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Experiential learning in “Innovation for Sustainability”: An Evaluation of Teaching and Learning Activities (TLAs) in an International Masters Course

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Purpose – The urgent challenges of sustainability require novel teaching methods facilitating different types of learning. The purpose of the paper is to examine the important role of experiential learning in higher education programmes relating to sustainability, and to evaluate a number of teaching and learning activities that can be used to leverage this approach.

Design/ Methodology/ Approach - Based on questionnaire surveys carried out over seven years with students from a highly international Masters-level course, this paper describes the utility of experiential learning theory in teaching around ‘innovation for sustainability’. Drawing on Kolb’s theories and subsequent modifications, the paper reviews and evaluates the teaching and learning activities (TLAs) used in the course that have fostered experiential learning in the classroom, including role-play seminars, case study-based seminars and sessions centred around sharing and reflecting on personal professional histories.

Findings - The qualitative data and discussion illustrate the utility of experiential learning approaches in post-graduate education for sustainable development, especially in generating empathy and understanding for different sustainability perspectives and priorities from around the world. In particular, the paper offers novel insights into the strengths and limitations of the TLAs.

Originality/ value – These insights are valuable to ESD practitioners dealing with international student intakes displaying variable levels of professional experience who are looking to foster experiential learning, reflection and inter-cultural empathy. They can inform the design of classroom-based TLAs that are capable of equipping students with not only the analytical skills for career success, but also the inter-cultural sensibility required for international leadership in the sustainable development domain.

Keywords: experiential learning, innovation, sustainable development, international education, teaching and learning activities, postgraduate

Introduction

Since Kolb’s ideas around experiential learning were introduced in the mid-1980s, they have had a dramatic impact on constructivist ideas in pedagogy and andragogy, especially in education in the business and management area (Holman *et al* 1997). While the theory has been subject to critique (Webb 2003) and debate (Kayes 2002), it has also been picked up by a number of scholars and practitioners, who have developed its focus on ‘learning by doing’ to explore the processes by which concrete experience can contribute to deep understanding in higher education (Fry *et al* 1999). This paper evaluates the teaching and learning activities (TLAs) used in a post-graduate, Masters level course on ‘Innovation for Sustainability’ through an experiential learning frame, contributing to our

understanding of how experiential learning concepts as applied to specific TLAs can improve learning opportunities for students from diverse socio-political and cultural contexts.

After introducing the 'Innovation for Sustainability' course and the context in which it is delivered, the paper considers the importance of experiential learning in education for sustainable development (ESD). In particular, it explores how experiential learning can respond to the specific challenges associated with ESD with diverse groups of students, including those from different international backgrounds and students at highly divergent stages in their careers. After considering the teaching and learning activities used in the course, the paper evaluates them by drawing on questionnaire surveys from past students, and reflecting on teaching experiences. The paper then describes the benefits of adopting an experiential learning approach and outlines possible future developments.

Innovation for Sustainability: An international course responding to global challenges

Since 2006, the 'Innovation for Sustainability' MSc option course has been run at SPRU-Science Policy Research Unit, University of Sussex, United Kingdom. Utilising a wide range of teaching and learning activities, the course introduces MSc students to research and thinking around the ways in which innovation can be harnessed to respond to global and local challenges of sustainability and development. The course aims to foster learning and interaction in order to contribute to the formation of global citizens, who will go on to make positive contributions to sustainability during their lifetimes, drawing upon the lessons and the network of individuals who they learned with during their post-graduate experience (Shiel 2006). The course is delivered in English, and closely linked to the work of the ESRC STEPS (Social, Technological and Environmental Pathways to Sustainability) Centre.

Drawing from the research of SPRU and the STEPS Centre (positioned within the much broader international literature), the course uses a series of lectures to introduce:

- Historical perspectives around the relationship between economic growth, population and the environment, in particular and the mediating role of technology and innovation
- Concepts and disciplinary approaches associated with different pillars (economic, social and environmental) of sustainability, and the importance of diverse 'framings', perspectives and worldviews when analysing and addressing sustainability problems.
- Policy and governance approaches that may be applied at national levels to direct innovation towards specific sustainability objectives.
- The importance of diverse knowledges in achieving sustainable development, including grassroots innovation.
- The challenge of international co-ordination and competition in creating 'sustainability-oriented innovation systems'.

The course responds to the global challenge of building an international community of leaders who are able to direct innovation processes towards a shared but reflexive vision of sustainable development. The learning outcomes (LOs) for 'Innovation for Sustainability' focus on students' development of a deep understanding of the course content and their application to real world problems; by the end of the 10 weeks over which the course runs, students should be able to:

1. Command a good knowledge and critically evaluate the key theoretical perspectives on innovation and the environment.
2. Be able to apply concepts from innovation theory in analysing a range of contemporary environmental policy problems
3. Be able to research the innovation dimensions of a contemporary environmental problem using a mix of academic and policy literature.

4. Demonstrate the understanding and intellectual skills identified in (1), (2) and (3) above by means of clear and concise written work.

The learning outcomes above clearly require a move from *verbatim* learning or memorising of facts and principles (knowledge) to the ability to apply principles and ideas to new policy problems (LOs 1-3). To critically evaluate theoretical perspectives (LO 1), students must have attempted to apply them in at least a small number of contexts (as required in Learning Outcome 2) and to reflect on their utility in real world settings. Learning outcome 3 requires students to synthesise and apply (theoretical) ideas from the academic literature and, importantly, to relate them to other literature from the policy field.

Discussion seminars and other teaching and learning activities (TLAs) facilitate students' relational learning (the ability to causally link ideas introduced in lectures, to analyse and apply them) and provide opportunities for extended abstract learning (in which students generalise, hypothesise and reflect – on the utility of theory and its extension to address new problems). This paper focusses on three TLAs employed consistently in the 'Innovation for Sustainability' course that draw on practical experiences to move from pre-structural to relational and eventually extended abstract phases.

- A seminar session dedicated to *reflecting on personal professional experiences* relevant to 'Innovation for Sustainability' from students' professional histories.
- A case-based *role-play seminar* in which students are invited to adapt and apply concepts from innovation theory in analysing a case (e.g. energy from woody biomass in the UK) and put forward recommendations for local and national government.
- A *competitive role-play game* in which teams of students are invited to 'pitch' an idea for a disruptive innovation to a group of 'impact investors' (played by either university faculty members or in some cases peer groups) in an attempt to raise venture capital for their innovation.

These TLAs are described in more detail below and evaluated on the basis of questionnaire surveys. First, however, we discuss the role of experiential learning in education for sustainable development, review our understanding of the state of the art and outstanding questions, and finally explain how an evaluation of the TLAs above can contribute to the knowledge in the field.

Education for Sustainable Development and the Role of Experiential Learning

Education for sustainable development (ESD) was highlighted as a critical element in moving society towards a more sustainable future in Chapter 36 of Agenda 21 (agreed at the Rio Earth Summit in 1992). Following the identification of a number of research priorities (Paden and Chokar 2007) the field of ESD has progressed greatly through the United Nations decade of ESD, whilst challenges remain (Nambiar and Sarabhai 2015), especially with regards to education across disciplinary boundaries (Lozano et al 2013; Di Giulio and Defila 2017). Efforts by scholars from across a number of natural and social sciences to define integrative frameworks (for example the still nascent 'discipline' of Sustainability Science (Clark and Dickson 2003; Clark 2007) have provided a focus for some ESD initiatives.

Disciplinary differences are only part of the challenge, however. The fact that 'sustainability' and 'development' remain contested terms, often subject to very different framings across different disciplinary boundaries, socio-cultural contexts and worldviews (Leach et al 2006) is increasingly being recognised by pedagogical and andragogical approaches in ESD (Alvarez and Rogers 2006). Indeed, normative competence, "the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets" has been identified as a key competency in sustainability, and one that should be integrated into higher education programmes

(Wiek et al 2011). This ability involves students being able to appreciate different analytical (disciplinary) framings of sustainability problems, as well as the knowledge and experience that non-academics (including their 'non-academic' selves) bring to the challenge of addressing them – going beyond interdisciplinarity to transdisciplinary competencies (Stauffacher et al 2006; Wiek et al 2011; Lotz-Sisitka et al 2015; Di Giulio and Defila 2017).

The 'Innovation for Sustainability' course encourages students to try to bridge between their own and their peers' perspectives and, like other 'Sustainability Science' programmes at the Masters level, stresses *experiential learning* as a way to 'acquire the skills and sensibility required of future leaders' (Onuki & Mino 2009). Experiential approaches can force students to look at problems in their entirety, avoiding the reductionist approach of strict disciplinary analysis – "on an emotional and intuitive level, we are capable of apprehending and 'experiencing' complex systems" (Dieleman and Huisingh 2006).

Scholars and practitioners in the field of ESD have contributed significantly (in the pages of this journal and elsewhere) to our understanding of how experiential learning can help to build such competences. Studies have put forward frameworks for experience-based learning (Brundiars 2010; Caniglia 2016), and explored various approaches, in particular the context of teaching (e.g. where it takes place, the process of design and implementation, with which stakeholders and to what ends). Going "out there" (Alvarez and Rogers 2006) through site visits forces students to be confronted with the complexity of real world problems, enabling them to appreciate different understandings of sustainability and the cultural and political challenges to action.

The transdisciplinary case study (TCS) approach described by Stauffacher et al (2006) and Scholz et al (2006) draws on earlier work on experiential case encounters (Scholz and Tietje, 2002). It has been used to build cognitive structures according to a hierarchy of case understanding, conceptualisation and analysis, contributing to 'sustainability learning' among stakeholders involving in complex real-world problem-solving (Scholz et al 2006). The concept of 'real-world learning' (Brundiars et al 2010) highlights the need for students to be exposed to such problems, going beyond project-based learning, service learning and internships to include a 'collaborative project course' that enables students to work with community project partners through solution workshops and study abroad schemes. These provide students at different stages in a degree programme with the opportunity to learn theory, apply it in their collaborative project course and then reflect on their experience and share with other students. Writing from the same institution (Arizona State University School of Sustainability), Wiek et al (2014) describe how problem and project-based learning (PPBL) can be integrated into sustainability programmes. PPBL is "student-centered, self-directed and collaborative learning that focuses on real-world issues and may involve stakeholder engagement", including work around urban development within the City of Phoenix. The authors offer quotes from student evaluations that point to project management, leadership, stakeholder engagement, report writing and "how to facilitate discussion around sensitive development topics in a positive, future-oriented way" as key skills they developed.

Other studies (Alvarez and Rogers 2006; Cheang et al 2017) have also emphasised the role of non-classroom, collaborative learning environments and their ability to enhance experiential learning and developed specific competences, whilst Maher and Burkhart (2017) have reported self-awareness, knowledge and problem-solving learning derived from a 'eco-friendly food challenge' that students undertook over a period of three weeks. Savage et al (2015) describe a sustainability leadership course that – without taking teaching outside the classroom – aims to build on all five of Wiek et al's (2011) competencies for sustainability research and problem-solving. They present statistical analysis on the basis of self-assessment surveys and open-ended responses that demonstrate "the program's experiential, application-oriented instructional methods resonated

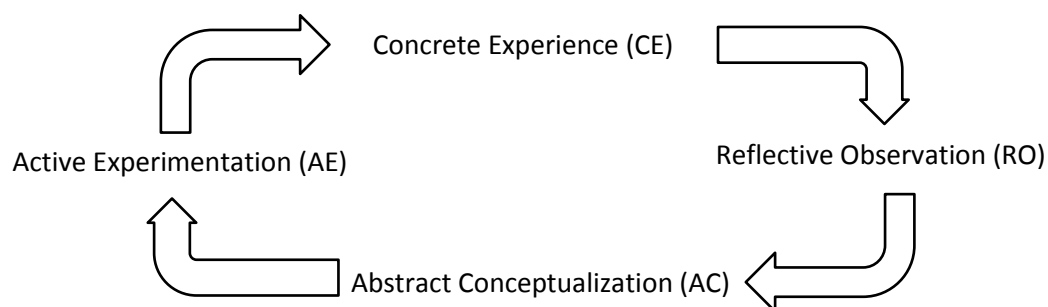
strongly with all participants, who frequently mentioned the positive contrast to the traditional lecture-style learning that typified their university experience.” Few of these studies, however, go into detail on the specific TLAs that are applied either inside or outside the classroom, or evaluate them on the basis of student perspectives. This paper contributes to this gap in the literature and poses the question of how *in class* TLAs might be designed to enable and enhance experiential learning based on students' professional experience and simulated processes in class.

Designing TLAs for experiential learning

The roots of the experiential learning approach go back to Ralph Tyler (1949), who wrote “learning takes place through the active behaviour of the student: it is what *he* does that he learns, not what the teacher does.” The subsequent ideas put forward by Kolb (1984) and later constructivist understandings around experiential learning likewise focus on the actions and choices of the learner themselves in building cognitive structures through engagement with experiences (both inside and outside the class), and subsequent reflection, conceptualisation and experimentation.

How do we enable student’s prior experiences, and also experiences that they have in class, to develop these forms of deeper learning? Kolb’s model can help us to understand the kinds of learning opportunities that students may utilise to bring about experiential learning, as well as the styles of learning that different students may use to build cognitive structures based on their experience. Kolb outlined these various processes in his ‘experiential learning cycle’, which is illustrated in Figure 1.

Figure 1. The Kolb Learning Cycle (adapted from Kolb 1984)



The figure illustrates that the *experience* (CE) itself is only part of the learning process, and therefore in designing TLAs, and the course itself, there is a need to focus on the various (RO, AC and AE) components of the cycle. Teaching and learning activities (TLAs) can provide opportunities for students themselves to draw on experiences inside and outside the class, to build new cognitive structures. The TLAs used in the ‘Innovation for Sustainability’ course aim to do this, often cutting across the various stages in Kolb’s learning cycle, rather than merely being associated with one or other as suggested above. Each of them are described in more detail below.

Personal reflections on professional experiences

In this activity, students were invited to highlight their own concrete experience (CE) by identifying ‘critical incidents’ that have led to lessons learned during their career, and encouraged to reflect on how these relate to theories or ideas introduced in the course. Opportunities were therefore provided for reflective observation (RO). Students were also able to discuss their experiences across cultures and across age-groups, offering opportunities for mid-career learners to bring insights to other, less-experienced peers. As this TLA was used early in the course, it also provided a way for the

author (and students) to identify the expertise in the room and to start to generate a rapport, based on a recognition of the diverse backgrounds, skills and experience present. Listening to others' experiences of learning provided opportunities for 'reflexive observation' (RO) by other members of the class. The important aspect of encouraging mutual understanding of different framings of 'sustainability' is often best-achieved by relating and sharing of concrete experiences between students from different backgrounds – recognising them "as a person" (Beatty 2009; 135).

Case-based discussions

Case studies have been used widely in business and management teaching, and also in courses associated with sustainable development. Unlike the TCS approach (Stauffer et al 2006; Scholz et al 2006) or PPBL (Wiek et al 2014) this is entirely a classroom-based exercise, even though the materials and introduction are drawn from a 'real-world' problem. The seminar format involved an introduction (by an external representative of an energy firm) of the state of play of bioenergy in the UK, and asked students to discuss, in small groups, options for local and national governments. These discussions were informed by key background readings provided to the students in advance. The seminar has taken place after specific concepts have been introduced in the lectures, and students were encouraged to apply (through a process of abstract conceptualisation - AC) some of these in their discussions. More specifically, they have been asked how policies might promote such 'green niches' (Kemp et al 1998; Smith 2006) in order to help bring about 'socio-technical transitions' (Elzen et al 2004; Smith et al 2005) and – through comparing the interests of different actors, have been required to explore the politics involved in such processes (Meadowcroft 2009; Kern 2011). As such, the seminar attempted not only to allow the application of abstract concepts to the concrete case, but also to simulate the experience of group decision-making within a local or national authority (CE). This process has also provided a focus for discussion of the very different cultures of decision-making and governance evident in the socio-political contexts from which students are drawn. Through these processes, students are again able to move towards abstract conceptualization of the theory introduced earlier in the course, and to experiment (AE) with its application to the case study in question.

Role Play Game

Role play games can create an emotional and passionate experience that can contribute to learning (Dieleman and Huisingsh 2006). The format used in the 'Innovation for Sustainability' course copies a popular television programme in the UK ('Dragons' Den') in which entrepreneurs are invited to 'pitch' their innovations to a panel of millionaire 'angel' investors, with the successful presentations rewarded by real-life contracts for investment, usually in return for an equity stake in the enterprise. This idea was adapted in the course by substituting the 'for profit' innovation for a "not-just-for-profit" (Ely et al 2013) disruptive innovation that aimed to bring about meaningful, system-wide impacts in terms of specified environmental or social objectives. In the 'Dragons' (Disruptive) Den' version used in the course, teams of 2-5 students were invited to formulate an idea for a specific enterprise, technology or business model, using the concepts (AC) introduced in the course, such as the 'double dividend' (Porter and van der Linde) or 'disruptive innovation' (Christensen 2006) present to a group of 2-3 'impact investors' (made up of university faculty members, each with a set imaginary budget that they could allocate to one or more team). As such, students were offered the opportunity to experiment (AE) with the concepts, with regard to sectors and sustainability challenges of their choosing. The underlying logic, rationale, viability and ethics associated with the presentations were interrogated through and cross-examination by peers and investors (RO). Following this process of cross-examination, investors announced the sums of (imaginary) money allocated to each team. The emotional engagement associated with the creative collaboration (and competition) in this particular role play format (CE) was not only greatly enjoyable for the participants but also provided further opportunities for completing Kolb's learning cycle.

Methodology

The methods used in this study provide qualitative evidence of the effectiveness, strengths and weaknesses of various TLAs in providing opportunities for experiential learning around ‘innovation for sustainability’.

Initially, between 2008 and 2010 the author conducted in-depth, semi-structured interviews with former students (following final assessments) to explore their learning experience and identify questions for a survey, from which the evidence in this paper is taken.

From 2011, a voluntary online questionnaire was offered for students to fill out anonymously. The response rate was very low but qualitative answers were received from three overseas (European) students and one UK student. Following a shortening and a move to pen and paper questionnaires in 2012 and clearer explanation of the objectives of the exercise, response rates to questionnaires (still voluntary and anonymous) have been much higher (see Table 1 below). This sample provides a robust evidence base for the qualitative evaluation of the TLAs described above.

Table 1. Evidence base from questionnaire survey used in this study (total N=128)

Year	2011	2012	2013	2014	2015	2016	2017
Class size	27	69	19	24	20	13	31
Responses	4	36	13	17	17	11	30
Response rate (%)	15	52	68	71	85	85	97

Each year the questionnaire asked “Do you have previous career experience (one year or more) of relevance to ‘innovation for sustainability’?”, with a scale of 1-5 (1 signifying “not at all” and 5 “much experience”). Table 1 provides the % of students that indicated they had some experience (answering 2 or more) each year, and also the average. These averages betray the variation in levels of experience (which have spanned from recent graduates with no professional experience, to students who had worked in unrelated areas, to seasoned UN, NGO or private sector employees with in some cases decades of professional practice to draw upon).

Table 1. Self-reported levels of experience (Likert Scale 1-5; 1=zero, 5 = much experience)

Year	2011	2012	2013	2014	2015	2016	2017
Experience (> 1) %	50	44	67	47	29	55	54
Average response (experience)	2.0	1.8	2.0	1.7	1.8	2.1	1.9

Beyond gathering general information about previous levels of professional experience, standard questions from years 2012-2017 took the following forms:

- “Did the course allow you to reflect upon your previous experience in seminar (specify seminar)? When else did you reflect on your previous experience?”
- “Did you find the seminar by (seminar facilitator) an interesting and worthwhile component to the course? Give details of how it helped you to understand any of the concepts from the lectures.”

- “Did you find seminar (specify seminar) helped you to understand how the theory introduced in the course can be applied in different contexts around the world? Give details of any interactions with fellow students that helped you to understand diverse international perspectives.”

In each case, questions offered closed responses to the initial part through a scale between 1 (not at all) to 5 (a great deal) and in addition provided space for open, qualitative responses. Given the small size of the data-set, statistical analysis of the numeric responses is not appropriate and the evidence presented below relates entirely to the qualitative responses to the questionnaire.

With regard to the use of the questionnaire as an input to formal research on the role of experiential learning in education for sustainable development, the students were informed that “The results will be anonymous. They may be used in future publications by (the author) and will be used to improve the course in future years.” Students were invited to provide their country of origin (although it was made clear that this was not mandatory, as it could compromise anonymity, so in some cases nationality was not divulged). Nevertheless, based on the responses in which nationality was included, Table 3 below describes the national make-up of students in the years sampled on the basis of United Nations geoscheme of geographic supranational regions/ UN M.49 statistical standard (Africa/ Americas/ Asia /Europe /Oceania). The percentage of ‘home’ students (from the UK) has also been included.

Table 3. Percentage of student responses that specified nationality from each UN geoscheme region - Africa/ Americas/ Asia /Europe (and the UK)/Oceania

Year	2011	2012	2013	2014	2015	2016	2017
% Africa		27		13	12		8
% Americas		27		31	24	57	28
% Asia		73	50	31	29		40
% Europe (% UK)	100 (25)	23 (16)	50 (25)	19 (13)	35 (35)	43 (14)	24(20)
% Oceania				6			

Findings

Qualitative findings from the questionnaire responses are summarised below, with selected quotes from anonymous students provided for further explanation. The findings are organised on the basis of the three TLAs described above, so as to address the question of how *in class* TLAs might be designed to enable and enhance experiential learning based on students' professional experience and simulated processes in class.

Personal reflections on professional experiences

The design of the TLA aimed to enable students to draw upon their own career experiences (critical incidents) in order to better-understand the course content, as well as sharing them in a way that helped other less experienced learners. Many of the students found this opportunity valuable, not only as a way of reflecting on their own experience but also of becoming aware of the other expertise among their peers ‘in the room’. Some experienced students pointed out that it was only during their studies (rather during their time working) that the learning and reflection process took place, and that further opportunities for reflective observation (RO) would have been welcome. An Italian student (2011) suggested that “Perhaps here an additional exercise could have been included

where students reflect on how their previous work relates to innovation or sustainability (since for some of us our previous work might not have been relevant or appropriate).” At the same time, younger students with fewer years in employment found this TLA somewhat frustrating as they could not identify ‘critical incidents’ from their past. A German student (2013) admitted a lack of professional experience, and as a result needed to draw upon what they had learned in other courses. A Colombian student (2017) stated “even when I don’t have much experience in the field for that exercise, I recall some concepts of my former jobs and other ‘life experiences.’” In order to provide opportunities to those students who struggled to identify relevant critical incidents from their own past, an alternative option (inviting students to reflect on an incident that they had read about, rather than experienced in person), was introduced in later years.

For other students (even more experienced ones), it was clear that this seminar format should appear later in the term, once the theoretical concepts had already been introduced. A Brazilian student (2014) noted that “it was early on in the module, so I wasn't sure how helpful it was”, whilst an Ecuadorian (2014) responded “I think the contributions should be asked at the end of the module when we get a better understanding about what innovations for sustainability means”. In this case some degree of abstract conceptualisation (AC) was required in advance of reflective observation, and further opportunities for reflective observation (RO) and active experimentation (AE) would have been appreciated. As discussed further below, this points to time constraints for a course such as this, as well as questions of sequencing in Kolb’s experiential learning cycle.

Case-based discussions

The biomass case study offered students an opportunity to consider the different interests and political positions of actors involved in a transition towards more sustainable energy systems in the UK. In general, students responded very positively, not only to having the concepts that had previously been introduced in the course related to a concrete case (abstract conceptualisation - AC)(as elucidated by an external expert), but also to the opportunity to apply them to detailed briefs and background information. Students mentioned an enhanced appreciation of transitions, and of the political tensions that they involve. A student from the USA/ Trinidad and Tobago (2014) said “It showed the complexity of different stakeholders in biomass as a renewable energy source”. One Japanese student (2013) wrote “I was able to grasp different positions and views in the topic”. This recognition was mirrored by a student from the Gambia (2014) who said “it allowed me to grapple with some of the tensions and interests in the policy making process.” In more recent years, the case based discussion has been shifted towards a role play exercise in which students are given a brief associated with a particular stakeholder and asked to put forward their particular perspective, simulating a concrete experience (CE) in the classroom setting. This led a Japanese student (2015) to write “through role playing regarding stakeholders, I can understand how complicated it is to implement shifting to sustainable way.” This kind of role-playing (as discussed further below) also brings a deeper engagement with the concepts (abstract conceptualisation - AC) and technical details provided in background materials. A UK student (2015) wrote “actually having to argue our position made us reflect upon course concepts to make valid points” (indicating reflective observation – RO – and perhaps pointing towards Dieleman and Huisingh’s 2006 suggestion that emotional and intuitive engagement enables a more holistic apprehension of complex systems).

Role Play Game

The ‘Dragons’ (Disruptive) Den’ seminar has consistently been the most popular among students, based on the very positive evaluations it has received. A Chilean student (2015) highlighted that they had reflected on their own professional experience (with start-ups) in formulating their own pitch. However the real strength of this format was to allow a creative experimentation (CE) with the concepts introduced in the course. A student of unspecified country of origin (2013) stated “I really appreciated the opportunity to develop one of my own [Innovation for Sustainability] ideas during

the disruptive den. This class was also useful in exposing me to other peoples' experience in the field of international development." A Colombian student (2015) responded "It was a fun challenge to apply the concepts to a business model," whilst one student from South Africa (2015) found that "it helped me to understand the concept of disruptive technology (*sic*)." A Malaysian student (2017) wrote "it 's an interesting experience trying to be in an entrepreneur's shoes, and truly innovation is a rather risky... the importance of creative skills and technological capabilities", whilst a contemporary from Mexico wrote "I think this was a useful exercise for us to try to realise and get in context of the real world, which is not the same as just talk and read about something".

Despite the overwhelming appreciation of this opportunity for active experimentation with the concepts introduced in the course, it was clear that some found it extremely challenging. A UK student (2015) reported that "I think a lot of people underestimated the analysis needed" and South Korean and Japanese (2017) students both stressed the need for more preparation time for the exercise. These and other responses point to the fact that active experimentation (AE) with concepts requires a depth of learning and commitment to the task at hand, which can be particularly difficult in a collaborative exercise. Group dynamics were mentioned by several students across two years as detrimental to its success. A Japanese student (2014) stated "Honestly was really difficult. Maybe because of the group formation?" whilst a Turkish student (2015) wrote "I really liked the 'Disruptive Den' exercise and as a group we took it in a serious and professional manner. I wish some other groups had the same approach." This response suggests that significant effort was dedicated to working across teams (with diverse membership), illustrating that the role play offered opportunities to explore and negotiate different perspectives, collaborating with colleagues from diverse backgrounds and drawing on their experience in a creative way.

Evaluation of the 'experiential learning' across the TLAs

Adopting an experiential learning approach in the 'Innovation for Sustainability' course has involved providing opportunities for students to attain the learning objectives set by rising up the hierarchy of learning from pre-structural to relational and eventually extended abstract understanding. This paper has evaluated the various TLAs outlined above with regard to their ability to enable students to move through (not necessarily in sequence) the various stages of the Kolb learning cycle in order to facilitate this, either on the basis of professional experience (reflecting on critical incidents in their previous professional lives) or simulated experience (through role plays or games in the course seminars.)

Approximately half of students taking 'Innovation for Sustainability' (with variation in years) identified themselves as possessing some professional experience that was relevant to the course. These students usually found recounting their own professional experiences useful, not only to reflect on their own learning processes in the past but also to get to know (those of) their colleagues. However only a small minority were prepared for this at an early stage in the course. For less experienced students (or those whose professional background was only loosely relevant), it has been necessary to give an alternative option based on studied (academic) knowledge rather than concrete experience. Others would have benefited from being asked either to reflect on how their previous experience was *or was not* relevant to the course, or to have first been introduced to some more abstract concepts that they could have linked to incidents in their professional life. This draws attention to the cyclical nature of experiential learning, and the fact that some introduction of abstract concepts can enhance the usefulness of reflection. At the same time it points to a challenge that educators face in drawing upon the experiential learning approach (at least as articulated by Kolb 1984) - finding enough time to offer opportunities for each of the stages in the learning cycle to occur. A resultant consideration is the need for courses that aim to employ experiential learning to be undertaken over longer timeframes (in more recent years the 'Innovation for Sustainability'

course has been extended to 14 weeks, including reading weeks/ vacations). Explicitly incorporating experiential learning into longer programmes of multiple years (see Brundiens et al 2010) can provide more scope for previous and simulated experience to play a role, and taking learning out of the classroom to the real world (Scholz et al 2006; Stauffacher et al 2006, Wiek et al 2014; Cheang et al 2017) can further enhance the experiential learning deriving from the TLAs described here. This is especially important when 'concrete experience' (CE) is the limiting stage in the cycle (e.g. for younger students with no professional experience to draw upon).

The case-based discussions proved to be useful in offering students the opportunity to apply concepts introduced in the literature to real-world scenarios. Informed by detailed (in some cases specialist technical) background information, they were better able to appreciate the complexity of systemic shifts towards lower carbon energy systems, and the trade-offs with other socio-economic and environmental objectives at different scales (national and international). Injecting a 'role-play' element to this seminar format incentivised deeper engagement, and as a result, enhanced abstract conceptualisation (AC) of the case study information provided and a better apprehension of the complex system and its political dimensions. Active experimentation (AE) did not appear to play an important role in this TLA, whilst this might be possible in TLAs that take students out of the classroom to engage in longer-term collaborative projects (e.g. Wiek et al 2014).

Active experimentation was possible in the specific role play format adopted in the Dragons' (Disruptive) Den TLA, as students had more time (3-4 weeks) to prepare their pitches. Experimenting and reflecting on their own ideas for an innovation that could bring about disruptive change for social and environmental goals proved a popular approach. Turning the role-play into a competition added to the fun and the depth of engagement that was reported by students. At the same time, the findings point to the importance of managing group dynamics in such a creativity-intensive exercise where the pertinence of linguistic and cultural differences (Dan and Mino 2016) is even more acute.

Beyond the above TLAs attempting to foster experiential learning at the individual level, they have also tried to leverage experiences between students from different socio-political and cultural backgrounds, so that the diversity in the class can enhance learning outcomes (Gurin et al 2002). The internationally-interconnected nature of both innovation processes and sustainability challenges increasingly requires an ability to relate to interlocutors with different values, priorities and framings (Leach et al 2010), one which international courses such as the one described here are uniquely capable of generating. A Japanese student (2017) explained "looking at the diverse positions of 'sustainability' depending on the people was interesting and useful. I understand any positions could ignore certain aspects." Students benefitted from opportunities for comparing these differences and the resulting differences in the ways they experimented with concepts introduced in the lectures (for example in the 'reflecting on personal histories' TLA). A Croatian student (2011) explained "it is amazing to see how people in my course from around the world and different backgrounds can actually apply the contents of the course in their context and background", whilst one of their UK counterparts wrote "I was most interested how the course learning affected colleagues from different backgrounds in different ways."

At the same time, there were limitations to this process. A UK student (2012) wrote "generally interactions with other students were not as illuminating as they could have been given the diversity of backgrounds - perhaps because of language or cultural barriers?" The difficulties experienced with the collaborative TLAs could be seen as a positive step towards developing what Wiek et al (2011) identify as the 'interpersonal' competence (defined as "the ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving") and – within that – "the capacity to understand, embrace, and facilitate diversity across cultures, social groups,

communities, and individuals". Whilst the TLAs discussed in this paper may play a role here, further research is required to better-understand the ways in which their strategic design can be improved to profit from diverse, international classes in a way that explicitly builds this competence.

Conclusion – Teaching and Learning Approaches for Experiential Learning

Experiential learning frameworks have been applied in ESD courses for decades, with particular attention being paid to taking learning outside the classroom (through experiential case encounters, transdisciplinary case studies and 'real-world learning' approaches). This evaluation of the TLAs used in the 'Innovation for Sustainability' course has focussed on 'in-class' activities which have been designed to enhance experiential learning on the basis of professional histories or simulated experience. The evaluation points to strengths and weaknesses in three different TLAs that have attempted to facilitate experiential learning in 'Innovation for Sustainability', and explains how they articulate with Kolb's (1984) learning cycle. In particular it has pointed to ways in which each of the TLAs can enable and enhance concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC) and active experimentation (AE).

The evidence presented suggests that students benefitted from the TLAs, which complemented the more traditional lectures and enabled a deeper degree of learning. At the same time limitations were identified, in particular associated with time constraints and sequencing, hindering the ability of all stages in the learning cycle (in particular active experimentation) to be reached, the different levels of previous professional experience among the class (which impacted in particular on the suitability of the 'professional histories' TLA), and inter-cultural/ linguistic differences contributing to difficulties in collaborative exercises. In some cases these have been responded to through alterations to the course (in ways described above), however further research is required to assess the effectiveness of these responses, ideally on the basis of a more structured framework (e.g. Wiek et al 2011).

The focus on experiential learning in the design of the course led to profound realisations of the differences between contexts and – reflecting earlier findings (Maher and Burkhart 2017) – shifts in personal knowledge and skills required to "be more sustainable". One student from China (2013) wrote "it is not just a course. It also spread an idea or an awareness for future life." Strategic design of TLAs in a way that enables experiential learning to enhance inter-cultural sensibility, empathy and understanding for different sustainability perspectives, represents a key opportunity for international postgraduate programmes. Combining such experiments with more formal assessment of improved 'normative competence' and 'interpersonal competence' across different cultural and socio-political backgrounds is an important potential area for parallel future research.

This paper adds to and strengthens existing evidence for the role of experiential learning in ESD by evaluating TLAs in the design of a particular 10-14 week course. Incorporating these lessons into teaching and learning at the broader curricular/ programme level, rather than merely at that of individual sessions, could allow further (and more effective) reflection, experimentation and the development of more complex cognitive structures. Beyond experiential learning at the individual level, this could improve the opportunities for *sharing of experiences* between students from diverse socio-political and cultural backgrounds in a way that enhances cross-cultural awareness and makes students better able to apply their learning in whatever context they find themselves after graduation.

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