sustainability. To invoke nuanced ethical contemplations, the students are instructed to engage in a digital version of an improvisation exercise by participating in collective story writing around a predetermined topic (e.g., artificial intelligence) in the learning platform. One by one, the students post on the platform and continue the story by introducing new characters, perspectives, thoughts, events, changes of scenery – whatever brings forth an illustrative example of an alternative ethical standpoint – and little by little a rich collective understanding on the matter is formulated.

23.7. ASSESSMENT

Assessment is based on individual and group performance using teacher, peer-to-peer and group internal evaluation-based techniques to ensure the representation of multiple voices also in the evaluation in line with the explorative and “no right answers” perspective applied throughout this course.

Individual performance is determined based on participation in seminars, workshops and completion of individual assignments. From each six individual performance events five points are available and graded pass or fail, amounting to a total of 30 points. *Group performance* consists of the successful delivery of the main course project: the written report with 30 points and the short film with 40 points, amounting to a total of 70 points. Different evaluation criteria and evaluators are used for the written report and the presentation. The quality of the written report is evaluated by the teacher against the learning objectives and competencies set for the course, and therefore should embody critical, systems and anticipatory thinking competencies in the analysis of the topic. The quality of the short film is an extension of the report but evaluated by student peers in the final seminar based on the presentation’s expression (originality and fit of chosen format), narrative (informative and critical), vision (plausibility), and novelty value (new perspectives presented). An equally important learning opportunity in the course is also how to learn, manage and create collaborative understanding and action (i.e., collaboration competency), which is why each student’s *individual scoring* from the total points awarded for the written report and the short film is determined by the other group members. The group members will evaluate each other by assigning a score from 1–100 % based on the perception of each team member’s ability to collaborate. An average of all evaluations is formed for each student and used as a weight to determine the number of final points awarded for the success of the group performance.

Table 23–5

Performance	**Target of evaluation**	**Basis of evaluation**	**Maximum points**	**Average collaboration scoring from group**	**Weight for final grade**
Individual performance	Participation in seminars	Pass/fail	2*5=10p.	NA	30 %
	Completion of individual assignments		2*5=10p.		
	Participation in workshops		4*2,5=10p.		

Performance	Target of evaluation	Basis of evaluation	Maximum points	Average collaboration scoring from group	Weight for final grade
Group performance	Final report	Separate criteria for final report	30p.	* 0,1–1	70 %
	Short film	Separate criteria for short film	40p.	* 0,1–1	

23.8. PREREQUISITES

Required prior knowledge from students:

- No prior knowledge required

Required instructors and their core competencies:

- Lecturer (competencies: technology, sustainability, innovation management, systems and design competency)
- Creative expert (competencies: drama teaching or film production)
- Industry expert (competencies: real-life business expertise)

Required tools:

- Online collaboration (e.g., Google docs), learning (e.g., Moodle) and communication platforms (e.g., Zoom)
- Video editing software (e.g., Filmora)

23.9. RECOMMENDED RESOURCES

Please note that given the wide scope of this course, independent information seeking on more specific topics withing the scope is a key element of this course. Therefore, the suggested materials are merely example frameworks and theories on how to approach each topic.

Week 1:

- United Nations (2015). Transforming our World: The 2030 Agenda for Sustainable Development. General Assembly Resolution A/RES/70/1.
- Diamandis, P. H., & Kotler, S. (2020). The future is faster than you think: How converging technologies are transforming business, industries, and our lives. Simon & Schuster.

Week 2:

- Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D. & Overy, P. (2015). Sustainability-oriented innovation: A Systematic Review. *International Journal of Management Reviews*, 00, 1–26.
- Lubberink, R., Blok, V., Van Ophem, J. & Omta, O. (2017). Lessons for Responsible Innovation in the Business Context: A Systematic Literature Review of Responsible, Social and Sustainable Innovation Practices. Sustainability, 9, 721.
- Owen, R., Macnaghten, P., & Stilgoe, J. (2012). Responsible research and innovation: From science in society to science for society, with society. Science and public policy, 39(6), 751–760.
- Stilgoe, J. Owen, R. & Macnaghten, P. (2013). Developing a framework for responsible innovation. Research Policy, 42, 9, 1568–1580.
- Buchanan, R. (1992) Wicked Problems in Design Thinking. Design Issues, 9 (2), 5–21.
- Oxman, N. (2016). Age of Entanglement. Journal of Design and Science. https://doi.org/10.21428/7e0583ad 1

Week 3:

- James, P, Magee, L., Scerri, A. & Steger, M. (2015) Urban Sustainability in Theory and Practice: Circles of Sustainability, Routledge, London, 2015.
- Penzenstadler, B., Duboc, L., Akinli Kocak, S., Becker, C., Betz, S., Chitchyan, R.,Easterbrook, S., Leifler, O., Porras, J., Seyff, N. & Venters, C. (2020, January). The SusAF Workshop – improving sustainability awareness to inform future business process and systems design (Version 2). Zenodo.
- Podder, S., Burden, A., Singh, S. K., & Maruca, R. (2020). How green is your software? Harvard Business Review, Sept.

Week 4:

- Bolton,R. & Hannon, M. (2016) Governing sustainability transitions through business model innovation: Towards a systems understanding. Research Policy 45, 9 (2016) 1731–1742.
- Geels, F.W., (2004). From sectoral systems of innovation to socio-technical system: insights about dynamics and change from sociology and institutional theory. Research Policy 33 (6/7), 897–920.
- Markard, J., Raven, R., & Truffer, B. (2012) Sustainability transitions: An emerging field of research and its prospects. Research Policy, 41,955–967.
- Rotmans, J. & Loorbach, D. (2009) Complexity and Transition Management. Journal of Industrial Ecology, 13, 2, 185–1196.

Week 5:

- Van de Poel, I. R., & Royakkers, L. M. (2011). Ethics, technology, and engineering: An introduction. Wiley-Blackwell.
- Bostrom, N. (2002). Existential risks. Journal of Evolution and technology, 9(1), 1–31.
- Bryden, J., & Gezelius, S. S. (2017). Innovation as if people mattered: The ethics of innovation for sustainable development. Innovation and development, 7(1), 101–118.
- de Vries, B. J. (2019). Engaging with the Sustainable Development Goals by going beyond Modernity: An ethical evaluation within a worldview framework. Global Sustainability, 2.

Week 6:

- Miller, R. (2018). Transforming the future: Anticipation in the 21st century. Taylor & Francis.
- United Nations Development Programme (2018) Foresight Manual. Empowered Futures for the 2030 Agenda. UNDP Global Centre for Public Service Excellence.

23.10. GENERAL TIPS FOR TEACHERS

Applying arts in STEM education is somewhat novel, which is why some change resistance regarding the new method can appear. Making a case for STEAM methodology by stating the objectives and needs for this kind of teaching is critical from the start, in addition to regularly gathered feedback sessions with students.

Some students may also find it uncomfortable to throw themselves into the theatre-based approach. To overcome the reservations of these students, it is important that teachers show their own example of role-playing, sharing opinions, creating example narratives, etc. to create a positive and secure environment where students can get creative too and enable an interactive learning experience. Therefore, the positive attitude, competencies and facilitator skills of teachers are extremely important for the successful implementation of this teaching format.

The topic of the course is wide and some of the theoretical concepts can seem somewhat abstract. Therefore, it is important to clearly link the theory of each session to the exercises to have a practical element that students can grasp onto and utilize in their main course project.

Finally, clarity of instructions regarding course implementation and assessment, as well as ease and efficiency of communication (among students, as well as between students and teachers) is of special importance to a successful teaching and learning process in an online course.

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