TIME for REFL-ACTION

Interpersonal Competence Development in Project-based Sustainability Courses

Theres Konrad

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TABLE OF CONTENT

Visions for this thesis

This dissertation is located at the interface of (higher) education and sustainability (science). In this spirit, I envision explicit learning outcomes[1] for the reader. The aim of this thesis has been to contribute to the body of research in "higher education as a motor of the sustainability transformation"[2]. Therefore, the following three **desirable and plausible visions** have been pursued:

First, the reader feels taken by the hand to explore the present dissertation.

To reach this, the structure of this dissertation is visually presented at the end of the introduction, allowing to see at first glance each chapter´s foci and their interconnections (supporting the creation of a mental model of this thesis). The visualization further familiarizes the reader with Corbin and Strauss´ (1990) Grounded Theory Coding Paradigm, something this research made use of at several stages.

Second, the reader recognizes this dissertation´s quality.

To reach this, transparency in terms of the WHY, WHAT, and HOW is provided in Chapter 1, while the conceptual, empirical, onto-epistemological, theoretical, and methodological foundations are outlined respectively in Chapters 2, 3, and 4.

Third, the reader feels inspired to experiment based on insights gained from this dissertation, i.e. the reader is motivated to put the new knowledge into (research) practice.

To reach this, alongside the individual articles from which this cumulative dissertation is composed that provide in-depth insights into individual moderating variables of interpersonal competence development, a synthesis and a visualization of these findings are provided. This allows the reader to grasp interpersonal competence development in project-based learning settings comprehensively. Outlined contributions, within and beyond sustainability higher education, further facilitate the transfer of findings into different contexts. Critical reflections, including limitations of this dissertation, as well as outlooks for the future show how future research and practice can be further developed (see Chapter 5).

1 "Explicit learning outcomes are an important orientation for both students and teachers [here: readers and author]. For teachers who are offering learning and teaching experiences to engage with sustainable development, defining and describing learning outcomes is an important way to reflect on the educational goals and how these goals should be achieved." (Barth 2015, pp. 57-58).

2 More on the *Educating Future Change Agents* research project: https://www.leuphana.de/zentren/cgsc/forschung-projekte/educating-future-change-agents.html [2.1.2021].

Summary

This dissertation investigates *interpersonal competence* development in project-based sustainability courses. Visions of a sustainable, safe, and just future cannot be reached by one individual alone. Thus, future change agents need to be able to *collaborate* and *engage with stakeholders*, to approach the manifold crises, challenges, problems, and conflicts we are facing together, and to promote and push forward sustainability transitions and transformations. Therefore, this research investigates three project-based sustainability graduate courses by comparing and contrasting teaching and learning outcomes, processes, and environments. A comparative case study approach using a Grounded Theory-inspired research design which triangulates several qualitative methods and perspectives is applied to allow for generalizable insights. Thereby, this dissertation provides empirically-informed insights which are further discussed in relation to selected teaching and learning theories. This leads, first, to a discussion of practical implications within (and beyond) sustainability higher education; and second, provides a theoretical foundation for interpersonal competence development in project-based learning settings – so that *educating future change agents* can gain momentum.

Findings of this research show that *embracing conflicts* when they occur (i.e. before they provoke cascading effects in the form of further conflicts down-the-road) is an effective strategy to help further develop interpersonal competence. This requires a conflict-embracing attitude. *Attitude*, in general, seems to be key in interpersonal competence and competence development overall. Self-*reflection*, if not explicitly required by outside influences (such as instructors), arises naturally from a self-reflective attitude, and is shown to provide the basis for developing interpersonal competence. This research introduces the term 'Refl-Action' which stresses the importance of pairing 'learning by doing' (as is often the focus in project-based learning settings) with conscious moments of 'reflecting about the doing'.

More specifically, the research presented here identified four *learning processes* for interpersonal competence development: receiving input, experiencing, reflecting, and experimenting. Based on the empirical data, when the four processes are purposefully combined, following a meaningful sequence attitudes, knowledge, and skills in *collaborative teamwork* and *impactful stakeholder engagement*, are fostered (two facets of interpersonal competence). Each of the four learning processes is set in motion through various *interactions* students engage in during project-based sustainability courses: student-student (labeled 'peer'), student-instructor (labeled 'deliberate'), student-stakeholder (labeled 'professional'), and student-mentor (labeled 'supportive') interactions. When these interactions are made *explicit subjects of inquiry* – i.e. the (inter-)action is linked with (self-)reflection – different learning processes complement one another: Interpersonal competence facets (collaborative teamwork and impactful stakeholder engagement) and domains (attitudes, knowledge, skills) are fostered. While, overall, *interactions, processes*, and *conflicts* have been identified as supportive for interpersonal competence development, *trust* has emerged as another variable inviting further investigation.

The findings of this thesis can be useful not only to support more conscious course design and facilitation, but should also be taken into consideration in other project-based (sustainability) settings. Both, sustainability novices and experts are regularly required to engage in teams and with stakeholders. Applying a conflict-embracing and self-reflective attitude allows to actively deal with differences encountered where diverse people interact, and to move forward on sustainability problems and visions in collaboration.

Zusammenfassung

Vorliegende Dissertation untersucht die interpersonelle (zwischenmenschliche) Kompetenzentwicklung in projektbasierten Nachhaltigkeitskursen. Visionen einer nachhaltigen, sicheren und gerechten Zukunft können nicht von einem Einzelnen allein erreicht werden. Zukünftige Change Agents (Akteure des Wandels) müssen daher in der Lage sein, zusammenzuarbeiten und mit Stakeholdern (Interessensvertretern) zu interagieren, um die vielfältigen Krisen, Herausforderungen, Probleme und Konflikte, mit denen wir konfrontiert sind, gemeinsam anzugehen, und um Übergänge zu nachhaltigeren Lebensweisen einzuleiten beziehungsweise Nachhaltigkeitstransformationen voranzutreiben. Daher untersucht diese Studie drei projektbasierte Nachhaltigkeitskurse, indem sie Lehr- und Lern-Ergebnisse, -Prozesse und -Umgebungen vergleicht und kontrastiert. Um verallgemeinerbare Erkenntnisse zu gewinnen, wird eine vergleichende Fallstudie mit einem von der Grounded Theory inspirierten Forschungsdesign angewendet, das verschiedene qualitative Methoden und Perspektiven trianguliert. Dadurch liefert diese Dissertation empirisch fundierte Erkenntnisse, die in Bezug auf ausgewählte Lehr- und Lerntheorien weiter diskutiert werden. Dies führt erstens zu einer Diskussion praktischer Implikationen innerhalb, als auch außerhalb der Nachhaltigkeits-Hochschulbildung, und bietet zweitens eine theoretische Grundlage für die Entwicklung interpersoneller Kompetenz in projektbasierten Lernsettings – sodass die Bildung zukünftiger Change Agents in Schwung kommen kann.

Die Ergebnisse dieser Forschung zeigen, dass das *Annehmen von Konflikten*, wenn sie auftreten (das heißt, bevor sie an anderer Stelle ausufern), eine effektive Strategie ist, um die Entwicklung interpersoneller Kompetenz zu fördern. Dies erfordert eine konfliktannehmende (oder „umarmende“) Haltung. Haltung beziehungsweise *Einstellung* scheint generell ein Schlüssel für die interpersonelle Kompetenz und Kompetenz-Entwicklung insgesamt zu sein. Selbst*reflexion*, wenn sie nicht explizit durch äußere Einflüsse (wie zum Beispiel durch Lehrende) gefordert wird, ergibt sich aus einer selbstreflexiven Haltung und bildet nachweislich die Grundlage für die Entwicklung interpersoneller Kompetenz. Vorliegende Forschung führt den Begriff „Refl-Action“ ein. Dieser verbindet aktiv das Prinzip des „Learning by Doing“ („Lernen durchs Tun“; wie es oft im Fokus projektbasierter Lernsettings steht) mit bewussten Momenten des „Reflektierens über das Tun“.

Die hier vorgestellte Forschung identifizierte vier *Lernprozesse* für die Entwicklung interpersoneller Kompetenz: Input erhalten, Erleben, Reflektieren und Experimentieren. Basierend auf den empirischen Daten werden, wenn die vier Prozesse zielgerichtet kombiniert werden und einer sinnvollen Abfolge folgen, Einstellungen, Wissen und Fertigkeiten in *kollaborativer Teamarbeit* und *wirkungsvollem Stakeholder-Engagement* gefördert (zwei Facetten der interpersonellen Kompetenz). Jeder der vier Lernprozesse wird durch verschiedene *Interaktionen* der Studierenden in projektbasierten Nachhaltigkeitskursen in Gang gesetzt: Interaktionen zwischen Studierenden (bezeichnet als „peer“), zwischen Studierenden und Lehrenden (bezeichnet als „deliberate“), zwischen Studierenden und Stakeholdern (bezeichnet als „professional“) und zwischen Studierenden und MentorInnen (bezeichnet als „supportive“). Wenn diese *Interaktionen explizit zum Gegenstand der Untersuchung gemacht werden* – also die (Inter-)Aktion mit der (Selbst-)Reflexion verknüpft wird – ergänzen sich unterschiedliche Lernprozesse: Interpersonelle Kompetenzfacetten (kollaborative Teamarbeit und wirkungsvolles Stakeholder-Engagement) und Domänen (Einstellungen, Wissen, Fähigkeiten) werden gefördert. Während *Interaktionen*, *Prozesse* und *Konflikte* als förderlich für die Entwicklung interpersoneller Kompetenz identifiziert wurden, hat sich *Vertrauen* als eine weitere Variable herauskristallisiert, die zu weiteren Untersuchungen einlädt.

Die Erkenntnisse dieser Arbeit können nicht nur zur Unterstützung einer bewussteren Kursgestaltung und -moderation nützlich sein, sondern sollten auch in anderen projektbasierten (Nachhaltigkeits-) Settings berücksichtigt werden. Sowohl NachhaltigkeitsnovizInnen als auch -expertInnen sind regelmäßig gefordert, in Teams zu arbeiten und mit Stakeholdern zu interagieren. Die Anwendung einer konfliktumarmenden und selbstreflektierenden Haltung ermöglicht es, mit den bei der Interaktion verschiedener Menschen auftretenden Unterschiedlichkeiten konstruktiv umzugehen, um gemeinsam an Nachhaltigkeitsproblemen und -visionen weiterzuarbeiten.

CONTEXT

1. Introduction

There are manifold crises facing humankind, from Covid-19, to the planetary boundaries that the activities of humankind have long since exceeded, leading to accelerating climate change and biodiversity losses that threaten the integrity and viability of the biosphere (Leal Filho et al., 2021; Rockström et al., 2009). In summary, planet Earth as a system is out of balance due to human (in-)action. I understand sustainability as 'yoga for the planet' – it is about finding, establishing, and maintaining the 'right balance'. What holds true for a comparatively small organism also holds true for a larger one. In other words, what is the case for a human body is also the case for the planet: If more is taken out than can be regenerated it will ultimately lead to depletion[3].

There are urgent sustainability challenges that call into question the very foundations of how we relate to self, to each other, and to the world at large (Evans, 2015; Ojala, 2016; Woiwode et al., 2021). Collective reflection and action, reflexivity, an understanding of 'interbeing' (Thích Nhất Hạnh, 2017) (i.e. the understanding that everything is interconnected; see also, e.g., Capra, 2009), as well as *collaboration* instead of competition need to be (re-)cultivated to avoid continued reproduction of the unhealthy patterns driving us into these deep socio-cultural, ecological, and economic crises (Barth, 2015; Caniglia et al., 2020; Dahm et al., 2019; Holmén, 2020; Jerneck & Olsson, 2020; Nelson & Cassell, 2012; Schor, 2012). The 17 *Sustainable Development Goals* (SDGs) that form the core of the *2030 Agenda for Sustainable Development* adopted by all United Nations Member States in the fall of 2015 (United Nations, 2015) are a step in this direction. The SDGs provide "a shared blueprint for peace and prosperity for people and the planet, now and into the future"[4]. SDG 4 suggests that *education* is one field where such (re-)cultivation can take place.

The current state of the world is the "greatest evidence of the need to transform education" (Cortese, 2003, p. 16). This calls for fundamental changes in the way we teach and learn, allowing for new ways of knowing, acting, and being in this world (Barth, 2015; Caniglia et al., 2018; John et al., 2017; Lotz-Sisitka et al., 2015; Ojala, 2016; Schor, 2012; UNESCO, 2015; Wilhelm et al., 2019). The focus can no longer be on 'how to do things better' (single-loop learning) nor on 'how to do things differently' (double-loop learning) (Argyris & Schön, 1996). What is particularly needed is what has become known as 'triple-loop learning', in which learners are encouraged to question and change the ways they look at things by focusing on the role of mindsets[5], i.e. our sets of attitudes (Barth, 2015; Frank, 2020; Göpel, 2016; Woiwode et al., 2021).

The *United Nations Educational, Scientific, and Cultural Organization* (UNESCO) is scaling up its efforts on this end. Based upon the Decade of *Education for Sustainable Development* (ESD), which lasted from 2005 to 2014 and was followed by the *Global Action Programme* (GAP) on ESD (2015 – 2019), a new framework, *ESD for 2030,* will be officially launched at the UNESCO World Conference on Education for Sustainable Development in May 2021. Promoting such things as the transformation of learning environments and capacity building for educators, it's overall vision is to "build a more just and sustainable world through strengthening ESD and contributing to the achievement of all 17 Sustainable Development Goals" (UNESCO, 2020, p. 54).

[3] For the importance of self-care see, e.g., Brundiers and Wiek (2017).

[4] United Nations, Department of Economic and Social Affairs, Sustainable Development: The 17 Goals: https://sdgs.un.org/goals [27.01.2021].

[5] Frank (2020) describes "mindsets for sustainability [as] mindsets that facilitate a constructive, pro-active posture toward the world, such as having a feeling of self-efficacy and a general positive attitude toward the future" (p. 40)

Higher Education Institutions (HEIs) are prime places for exploring and shaping future visions, and further, play a key role in educating future *change agents* (Barth et al., 2020; Barth, 2015; Holmén, 2020; Tejedor et al., 2019). Universities need to equip students with the competencies needed to provoke and guide sustainability transitions and transformations[6] (Hernández-Barco et al., 2020; Wiek, Withycombe, & Redman, 2011). This is particularly challenging because the future and, therefore, what precisely to educate 'for' is largely unknown (Barth, 2015; Budwig, 2015; Gulikers & Oonk, 2019).

Wiek, Withycombe, and Redman (2011) put forward an overarching *problem solving competence framework*, specifying key competencies needed for moving forward in sustainability research and practice (Wiek, Withycombe, Redman et al., 2011). One of the key competencies in sustainability the authors identify is *interpersonal* or *collaborative* competence (Wiek, Withycombe, & Redman, 2011; interpersonal competence from here onwards). Sustainability solutions, research and practice, transitions, and transformations depend upon group synergy (i.e., on individuals´ ability to collectively make use of their competencies in collaboration) (Dahm et al., 2019; Fam et al., 2019; Freeth & Caniglia, 2020; Gulikers & Oonk, 2019; Oxenswärdh & Persson-Fischier, 2020). Future change agents are key actors, often referred to as innovators, frontrunners, leaders, or entrepreneurs; but also as intermediaries or net weavers, capable of projecting themselves into the future and of developing strategic pathways towards an envisioned future state (Moriggi et al., 2020). Further, change agents need to be inspirational and able to support the creation of trust, the identification of common ground, and cooperation towards achieving shared visions (ibid.). Put differently, change agents need to be integrating, visionary, motivated and motivating, as well as able to collaborate with and engage stakeholders (Brundiers & Wiek, 2017; Molderez & Fonseca, 2018; Noble et al., 2017) to collectively explore solutions to the complex sustainability issues we are facing, and working towards a safe, just and regenerative society able to function within planetary boundaries (Caniglia et al., 2020; Raworth, 2012; Rockström et al., 2009).

A paradigm shift in education on several levels is required (Barth, 2015; Cortese, 2003) – at the institutional level (Weiss et al., in review); the curriculum level (Birdman, 2020); and, last but not least, at the course level. This thesis focuses on the micro-level of individual course offerings (i.e. the course-level). Transmissive ways of teaching, in which students are perceived as "empty vessels" to be filled[7] (Tilbury, 2016, p. 276) denies students the opportunity to test themselves in practice and demonstrate to themselves what they are capable of: Exactly such opportunities are encountered in project-based learning settings (Kolb & Kolb, 2005; Heiskanen et al., 2016; Holmén, 2020; Tilbury, 2016). While instructor inputs (e.g., lectures) have their place in these settings; when used exclusively, they fall short in effectively educating future change agents.

Therefore, various universities have integrated innovative teaching and learning approaches such as *project-based learning* (Birdman et al., in review; Brundiers & Wiek, 2013; Wiek et al., 2014) into their courses to foster the development of key competencies in sustainability, including interpersonal competence (Earl et al., 2018; Oxenswärdh & Persson-Fischier, 2020). There is growing evidence that project-based sustainability courses are conducive to developing several key competencies, and interpersonal competence in particular (Molderez & Fonseca, 2018; Roy et al., 2020; Savage et al.,

6 Moriggi et al. (2020) refers to transitions as "gradual long-lasting processes, with a final aim of making the current systems of production and consumption more sustainable" while the "common denominator within the transformations literature is the idea that transformations are fundamental changes, opposed to minor, marginal or incremental ones".

7 Something Freire (2007) referred to as the *banking model of education*.

2015; Skinner et al., 2016; Soini et al., 2019). This is attributed to the idea that being engaged in an authentic situation around a challenging real-world problem requires a move from being passive to being active; thus, sparking motivation through meaning (Barth, 2015; Steinemann, 2003).

While there is an increasing number of publications *on* innovative teaching and learning approaches, including those that point to interpersonal competence as one of the key competencies in sustainability; there is still a lack of further research *into* these approaches (Earl et al., 2018). What is missing, and what this thesis, therefore, contributes is an evidence-based and theoretically informed explanation of *how* certain teaching and learning processes and environments actually facilitate interpersonal competence development. If project-based sustainability courses are to be improved and replicated around the world as a way to educate interpersonally competent change agents, solid insights into these teaching and learning processes and environments that help explain interpersonal learning outcomes, are needed (Barth, 2015; Clevenger & Ozbek, 2013; Remington-Doucette et al., 2013).

Correspondingly, I conducted a *comparative* case study (Yin, 1984) on three different project-based sustainability graduate courses at four higher education institutions in the U.S., Germany, Switzerland, and Spain to derive representative and *generalizable* insights on students´ interpersonal competence development. Further, a range of methods and perspectives were triangulated to generate a more comprehensive understanding of the process of interpersonal competence development in course participants. In other words: I embarked on an experiential journey during which I accompanied 'caterpillars' on their way to becoming 'butterflies', able to pollinate and instigate change after having undergone a personal transformation (i.e. a learning process) themselves (Paulus, 1972; Macintyre, 2019). Gathering and analyzing empirical evidence of how such learning actually takes place, and discussing these findings in relation to prominent teaching and learning theories can provide a foundation to support the design and implementation of project-based learning settings that aim to foster interpersonal competence development.

Vision 1: Taking the reader by the hand

Based on the *context* outlined in Chapter 1, Chapter 2 presents the *causal conditions* of this thesis (figure 1, (2)). These encompass both a literature-based outline of the conceptual and empirical foundations on which the research is based, and the research and knowledge gaps identified through this review that this thesis aims to fill. Continuing with the *intervening conditions* (figure 1 (3)), in Chapter 3 both the onto-epistemological and the theoretical foundations are made transparent, thus presenting the lens through which the research findings are discussed. Chapter 4 sheds light on research design and implementation, revealing my methodological foundations, i.e. the *strategy* applied. This leads ultimately to the outcomes, or *consequences,* of this dissertation. Among these are the research findings (5.), their discussion (6.), before contributions within and beyond sustainability higher education are spelled out (7.). Conclusions (8.) are followed by the limitations of this research, and critical reflections on the methods used and the role of the researcher (9.). This dissertation closes with an outlook (10.) on potential future research areas, and shares preliminary visualizations as 'food for thought' (appendices); thus, inviting readers to further ponder and explore the topic themselves.

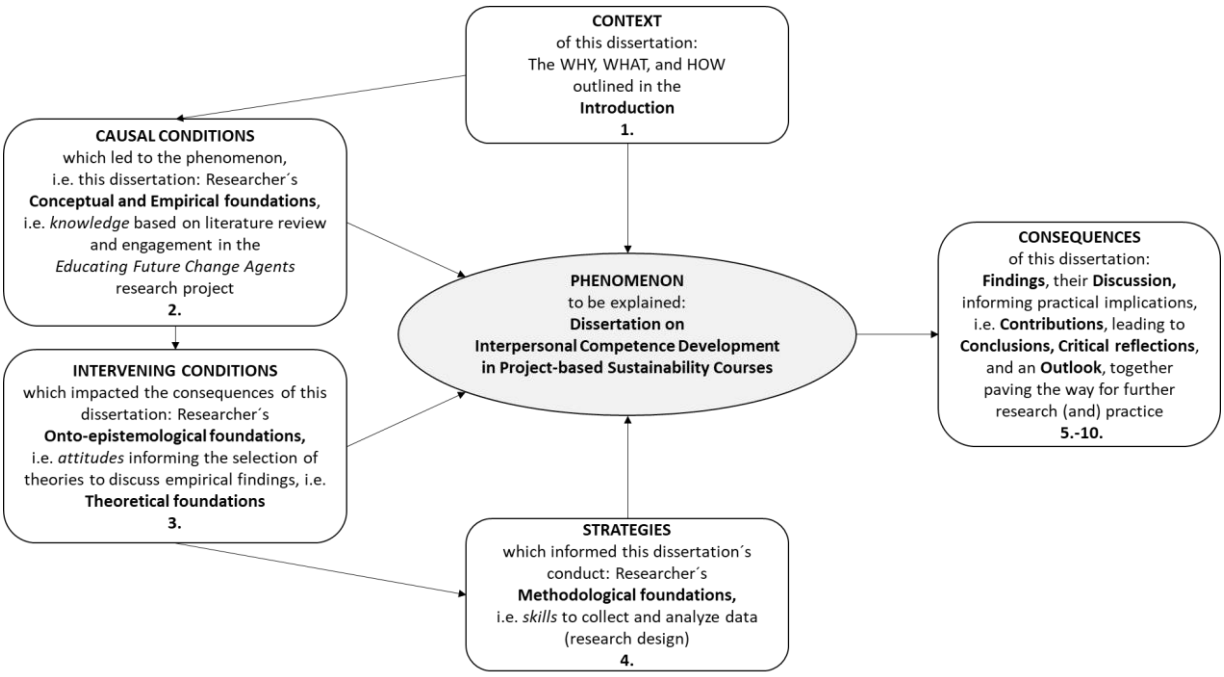


Figure 1: Graphic representation of the table of contents of this dissertation, drawing on Corbin and Strauss (1990) Coding Paradigm.

CAUSAL CONDITIONS

2. Background

Sustainability Science has emerged out of the necessity to understand the complex problems of our time holistically, and to find answers to how we, as a society, can live in a way that meets our current needs, but also allows future generations to live decent lives in which their needs are also met (United Nations General Assembly, 1987; Kates et al., 2001)[8]. In its broadest sense, sustainability science "can be understood as a field of research that points the way towards a sustainable society and, on a global level, pays equal attention to how social change shapes the environment and how environmental change in turn shapes society" (Barth, 2015, p. 16). *Sustainability Higher Education* has come into being because higher education institutions (HEIs) are a crucial leverage point for moving in this direction (Sachs et al., 2019) by providing students the tools to understand systems in their complexity, anticipate future scenarios, create desirable and informed future visions, and start strategic, collaborative actions that are guided by human values (Wiek, Withycombe, & Redman, 2011; Wiek, Withycombe, Redman et al., 2011). *Education for Sustainable Development* (ESD), a term referred to by, e.g., the United Nations, encompasses educational reforms which are, overall, based on an interconnected view of the environmental, economic and social spheres (Barth, 2015; UNESCO, 2017). ESD promotes the creation of learning environments and pedagogies that are interactive and participatory, learner-centered and action-oriented, that foster self-directed, collaborative learning in inter- and transdisciplinary contexts, empower people with key competencies in sustainability, and enable them to envision, co-create, and engage in the discourse of a sustainable future (Cebrián et al., 2020; Frank, 2020; Holmén, 2020; UNESCO, 2020). Tikly et al. (2020) defined ESD as

> "access to a good quality education for all that can facilitate existing and future generations of learners across the lifespan, in formal and informal settings, to realise the rights, freedoms and capabilities they require to live the lives they have reason to value and to protect and co-evolve in a more harmonious relationship with the natural environment of which human beings are an integral part so that natural and social systems may flourish" (p. 21).

The *Educating Future Change Agents*-research project (EFCA), a joint endeavor between Arizona State University (USA) and Leuphana University of Lüneburg (Germany), dedicated several years of investigation into observing, analyzing, assessing, questioning, reflecting, and discussing the potential for universities to serve as motors of the sustainability transformation on different levels. The world is in urgent need of *agents of change*. My task and goal in the research presented here, which was embedded within EFCA, was to investigate *how* (2.1.3.) they can best be supported to develop interpersonal competence (2.1.2.), as one of the key competencies in sustainability (2.1.1.).

The following sections are intended to move the reader towards the understanding of this dissertation´s causal conditions. These encompass the conceptual and empirical foundations that instigated this thesis in the first place. Insights into the discourse of interpersonal competence development in project-based sustainability courses demonstrate the gaps which I set out to fill.

8 For a broader discussion of Sustainability Science, see Heinrichs et al. (2016).

Vision 2: Transparency

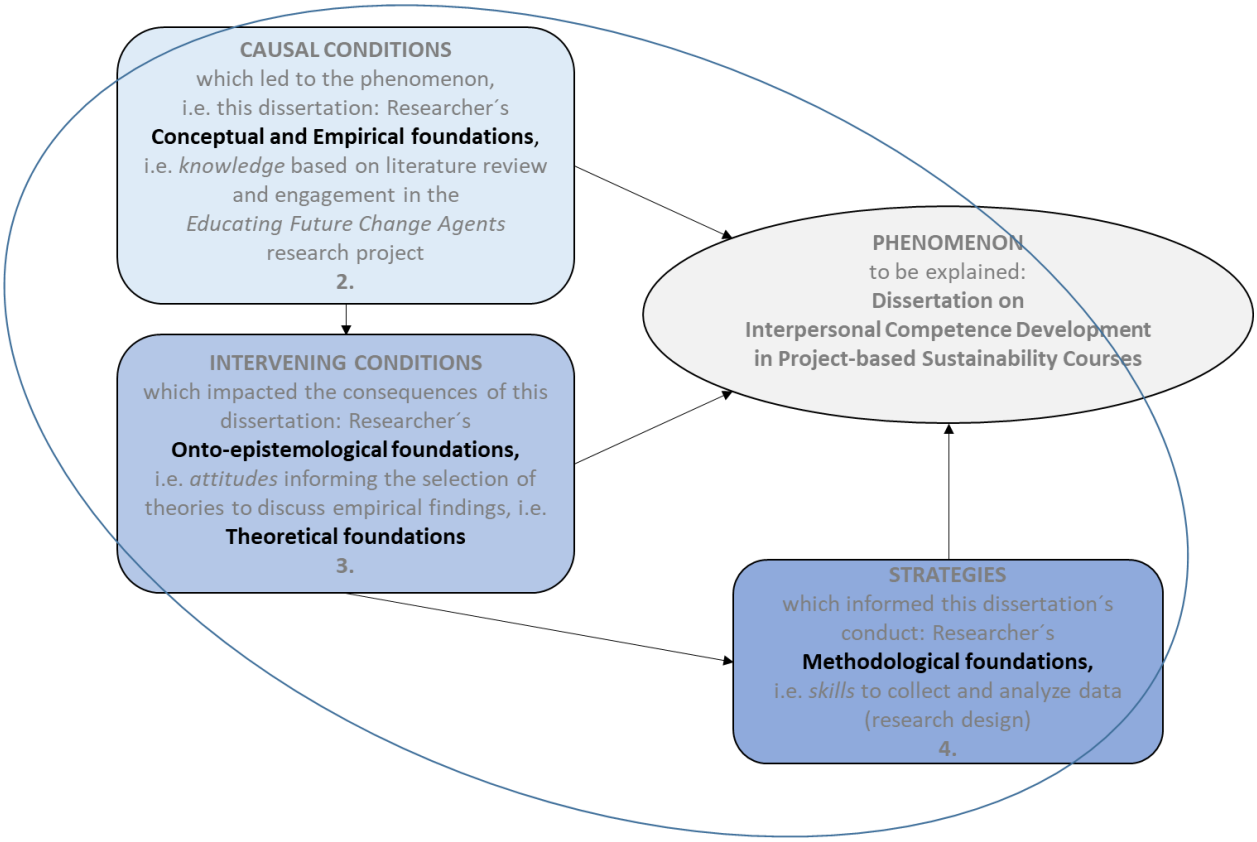


Figure 2: Foundations of present research. Conceptual, empirical, onto-epistemological, theoretical, and methodological foundations are outlined to provide for transparency in terms of why and how this research was conducted (source: author´s elaboration).

2.1. Conceptual foundations

2.1.1. Key competencies in sustainability

Sustainability change agents are needed to initiate, push forward, and lead sustainability transitions and transformations (Giangrande et al., 2019; Wiek et al., 2015). Several scholars have formulated descriptions of the qualities of change agents using different terms and categorizations (Haan, 2010; Rieckmann, 2012; Thomas & Day, 2014). However, each of these different descriptions contains a reference to the ability to solve problems and to take and shape actions (Brundiers et al., 2020; Wilhelm et al., 2019).

Key competencies in sustainability are defined as functionally linked "complexes of knowledge, skills, and attitudes that enable successful task performance and problem solving *with respect to real-world sustainability problems, challenges, and opportunities*" (Wiek, Withycombe, & Redman, 2011, p. 204). *Knowledge* refers to the theoretical, cognitive background and mental models a person has, while *skills* are the methodological repertoire from which a given individual can draw, and *attitudes* can be understood as the values that guide one´s behavior (i.e., actions) (Dlouhá et al., 2019). More recently, a *framework* of key competencies was defined as a

> "minimal set of distinct (non-overlapping), yet functionally interrelated key competencies, which are synthesized into an integrated perspective. This integrated set facilitates achieving successful performance and a positive outcome that progresses sustainability, while working on a specific sustainability challenge in its context and a range of contexts." (Brundiers et al., 2020, Table 2)

Applied to sustainability higher education, this framework can serve as a reference for both academic programs as a whole, and for individual course development and evaluation (Barth, 2015; Wiek, Withycombe, & Redman, 2011). Focusing on the course level, in contrast to learning objectives emphasizing the knowledge domain, key competencies in sustainability reveal themselves in practice, where students bring to the surface was lies within them. This sort of key competence development requires opportunities to perform which are an inherent element in a practice-oriented course format (Barth, 2015; Brundiers et al., 2020). Mitchell et al. (2020) therefore refer to competence as

> "an outcome of a relationship-in-action. It emerges in a particular situation where that capacity is needed and is triggered by a combination of the task at hand, the other humans (and non-humans for that matter) as well as materials that affect the situation, and the qualities and capabilities a person brings to the situation" (p. 4).

Key competencies in sustainability are content-independent, therefore spanning traditional disciplinary boundaries (Redman, 2020). They can be understood as a resource continuously growing over one´s life span (Barth, 2015). Key competencies in sustainability are, further, based upon basic academic competencies such as critical thinking, communication, and research; therefore these are not further elaborated on within the key competencies in sustainability framework (Brundiers et al., 2020; Wiek, Withycombe, & Redman, 2011).

This dissertation refers to Wiek, Withycombe, and Redman´s (2011) *framework*, as it has received broad resonance in sustainability higher education. It is not only the most frequently cited framework to date (Brundiers et al., 2020; Evans, 2019), but has been described as the "best we can do with our available knowledge" (Redman, 2020, p. 64). Wiek, Withycombe, and Redman´s (2011) framework is the result of a thorough literature review and synthesis of sustainability research and

problem-solving competencies. Since its development, the framework has been used to inform efforts in ESD (UNESCO, 2016; UNESCO, 2017), including the design of program and courses (Redman, 2020) such as the courses investigated in this dissertation (see Chapter 4 and Appendix 1). In addition to interpersonal or collaborative competence, the framework encompasses competencies in systems-, futures-, values-, and strategic-thinking. In combination, they constitute *problem-solving* competence, as reflected in the name - *sustainability research and problem-solving framework*.[9]

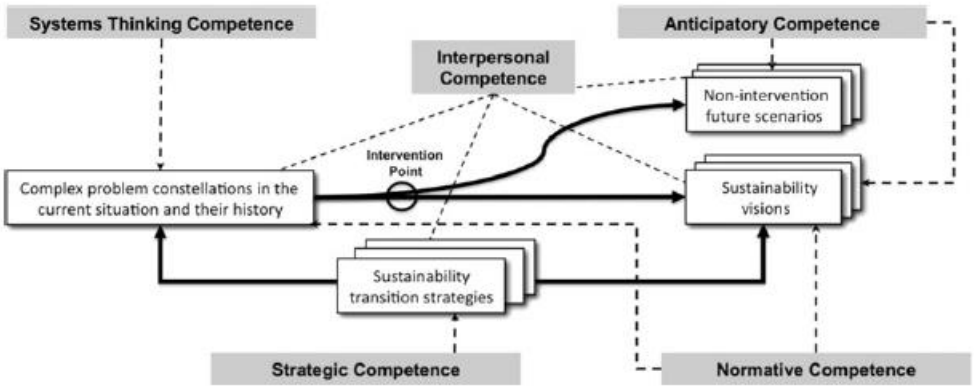


Figure 3: Sustainability research and problem-solving framework by Wiek, Withycombe, and Redman (2011, p. 206).

Despite its wide usage, the authors of this framework neither claim it to be complete nor set in stone. Savage et al. (2015), for instance, emphasize the importance of *intra*personal competence, which eventually found entrance into Brundiers and Wiek´s (2017) set of *professional skills*, looking beyond interpersonal competence[10]. More recently, Brundiers et al. (2020) derived additional competencies from research using a Delphi process, and Redman (2020) from a literature review. Integration and implementation competence are suggested to complement the key competencies in sustainability framework with more hands-on competencies (Brundiers et al., 2020; Redman, 2020).

Although Barth (2015) argues that education always has a purpose, due to the term ESD – Education *for* Sustainable Development – there is controversy about competence-orientation as such. ESD risks being criticized as instrumental, despite its focus on instrinsic motivation, and aims of moving towards education *as* sustainability (Holmén, 2020). According to Barth (2015) ESD should "offer opportunities to engage with the underlying values of sustainability and to support the learner´s critical reflection on them" (p. 61). At the other end of the spectrum, what have been referred to as emancipatory approaches, have also been criticized for focusing on the autonomous individual guided by their 'free will' which is seen as an "insufficient response to the challenges humankind is facing" (Barth, 2015, p. 60). No matter where in the spectrum a given approach is located, Barth (2015) claims:

> "These approaches all have a common struggle to acknowledge the individual as an autonomous learner in their own right and the quest to respond to urgent social challenges. Indeed, both sides have important arguments in their favour. (…) sustainable development will not take place if significant action is not taken, and this action is more urgent now than

9 Although Brundiers et al. (2020) with the most recent article on key competencies in sustainability write "competency", I am sticking to the version "competence" for consistency with the articles published within this dissertation.

10 Brundiers and Wiek (2017) professional skills encompass next to preventative self-care, effective and compassionate communication, responsive project management, advanced continuous learning, as well as the interpersonal competence facets collaborative teamwork and impactful stakeholder engagement which are in focus of this research.

ever before. At the same time, we neither can nor should prescribe specific activities for the individual as these limit their capacity to manage change and do not respond adequately to the complexity and uncertainty of future developments."[11] (p.60)

In fact, Papenfuss et al. (2019) provided a matrix outlining instrumental as well as transformative, emancipatory pedagogies, suggesting that they are not necessarily mutually exclusive. In any case, most authors agree that competencies cannot simply be taught (Singer-Brodowski, 2016). Instead, competencies require opportunities to let them come to the forefront, i.e. letting people enact their attitudes, knowledge, and skills in practice (Mitchell et al., 2020; Wilhelm et al., 2019). This need for hands-on experience is what makes project-based sustainability courses a promising format for fostering the development of key competencies in sustainability, particularly interpersonal competence.

2.1.2. Interpersonal competence

Interpersonal competence is literally seen as key in solving sustainability problems, as it underpins each step in the process of solving sustainability problems (Schaltegger et al., 2016; Wiek, Withycombe, & Redman, 2011; see figure 3). It is cross-cutting and linked "to all other competencies, as all rely on collaborative approaches to create ownership for the (intermediate) results, to leverage implementation, and to build joint capacity to cope with complex sustainability challenges." (Wiek, Withycombe, & Redman, 2011, p. 211).

Interpersonal competence is defined as "the ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving", and further includes the "capacity to understand, embrace, and facilitate diversity across cultures, social groups, communities, and individuals" (Wiek, Withycombe, & Redman, 2011, p. 211). It can be further broken down into collaborative teamwork and impactful stakeholder engagement. Collaborative teamwork can be described as "the process when people engage in utilizing different and complementary types of expertise, skills, and attitudes to complete a task", resulting in "high-quality task delivery (task effectiveness) by co-creating a stimulating and healthy work environment (social process effectiveness)" (Brundiers & Wiek, 2017, p. 5). Impactful stakeholder engagement can be understood as "the collaboration between sustainability professionals and people who have a stake in the process and outcomes of a given project" that engages "diverse stakeholders from government, businesses, and civil society" and aims "to yield task outcomes like quality project deliverables that have been informed by a plurality of views and are broadly accepted, as well as social outcomes including new perspectives, relationships and built capacity" (Brundiers & Wiek, 2017, p. 6). In short, interpersonal competence refers to the degree to which a person is able to interact with others in fruitful ways. Recently, interpersonal competence was further described as the ability to "apply the concepts and methods of each competency not merely as 'technical skills,' but in ways that truly engage and motivate diverse stakeholders […] and to empathically work with collaborators' and citizens' different ways of knowing and communication" (Brundiers et al., 2020, see specific learning objectives).

What distinguishes this understanding of interpersonal competence as one of the key competencies in *sustainability* (based on Wiek, Withycombe, & Redman, 2011) from other notions of interpersonal

11 Responses to this either/or debate have been delivered by Vare and Scott (2007), for instance, suggesting that it needs two types of learning: ESD 1 and ESD 2.

competence (see e.g. Buhrmester et al., 1988), is the role of stakeholders (Brundiers et al., 2020). As each of the definitions listed above suggest, interpersonal competence is essential for change agents, as sustainability transitions and transformations cannot be achieved by individuals acting alone, but only by those who understand and know how to join forces with others, to work together and engage the people who have a stake in the respective undertaking (Gulikers & Oonk, 2019). Within sustainability science (Fam et al., 2019; Freeth, 2019) as well as in other sustainability professions (see e.g. Kricsfalusy et al., 2018; Oxenswärdh & Persson-Fischier, 2020; Terrón-López et al., 2020), being interpersonally competent is an important requirement. However, in practice, research shows there is still much room for improvement (Caniglia et al., 2020; Freeth, 2019). Current courses informed by the solving-sustainability-problems framework pay attention to the development of students´ interpersonal competence by designing courses accordingly.

2.1.3. Project-based learning

To provide an understanding of project-based learning sustainability courses, Birdman et al. (in review) synthesized criteria that characterize the teaching and learning processes and environments they provide. First, in terms of **teaching and learning processes**, students work in self-regulating teams. Project-based learning shifts student learning from passive to active, making them protagonists in their own learning processes; as ideally, actual solutions to real-world sustainability problems are to be developed in such course formats (Tejedor et al., 2019). This is accomplished by students working, i.e. collaborating and cooperating in multi-disciplinary teams in an autonomous way while engaging with externals (stakeholders, experts), with instructors performing the roles of coach and facilitator (Brundiers et al., 2010; Brundiers & Wiek, 2013; Budwig, 2015; Helle et al., 2006; Holmén, 2020; Segalàs & Tejedor, 2016; Soini et al., 2019; Stauffacher et al., 2006; Wiek & Kay, 2015). This process is expected to foster students´ competence development, provided that, to some degree, they are owners of the project. Second, in terms of the **teaching and learning environments**, project-based learning is situated learning, i.e. the learning takes place around the issue students are working on. Having defined targets and set timelines, while working on an ill-defined problems, supports the learning process in project-based sustainability courses, as it provides orientation and guidance (Birdman et al., in review; Blumenfeld et al., 1991; DeFillippi, 2001; Stauffacher et al., 2006). To further support the goal of increasing student competence levels so that they become competent sustainability problem solvers, real stakeholders should be potential beneficiaries of student outputs in project-based sustainability courses (Brundiers et al., 2010; Helle et al., 2006).

Project-based learning and competence development

There is agreement that conventional teaching and learning approaches, such as lectures in classrooms, are insufficient for fostering key competencies in sustainability (Barth, 2015; Hardin et al., 2016). Competence development requires touching upon the existing knowledge base, skill repertoire, and worldviews, and being made to re-evaluate those, e.g. through emotion-triggering experiences (Dlouhá et al., 2019; Ojala, 2017). Real-world learning opportunities, often organized through applied projects, provide students with experiences (such as professional interaction with external stakeholders) that classroom lectures cannot offer (Wiek, Withycombe, & Redman, 2011). This dissertation started from the premise that "[r]eal-world learning opportunities provide students with competencies that cannot be taught in a classroom, because real-world situations include different kinds of challenges, communication styles, deadlines, politics, and so forth" (Wiek, Withycombe, Redman et al., 2011, p. 11).

Conducting a project-based sustainability course requires several steps. First of all, it requires a phase of pre-structuring. A faculty-stakeholder network should be established prior to course start. At the beginning of the course, orienting and framing the research requires exchange between faculty, students, and stakeholders about the real-world problem at hand. These exchanges pave the way for students to conduct research in collaboration with one another, supported by faculty and engaged with stakeholders. Research on implementation is outlined as the final step of project-based sustainability courses (see (Brundiers & Wiek, 2013, p. 1731). Criteria based upon these phases informed the case selection process for the research presented in this thesis, (see Chapter 4 and Appendix 1]. Whether such a (re-)design of courses actually leads to the intended learning outcomes, and students finish courses with a higher level of interpersonal competence, has not been investigated sufficiently to date. This makes the study of this key competence, and how it can (best) be developed, a valuable and necessary undertaking. The next section presents previous relevant research and outlines remaining gaps this thesis aims to fill.

2.2. Empirical foundations

Interpersonal competence development in project-based learning sustainability courses

A review of the literature reveals that several project-based sustainability courses, both at the graduate and undergraduate levels, have already been investigated in recent years to analyze their impact on student learning.[12] Interpersonal attitudes, knowledge, and/or skills were among the learning outcomes identified, mostly based on student self-assessments (Clevenger & Ozbek, 2013; Heiskanen et al., 2016; Kricsfalusy et al., 2018; Molderez & Fonseca, 2018; Müller et al., 2020; Savage et al., 2015; Singer-Brodowski, 2016; Soini et al., 2019). Roy et al. (2020) for instance, found that leadership and communication skills were developed through peer and stakeholder collaborations combined with discussion and intrapersonal reflection. Similarly, Soini et al. (2019) stated that students´ ability to position their own perspective in relation to others and communicate across different cultural and academic backgrounds is facilitated through project experience and reflection overall. Few attempts have been made to specifically link learning outcomes, processes, and environments (Lozano et al., 2017). However, studies by Hilser (2016) and Zemler (2016) empirically identified learning activities that contribute to interpersonal competence development, such as team building, networking, presentations, and project fairs (Hilser, 2016). Based on a single case study, Oxenswärdh and Persson-Fischier (2020) contributed a more differentiated view of interpersonal competence, which broke it down into affective, cognitive, and behavioral interpersonal skills, and highlighted the factor 'time' as important for such development to occur.

While previous research has shown that project-based sustainability courses are conducive to interpersonal competence development and other key competencies, most of these findings have been largely *descriptive* in nature and based on *single* case studies (Barth & Rieckmann, 2016; Barth & Thomas, 2012; Helle et al., 2006). Further, research so far focused on learning outcomes, partially links them to course activities (e.g. Hilser, 2016), while not *explaining* the underlying learning processes and environments (Backman et al., 2019; Lozano et al., 2019; Meza Rios et al., 2018; Molderez & Fonseca, 2018; Müller et al., 2020). This lack of connections and understanding, i.e. the *missing pedagogical foundation for key competence development*, is an impediment to the professional development of university instructors in this regard, leaving key competence

[12] This section draws strongly upon the literature review undertaken for and published in the second paper of this cumulative thesis (see further 5.2.).

development a challenge, amongst others, at the course-level (Ayers, 2020; Brandt, 2021; Brundiers et al., 2020; Dlouhá et al., 2019; Wilhelm et al., 2019). Most studies focus either on instructor/faculty *or* student perspectives (Backman et al., 2019). Research triangulating various methods as well as perspectives of course participants is lacking (Brundiers et al., 2020; Brundiers & Wiek, 2013; Soini et al., 2019). In addition to the need for such research to draw on several perspectives, Budwig (2015) asserts that the role certain actors play in student learning processes deserves more attention. Delving into student interactions with typical project-based sustainability course participants can reveal whether, and if so, how scaffolding (see 3.2.) supports students´ interpersonal competence development.

While project-based learning, as such, is not a new concept in general (Blumenfeld et al., 1991; DeFillippi, 2001), or within the realm of sustainability education (see e.g. Barth & Michelsen, 2013; Birdman et al., in review; Brundiers et al., 2010; Brundiers & Wiek, 2013; Evans, 2019; Stauffacher et al., 2006; Wiek et al., 2014; Wiek & Kay, 2015), it is still labeled as innovative, as it is far from being the most prominent way of teaching (Gulikers & Oonk, 2019). There is already evidence that project-based sustainability courses foster competence development, including interpersonal competence. What is still missing, though, are explanations – drawn from comparable cases and including several perspectives – of *why* this is the case (i.e. *how* project-based sustainability courses can lead to interpersonal competence development). Here lies the focus and contribution of the present dissertation: **How and why project-based sustainability courses can turn into a generative field[13] to allow students to discover, enact, explore, and (further) develop their interpersonal competence facets and domains**, supported by empirical evidence and backed-up with teaching and learning theories.

13 The *Center for Systems Awareness* has started the *Generative Social Fields Initiative* as "a collective effort to deepen our understanding of the relational spaces in which we all live and how shifts in these spaces can lead to the transformation of individuals, families, and organizations" (see further: https://www.systemsawareness.org/project-category/generative-social-fields-initiative/; 27.01.2021).

INTERVENING CONDITIONS

3. Perspectives

Continuing in line with Corbin and Strauss´s (1990) Grounded Theory Coding Paradigm to guide the reader through this thesis (figure 1), the intervening conditions are presented below. They inform the strategies used in undertaking this research (Chapter 4), and serve to further explain how a certain phenomenon leads to particular consequences. In other words, my onto-epistemological foundations are outlined here. In addition, particular teaching and learning theories are introduced which will later be used in discussing the empirical findings (see theoretical foundations, 3.2., in terms of teaching learning theories).

3.1. Onto-epistemological foundations

The onto-epistemological departure point for this thesis is that of social contructivism in which learning is understood as the social process of meaning making undertaken by each individual on their own terms (Backman et al., 2019). Knowledge is, therefore, not gained, but rather, created based on (prior) experiences (see e.g. Kolb & Kolb, 2005), and further co-constructed in interaction with the surrounding environment (Budwig, 2015). Therefore, my cultural and academic background, my privileges, gender, age, class, abilities, rank, etc., and experiences at their intersection, are the tacit foundation for new experiences, such as those made in, through, and during this research[14]. Frank (2020) writes "that scientific inquiry always reflects something about ourselves" (p. 85). As I understand doing research as engaging in a learning process myself, it was clear to me that undertaking this research had the potential to lead to transformation on the personal, i.e. researcher level, too. As Horlings et al. (2020) write:

> "Self-transformation happens by engaging with critical theories related to sustainability and transformations (head), by reflecting upon one's own normative position as a researcher (heart), by experimenting with methods grounded on one's own values (hands) and by engaging in places as a human being open to developing response-ability (feet)." (p. 480)

As a researcher, and more precisely as a sustainability scientist with roots in anthropology, I have an affinity for human diversity and life on Earth. As Moriggi et al. (2020) point out, drawing on the ethics of care, "the way we address sustainability and change as scientists and decision-makers cannot be morally neutral" (p. 12). In this sense, what Barth (2015) claims for the context of education (with reference to students and teachers), holds true in the present context, too (with reference to readers and the author): "students are continually exposed to filtered experiences through their teachers (…) which means that education can never be a completely neutral process" (Barth 2015, p. 60).

By being open about my personal worldview, in terms of my onto-epistemology, and by introducing the theories I used as lenses to discuss my empirical findings, I strive to adhere to the scientific standard of transparency, and provide the basis for open discussion of potential limitations and biases of this research. A critical reflection on my role as a researcher can further be found in Chapter 9.

Although my background is not in educational sciences, with this thesis I set out to provide a theoretical grounding for interpersonal competence development in project-based learning settings. As Budwig (2015) states "[l]earning scientists can contribute to a more nuanced understanding of

[14] Gaia Education (2017/2018) offers support to uncover one´s privileges.

transformative learning and in particular ways to deepen sustainability science goals of building ecosystems that build the transformative social learning necessary for sustainable futures" (p. 99). Therefore, in the following section, I introduce selected teaching and learning theories with the aim of establishing a shared language to allow the reader to better understand the discussion of the empirical findings of this research.

3.2. Theoretical foundations[15]

Several theories that lend themselves to the discussion of my research findings are introduced here. Presenting these as *intervening conditions* suggests that, in socio-constructivist terms, consequences outlined later are linked to these theories.

One theory several scholars refer to when investigating project-based learning sustainability courses is ***experiential learning theory***, which is based upon the work of several scholars, such as Freire, Jung, Dewey, Piaget, Vigotsky, and Lewin (Kolb & Kolb, 2012). Experiential learning theory sees experience as the foundation for learning. Building upon this foundation, Kolb and Kolb (2005) describe a learning cycle as follows: A *concrete experience* is followed by *reflective observation*, *abstract conceptualization*, and *active experimentation*. While experiencing and abstracting allow an individual *to grasp an experience*, reflective observation and active experimentation allow that individual *to transform an experience*, leading to new insights, or more simply, to learning. Learning, understood as the creation of knowledge through transformation of experience (Kolb & Kolb, 2005), entails moments of perceiving (divergence), understanding (assimilation), planning (convergence), and acting (accommodation) (Bawden, 2010).

The learning circle starts with the moment when someone perceives something that is different (or diverges) from what was known before, and the need arises to reconcile the new information with the existing knowledge base, skill repertoire, and mindsets (Bawden, 2010; Kolb & Kolb, 2005). Learning is understood as occurring "through the course of connected experiences" (Kolb & Kolb, 2012, 1216). A learning cycle simultaneously 'concludes' and 'restarts' with the transfer of knowledge into practice, or by applying one´s competencies in "authentic situations calling for unscripted solutions" (Budwig, 2015, p. 100). What makes this theory particularly suitable for the present investigation are several of its propositions. First, that learning is *process*- instead of outcome-focused. As stated earlier, the 'how', or process of interpersonal competence development has yet to be fully explored, while ample previous studies have reported on interpersonal learning outcomes. Second, the constructivist perspective that *all learning is re-learning* and thus, builds upon prior held mental models. Third, its focus lies on *interaction* between person and environment as well as the notion of *conflicts* (disagreements, differences) as drivers of learning (Kolb & Kolb, 2005). According to Kolb and Kolb (2005), "learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world" (p. 194). This can refer to inner or outer conflicts (see further 5.1.).

Linking to the notion of conflict, the concept of ***cognitive dissonance*** (Festinger, 1957) is also based upon such an experience of tension between what has been and what is. It requires the development of strategies of decreasing psychological discomfort (what are referred to as inner conflicts in paper 1, see 5.1.). Humans strive for consonance, or in other words, harmony and for (inner) 'balance'. If something is encountered that creates the opposite, i.e. dissonance, humans are motivated to

[15] Theoretical foundations refer to teaching and learning theories. Conceptual foundations are, of course, also part of my theoretical `backpack` in this research.

overcome this feeling. To do so, different strategies can be applied, not all of which necessarily lead to learning. Instead of deeply reflecting upon one´s feelings and thus, going to the root causes, uncomfortable feelings could instead be rationalized away or repressed (Frank, 2020). Also, defensiveness and resistance can be the reactions if, for instance in the present context of sustainability education, students feel pushed too far out of their comfort zones (Ettling, 2012).

In this dissertation, the term **'conflict'** was applied as an overarching category to describe feelings of inner and outer tension, or dissonance. An inner tension, for instance, occurs when an individual encounters a situation to which their current worldview is unable or unequipped to properly respond. An outer tension refers to tensions between two or more people, and is linked to inner tensions, as tension usually occurs where there are discrepancies between worldviews. As Illeris (2003) states, "all learning implies the integration of two very different processes, namely an external interaction process between the learner and their social, cultural or material environment, and an internal psychological process of acquisition and elaboration" (p. 398). In line with cognitive dissonance theory (Festinger, 1957) "[c]onflicts have the potential for producing both highly constructive or highly destructive outcomes, depending on how they are managed" (Johnson & Johnson, 1979, pp. 51–52). No matter whether it occurs on the individual level of the learner, at the group, or the societal level, wherever there is conflict there is the need to learn how to 'sit in the fire' (Mindell, 1995/2014), i.e. to constructively deal with it, to derive the learning opportunities conflicts offer. Several scholars highlight the role of instructors[16] in teaching students how to leverage feelings of discomfort, dissonance, or tension to support (transformative) learning (Ojala, 2016; Vare et al., 2019).

A theory which is focused on processes to be undertaken on the instructor side, is ***cognitive apprenticeship*** (Collins et al., 1987). *Modelling* is the process by which students are shown what it is to be learned first, allowing them to create a *mental model* or *cognitive map* of the task at hand – having a vision or clear goal – to further guide their learning journey (see also Budwig, 2015). With this initial stage of learning by observation and reflection, cognitive apprenticeship is claimed by some to be the most natural way humans learn, by bringing "tacit processes into the open, where students can observe, enact, and practice them with help from the teacher and from other students" (Collins et al., 1987, p. 6). *Scaffolding*, i.e. the instructor carrying out tasks the students cannot yet manage, and thus, supporting the construction of student competence step-by-step until the entire responsibility for managing a particular task lies with the student (Budwig, 2015; Holmén, 2020; van de Pol et al., 2010), highlights the cooperative problem-solving character of cognitive apprenticeship. The student-instructor relationship is, therefore, in flux. As the goal is the learner´s independent task performance, it is required that at some point, with the help of *scaffolding* and *coaching*, the teacher becomes obsolete, or *fades*. From this point on, students should be able to explore and approach a problem on their own, i.e. their exploration being the culmination of the fading of supports (Collins et al., 1987). As in experiential learning, cognitive apprenticeship can also be an effective means of supporting students (to learn to) constructively deal with conflicts, i.e. to overcome dissonance in ways that lead to learning.

Another theory, ***staged self-directed learning*** (Ryan & Deci, 2000), also focuses on the student-instructor relationship, describing the shifting role of students and instructors along the learning process. Key in both cognitive apprenticeship and staged self-directed learning is the delicate process of the instructor moving more and more into the background to enable students to flourish and

[16] In a different context they might be called leaders, frontrunners, or role models.

become independent task performers. As Ettling (2012) wrote, while learning rests with the learner "educators […] hold the process in [their] hands and can never take lightly the responsibility that entails" (p. 543).

With this brief elaboration of theoretical foundations of learning theory, upon which the three articles of this cumulative thesis mostly draw, I aim to fill the missing piece of theoretical support of empirical evidence of key competence development in project-based sustainability courses.

STRATEGIES

4. Methodological foundations

This doctoral research project was based on the question ***"How do students develop interpersonal competence, as one of the key competencies in sustainability, in project-based sustainability courses?"*** As outlined in the state of research (2.2.), there is still a lack of comparative, explanatory case studies (Barth & Rieckmann, 2016) that focus on the link between teaching and learning outcomes (such as key competencies in sustainability), teaching and learning processes, and teaching and learning environments (Lozano et al., 2019), seen from various perspectives (Backman et al., 2019) (table 1). With the research presented here, I aim to close these gaps by providing empirically informed insights into interpersonal competence development in project-based learning settings.

To do so, I combine the descriptive-analytical and the transformative, practical solution-oriented modes of sustainability science (Wiek et al., 2012) by providing practical implications based on a qualitative, comparative case study. I conducted this research following a **Grounded Theory-inspired multi-method, comparative, multi-case study approach** (Yin, 1984) in which I triangulate multiple perspectives on learning outcomes, processes, and environments. The research design is elaborated in the chapter that follows (4.1.). After the concrete units of analysis have been introduced (4.1.1.), triangulated methods are presented (4.1.2.), before the data analysis procedure is made transparent (4.2.). Figures and tables provide quick overviews of the methods applied and the investigated units. A critical reflection of methods can be found in chapter 9.

Table 1: Research and knowledge gaps this thesis addresses to support future course design and facilitation.

Gaps		
1	Comparative, explanatory case studies	Barth & Rieckmann, 2016
2	Link between teaching and learning outcomes, -processes, and -environments	Lozano et al., 2019; Wilhelm et al., 2019
3	Comprehensive picture of interpersonal competence development, based on triangulation of methods and perspectives	Backman et al., 2019

4.1. Research design

The research presented here was undertaken as a comparative multi-case study, starting from an in-depth single case study and subsequently transferring the same analytical framework and methods to comparable cases (see 4.1.1.), in line with Yin´s **replication logic**[17] (Yin, 2009), making this research robust (Miles et al. 2014). In terms of Yin´s (1984) five key components of case study design,

(i) the *research question* "How do students develop interpersonal competence, as one of the key competencies in sustainability, in project-based sustainability courses?" is based on the

[17] In bold analysis steps represented in figure 4.

(ii) *proposition* or the claim made by other scholars that project-based learning courses are conducive to key competence development, making me as the researcher enter the research process with a certain **theoretical sensitivity**[18] (Strauss & Corbin, 1990).

(iii) The *units of analysis* are three project-based sustainability graduate courses at higher education institutions, which were selected based on certain criteria (Appendix 1).

(iv) To *link the data to the propositions*, data collection included methods such as observations, semi-structured interviews, and focus groups combined with the Photovoice method (4.1.2. and the rounded boxes in figure 4). Triangulation of these methods allows me to track students´ learning processes, generate thick descriptions and therefore, provide rich pictures of competence development in project-based learning settings.

(v) Inspired by Strauss and Corbin´s (1990) Grounded Theory approach, *criteria for interpreting findings* included iterative rounds of data collection and subsequent phases of open, axial and selective coding (figure 4).

This means data was first approached inductively, allowing themes to emerge from the data via first cycle open coding (Miles et al., 2014; figure 4). Codes grouped under meta-codes, called categories, were put in relation to one another in the step of **axial coding** in which answers to questions such as *how*, *why, who*, and *with what consequences* are sought (see Coding Paradigms in Chapters 1 and 5). Exploring the structure, i.e. what gives rise to a certain phenomenon, allows the researcher to explain a process, dissect complexity, and thus, provide the missing pieces that help explain why/how interpersonal competence is developed in project-based learning sustainability graduate courses. Several times, discussions of preliminary findings with the research team led to additional iterations of the step of axial coding, that slowly and steadily increased the abstraction level of research findings, culminating in the selective coding phase (see arrows indicating a back-and-forth between data condensation, articulation, axial coding, and additional data condensation; figure 4). The selective coding phase allows the analyst to better articulate the core category and its interlinkages, i.e. the overall structure that ultimately gives rise to the phenomenon being studied, including its consequences, and helps to explain research findings (Strauss & Corbin, 1990).

Paper 1 (see 5.1. and indicated with the circle "P1" in figure 4) presents insights gained from the analysis of the initial in-depth case study. Papers 2 and 3 (see 5.2. and 5.3. respectively and lighter grey circles in figure 4) build upon the data collection methods tested in the initial in-depth case study, i.e. **replication logic** was applied. Insights gained from each new individual case were used to further refine the insights gained from previous cases (see cross-case analysis, figure 4), i.e. there was a mix of inductive and deductive coding. The present framework paper concludes this research on interpersonal competence development in project-based learning settings by synthesizing the individual findings, and providing a comprehensive perspective of the phenomenon under investigation (see figures 4, 8, and 9).

[18] Next to the study of literature, my theoretical sensitivity further stemmed from my previous experiences, e.g. of such a course, and further increased with the intensity of engagement in this research.

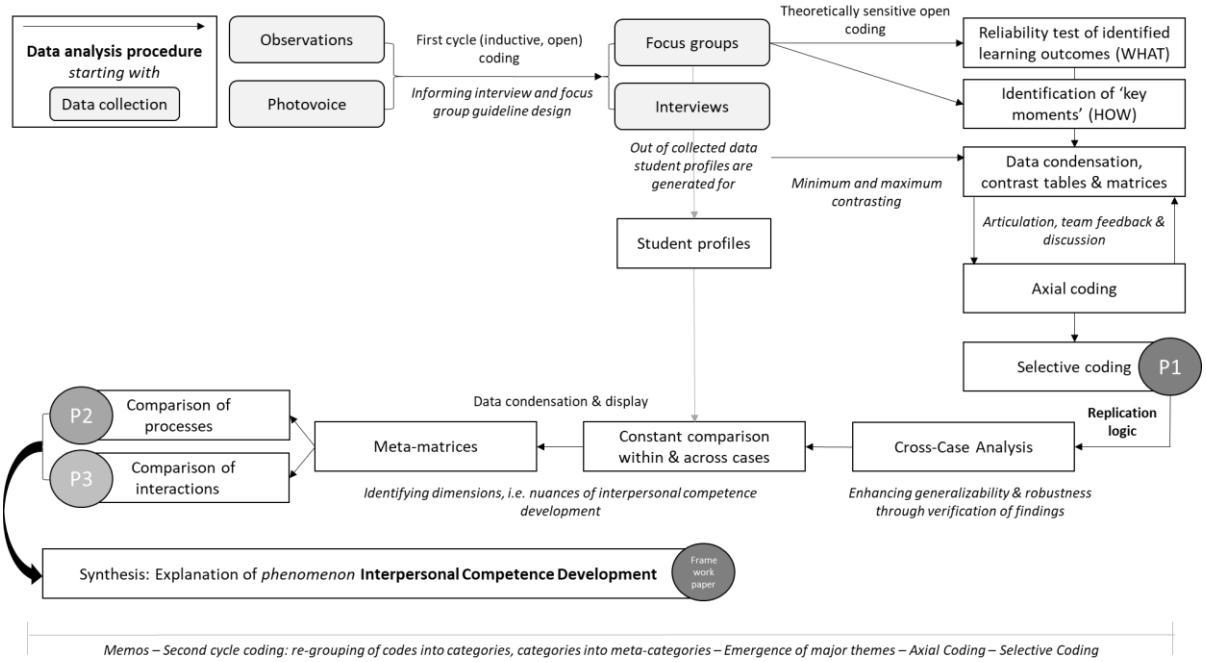


Figure 4: Procedural depiction of the process of data collection and analysis. Rounded, light grey boxes represent the data collection methods applied; white boxes and arrows indicate the analysis steps, leading to the explanation of the phenomenon of interpersonal competence development. (source: author´s elaboration)

Following an overview of each of the selected cases (4.1.1.), the methods applied are described (4.1.2.), before the data analysis procedure (4.2.) underlines this research´s reliability (Miles et al., 2014).

4.1.1. Course selection

Wiek, Withycombe, and Redman (2011) wrote, "the goal of academic sustainability programs is to enable students to plan, conduct, and engage in sustainability research and problem solving based on the interplay of systems-thinking, anticipatory, normative, strategic, and interpersonal competencies" (p. 207). Hence, programs with courses pursuing this goal were considered and three selected for investigation. In addition to the in-depth case study at Arizona State University (ASU), Tempe, USA, and Leuphana University of Lüneburg (LEU), Lüneburg, Germany, courses offered at the Swiss Federal Institute of Technology (ETH) Zurich, Switzerland and the Polytechnic University of Catalonia (UPC), Barcelona, Spain, were chosen, as all have long track records of pioneering project-based sustainability education on the university level. Beyond the fulfillment of selection criteria, allowing for replication logic (Miles et al., 2014; Yin, 2009) courses were also chosen for pragmatic reasons, based on geographical location and timing (Miles et al., 2014). Table 3 provides an overview of the three selected cases (for detailed case portraits providing information on context, teaching and learning formats and activities, and participants, see Appendix 1), while table 4 shows overall and case specific data collected.

Table 2: Overview of the three selected project-based sustainability courses.[19]

University	Arizona State University (ASU), USA & Leuphana University of Lüneburg (LEU), Germany	Swiss Federal Institute of Technology (ETH) Zurich, Switzerland	Polytechnic University of Catalonia (UPC) Barcelona, Spain
Program	Double-degree international master program: *Global Sustainability Science*	4 different master programs [10 different majors]	Master program: *Sustainability Science and Technology*
Course	*Global Sustainability Research* (GSR)	*Transdisciplinary Case Study* (tdCS)	*Action Research Workshop* (ARW)
Mandatory	Yes	No	Yes
Course duration	3 semesters (study focus: semester 3)	1 semester + field phase (3 weeks)	1 semester
Course location	Germany & Arizona	Switzerland & Seychelles	Spain
Pedagogy of place	On- and off-campus	On- and off-campus	On- and off-campus
ECTS	10+10+5	7	5
# of students	12 (2016-2017)	19 (2018)	15 (2018)
# of student groups	3 + 1	7	5
Project topic	Food economy	Waste management	Energy; Food; Housing
Stakeholder engagement	3 major events; City staff, public, food economy entrepreneurs	Continuous with peak phase; NGOs, government, businesses, citizens	Ranging from few check-ins to continuous; NGOs, members, supermarkets
# of instructors	1 (lead) + 3 [in semester 3]	1 (lead) + 1	1 (lead) + 1
# of tutors	0	ETH: 1; Seychelles: 2	0 (occasionally 1)
Expert support	City sustainability officer	Scientific experts and advisory board (local ministry, NGO and business representatives)	Faculty members, project providers

Table 3: Number of instances of each data collection method employed in each of the three project-based sustainability courses.

Case	Observations	Interviews	Focus Groups	Photovoice
GSR	55	23	2	3 of 3 groups; 22 photos
tdCS	11	14	2	1 group; 23 photos
ARW	3	8	2	3 of 5 groups; 23 photos
Total	**69**	**45**	**6**	**7 of 9 groups; 68 photos**

4.1.2. Data Collection – Triangulation of Methods

The method of (i) observation was triangulated (Miles et al., 2014) with methods such as (ii) Photovoice, (iii) semi-structured interviews and focus groups. To gain a holistic, comprehensive, and reliable understanding of interpersonal competence development in project-based sustainability

[19] Tables 2 and 3 have already been published in Konrad et al. (2021) and can therefore be found in 5.2., as well as in 5.3., and in Appendix 1.

courses, several perspectives were sought (students, instructors, tutors, stakeholders). A conceptual framework shared amongst the entire Educating Future Change Agents research project informed data collection, encompassing, first, students´ dispositions and performances (e.g. key competence level); second, the teaching and learning processes (e.g. activities and interactions); third, the teaching and learning environment (including instructor performance and stakeholders); and, fourth, the institutional and cultural contexts (referred to in table 4). In the following, each method is briefly introduced and its application in the present context justified. Methods are further critically discussed in Chapter 9.

Table 4: Data collection methods, specific applications, and areas of the conceptual frame covered with each method (adapted from Konrad et al., 2021).

Methods	**Specific Applications**	**Covered Aspects**
Observations	Class sessions (2-4 hours) Student team meetings (1,5-3 hours) Instructor team meetings (0,5-1 hour) Stakeholder meetings (2 hours) Stakeholder engagement events (2-7 hours) Cultural context (continuous)	*External researcher's perspective on:* Teaching and learning processes Teaching and learning environment Students´ dispositions and performances Institutional and cultural contexts → informed further data collection
Interviews	Individual students Individual instructors Individual stakeholders Group interviews (0,5-1,5 hours)	*Participant´s perspectives on:* Teaching and learning processes Teaching and learning environment Students´ dispositions and performances → informed further data collection
Focus groups	Individual teams (1 hour) Across teams (1 hour)	*Students´ reflections on:* Teaching and learning processes Teaching and learning environment Teaching and learning outcomes → concluded data collection
Photovoice	Process tracking of teams´ learning processes, in- and outside of class (continuous) Collective reflection session (combined with focus group)	*Students´ emic perspectives on*: Teaching and learning processes Teaching and learning environment Teaching and learning outcomes → concluded data collection → provided opportunity for reflection

(i) Observations

Observation is a method often used in ethnographic research to understand processes and structures from "within" a given context. In the Encyclopedia of *Social and Cultural Anthropology*, participant observation is described as "the most basic technique of anthropological fieldwork", whose activities include "participation in everyday activities, working in the native language and observing events in their everyday context" (Barnard & Spencer, 1996/2002, p. 616).

Direct, i.e. the researcher is present; *open*, i.e. the researcher declares her role as researcher to other participants; *participant* and *non-participant* (Emerson et al., 2001/2007) observations were applied to gain an understanding of students´ experiences in and through project-based learning sustainability courses. Observation was directed towards teaching and learning processes, covering both activities and interactions; the teaching and learning environment, covering roles of instructors, tutors, stakeholders, and physical setting; as well as the participants, covering students´ non-cognitive dispositions and performance and giving further insights into students´ competence levels. Observations were unstructured and applied during class sessions, focused particularly on student-instructor and student-student interactions as well as student-tutor interactions where applicable; during internal student and instructor team meetings, focused particularly on student-student and instructor-instructor interactions; and during meetings with project providers, stakeholder engagement events, and excursions, particularly focused on student-stakeholder interactions, but also on student-student, student-instructor and student-tutor interactions.

(ii) Photovoice

Photovoice is a participatory action research method used to 'give voice' to research participants by allowing them to photo-document their own realities. Engaging in a collective meaning making (reflection) of these photos to uncover participants´ strengths and concerns paves the way for change, i.e. improvements in participants´ experiences (Wang & Burris, 1997). Most often applied in the fields of health, social work, and community studies (own tracking of Photovoice publications via Scopus), it is receiving more attention in educational settings (Chio & Fandt, 2007; Ciolan & Manasia, 2017; Cook & Quigley, 2013; Hernandez et al., 2014).

While observations were applied to capture events and processes in the classroom and during official stakeholder meetings and events, Photovoice provided insights into happenings *outside* of class, (e.g. in informal team meetings). The Photovoice method was included in not only in the research design, but, in cases, also in the course design. Thus, it served a dual purpose; to let student groups track their own learning processes and support reflection [learning aspect], and to gain a comprehensive and emic understanding of these [research aspect] (Cook & Quigley, 2013; Ciolan & Manasia, 2017; Mannay, 2010). Being a participant-driven method, Photovoice has the potential to capture more than just processes (see table 4, right column). From context to individual competence levels, students capture what they want and/or feel the need to share, guided by an overall question.

In this study, after receiving a brief *introduction* to the method from me (the researcher) in class (see figure 5), including its origin (Wang & Burris, 1997), students were asked to use the method to capture the following: their own perspectives on teaching and learning processes both in- and outside of the course classroom; moments showing how they felt before/ during/ after the class/ group work session/ stakeholder meeting, etc.; activities/ moments/ events/ meetings/ etc. where "something" is happening in relation to the course.[20] The *student activity* (figure 5) was to either take a photograph or select an existing photograph during the week in response to the prompting inputs above. Photographs were submitted either via Email or through an online teaching and learning plattform, together with a title and one to two sentences explaining why this photo was chosen. Students could be creative in what they documented with these photos – from capturing concrete moments (e.g. group work sessions) to abstract, symbolic impressions (see exemplary photos, figure 5). These photographs are not intended to speak for themselves but rather to serve as inspiration for

[20] As communicated to the students (task introduction).

a *collective meaning making* session. In such a session, narratives behind the pictures or triggered associations are shared and harvested[21]. Photos are, so-to-say, used as a "springboard" (Cook & Quigley, 2013, p. 352) to uncover stories that otherwise might potentially remain untold.

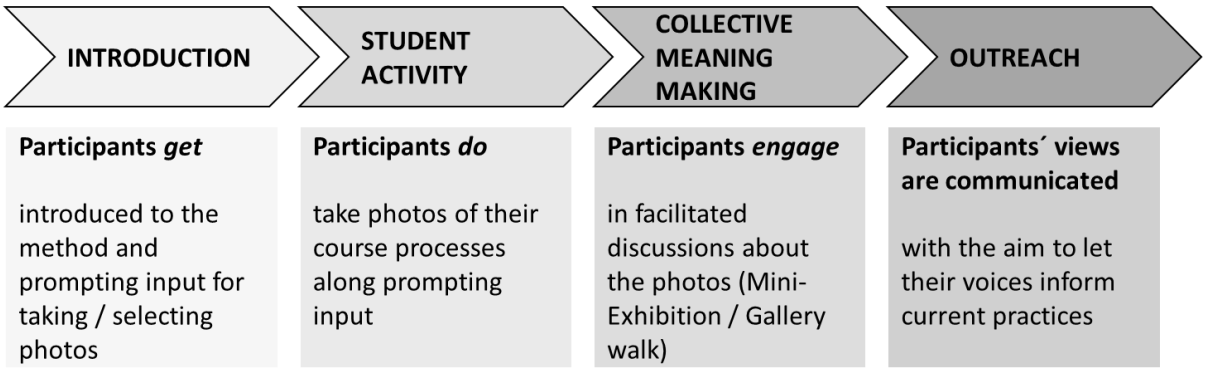
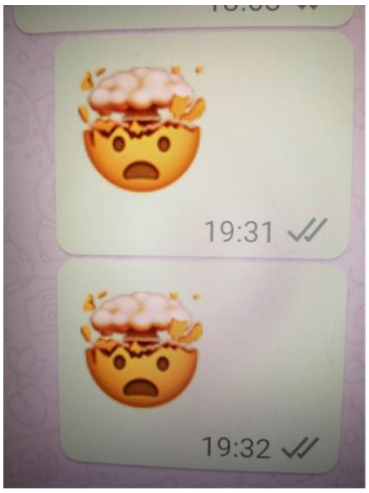


Figure 5: Steps in application of the Photovoice method in the present study (author´s elaboration).

The way stories were harvested in this study was adapted from the SHOWED approach, which usually asks the following five questions: "What do you **S**ee here? What is really **H**appening here? How does this relate to **O**ur lives? Why does this condition **E**xist? What can we **D**o about it?" (Wang & Burris, 1997; Gant et al., 2009). For this research, a small exhibition / gallery walk was created, giving students time and space to visually revisit and literally going through their course semester again by looking at their own and peer groups´ photographs, along with the focus group´s overall course timeline. Students were then asked to *choose one* of these photographs and *elaborate why it resonated* most with them. Some students told the story behind their own photo submissions, while others shared stories triggered by the visual inputs provided by one of their peers; thus provoking associations of individual group work processes and course happenings and allowing opportunities for comparing and contrasting experiences and perspectives (see also Ciolan & Manasia, 2017).

Title: **Interrupted After Work activity**
"After a meeting we decided to go to the beach. Unfortunately this nice after work activity was interrupted by an email of our external partner [...] which leads us to go home and fix the problem...." (S_702, **Photovoice hand-in,** 26.04.2018)



Title: **Explosion**
"The last week was quite intense and exhausting. Our heads feel like exploding every moment. The reasons are time pressure and different views between our external partner and us how to do the surveys etc." (S_702, Photovoice hand-in, 17.04.2018)

Title: **Shortly before twelve**
"After the holidays, we realized that we just have five weeks left to do the whole research. We are feeling time pressure at the moment." (S_702, Photovoice hand-in; 05.04.2018)

Figure 6: Exemplary photographs submitted by students, showing that sometimes what is captured and shared is quite symbolic.

[21] Harvesting is an integral part of what is known as "Art of Hosting" which is about facilitating (or harvesting) "conversations that matter". Art of Hosting is about conversational processes able to harness "collective wisdom and self-organizing capacity of groups of any size" (http://www.artofhosting.org/; 04.02.2021).

(iii) Semi-structured interviews and focus groups

Interviews and focus groups are qualitative research methods often used to directly elicit information about a specific topic from stakeholders. Depending on the research interest, interview formats can vary in terms of the level of structure provided; and, depending on the research context, interviews can be of a formal or informal character. Focus groups, as a kind of group interview, engage several people around a specific topic at the same time, allowing opportunities not only for the interviewer to pose questions to participants, but also the chance that additional (perhaps unanticipated) questions and discussions arise among the participants themselves (May, 2011). Hence, these qualitative research methods require the researcher to have a certain level of interpersonal competence in order for them to be an effective means of data collection.

In the present study, an interview guideline with open-ended questions was applied. Development of this guide was informed by both the conceptual frame (aspects see table 3, right column) and by researcher observations (see figure 4) to allow for the capture of diverse perspectives and perceptions of course happenings from student, instructor, tutor, and stakeholder perspectives. Eliciting various perspectives based on these *semi-structured* interviews provided a basis to compare and contrast these potentially diverse perspectives, as well as to overcome potential researcher biases. *Focus group* discussions were also based on a pre-developed guide (for an example see Appendix of paper 2 (5.2.)), allowing to compare and contrast more easily between cases.

In both interview formats, students´ self-perceptions of their own learning outcomes were solicited using open-ended questions, with an emphasis on avoiding 'putting words into their mouths', to avoid potential bias. Learning outcomes specifically mentioned by students were captured on paper for all to see. In a second step, students were offered a 'language' for learning objectives, i.e. the course´s expected learning outcomes were revisited and students were asked to evaluate the degree to which each expected learning outcome was achieved.

After sharing and discussing the *what* (i.e. learning outcomes), each focus group undertook an interactive skill tracing activity. Each student was handed a sheet with a pre-printed timeline indicating the start and end dates of the course. A box was provided to insert the learning outcome where the student was asked to insert the learning outcome most developed during the course. An additional timeline indicating major course happenings was provided throughout the focus group meetings, thus allowing students to refresh their memories of past course happenings, while, at the beginning of the focus group, students were invited to complement this timeline with 'key moments' from their perspectives. For the individual skill tracing activity, students were asked to reconstruct and trace-back their specific competence development. Thereafter, students´ course impressions on the teaching and learning processes and environment, leading to their learning outcomes, were shared and compared and contrasted in a facilitated discussion. Both, semi-structured interviews and focus groups provided insights into the students´ realities, as they were based on their own observations and experiences. Focus groups, concluding the semester and data collection at each case study site, were further combined with the Photovoice collective meaning making session (see table 4).

4.2. Data Analysis – Procedure

To allow the reader to assess the credibility of the presented findings from this research, the data analysis procedure is chronologically described (**analysis steps** in bold found in figure 4). This allows insight into how the rich qualitative data collected (table 4) led to the findings presented in the next Chapter. For shorter versions of the research design and specific analysis steps, see papers 1, 2, and 3 (sections 5.1.-5.3.). Instead of a general introduction to Grounded Theory, the following is intended to provide the reader with an idea of how a Grounded Theory perspective inspired and guided me throughout the research process.

Overall, **data analysis** began immediately following the initial *data collection* step (Corbin & Strauss, 1990) and helped to inform and guide further data collection steps (theoretical sampling, see Corbin & Strauss, 1990). The 'interim' steps of 'clean-reading' and writing up of field notes before transfer of the data collected into the coding software MAXQDA, present already a first data analysis step, as, increasing familiarity with the case generated new thoughts and hypotheses which were jotted down or recorded in research memos (Emerson et al., 2001/2007; Miles et al., 2014). Data collected during *interviews, focus groups* and *Photovoice* submissions were transcribed by student assistants and only corrected and anonymized where still needed before being entered into the MAXQDA software for **first cycle coding**.

To elaborate further on the process of coding itself: It was a combination of 'holistic coding', i.e. attributing single codes to large units of data, such as paragraphs, and 'simultaneous coding', i.e. "application of two or more different codes to a single qualitative datum" (Miles et al., 2014, p. 81). Later analysis steps included a mix of deductive and inductive coding: deductive in terms of the application of codes such as interactions, that were already part of the conceptual frame (see 4.1.2.), while continuing to let new themes emerge from the data itself (inductive) (Miles et al., 2014). Recording thoughts and hypotheses as memos was an additional part of the analysis that took place simultaneous to the coding process. These memos were re-visited throughout the various steps of the coding process. Second cycle coding, such as 'pattern coding', i.e. the re-grouping of codes along patterns to form meta-codes, at some point began to happen simultaneously to the process of open coding of new data material. Categories evolved through the similarities of codes. For example, the category 'learning outcomes' encompassed a collection of codes specifying individual competencies and inductive codes for mentioned learning outcomes. A record of these data fragments that I had coded and categorized unter 'learning outcomes' was compiled with the software, and **interrater-reliability tests** prepared, with blank boxes on the right of each data fragment to allow peer researchers and co-authors equally familiar with the key competencies in sustainability framework (Wiek, Withycombe, & Redman, 2011) to apply their own codes. The comparison of my own codes with those attributed by peer researchers showed that my interpretation aligned with those of other researchers.

Broadly summarized under the category 'happenings', defined as moments where something occurred that triggered e.g. a 'shift' or provoked an 'aha-moment' (as examples of a sub-codes), 'key moments' were identified. These were moments which occurred more than once, i.e. these were mentioned at least twice and by different students, leading to the hypothesis that this might be a pattern code (Miles et al., 2014) to look further into. To give an example, a particular event that occurred during the course of one of the case studies (AudaCity/GSR case study) was mentioned several times. As a consequence, observational data related to this event were coded to get a better

understanding of this potential 'key moment' that might have contributed to students´ interpersonal competence development.

As focus groups (combined with the Photovoice step of collective meaning making) represent the method capturing the entire course in retrospect, this data set was also the point of departure for diving deeper into data analysis, i.e. trying to answer the research question by finding out *what* was learned and *how* (figure 4). **Data condensation**, or qualitative data reduction, i.e. moving constantly to a higher level of abstraction (from codes to categories), supported the elaboration of a cognitive map, i.e. an evolving scheme of understanding by surfacing common themes (Miles et al., 2014). Tables were used to explicitly show links between the *what* and the *how*, which further allowed for the identification of potential causal effects or other relations (ibid.). **Minimum and maximum contrasting** of learning processes leading to interpersonal competence development helped to assure the representativeness of the findings (ibid.). This step was based upon **student profiles** which contained, for instance, information about their experiences prior to the course; thus giving insights into the students´ pre-course competence levels. The profiles were generated through analysis of focus group, interview and selected observational data revealing such information. Here, minimum contrasting refers to the comparison of students with similar backgrounds, i.e. either students with no experience in group work and/or stakeholder engagement or more experienced students. In a next step, I purposefully sought out contrasting cases, ultimately comparing and constrasting experienced and unexperienced students. Resulting **contrasting tables** (ibid.) (competence development of students with no prior experience compared to competence development of experienced students) **and matrices** further informed the process of **axial coding**, where different (sub-)categories were put in relation with one another with the intention of explaining links between categories and reaching a higher level of abstraction (Corbin & Strauss, 1990). Discussing these Axial Coding Paradigms with peers and co-authors led to iterations of visualizations and, through repeated articulation of all findings, a core category was ultimately identified (5.1.).
Following Yin´s (2009) **replication logic,** these same steps were applied for each of the other two case studies, in terms of both data collection and analysis. Matrices resulting from within-case constant comparison were later merged for **cross-case analysis**, resulting in further data condensation. The resulting **meta-matrices** (Miles et al., 2014), already on a high abstraction level, pointed in two directions deemed worthy of deeper analysis. Therefore, further analysis of learning processes (5.2.) and interactions (5.3.) followed. Through this step 'back', additional dimensions and further **nuances** of interpersonal competence development in project-based sustainability courses were identified. Chapter 5 brings now all findings from the individual papers together and explains with the help of Corbin and Strauss (1990) Coding Paradigm the phenomenon *interpersonal competence development in project-based sustainability courses*.

Vision 3: Inspired to go out, explore, and co-create

Figure 7: Ready? (source: author´s elaboration)

CONSEQUENCES

5. Findings

This thesis frame brings together insights from three articles (figure 8). As each article looks deeper into *one* moderating variable of interpersonal competence development in project-based sustainability courses, here I am bringing these insights together to provide a more comprehensive answer to the research question. For detailed insights on the individual, but connected, moderating variables, the reader can consult the respective articles following as sub-chapters after the synthesis.[22]

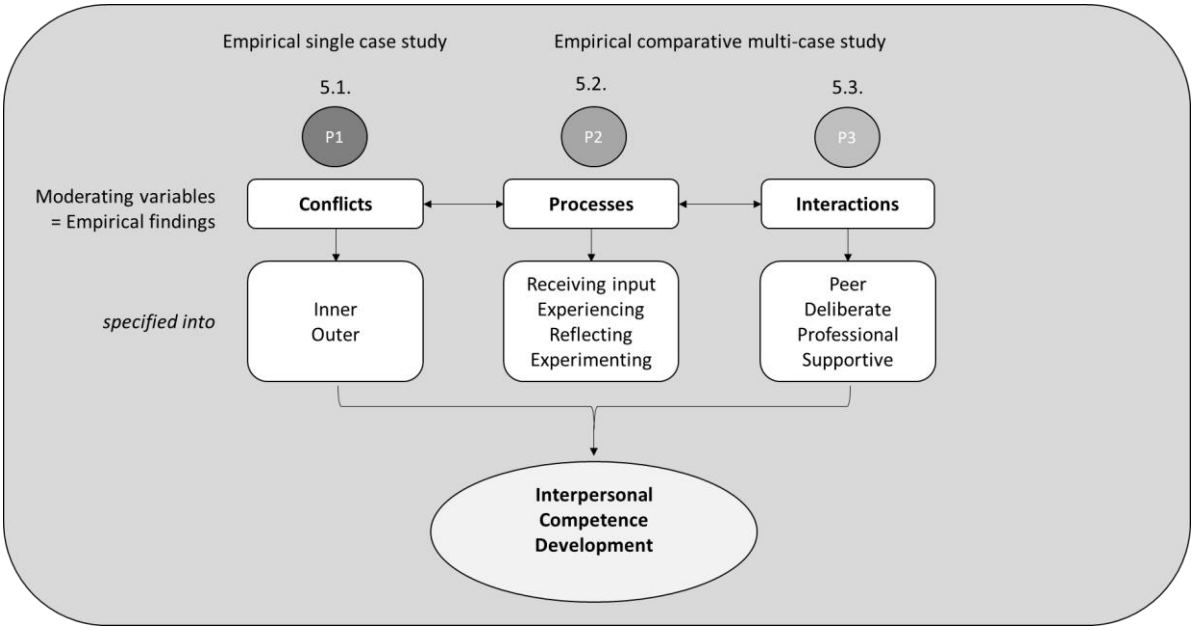


Figure 8: Key findings of the three individual articles together provide a more comprehensive picture of interpersonal competence development in project-based learning settings.

Synthesis

The overarching research question of this thesis – "*How do students develop interpersonal competence, as one of the key competencies in sustainability, in project-based sustainability courses?"* – can be answered as follows: **Interpersonal competence, in project-based sustainability courses, is developed through diverse interactions, particularly by being made explicit subjects of inquiry. These interactions trigger a sequence of processes moderating interpersonal competence development. The meaningful combination of these learning processes, and hence, interactions, allows students to develop attitudes, knowledge, and skills of interpersonal competence, particularly in collaborative teamwork and impactful stakeholder engagement. Both inner and outer conflicts, provoked through and in these interactions, can lead to the development of interpersonal competence if embraced.**

Characteristic interactions that occur in project-based sustainability courses are *peer* (student-student), *deliberate* (student-instructor), *professional* (student-stakeholder), and *supportive* (student-mentor, e.g. tutor) interactions (figure 9: P3). The learning processes identified are learning through and from *receiving input, experiencing, reflecting*, and *experimenting* (figure 9: P2). These

[22] Although inserted as sub-chapters of this thesis, the articles will be presented the way they were or are to be published, i.e. numbers of figures and tables will start to count with the beginning of each article anew; and each article closes with its respective references.

complement one another to support attitude, knowledge, and skill development of interpersonal competence (i.e. competence in collaborative teamwork and impactful stakeholder engagement). *Inner conflicts* refer to an individual's internal or intrapersonal experiences, i.e. feelings of frustration, surprise, disorientation, excitement, tension, or discomfort that are triggered through various interactions, such as new or unfamiliar action- and/or thought-provoking encounters. *Outer conflicts* refer to external tensions between individuals and/or groups. In order for indivuals to learn from these conflicts, their existence needs to be explicitly acknowledged and constructively dealt with, i.e. *embraced as learning opportunities with a lens focused on learning outcomes* (figure 9: P1). Interpersonal competence is not developed solely through these interactions, however. Students' interactions with different actors (often 'learning by doing') trigger particular learning processes, including learning through and from conflicts. Making these interactions *explicit subjects of inquiry* is what matters for the development of attitudes, knowledge, and skills in collaborative teamwork and impactful stakeholder engagement. Key here is complementing learning by doing with *(self-) reflection*; in one word: Refl-Action.

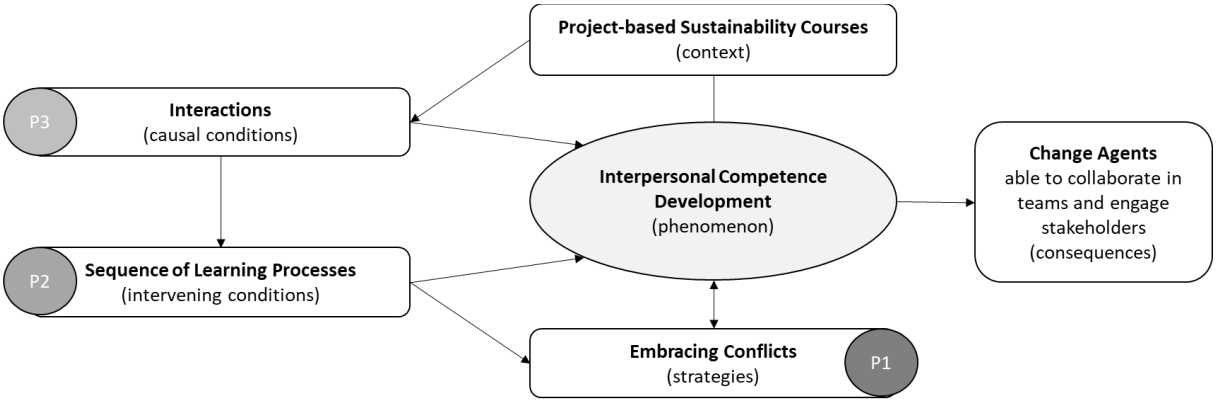


Figure 9: Graphic depiction of the phenomenon of interpersonal competence development (center). Interpersonal competence development is triggered by certain *interactions* (P3) that trigger particular learning *processes* (P2). If meaningfully combined, these learning processes lead to strategies, such as *embracing conflicts* (P1) that support interpersonal competence development in the context of project-based sustainability courses. In turn, being interpersonally competent includes a conflict-embracing attitude.

The following sub-chapters are reproductions of the three articles constituting this cumulative thesis. They allow for more detailed insights into conflicts, processes, and interactions as moderating variables for interpersonal competence development.

"we shall not be afraid of conflict, but shall recognize that there is a destructive way of dealing with such moments and a constructive way."
(Mary Follett)[23]

*

"to eliminate conflict is to remove the richness of diversity from the human experience."
(Porter-O´Grady, 2004)

*

"One ship drives east and another drives west
With the self-same winds that blow.
'Tis the set of the sails
And not the gales
Which tells us the way to go.

Like the winds of the sea are the ways of fate;
As we voyage along through life,
'Tis the set of a soul
That decides its goal,
And not the calm or the strife."
('The winds of fate' by Ella Wheeler Wilcox)

[23] In Metcalf and Urwick (1942/2003), Volume III of "The Early Sociology of Management and Organizations" edited by Kenneth Thompson.

5.1. Embracing Conflicts for Interpersonal Competence Development in Project-based Sustainability Courses

Citation
Konrad, Theres; Wiek, Arnim; Barth, Matthias (2020): "Embracing conflicts for interpersonal competence development in project-based sustainability courses". In *International Journal of Sustainability in Higher Education 21* (1), pp. 76–96. DOI: 10.1108/IJSHE-06-2019-0190.

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Abstract

Purpose – Advanced skills in communication, teamwork and stakeholder engagement are widely recognized as important success factors for advancing sustainability. While project-based learning formats claim to advance such skills, there is little empirical evidence that demonstrates how interpersonal competence is being developed. This study aims to describe and explains teaching and learning processes of project-based sustainability courses that contribute to the development of interpersonal competence as one of the key competencies in sustainability.

Design/methodology/approach – This study on an international project-based learning course adopted a multi-method case study approach, triangulating observations, semi-structured interviews and focus groups supported by Photovoice method through which students tracked their learning processes. Data collection and analysis followed a Grounded Theory approach.

Findings – Learning through and from conflicts within a learning community can foster competence development in teamwork, communication and stakeholder engagement. This study identified inner and outer conflicts (within individuals versus between individuals or groups) as potential drivers of learning processes, depending on strategies applied to address these conflicts.

Originality/value – The value of this study is fourfold: (i) it demonstrates how conflicts can be leveraged for students' competence development; (ii) it provides in-depth empirical data from multiple perspectives, (iii) it discusses the findings in the context of teaching and learning theories, and (iv) it demonstrates an application of the Photovoice method to track and improve teaching and learning processes.

Keywords Project-based learning, Experiential learning, Change agents, Education for sustainable development, Key competencies in sustainability, Teaching and learning processes

Paper type Research paper

1. Introduction

Universities ought to play a key role in educating future sustainability change agents, i.e. equipping students with the competencies needed to guide and support transformations toward sustainability (Thomas, 2009; Wiek et al., 2011a). There is emergent agreement on the suite of key competencies that sustainability professionals in general and sustainability change agents in particular should possess to be able to address sustainability problems (Perez Salgado et al., 2018; Wiek et al., 2011b). Among these key competencies, advanced skills in communication, teamwork and stakeholder engagement are widely recognized as important success factors for change agents working on

sustainability problems (Brundiers and Wiek, 2017; Wals and van der Leij, 2009). This multi-faceted interpersonal competence is a key competence in sustainability because the ability to coordinate and collaborate with others, to engage and motivate others, to find compromises and resolve conflicts, and so forth – these are all critical interactions for solving sustainability problems and advancing sustainability worldwide.

Project-based, problem-based, real-world, solution-oriented, learner-centered and other experiential learning approaches are considered impactful learning settings for developing key competencies in sustainability in general (Barth, 2015; Caniglia et al., 2016; Tejedor et al., 2019; Wiek et al., 2014) and interpersonal competence in particular (Brundiers et al., 2010; Brundiers and Wiek, 2013). The main reason is that these formats shift students' learning from passive to active as students develop solutions to real-world sustainability problems working in multi-disciplinary teams and engaging with external stakeholders, supported by instructors as coaches (Segalàs and Tejedor, 2016; Stauffacher et al., 2006). Scholars such as Barth (2015), Thomas (2009), Wals and Corcoran (2012) and others call for such a re-orientation of educational practices.

Research so far suggests that students can develop interpersonal competence through project-based learning. Kricsfalusy et al. (2018) analyzed students' pre-/post-course self-assessment of competencies related to a project-based learning course that mirrored "professional consulting practice" with a client. The results indicate increased levels of written and verbal communication, community consulting and teamwork. Stakeholders confirmed the assessments' findings. Savage et al. (2015) also elicited students' pre-/post-course self-assessment for a study on competence development in a project-based learning course. The findings indicate the importance of an active learning community "to practice interpersonal skills and to collaborate with people of diverse perspectives" (Savage et al., 2015, p. 698). Students also considered working through tensions among people holding different values as important experiences for developing interpersonal competence. Heiskanen et al. (2016) interviewed alumni on what competencies they consider essential for their professional practice and in how far these were developed in the project-based learning course they had completed during their studies. The alumni mentioned the following interpersonal competence facets, among others: communicating compassionately with people from diverse backgrounds, as well as motivating them, and communicating effectively, bringing one's own message across while understanding different viewpoints. Clevenger and Ozbek (2013) complemented pre-/post-course surveys with concept maps and short-answer reflection questions on a project-based learning course, finding evidence for improved abilities to consider and understand others' perspective as well as empathize with people of different backgrounds. Improvement in teamwork and leadership skills were also reported because of the applied service-learning course format. Students specifically stated in their reflections on interpersonal competence that they learned "how to interact with a group to find a solution" and "how to explain concepts to high school students in a manner that engages them in a discussion on the topic" (Clevenger and Ozbek, 2013, p. 7).

While these studies suggest that interpersonal competence was developed (mostly based on students' self-assessments), they only provide limited insight into how it is being developed through multi-layered teaching and learning processes. A few studies have taken a closer look at these processes. Hilser (2016), for instance, identified contributing activities to interpersonal competence development such as team building, networking, presentations and a project fair (Hilser, 2016). Zemler (2016) offers qualitative data on individuals' experiences in a project-based learning course,

confirming that project-based learning courses develop interpersonal competence. Success factors include:

> "Clear and transparent communication, articulation of roles and responsibilities, engaged clients who have previous knowledge of the academic institution, tools and training for participants to assist in building interpersonal skills, follow-up and potential for continued partnership, a dynamic supervision style, structured opportunity for reflection and critical thinking, and place-based learning opportunities." (Zemler, 2016, p. 74)

Several students expressed an interest in receiving "more training, tools and methods for facilitating interpersonal and collaborative processes" (Zemler, 2016, p. 54).

Despite these relatively consistent findings, project-based learning processes for interpersonal competence development can still largely be considered "black-boxed." What is missing is "impartial research where students' individual experiences [. . .] are studied in-depth, [. . .] investigating the multitude of influences on their learning" (Backman et al., 2019, p. 149). Brundiers et al. (2010) highlighted that the "the devil is in the details" and assert that "design and implementation of the learning opportunity largely determine whether the opportunity provides a real learning experience" (Brundiers et al., 2010, p. 313). Following Barth's (2015, p. 86) question of "how such learning takes place and how it can best be supported," the research question of this study is:

> *How do students develop interpersonal competence as one of the key competencies in sustainability, through project-based learning?*

The aim is to uncover concrete "mechanisms" that work either as drivers or barriers for learning, i.e. interpersonal competence development, to go beyond confirming what works and elaborating *why* it works.

The authors present the results of a case study on an international graduate-level sustainability course that adopted a project-based learning approach (see case description in Section 2 below). While unique in some features, this course serves as a representative example for numerous project-based learning courses in sustainability programs around the world.

This study offers detailed insights into the teaching and learning processes that foster and hinder interpersonal competence development through project-based learning, by linking empirical data with learning theories and synthesizing perspectives from students, instructors and an external researcher.

The findings offer guidance to instructors and course designers interested in enhancing the impact of their project-based learning courses on students' learning and development of key competencies in sustainability.

2. The case of the global sustainability research project course

To ensure the "accessibility of contextual experience" (Corcoran et al., 2004, p. 18) to overcome an often-criticized "storytelling" approach (Barth and Thomas, 2012), the authors first provide a thick description that details the context of the case. There are three relevant layers (figure 1): The specific course module under investigation, i.e. "Module 4," is the culminating part of a three-semester project course, i.e. the "Global Sustainability Research (GSR)" project course, which is a signature component of an international sustainability master program, i.e. the "Global Sustainability Science" (GSS) program.

The GSS master program is an international dual-degree program jointly organized by Leuphana University of Lüneburg, Germany, and Arizona State University, USA[24]. It is a two-year, four-semester program in which students start their first semester at one of the two universities, work together at Leuphana in Semester 2 and at ASU in Semester 3 before they complete the degree with a master thesis in Semester 4. In total, 12 GSS students, native to Germany, South Africa, USA, and Mexico participated in the 2016-2017 cohort.

The so-called GSR project course is a mandatory course embedded in the GSS program. The course is structured into four modules and runs from Semesters 1 through 3 (figure 1), with the option that students can conduct their master thesis (Semester 4) by building upon the GSR project course. In Semester 1, students first familiarize themselves with research topic and methodology at their respective university (Module 1). The research topic is provided to the students and derived from one or more ongoing research project(s), in which the GSR project course is embedded in. In Semester 2, all students are at Leuphana University together. The semester is structured into two research modules (Modules 2 and 3). During Module 2, student teams are composed (based on preferences, experiences, etc.) and team-building activities are facilitated. The teams then develop specific research plans. In Module 3, the teams conduct the first part of the research project. In Semester 3, all students complete the research project at Arizona State University (Module 4).

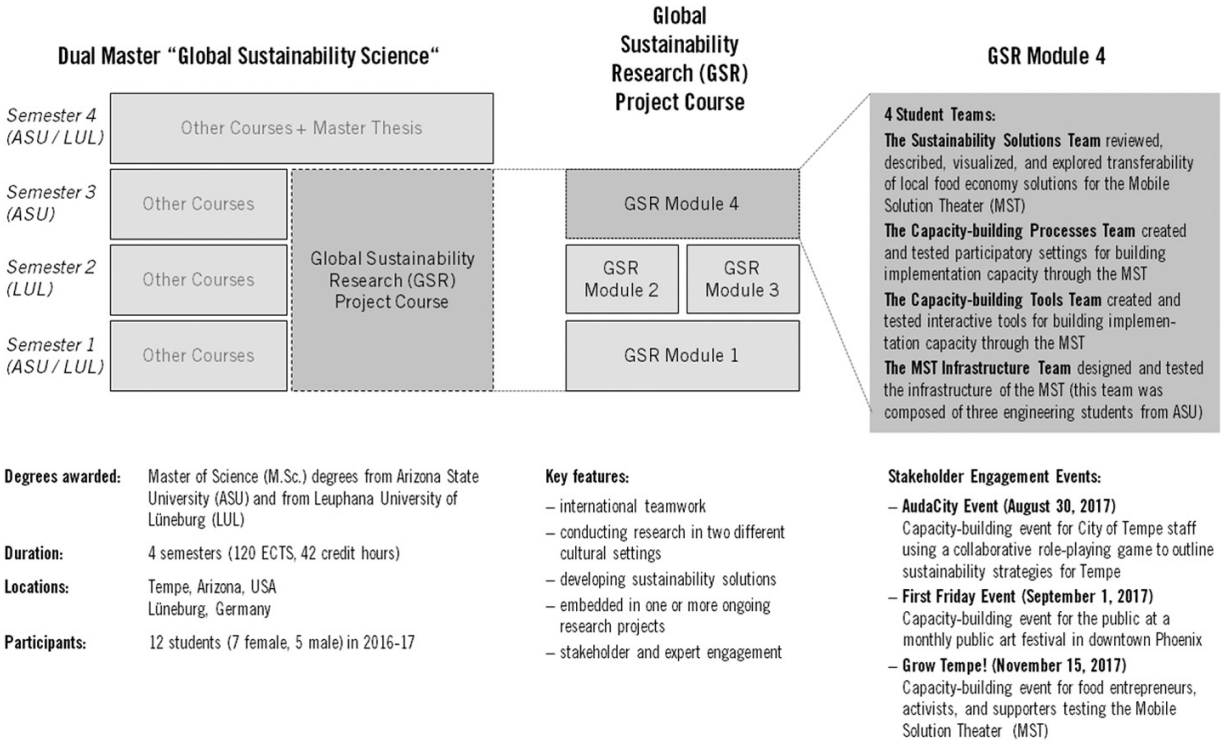

Figure 1: Structure and key features of the GSR project course.

The GSR project course's ultimate learning objective is to develop students' transdisciplinary research and practical sustainability problem-solving competence. While the topical focus changes for every cohort, the key features of the GSR project course remain the same (figure 1). The educational design of the course builds upon an international sustainability education pilot project (Wiek et al., 2013; Caniglia et al., 2018) and an extensive project-based learning program (Wiek et al.,

[24] www.leuphana.de/en/graduate-school/master/course-offerings/global-sustainability-science.html

2014). It has been formed and adopted over several years and utilizes insights from experiential learning, professional skill development, bounded student leadership and coaching formats (Brundiers and Wiek, 2013; Wiek et al., 2013; Wiek et al., 2014; Caniglia et al., 2016; Caniglia et al., 2018).

The GSR project course 2016-2017, which is the focus of this case study, was linked to two ongoing research projects: first, to "Bridging the Great Divide in Sustainability Science," which was conducted by an international research team from Leuphana University of Lüneburg and Arizona State University, 2016-2018 (Lang et al., 2016; Lang et al., 2017), and second to "CapaCities – Building Implementation Capacity through City-University Partnerships," which was conducted by an international research team from Leuphana University of Lüneburg, Arizona State University and other universities, 2016-2018 (Withycombe Keeler et al., 2018; Withycombe Keeler et al., 2019).

In alignment with the two research projects mentioned above, the topical focus of the GSR project course was on local food economy solutions, as a particular domain of solutions, which are based on regional economy, social entrepreneurship, and sustainability enterprise concepts. The goal of the GSR project course was to conceptualize and pilot a so-called "Mobile Solution Theater," i.e. a flexible facility that uses data, visuals, narratives, etc. in various engagement activities to enable and empower decision makers and other stakeholders to implement sustainability solutions (Wiek and Lang, 2017; Wiek et al., 2017). Consequently, the research question the students engaged with was: How can a mobile solution theater foster capacity for implementing sustainability solutions in general and local food economy solutions in particular in Lüneburg and Tempe?

The focus of this case study is on the culminating Module 4 of the GSR project course 2016- 2017, which took place from August to November 2017 in Tempe, Arizona. It was a three credit-hour (five ECTS) module in which students from both universities continued and finalized the research project they started at Leuphana University in Semester 2. At Arizona State University, the GSS students worked in three teams and collaborated with a team of engineering students (infrastructure team) on designing and testing the Mobile Solution Theater (MST). Figure 2 maps out each group's main task, the key project activities and the interplay among the different project teams. Run-through and dry-run sessions allowed for iterative refinements of solutions, tools and processes.

A major learning objective was to develop students' interpersonal competence, specifically to enable students to effectively and compassionately communicate in intercultural settings, successfully collaborate in teams (roles, effective meetings, executing work plan, etc.), as well as engage with various societal stakeholder groups in impactful ways (Course Syllabus for Module 4 of the GSR project course 2016-2017).

This was supported in several ways: first, there was assistance provided to each of the student teams by the three main instructors. Second, there was an expert advisor who led three training sessions on professional skill development, including a practice of conflict resolution during Module 3, and offered consultation, review and mediation meetings on demand during Module 4. Third, the collaboration with the infrastructure team offered additional opportunities for extended teamwork.

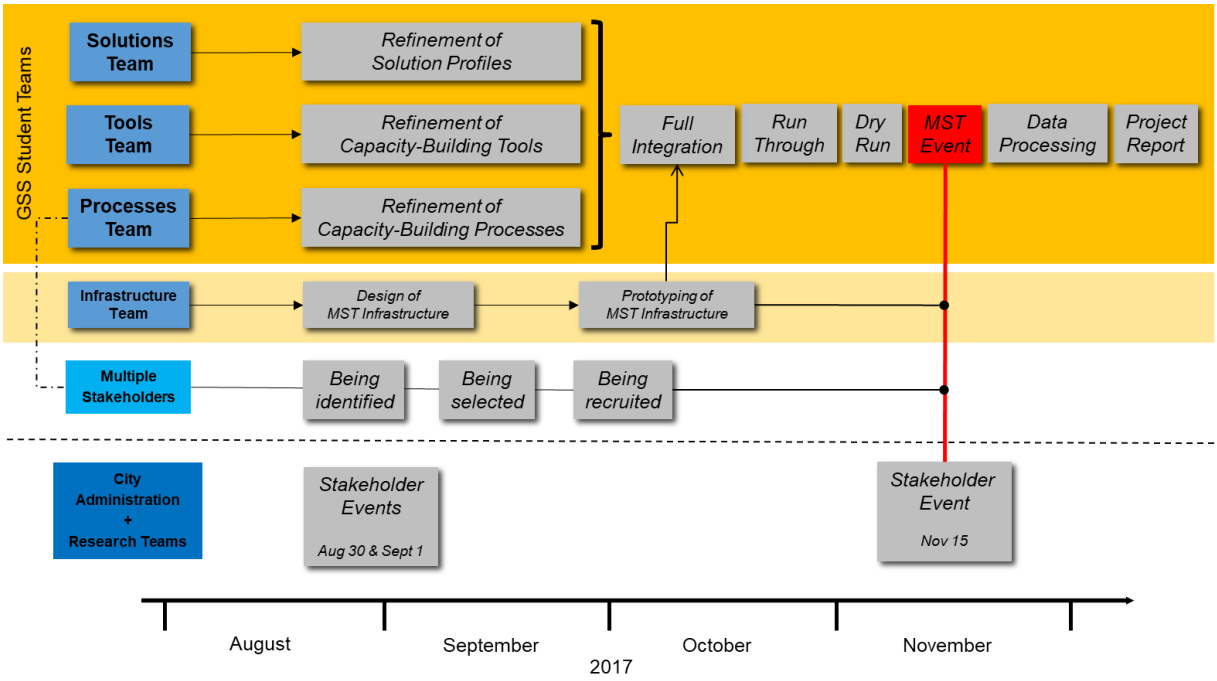

Figure 2: Project teams, activities, interactions and timeline of Module 4 of the GSR project course 2016-2017.

Additionally, several local project partners, most notably the Sustainability Director of the City of Tempe, and about 30 local food economy stakeholders were involved in research and project activities providing professional resources and a real-world application context. As students were involved in major stakeholder events (figures 1 and 2), the team of instructors provided them with a sequence of specific training sessions on stakeholder engagement to prepare them for the different tasks. The sequence started with film-based familiarization and went through various stages with facilitation trainings, observations, participant observations, walk-throughs, dry-runs, co-facilitation, to full facilitation and coleading the culminating stakeholder event in November 2017.

3. Research design

Research was carried out as an in-depth, multi-method case study following a Grounded Theory approach (Corbin and Strauss, 1990; Yin, 1984). The project team was accompanied over the entire project duration, at Leuphana University and Arizona State University, including all class sessions, all stakeholder engagement events and selected team meetings. Multiple methods of data collection were applied to allow for triangulation and to ensure construct validity (Creswell and Clark, 2017). Table 1 compiles the data collection methods and data collected. Data collection took place from March to November 2017 at Leuphana University of Lüneburg and Arizona State University. It was conducted by an external researcher (T.K.), who was not involved in teaching or grading. The study was approved by the relevant ethical boards and is based on written consent from all participating students and instructors.

Table 1. Data collection methods and data collected

Observations	n=55 (class sessions, meetings and events), unstructured, real-time fieldnotes
Interviews Students	n=4 pre-Module-4-interviews; n=12 interviews during Module 4 Total of 16 interviews (15-90 minutes) [voice recorded, transcribed]
Interviews	n=5 pre-Module-4-interviews, n=1 post-final-event interview

Instructors	Total of 6 interviews (30-60 minutes) [voice recorded, transcribed]
Focus Groups	n=2, 6 students each (75 minutes) [voice recorded, transcribed]
Photovoice	22 Photographs 1 Collective meaning-making session (25 minutes) [voice recorded, transcribed]

Direct, open, both participant and non-participant observations (Emerson et al., 2001/2007) were directed toward teaching and learning processes (activities and interactions), the learning environment (physical setting, role of instructors and stakeholders) as well as the participants (students' non-cognitive dispositions) (Redman et al., 2019). Observations covered class sessions, stakeholder engagement events, instructor meetings and selected student team meetings. Semi-structured interviews (May, 2011) with selected students were carried out before Module 4, while every student was interviewed during the module. The structure of the interviews was based on preliminary insights from observations and fieldnotes. To cover shared impressions on the teaching and learning processes throughout the GSR project course and to compare students' experiences, focus groups (May, 2011) were conducted at the end of the course. A timeline of the entire GSR project course was provided to support reflections while allowing students to add key moments of their learning and uncovering potential blind spots of the external researcher. Photovoice, originally developed as a participatory action research method (Wang and Burris, 1997; Chio and Fandt, 2007), and used in health and community studies, was introduced to facilitate "authentic conversations" based on photographs taken by students over the course of the project (Ciolan and Manasia, 2017). Each week, students submitted one or more photographs per group, which portrayed and tracked the group's learning process, in class and outside of class, which is often less accessible to data collection. These visuals, together with short titles and comments, formed the basis for a collective meaning-making session, which took place right after the focus groups. The submitted photographs were used as "springboards" to spark narratives and discussions about the learning processes (Cook and Quigley, 2013, p. 352). Each student, irrespective of the photographs' origin, was asked to choose the picture which resonates most with them and to elaborate why. Finally, semi-structured instructor interviews provided insights into course conditions, pedagogical approaches and instructor observations.

Data analysis followed a Grounded Theory approach (Corbin and Strauss, 1990). First, focus group data were analyzed by the external researcher, deriving codes and categories inductively. High familiarity with the data was given because of data collection, fieldnotes review and transcript proofreading. On this basis, a code book was created. Codes were grouped in categories, categories in meta-categories, eventually leading to major themes. For instance, the category "student perception (of . . .)" was comprised of the codes "course start," "course process," "course output," "teaching environment," "(importance of) roles," allowing for nuanced insights into the GSR course from student perspective. "Teaching and Learning Approach," as a category under the meta-category "Instructors," encompassed in vivo codes such as "making it real," "stakeholder engagement," "mix between top-down and bottom-up," delivering insights from instructor perspective. "What matters" is a meta-category subsuming categories that stood out as potential themes, e.g. "direction," "ownership," "communication," "social relationships" and "trust." Data and categories were then discussed with the broader research team to uncover potential biases and allow for different interpretations. Iterations of axial coding, comparing and contrasting, for instance, diverging student perspectives, followed until ultimately a core category across all analyzed key phenomena was

identified which uncovered conflicts as a key facilitating factor of interpersonal competence development (figure 3).

4. Results

The central finding of this study is that interpersonal competence can be developed by learning through and from conflicts within a learning community. This does not mean that learning through and from conflicts are the only or primary ways of developing interpersonal competence, nor that conflicts per se foster interpersonal competence. The authors first present evidence on developed interpersonal competence and then the findings how it was developed.

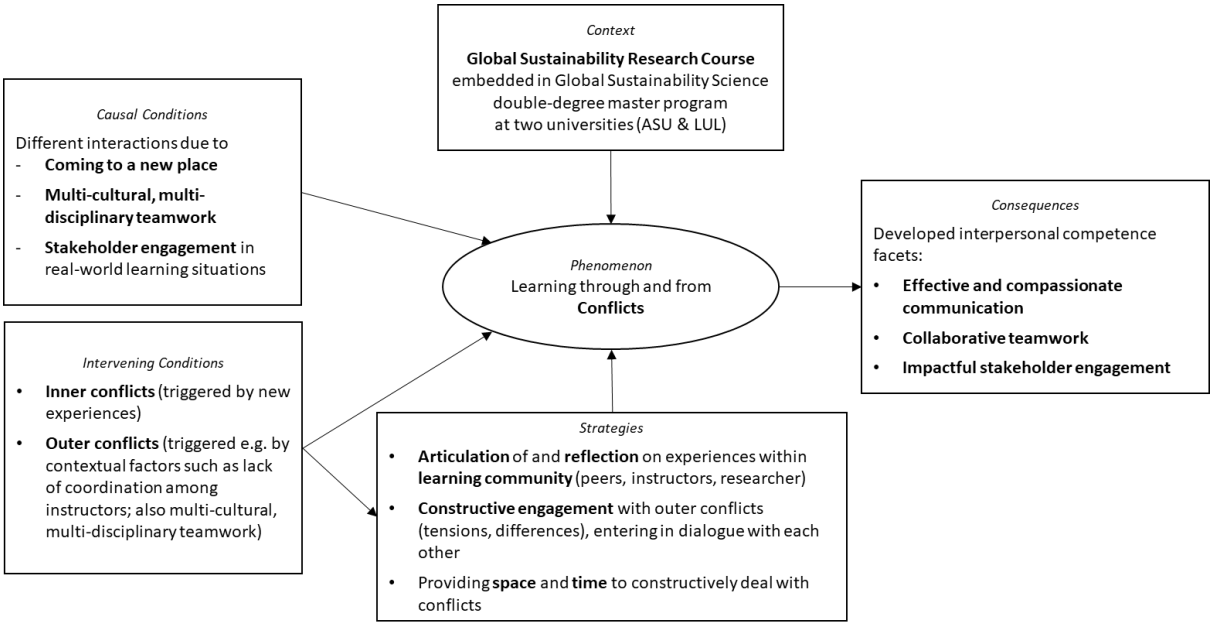

Figure 3: Selective coding map for "learning through and from conflicts," indicating context, causal and intervening conditions, strategies and consequences

4.1. Evidence of developed interpersonal competence

Students developed interpersonal competence, more specifically, skills in communication, teamwork and stakeholder engagement (Brundiers and Wiek, 2017). The authors present selective evidence for the main competence components, i.e. knowledge, skill and attitude (Wiek et al., 2011b).

That knowledge and skills of compassionate communication, corresponding to the learning objective of being "able to communicate with compassion," were gained is indicated in this student's statement:

> "Understand their perspectives, so meetings are more effective. So, if you get someone's perspective and you know that this is something that was bothering them, maybe they do not feel comfortable saying it. You can say it and you can say, 'Let's try to reassess this', and [...] I tried to do that a lot" (S1_011, focus group, November 30, 2017, line 267).

The learning objective of being "able to communicate with project supervisors on progress and milestones" needed a shift in attitude, which is demonstrated here:

> "We had this September crisis […]. But then after that […] I took a lot of ownership. […] I felt like I could […] take initiative on tasks and communicate that with the professor clearly, rather than waiting for him to tell us what we need to do. Just saying 'we are doing x, y and z

by this date', and saying it firmly and realizing that when we did that, he was like 'okay', and […] I felt like it worked." (S1_007, focus group, November 30, 2017, line 244).

That students gained a better understanding of collaborative teamwork, corresponding to the learning objective of being "able to conduct and contribute to effective team meetings," shows this student's reflection:

> "I learned how influential the group composition is […] I have worked […] in the project in two different groups with mostly similar compositions, but the second one worked so much better together than the first one. […] how the four of us complemented each other […] we have […] different approaches to do things, but we made it work together." (S1_002, focus group, November 30, 2017, line 104).

The following reflection shows that, beyond knowledge, students learned practical skills of being "able to critically review and improve teamwork processes":

> "We spent hours and it was frustrating […] but we got what people valued and wanted from this project and how we operate. So, we need breaks, we need food, we need time to relax. So, we were really on the same page with what we needed […] and I think that allowed us to have effective team meetings" (S1_011, focus group, November 30, 2017, line 249).

Students acquired knowledge of impactful stakeholder engagement through enabling them "to conduct walk-throughs and dry-runs in preparation of engagement events":

> "It was interesting to select which aspects of the [stakeholder] workshop we would do in the run through and in the dry run. And then we had intensive revisions directly after that and then more revisions when we got feedback from different […] experts on how they think it would be more helpful to stakeholders. […] It was interesting to be involved with the changes and have explanations for the challenges" (S1_006, focus group, November 30, 2017, line 284).

Students made progress on the learning objective of being "able to work well with external stakeholders, adopting good practices," which one student describes as follows:

> "I got a feel of what […] workshop engagement with people […] feels like and where you need to be very careful to spend the time smartly […], where you need to give them leeway to take longer […], of course, they do not behave the way you set it out to be. […] The question is how you can then spontaneously react to that, how can you still maintain a friendly atmosphere even though things are not going by your plan. The entire idea of pretesting a lot and that it needs so many 'hands on deck' is something that I think for me is beneficial from the GSR project" (S1_002, student interview, October 30, 2017, line 12).

The sequence of stakeholder engagement trainings created ultimately a positive attitude, as indicated here:

> "I feel prepared to take on this project not just because […] I have already experienced one that went well. So I see how something can go well and how a professionally developed game for this can be working, maybe I can reapply this to another context. […] I was in a situation I was not excited about being part of the AudaCity event, but in hindsight it was good". (S1_002, student interview, October 30, 2017, line 20).

4.2. How was interpersonal competence developed?

The phenomenon that explains interpersonal competence development in the present case study is learning through and from conflicts within a learning community. Different "mechanisms" how

learning and interpersonal competence development is facilitated (drivers) or obstructed (barriers) through arising conflicts, inner and outer ones (figure 4), were identified[25]. An inner conflict occurs when an individual's worldview or perspective is challenged by a divergent experience. Inner conflicts often express themselves in discomfort, frustration or perplexity on how to respond or react. One student articulated an inner conflict as follows: "Because of how this project is made up, it's messing with all of my personal dynamics" (S1_004, July 12, 2017, line 61). An outer conflict occurs when two or more individual's worldviews or perspectives collide. This collision or tension can trigger inner conflicts, too. The following quote indicates an outer conflict a student noticed: "We had this giant conflict in the end of last semester, and it's always there and […] I can't put a finger on what it is, it might just be personalities" (S1_004, student interview, November 7, 2017).

A critical factor in facilitating learning through and from conflicts is a supportive learning community, a group of people who share and discuss experiences (articulation and reflection), here including instructors, students and the external researcher of this study. Upstream drivers of conflict occurrence are key features of the course (particularly in terms of inner conflicts) as well as framing conditions determined by the program the course is embedded in and the institutional culture the program is embedded in (particularly in terms of outer conflicts). In the following, the "mechanisms" how learning, i.e. interpersonal competence development, is facilitated (4.2.1.) or obstructed (4.2.2.) through arising conflicts, as well as contextual factors of relevance (4.2.3.) are presented.

4.2.1. Interpersonal competence development via learning through and from conflicts (drivers)

Competence development via learning through inner conflicts

Multi-cultural and multidisciplinary teamwork, relocation to a new place and engagement with stakeholders were key features of the GSR course (see case description, Section 2), widely recognized by the participants (focus groups, student interviews, observations, instructor interviews). These experiences triggered inner conflicts as students were new to these activities and circumstances, or the experiences took place in a new context (e.g. stakeholder engagement experience in the USA versus in Germany) and appeared to be important intervening conditions (see figure 3). Students needed to reconcile new information with their existing knowledge base or to develop new skills not yet available in their repertoire.

Interpersonal competence was developed in that context if students positively approached inner conflicts and accepted the challenges they posed. Accepting the challenge of leaving one's comfort zone and the willingness to deal constructively with conflicts proved to be an important facilitating factor of interpersonal competence development. As one student put it:

> "it's very, very much out of my comfort zone to talk to strangers. […] I think I talked to like 40 or 50 people, and it was really exciting to just push myself to do that and then be somewhat successful. […] I would actually go to such an event again, if there was the opportunity." (S1_010, student interview, September 21, 2017, line 44).

Articulation of and reflection on these inner conflicts within a supportive learning community proved to be one important strategy to facilitate interpersonal competence development. Having a "safe space" to share challenging experiences is seen important for the learning process. Part of this learning community were also the instructors who facilitated "individual meetings […] where [students] reflect on […] where am I heading" (T_201, instructor interview, September 25, 2017, line

[25] Inner and outer conflicts are labeled differently in the literature, e.g., as intra- and interpersonal conflicts (Tjosvold et al., 2014, p. 547).

34) offering time and space to constructively deal with conflicts and for articulation and stimulating reflections.

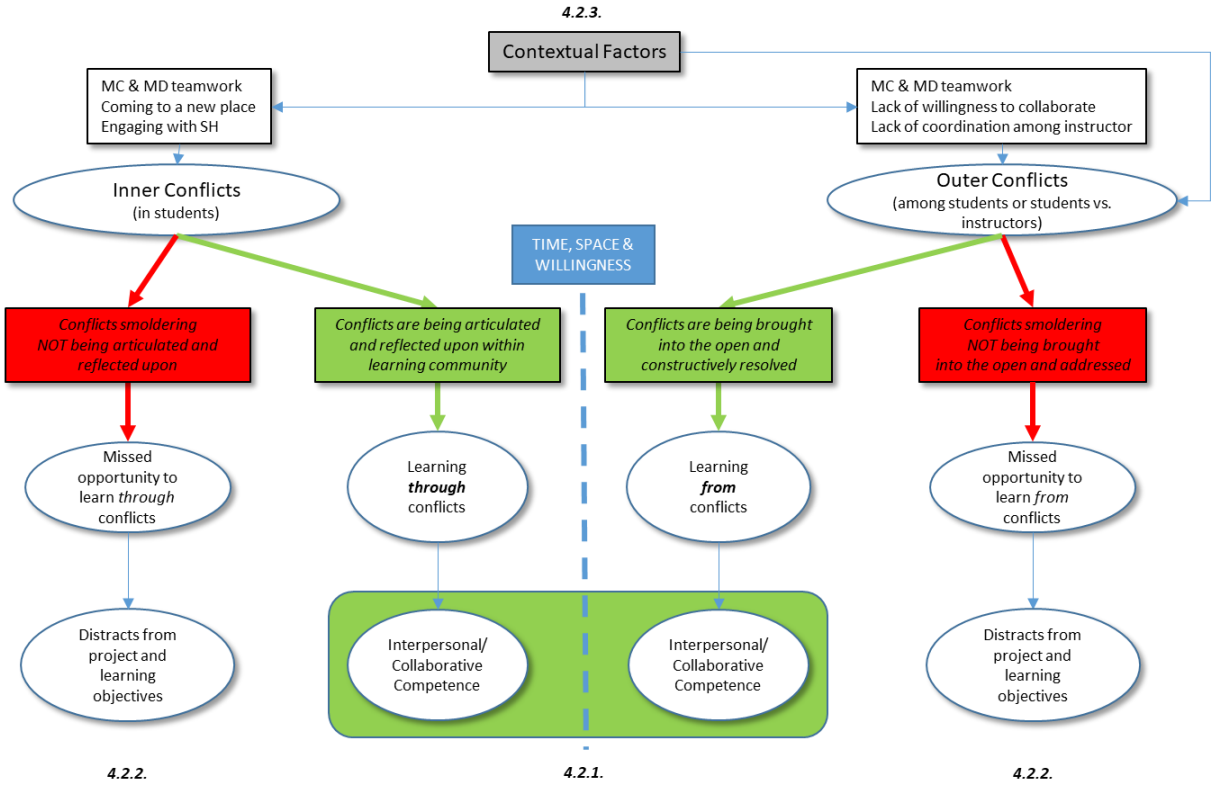

Figure 4: Overview of how learning, i.e. interpersonal competence development, was facilitated (center) or obstructed (left and right) through arising conflicts and contextual factors (top). ("MC andMD teamwork" =multicultural and multidisciplinary teamwork; "SH" = stakeholders)

Competence development via learning from outer conflicts

Interpersonal competence was also developed if outer conflicts were brought into the open and constructively addressed to reconcile conflicting perspectives. The authors first address outer conflicts among students, and then outer conflicts between students and instructors.

Multi-cultural and multi-disciplinary teamwork among students, in which diverse perspectives were articulated, triggered outer conflicts among students, at times. If an outer conflict was addressed with time and willingness to resolve or learn from it, interpersonal competence (teamwork, communication) was fostered in terms of trying to find common ground by talking empathically with each other, applying a solution-oriented attitude.

All instructor-led teamwork trainings (see case description, Section 2) aimed at developing students' interpersonal competence, in particular, collaborative teamworking skills. These sessions offered opportunities to reflect on and articulate encountered difficulties in a safe and mediated space, as well as experience and rehearse conflict resolution. Again, providing space and time to constructively deal with conflicts was experienced as a relevant strategy:

> "I always feel like their sessions are really helpful, when they gave us the chance to write down […] two situations where a conflict occurred and then in class we acted through […] hypothetical scenarios. […] They gave us the chance to talk about it, and it was a roleplay, so we had different roles and […] while we were playing, […] you could understand the other person." (S1_004, student interview, July 12, 2017, line 55).

Even in situations in which outer conflicts among students could not be resolved entirely, such instructor-led offerings as well as the student interviews with the external researcher brought outer conflicts into the open, stimulated reflection and facilitated learning by entering in dialogue with each other. One student described this learning journey as follows:

> "The project itself has been the most useful part. Even to learn how to deal with people, I mean, it's so complicated […]. I had to do teamwork before, during my first semester in the master's and during my bachelor's, but it was never this complicated. I don't know why, […] we're always having conflicts, we're always having issues during the meeting […], there is always drama now. Right now, I'm dealing with this close situation with another person of the team that I don't think I can work with, and I need to find out, how am I'm going to solve that. So, that's very useful too, like just what happens when I ever encounter a person like that in real life. Even in my dream job with this NGO, I'm […] fixing the world and everything and suddenly, boom, I run into this person I cannot work with." (S1_005, student interview, line 210, July 13, 2017).

Active conflict resolution between students and instructors can be seen as an important trigger to rebuilt mutual understanding and trust by actively listening to each other and engaging in honest dialogue. Active listening, empathy, willingness to change perspectives and openness to compromise are some of the interpersonal competence features that are demonstrated and witnessed on such occasions. While resolving conflicts offers learning opportunities for interpersonal (communication) competence development, it also allows students to refocus on the project to seize more learning opportunities for interpersonal competence development, which were before blocked by the smoldering conflict. One student made this link by stating that "checking in, making sure all voices are heard – is extremely beneficial. For the future, I hope we feel comfortable in talking to each other" (S1_011, observation, September 12, 2017, lines 94).

The conflict resolution, as well as follow-up conversations between students and instructors, prompted an attitude shift with increased motivation and project ownership on students' part. Newly introduced "Terms of Reference" were useful, too, indicating what the obligations and boundaries of the project were and defined the frame within students could take ownership. This shift was accompanied by interpersonal competence development such as articulating one's position and negotiating.

Similarly, some students demonstrated interpersonal competence by initiating a "Code of Conduct" session, clarifying roles for project conduct (observation, September 19, 2017, line 24). Communication and collaboration were improved, as one student stated: "I personally worked very well then with [the instructors] on getting this workshop done […] and I enjoyed that" (S1_002, focus group, November 30, 2017, line 242). The days before the final project event were, despite high workload, positively remembered as the team "united in purpose" (S1_009, Photovoice, November 30, 2017, line 86).

Learning interpersonal skills from outer conflicts might be more effective than conventional ways, as one student suggested: "Seeing what can go wrong and then how to handle it and how to move forward, I think, that's the biggest skill and the biggest thing that, I would say, the GSR project achieved and is still achieving" (S1_010, student interview, September 21, 2017, line 54). This shows that interpersonal competence is developed through contrasting procedures and the opportunity to reflect on them.

4.2.2. Missed opportunities to leverage conflicts for interpersonal competence development (barriers)

No, missed or delayed opportunities to leverage inner conflicts

Inner conflicts can trigger learning and competence development, but this is not always the case. Often, situations are not seen as an opportunity to leverage inner conflicts for learning, or an opportunity is not seized, or it is seized with delay.

Three main reasons blocked such learning in teamwork, relocation to a new place or involvement in stakeholder engagement activities: first, when students perceived themselves as already competent in the specific activities because of prior studies, jobs or internships; second, if students did not recognize or had the opportunity to develop competencies in that specific activity; and third, when students did not – willingly or not – seize an existing opportunity. One student, for example, who stated to have "facilitated plenty of times before" and was given the opportunity to facilitate at the main event (the "Grow Tempe" stakeholder workshop) thought that another student might have benefited more from such an opportunity (observation, November 15, 2017, line 581). Another student, who was not assigned a (co-)facilitator role at this stakeholder event, articulated this as a missed opportunity to develop his/her interpersonal skills further "in terms of speaking more slowly [and] engaging people that want to participate that are quiet" (S1_001, student interview, December 01, 2017, lines 67, 69).

Some opportunities for leveraging inner conflicts for interpersonal competence development were seized only with delay. Here, reasons were a lack of reflection and/or support in seizing these opportunities. Collective reflections on the first two stakeholder engagement events helped students to make meaning of their experiences and resolve inner conflicts. One student explained: "[The instructor] explained a lot and that helped me to understand [the instructors'] objective and how [and] where we come in the picture […] It would be nice to have a briefing before: this is what we want to do and why we want to do it and how you can learn from it" (S1_004, student interview, November 07, 2017, lines 77-79). However, it would be misleading to consider more explanations from course instructors as the "silver bullet" in these situations.

The course's direction, goals and learning objectives were stated in the course syllabus and regularly repeated by course instructors as well as specified for activities and events. Yet, students still struggled with internalizing them – which, in return, led to frustration on both sides. Trust among students and instructors, timing of interactions, openness/willingness, sufficient processing time and iterations seem to be critical for resolving such inner and outer conflicts – and for facilitating interpersonal competence development.

Effects of smoldering outer conflicts

Outer conflicts also can pose barriers to learning, if they are not addressed directly. If they are left smoldering, because of a lack of time, space and/or willingness, they cause distraction from the project and the learning objectives. Smoldering outer conflicts lead to frustration, withdrawal or low motivation and negatively impact group dynamics and project progress.

These effects became visible in a major outer conflict between students and instructors. The conflict can be understood as a cascading effect from insufficient coordination among instructors at the beginning, leading to inconsistency in course delivery, and eventually resulting in low student engagement with and ownership of the project. This situation negatively affected motivation and decreased self-efficacy to work on the project. One student explained: "It is very hard to give

meaningful input into a group when you do not know what the goal is, where we are heading. So, I think having a goal really helps to increase the meaningful input and also a little bit more motivation" (S1_007, focus group, November 30, 2017, line 194). While this conflict was smoldering, students waited for and followed instructions rather than showing initiative and creativity.

4.2.3. Contextual factors that trigger conflicts

The authors have presented evidence that occurring conflicts can offer learning opportunities for interpersonal competence development, if brought to the open and sufficiently addressed. However, conflicts not addressed at the source can spin out of control and create significant damage. It is worth exploring the sources of the main conflicts encountered in the GSR project course to get a sense for the influence of contextual factors.

The key objective of the GSR project course was to teach graduate students how to conduct solution-oriented sustainability research in real-world settings. The way this objective was pursued was by embedding it into ongoing international research projects and adopting a project-based learning approach (see Section 2 above). One instructor described it as follows to the students: "You were brought into a living project to see what it looks like from the inside, to know what it is like" (observation, September 12, 2017, lines 71-72). While such a setting allows students to witness and participate in sustainability project development and execution "in real time," it also comes at some cost. Namely, this objective was not always matched with students' and/or instructors' expectations and attitudes, which led to conflicts.

First, the instructors shared the opinion that the workload for teaching project-based learning courses is often underestimated and "not […] compatible with other things that you are doing" (T_203, instructor interview, September 05, 2017, line 98). One instructor stated: "I am really surprised how often even very experienced people, including myself, are underestimating how much time it costs, how much effort it costs, and how much attention is necessary to make that a really good course" (T_006, instructor interview, August 24, 2017, line 111). This situation was aggravated by the lower priority that teaching efforts receive at research universities (T_204, instructor interview, July 20, 2017, lines 82-90), which can negatively affect instructor investment and motivation (Observation, September 12, 2017, lines 40-41). One instructor stated that she/he tried "to build basically the GSR course in a way […] that it really fits into lines with my other research efforts" (T_006 instructor interview, August 24, 2017, line 103). In contrast, another instructor suggested that "in this kind of projects, one should care more about the teaching effort itself and really prioritize that" (T_204, instructor interview, July 20, 2017, lines 82-90).

Second, there were different perceptions on ownership. Students sometimes struggled with the course being embedded in evolving research projects, making the course instructors and principal investigators the "owners" of the project. Some students felt "it was hard to know […] at what point […] are we in control and have ownership over this project and at what point do we look to […] a professor for guidance" (S1_007, focus group, July 30, 2017, line 109). One of the instructors discussed with the students the adopted model and emphasized the importance of "frames" in project-based learning as a means to prepare for professional careers: "The first 10 years, you'll be working, you'll always have frames to work within. […] Being a professional is taking these frames and working within them" (T_006, observation, September 12, 2017, line 44). In the post-course focus group, a student shared this view, describing as his/her lesson learned fromthe GSR course:

> "Not seeing the immediate results of your work, or in teamwork is […] difficult. Somebody has to delegate something to you […] and you have to just do it. And you might not understand exactly what you are doing, you might not feel happy about it, but that is the reality of the workspace. […] I cannot expect just because I have a master's now to go there and they must give me a nice job. I am going to have to do [work] at the bottom, and I am not going to like it […] [It] is going to take a while, maybe a few years, to get to a point. I think this was valuable for that." (S1_008, focus group, lines 115, 124, 129).

Most students were used to more conventional education models and needed to learn that project ownership has various facets, evolves over time and that they are, after all, responsible for their learning.

Third, the team-teaching setting increased the course complexity, too, demanding time for coordination across different schedules and responsibilities. One instructor explained: "There is a lot of coordination required, and for this we need time" (T_006, instructor interview, August 24, 2017, line 91). The more people involved, the harder it is to get "on the same page" and aligning "the interest of all instructors," especially under time constraints (T_203, instructor interview, September 05, 2017, line 146). For the GSR project course, spanning over three semesters, insufficient coordination at the beginning had a cascading effect, as described above.

Fourth, a project-based learning course of this nature carries uncertainties. While a certain level of uncertainty is inevitable, it poses a challenge to teaching and learning. This uncertainty, however, is also inherent in solution-oriented sustainability projects that seek out opportunities to maximize impact. As such, the broader project and, by extension, the GSR project course needed to be "opportunistic" (T_006, observation, September 12, 2017, line 88). One instructor described his/her education vision as follows:

> "We need to look more strategically for opportunities for our students to have an impact. That is the reason why we improvise now at the beginning of Module 4, because the opportunity is tremendous. That they can actually witness and [do] participant observation of such a stakeholder event here in Tempe is a wonderful opportunity. Seizing these opportunities, that is my big vision. […] Real-world opportunities should guide what we are offering." (T_006, instructor interview, August 24, 2017, line 35).

This constellation of factors, representing challenges as well as opportunities, provided a fertile breeding ground for conflicts. The compiled evidence from this study offers points for reflection on how to prevent conflicts at the source as well as how to leverage conflicts for students' interpersonal competence development.

5. Discussion

Interpersonal competence is a critical success factor for advancing sustainability. Yet, the evidence for how to best develop interpersonal competence is still fairly thin. Previous studies have suggested that project-based learning settings are conducive for developing interpersonal competence (Heiskanen et al., 2016; Hilser, 2016; Zemler, 2016). While these studies specified some of the interpersonal skills that are being developed, they did not unpack the specifics of the teaching and learning processes.

Most notably, the authors found that inner and outer conflicts, if brought to the open and sufficiently addressed, offer prime learning opportunities to develop interpersonal competence, e.g. through active listening, articulating experiences, expectations and/or feelings, negotiating, discussing,

compromising, conflict resolution and so forth. More indirectly, resolving inner and outer conflicts also allows to pursue further learning opportunities, which are often blocked by smoldering conflicts.
These findings align with pertinent learning theories. Kolb and Kolb (2005, 194) assert in their experiential learning theory that "learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world." This is what this study referred to as constructively dealing with inner conflicts. Similarly, other empirical studies point to "identify and overcome barriers" (Steinemann, 2003, p. 219), "manage conflict" (Jarchow et al., 2018, p. 550) and "deal with troublesome experiences" (Fortune et al., 2019, p. 61). Also, the theory of cognitive dissonance (Festinger, 1957) describes strategies of decreasing psychological discomfort – here referred to as inner conflicts – allowing for learning processes.
Tjosvold (1991) asserts that "avoiding conflicts does not make problems disappear, but allows them to linger and fester, and then emerge in more divisive ways" (Tjosvold, 1991, p. 5). "Conflict-positive" attitude is needed for realizing the educational potential of conflicts. Johnson and Johnson (1979, pp. 51-52) assert that by "avoiding and suppressing […] conflicts teachers lose valuable opportunities to increase student motivation, creative insight, cognitive development, and learning. Conflicts have the potential for producing both highly constructive or highly destructive outcomes, depending on how they are managed." Savage et al. (2015), Steinemann (2003) and others actively accounted for reflection time and activities in their courses to allow to deal with experiences, including conflicts. Such reflection opportunities were provided in the GSR project course, in part facilitated through the external researcher, and appreciated by students. Outer conflicts, as demonstrated by this study, need to go beyond individual reflection and be openly addressed within the learning community. As conflicts are inevitable within complex teaching and learning formats such as project-based learning courses what matters is how these conflicts are being addressed.
Other empirical studies that found interpersonal competence development to happen in project-based learning courses already called for further introduction of "tools for interpersonal and intergroup communication, conflict management, and critical reflection and dialogue" (Zemler, 2016, p. 67). Also, Hilser (2016) suggested that potential insufficient preparation for conflict management, how to deal with differences resulting out of the diverse student backgrounds, can cause difficulties which then rather act as barriers than drivers of interpersonal competence development. Based on the findings of this study, harvesting conflicts for competence development requires first a shift of perspective, recognizing conflicts as "part of the solution" (Tjosvold, 1991, p. 3), namely, as unique and effective learning opportunities. This study showed how the conduct of a conflict resolution circle became a game changer for the GSR project course because of improved team dynamics and enhanced interpersonal skills. Referring back to the intention to support the creation of meaningful learning environments (Barth, 2015, p. 87), the authors suggest the following conflict-embracing attitude to harvest learning processes:

- identifying conflicts at the source;
- accepting conflicts as challenges to be overcome before they get out of control;
- embracing conflicts as learning opportunities; and
- recognizing the learning outcomes.

The potential of conflicts for interpersonal competence development is high but should not be overstated. The GSR project course offered various other opportunities to develop interpersonal competence and showed many overlaps with Collins et al.'s (1987) cognitive apprenticeship model. The course offered students first to observe what experts model in the field, which allowed students

to create a mental model of what an impactful stakeholder engagement event looks like. On this base, instructors and students engaged in a coaching, scaffolding relationship, in which the instructor, as needed, guided students toward independent task performance. For interpersonal competence development, this study suggests linking such a sequencing model with creating additional educational opportunities by leveraging conflicts.

A limitation of this study is the fairly brief elaboration on contextual factors. Recent studies (Backman et al., 2019; Kricsfalusy et al., 2018; Tejedor et al., 2019) as well as previous studies (Brundiers et al., 2010; Brundiers and Wiek, 2013; Steinemann, 2003; Wiek et al., 2014) point in the direction of needed institutional changes for benefits on the course level. This study supports, yet, does not detail the changes necessary. Another limitation is the lack of an appropriate assessment that would have more precisely captured students' competence facets and levels (pre- and post-course). Further, this study would benefit from a comparison to other empirical case studies, which, however, requires application of a similar empirical framework (Redman et al., 2019).

6. Conclusions

Communication, teamwork and stakeholder engagement are widely recognized as important success factors for advancing sustainability. This research provides evidence for how interpersonal competence is being developed, with a focus on learning through and from conflicts. Ignoring conflicts neither makes them disappear nor seizes the presented learning opportunities. Instead, smoldering conflicts absorb emotional energy and attention, negatively impacting learning and project progress. In contrast, conflicts can facilitate interpersonal competence development: if their number is not overwhelmingly high, if cascading effects are not spreading out of control, if they are being accepted once present, if they are embraced as effective learning opportunities and addressed with sufficient time and the right means and if they are being reflected upon through the lens of learning outcomes. Open communication within a trusted learning community that supports articulation of and reflection on conflicts is conducive to leveraging inner and outer conflicts for interpersonal competence development. Course design should take advantage of established project-based learning pedagogies such as sequencing training sessions. Institutional factors such as prioritizing and supporting engaged learning settings can further enhance the chances that such opportunities are being recognized and leveraged to the benefit of the students. Future research needs to find more pragmatic and economical ways of assessing interpersonal competence development and tracking of learning pathways.

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References

Backman, M., Pitt, H., Marsden, T., Mehmood, A. and Mathijs, E. (2019), "Experiential approaches to sustainability education: towards learning landscapes", *International Journal of Sustainability in Higher Education*, Vol. 20 No. 1, pp. 139–156.

Barth, M. (2015), *Implementing Sustainability in Higher Education: Learning in an Age of Transformation*, Routledge.

Barth, M. and Thomas, I. (2012), "Synthesising case-study research – ready for the next step?", *Environmental Education Research*, Vol. 18 No. 6, pp. 751–764.

Brundiers, K. and Wiek, A. (2013), "Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability", *Sustainability*, Vol. 5 No. 4, pp. 1725–1746.

Brundiers, K. and Wiek, A. (2017), "Beyond Interpersonal Competence. Teaching and Learning Professional Skills in Sustainability", *Education Sciences*, Vol. 7 No. 1.

Brundiers, K., Wiek, A. and Redman, C.L. (2010), "Real-world learning opportunities in sustainability: from classroom into the real world", *International Journal of Sustainability in Higher Education*, Vol. 11 No. 4, pp. 308–324.

Caniglia, G., John, B., Bellina, L., Lang, D.J., Wiek, A., Cohmer, S. and Laubichler, M.D. (2018), "The glocal curriculum. A model for transnational collaboration in higher education for sustainable development", *Journal of Cleaner Production*, Vol. 171, pp. 368–376.

Caniglia, G., John, B., Kohler, M., Bellina, L., Wiek, A., Rojas, C., Laubichler, M.D. and Lang, D. (2016), "An experience-based learning framework", *International Journal of Sustainability in Higher Education*, Vol. 17 No. 6, pp. 827–852.

Chio, V.C.M. and Fandt, P.M. (2007), "Photovoice in the Diversity Classroom. Engagement, Voice, and the "Eye/I" of the Camera", *Journal of Management Education*, Vol. 31 No. 4, pp. 484–504.

Ciolan, L. and Manasia, L. (2017), "Reframing Photovoice to Boost Its Potential for Learning Research", *International Journal of Qualitative Methods*, Vol. 16 No. 1, 160940691770290.

Clevenger, C.M. and Ozbek, M.E. (2013), "Service-Learning Assessment. Sustainability Competencies in Construction Education", *Journal of Construction Engineering and Management*, Vol. 139 No. 12, A4013010.

Collins, A., Brown, J.S. and Newman, S.E. (1987), "Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics. Technical Report 403".

Cook, K. and Quigley, C. (2013), "Connecting to Our Community. Utilizing Photovoice as a Pedagogical Tool to Connect College Students to Science", *International Journal of Environmental and Science Education*, Vol. 8 No. 2, pp. 339–357.

Corbin, J. and Strauss, A. (1990), "Grounded Theory Research: Procedures, Canons and Evaluative Criteria", *Zeitschrift für Soziologie*, Vol. 19 No. 6, pp. 418–427.

Corcoran, P.B., Walker, K.E. and Wals, A.E.J. (2004), "Case studies, make-your-case studies, and case stories: a critique of case-study methodology in sustainability in higher education", *Environmental Education Research*, Vol. 10 No. 1, pp. 7–21.

Creswell, J.W. and Clark, V.L.P. (2017), *Designing and conducting mixed methods research*, SAGE Publications.

Emerson, R.M., Fretz, R.I. and Shaw, L.L. (2001/2007), "Participant Observation and Fieldnotes", in Atkinson, P., Coffey, Amanda, Delamont, S., Lofland, J. and Lofland, L. (Eds.), *Handbook of Ethnography*, SAGE.

Festinger, L. (1957), *A Theory of Cognitive Dissonance*, Stanford University Press, Stanford, California.

Fortune, T., Borkovic, S., Bhopti, A., Somoza, R., Nhan, H.C. and Rangwala, S. (2019), "Transformative Learning Through International Project-Based Learning in the Global South: Applying a Students-

as-Partners Lens to a “High-Impact” Capstone”, *Journal of Studies in International Education*, Vol. 23 No. 1, pp. 49–65.

Heiskanen, E., Thidell, Å. and Rodhe, H. (2016), “Educating sustainability change agents. The importance of practical skills and experience”, *Journal of Cleaner Production*, Vol. 123, pp. 218–226.

Hilser, S. (2016), “Key Competencies to Action. Transdisciplinary Learning of Key Competencies for Sustainability”, Master Thesis, LUCSUS, Lund University, Lund, 2016.

Jarchow, M.E., Formisano, P., Nordyke, S. and Sayre, M. (2018), “Measuring longitudinal student performance on student learning outcomes in sustainability education”, *International Journal of Sustainability in Higher Education*, Vol. 19 No. 3, pp. 547–565.

Johnson, D.W. and Johnson, R.T. (1979), “Conflict in the Classroom: Controversy and Learning”, *Review of Educational Research*, Vol. 49 No. 1, pp. 51–70.

Kolb, A.Y. and Kolb, D.A. (2005), “Learning Styles and Learning Spaces. Enhancing Experiental Learning in Higher Education”, *Academy of Management Learning & Education,*, Vol. 2, pp. 193-212.

Kricsfalusy, V., George, C. and Reed, M.G. (2018), “Integrating problem- and project-based learning opportunities:. assessing outcomes of a field course in environment and sustainability”, *Environmental Education Research*, Vol. 24 No. 4, pp. 593–610.

Lang, D.J., Wiek, A., Luederitz, C., Wehrden, H. von and Laubichler, M. (2016), *Bridging the Great Divide in Sustainability Science: Linking High-Performance Modeling and Transition Experiments to Foster Transformational Change towards Sustainability.*, Project Proposal. Center for Global Sustainability and Cultural Transformation, Leuphana University of Luneburg, Luneburg, Germany and Arizona State University, Tempe.

Lang, D.J., Wiek, A. and Wehrden, H. von (2017), “Bridging divides in sustainability science”, *Sustainability Science*, Vol. 12 No. 6, pp. 875–879.

May, T. (2011), *Social research: Issues, methods and process,* 4th ed., Open University Press, Buckingham, Philadelphia.

Perez Salgado, F., Abbott, D. and Wilson, G. (2018), “Dimensions of professional competences for interventions towards sustainability”, *Sustainability science*, Vol. 13 No. 1, pp. 163–177.

Redman, A., Wiek, A., Barth, M. and Timm, J. (2019), *Generating generalizable insights from case studies on competencies-oriented sustainability education.*, Working Paper, Center for Global Sustainability and Cultural Transformation, Lüneburg, Germany and Tempe, AZ, USA.

Savage, E., Tapics, T., Evarts, J., Wilson, J. and Tirone, S. (2015), “Experiential learning for sustainability leadership in higher education”, *International Journal of Sustainability in Higher Education*, Vol. 16 No. 5, pp. 692–705.

Segalas, J. and Tejedor, G. (2016), *Transdisciplinarity Action Research workshop for sustainable technology communities: Research Institute for Sustainability Science and Technology, Universitat Politècnica de Catalunya - Barcelona Tech, Spain*, Engineering Education for Sustainable Development (4-7 September 2016, Bruges, Belgium).

Stauffacher, M., Walter, A.I., Lang, D.J., Wiek, A. and Scholz, R.W. (2006), “Learning to research environmental problems from a functional socio-cultural constructivism perspective. The transdisciplinary case study approach”, *International Journal of Sustainability in Higher Education*, Vol. 7 No. 3, pp. 252–275.

Steinemann, A. (2003), “Implementing Sustainable Development through Problem-Based Learning”, *JOURNAL OF PROFESSIONAL ISSUES IN ENGINEERING EDUCATION AND PRACTICE*, pp. 216–224.

Tejedor, G., Segalàs, J., Barrón, Á., Fernández-Morilla, M., Fuertes, M., Ruiz-Morales, J., Gutiérrez, I., García-González, E., Aramburuzabala, P. and Hernández, À. (2019), “Didactic Strategies to Promote Competencies in Sustainability”, *Sustainability*, Vol. 11 No. 7, p. 2086.

Thomas, I. (2009), “Critical Thinking, Transformative Learning, Sustainable Education, and Problem-Based Learning in Universities”, *Journal of Transformative Education*, Vol. 7 No. 3, pp. 245–264.

Tjosvold, D. (1991), *The Conflict-Positive Organization: Stimulate Diversity and Create Unity*, Addison-Wesley Series on Organizational Development.

Tjosvold, D., Wong, A. and Chen, N.Y.-F. (2014), “Cooperative and competitive conflict management in organizations”, in *Annual Review of Organizational Psychology and Organizational Behavior*, Vol. 1, pp. 545–568.

Wals, A.E.J. and Corcoran, P.B. (2012), “Re-orienting, re-connecting and re-imagining: learning-based responses to the challenge of (un)sustainability”, in Wals, A.E.J. and Corcoran, P.B. (Eds.), *Learning for sustainability in times of accelerating change*.

Wals, A.E.J. and van der Leij, T. (2009), “Introduction”, in Wals, A.E.J. (Ed.), *Social learning towards a sustainable world: Principles, perspectives, and praxis*, pp. 17–32.

Wang, C. and Burris, M.A. (1997), “Photovoice: Concept, Methodology, and Use for Participatory Needs Assessment”, *Health Education & Behavior*, Vol. 24 No. 3, pp. 369–387.

Wiek, A., Bernstein, M.J., Laubichler, M., Caniglia, G., Minteer, B. and Lang, D.J. (2013), “A Global Classroom for International Sustainability Education”, *Creative Education*, Vol. 04 No. 04, pp. 19–28.

Wiek, A., Forrest, N. and et al. (2017), “Building Implementation Capacity for a Sustainable Local Food Economy through a Mobile Solution Theater. Project Report. Center for Global Sustainability and Cultural Transformation, Arizona State University and Leuphana University of Lüneburg.”.

Wiek, A. and Lang, D.J. (2017), “The Mobile Solution Theater for Sustainability - Functions and Structure. Working Paper. Center for Global Sustainability and Cultural Transformation, Arizona State University and Leuphana University of Lüneburg.”.

Wiek, A., Withycombe, L., Redman, C. and Mills, S.B. (2011a), “Moving Forward on Competence in Sustainability Research and Problem Solving”, *Environment: Science and Policy for Sustainable Development*, Vol. 53 No. 2, pp. 3–13.

Wiek, A., Withycombe, L. and Redman, C.L. (2011b), “Key competencies in sustainability. A reference framework for academic program development”, *Sustainability Science*, Vol. 6 No. 2, pp. 203–218.

Wiek, A., Xiong, A., Brundiers, K. and van der Leeuw, S. (2014), “Integrating problem- and project-based learning into sustainability programs”, *International Journal of Sustainability in Higher Education*, Vol. 15 No. 4, pp. 431–449.

Withycombe Keeler, L., Beaudoin, F., Lerner, A., John, B., Beecroft, R., Tamm, K., Wiek, A. and Lang, D. (2018), “Transferring Sustainability Solutions across Contexts through City–University Partnerships”, *Sustainability*, Vol. 10 No. 9, p. 2966.

Withycombe Keeler, L., Beaudoin, F., Wiek, A., John, B., Lerner, A.M., Beecroft, R., Tamm, K., Seebacher, A., Lang, D.J., Kay, B. and Forrest, N. (2019), “Building actor-centric transformative capacity through city-university partnerships”, *Ambio*, Vol. 48 No. 5, pp. 529–538.

Yin, R.K. (1984), *Case Study Research: Design and Methods*, SAGE Publications.

Zemler, L. (2016), “The convergence of societal advancement and the education of future sustainability professionals: a solution-oriented approach to place-based environmental challenges. A descriptive case study of the Master’s course ‘Strategic Environmental Development’ of Lund University, Sweden”, Master Thesis, Lund, 2016.

"Teaching is a performative act. (…) To embrace the performative aspect of teaching we are compelled to engage 'audiences,' to consider issues of reciprocity. Teachers are not performers in the traditional sense of the word in that our work is not meant to be a spectacle. Yet it is meant to serve as a catalyst that calls everyone to become more and more engaged, to become active participants in learning."

(hooks, 1994)

5.2. Learning Processes for Interpersonal Competence Development in Project-Based Sustainability Courses – Insights from a Comparative International Study

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Abstract

Purpose – For professional sustainability work, graduates need to be able to work in teams and collaborate with stakeholders; in other words, they need to have developed interpersonal competence. There is growing evidence that project-based sustainability courses facilitate interpersonal competence development. However, research so far has focused on single case studies and on assessing learning outcomes. The purpose of this study is to deepen the understanding of how graduate students learn interpersonal competence in project-based sustainability courses.

Design/methodology/approach – This study adopts a multi-case study approach triangulating observations, semi-structured interviews and focus groups supported by Photovoice method. A comparison of three project-based sustainability courses in graduate programs at universities in the USA, Germany, Switzerland and Spain is conducted to gain generalizable insights on how interpersonal competence can be developed through project-based sustainability courses.

Findings – Receiving inputs, experiencing, reflecting and experimenting are four learning processes supportive of interpersonal competence development. Interpersonal attitudes seem to be mostly learned through a combination of experiencing and reflecting, followed by experimenting; not surprisingly, interpersonal knowledge is mostly developed through a combination of receiving inputs, experiencing and (collective) reflection; and interpersonal skills seem to be mostly learned through a combination of receiving inputs and experimenting, or, more directly, experiencing and experimenting.

Practical implications – These findings support the unique learning opportunities offered through project-based sustainability courses and can help instructors to better facilitate students' development of interpersonal competence.

Originality/value – The value of this study is three-fold: (i) it provides a comprehensive picture of interpersonal competence, including attitudes, knowledge, and skills; (ii) it spells out specific teaching and learning processes; and (iii) it links these to specific interpersonal competence facets and components.

Keywords Experiential learning, Sustainability education, Project-based learning, Teaching and learning processes, Interpersonal competence, Multi-case analysis

Paper type Research paper

1. Introduction

Interpersonal competence is widely recognized as a key competence in sustainability (Brundiers and Wiek, 2017; Konrad et al., 2020; Molderez and Fonseca, 2018; Noble et al., 2017; Soini et al., 2019; Wiek et al., 2011). The abilities to collaborate with people from different cultural and disciplinary backgrounds; to engage, motivate and learn from others; to understand others' perspectives and find compromises; to establish and maintain trust in teams; to resolve conflicts among diverse stakeholders; etc. – are all important for solving sustainability problems and advancing sustainability worldwide (Bickford and Wright, 2006; Činčera et al., 2019; Di Giulio and Defila, 2017; Evans, 2015; Fam et al., 2019; Freeth and Caniglia, 2020; Giangrande et al., 2019; Gulikers and Oonk, 2019). Universities play a key role in equipping students with such interpersonal attitudes, knowledge and skills (Gulikers and Oonk, 2019; Hernández-Barco et al., 2020; Thomas, 2009; Wiek et al., 2011). Project-based learning approaches have been demonstrated to develop students' key competencies in sustainability in general (Azeiteiro et al., 2015; Barth, 2015; Tejedor et al., 2019; Wiek et al., 2014) and interpersonal competence in particular (Birdman et al., 2020; Blumenfeld et al., 1991; Brundiers et al., 2010; Brundiers and Wiek, 2013), in both, graduate (Konrad et al., 2020; Molderez and Fonseca, 2018; Oxenswärdh and Persson-Fischier, 2020; Soini et al., 2019) and undergraduate courses (Caniglia et al., 2016; Skinner et al., 2016). Despite these findings, project-based learning for interpersonal competence development is still in need of further exploration (Earl et al., 2018). First, there is a need for in-depth studies of the learning process – "impartial research where students' individual experiences […] are studied in-depth, […] investigating the multitude of influences on their learning" (Backman et al., 2019, p. 149). Ideally, such studies ought to capture both learning outcomes and processes as well as link them and consider context conditions (Molderez and Fonseca, 2018; Müller et al., 2020). Second, there is a need to go beyond unpacking the development of the knowledge (cognitive) component of interpersonal competence, paying attention also to interpersonal attitude, i.e. the affective dimension (Soini et al., 2019). Third, findings from single case studies need to be validated through comparative studies across multiple cases (Konrad et al., 2020).

Thus, the research question of this comparative study is: *How do students develop interpersonal competence, as one of the key competencies in sustainability, in project-based learning sustainability courses?*

The objective is to achieve a more complete understanding of *how* students develop all facets of interpersonal competence, including interpersonal attitudes, knowledge and skills, in project-based learning settings. We present findings from a comparative multi-case study on three graduate-level sustainability courses (at four universities) that adopted project-based learning approaches, comparing and contrasting these cases. The findings can help course designers, instructors and students in improving teaching and learning of interpersonal competence.

2. Theoretical framing and state of research

This study investigates the development of interpersonal competence, as a key competence in sustainability, through project-based learning. The project-based learning approach was already described decades ago (Blumenfeld et al., 1991; DeFillippi, 2001) and has been adopted to sustainability education (Brundiers et al., 2010; Cörvers et al., 2016; Wiek et al., 2014). Project-based learning uses "real-world work assignments on time-limited projects to achieve mandated performance objectives and to facilitate individual and collective learning" (DeFillippi, 2001, p. 6). It

shifts students' learning from passive to active as students develop solutions to real-world problems, collaborating in multi-disciplinary teams and engaging with external stakeholders, supported by instructors as coaches (Brundiers and Wiek, 2013; Segalàs and Tejedor, 2016; Soini et al., 2019; Stauffacher et al., 2006; Wiek and Kay, 2015). Project-based learning pedagogy aligns with experiential learning theory (Kolb and Kolb, 2012), social learning theory (Wals et al., 2009) and the theory of staged self-directed learning (Grow, 1991/1996; Ryan and Deci, 2000). Key competencies in sustainability are defined as "complexes of knowledge, skills, and attitudes that enable successful task performance and problem-solving with respect to real-world sustainability problems, challenges, and opportunities" (Wiek et al., 2011, p. 204). Based on a broad literature review, Wiek et al. (2011) synthesized a framework of key competencies in sustainability, which identifies the interplay of systems thinking, futures thinking, values thinking, strategic thinking and interpersonal competence as essential for sustainability problem-solving. Since its inception, this framework has been broadly confirmed in the literature (Redman and Wiek, 2020) and through a recent expert Delphi study (Brundiers et al., 2020). Brundiers et al. (2020) suggest complementing this framework by integrating intrapersonal competence, emphasizing normative thinking to develop genuine sustainability competence and a few other components.

There is growing evidence that these competencies can best be acquired and developed through performance-oriented learning settings such as project-based learning (Barth, 2015; Birdman et al., 2020; Brundiers et al., 2010; Konrad et al., 2020). Interpersonal competence can be structured into competence in collaborative teamwork and competence in impactful stakeholder engagement (Brundiers and Wiek, 2017; Wiek et al., 2011). Collaborative teamwork is "the process when people engage in utilizing different and complementary types of expertise, skills, and attitudes to complete a task" and "results in high-quality task delivery […] by co-creating a stimulating and healthy work environment" (Brundiers and Wiek, 2017, p. 5). Impactful stakeholder engagement is an interpersonal competence facet specific to sustainability and goes beyond conventional interpersonal competence concepts (Buhrmester et al., 1988). It is "the collaboration between sustainability professionals and people who have a stake in the process and outcomes of a given project" and "yield[s] task outcomes like quality project deliverables that have been informed by a plurality of views and are broadly accepted, as well as social outcomes including new perspectives, relationships and built capacity" (Brundiers and Wiek, 2017, p. 6).

Studies by Clevenger and Ozbek (2013), Savage et al. (2015), Hilser (2016), Zemler (2016), Heiskanen et al. (2016), Kricsfalusy et al. (2018), Molderez and Fonseca (2018), Soini et al. (2019), Roy et al. (2020), Konrad et al. (2020) and Oxenswärdh and Persson-Fischier (2020) suggest that students develop interpersonal competence in a number of educational settings, mostly in project-based learning settings. These studies rely, for the most part, on students' self-assessments. There are a few attempts of linking learning outcomes, processes and environment. Lozano et al. (2017) contributed with the linkage of certain competencies to pedagogical approaches, from case studies to community service learning. Studies (master theses) by Hilser (2016) and Zemler (2016) empirically identified learning activities for interpersonal competence development such as team building, networking, presentations and project fairs. Roy et al. (2020) identified collaborative competence, including leadership and communication skills, being developed through hands-on collaborations with peers and stakeholders, combined with discussion and intrapersonal reflection. Similarly, Soini et al. (2019) identified interpersonal competence, specifically students' ability to position their own perspective in relation to others and communication across different cultural and academic backgrounds, being facilitated through project experience and reflection. Konrad et al.

(2020) empirically confirm that project-based learning courses develop interpersonal competence, identifying conflicts to be a trigger for learning processes. For learning success, however, there needs to be time, space and willingness to constructively engage with these conflicts (Fam et al., 2019; Konrad et al., 2020; Walker and Daniels, 2019). Oxenswärdh and Persson-Fischier (2020) also mention the common occurrence of conflicts in group collaboration, while highlighting the creative potential such settings offer. The interaction with stakeholders presents another potential source of conflicts and thus provides opportunities for developing interpersonal competence. Oxenswärdh and Persson-Fischier (2020) differentiate affective (e.g. identification with the team), cognitive (learning and innovation) and behavioral interpersonal skills. Similar to Konrad et al. (2020) sufficient time is highlighted as important success factor for interpersonal competence development. While Oxenswärdh and Persson-Fischier (2020) offer detailed insights on interpersonal competence development, they are limited as they are based on a *single* case study.

3. Selection of project-based sustainability graduate courses

Based on a previous in-depth case study of a project-based sustainability graduate course offered at Arizona State University (ASU), USA and Leuphana University of Lüneburg (LEU), Germany (Konrad et al., 2020), the selection of further cases was informed by criteria derived from Brundiers and Wiek´s (2013) process model of project-based learning courses, including the following:

1. Course relies on stakeholder relationships established by faculty (prior to the course).
2. Course goes through a number of project phases, from orientation to conclusion.
3. Course moves beyond problem analysis and engages in solution-oriented project work.
4. Course engages students in teamwork and stakeholder engagement.
5. Course is facilitated by faculty who provide inputs and offer coaching to students.
6. Course generates deliverables of relevance to external stakeholders.

The following three cases were further selected as they demonstrate a long track record of adherence to these criteria and of pioneering project-based sustainability education on the university level:

- the *Global Sustainability Research* (GSR) course at ASU, USA and LEU, Germany;
- the *transdisciplinary Case Study* (tdCS) course at the Swiss Federal Institute of Technology (ETH) Zurich, Switzerland; and
- the *Action Research Workshop* (ARW) course at the Polytechnic University of Catalonia (UPC) Barcelona, Spain (see further Konrad et al., forthcoming).

Existing stakeholder networks (table 1) were used in all three courses based on previous or ongoing transdisciplinary projects (Criterion 1). Each course followed an established sequence of phases (Konrad et al., forthcoming) (Criterion 2). All three courses worked, in varying degrees, toward solutions (Criterion 3), through teamwork and stakeholder engagement (Criterion 4). All courses provided inputs on context, content and methods, while coaching students both through check-ins and on request (Criterion 5). The ARW course produced relevant deliverables for stakeholders through project mandates and client relationships; the tdCS course produced a transdisciplinary report, vetted through stakeholders; and the GSR course facilitated a workshop on the local food economy that was co-designed and vetted by the participating stakeholders (Criterion 6). Table 1 provides an overview of the three selected cases.

Table 1: Overview of the three selected project-based sustainability graduate courses.

University	Arizona State University (ASU), USA & Leuphana University of Lüneburg, Germany	Swiss Federal Institute of Technology (ETH) Zurich, Switzerland	Polytechnic University of Catalonia (UPC) Barcelona, Spain
Program (2 years, 4 semesters/ terms)	Double-degree international master program: *Global Sustainability Science*	4 different master programs [10 different majors]	Master program: *Sustainability Science and Technology*
Course	*Global Sustainability Research* (GSR)	*Transdisciplinary Case Study* (tdCS)	*Action Research Workshop* (ARW)
Mandatory	Yes	No	Yes
Course duration	3 semesters (study focus: semester 3)	1 semester + field phase (3 weeks)	1 semester
Course location	Germany & Arizona	Switzerland & Seychelles	Spain
Pedagogy of place	On- and off-campus	On- and off-campus	On- and off-campus
ECTS	10+10+5	7	5
# of students	12 (2016-2017)	19 (2018)	15 (2018)
# of student groups	3 + 1	7	5
Project topic	Food economy	Waste management	Energy; Food; Housing
Stakeholder engagement	3 major events; City staff, public, food economy entrepreneurs	Continuous with peak phase; NGOs, government, businesses, citizens	Ranging from few check-ins to continuous; NGOs, members, supermarkets
# of instructors	1 (lead) + 3 [in semester 3]	1 (lead) + 1	1 (lead) + 1
# of tutors	0	ETH: 1; Seychelles: 2	0 (occasionally 1)
Expert support	City sustainability officer	Scientific experts and advisory board (local ministry, NGO and business representatives)	Faculty members, project providers

In the following, relevant context for the development of interpersonal competence is described – similarities and differences in the approaches to teamwork and stakeholder engagement across the three courses (Table 2; for further details see Konrad et al., forthcoming).

In all three cases, many students entered the course with prior experience in teamwork. However, these experiences were, for the most part, gained in less than a semester, not related to real-world sustainability projects and not professionally supported (training and/ or coaching). While two courses (GSR, ARW) used personality tests for team formation, in all courses, students were ultimately assigned to a team they had stated a preference for. In all courses, student teams were specifically supported in their teamwork, while there were differences across the three approaches.

The GSR course's team of instructors included a professional skill trainer who supported the teams through specific input sessions as well as general coaching sessions. The tdCS course's team of instructors included two alumni as tutors offering support based on first-hand (teamwork) experience in previous years. In the ARW course, a PhD student experienced in theater pedagogy used embodied approaches to teach the teams about group processes (Tejedor et al., 2018). Opportunities for reflections on teamwork and stakeholder engagement were offered in all courses; however, they varied in intensity. The GSR and the tdCS course used class time for teamwork. The teams in both courses arranged for additional teamwork outside of class (6–9 h per week). The ARW course used class time for input sessions and presentations; students needed to self-organize teamwork outside of class (1.5–8 h per week). Self-organized teamwork outside of class showed various patterns, ranging from teams meeting regularly, with an agenda, emotional check-in, task distribution, etc. vs teams meeting infrequently and in *ad hoc* fashion.

Stakeholders were engaged in the projects of all three courses; yet, in different frequencies and ways. The GSR course involved stakeholders in three major stakeholder events, using a successive "modeling behavior" approach to guide students from observation to co-execution of stakeholder engagement. The events had different designs and engaged three different stakeholder groups (city staff vs the public vs food entrepreneurs, advocates and city officials). The tdCS engaged stakeholders in a continuous way, more infrequently over the course of the semester and very intensely during the three week field phase. Stakeholder engagement in the ARW course varied across the teams from few check-ins in some and close collaboration in others, in addition to the semester-long collaboration with the external project providers.

Table 2: General learning objectives, student activities, and approaches applied in three selected project-based sustainability courses.

	GSR Course	tdCS Course	ARW Course
Study conducted	Pre-second to third semester	Second semester	Second semester
General learning objectives and activities	Students get familiarized with sustainability solutions. Students produce high-quality deliverables as spelled out in Terms of Reference. Students manage the project by applying good practices in project management. Students collaborate as an international team by applying good practices in teamwork.	Students understand a case and its context from a variety of perspectives. Students define research questions on a sustainability problem; select and apply transdisciplinary methods to collect, analyze, and interpret data to answer research questions. Students independently manage research activities. Students work in an inter-disciplinary and	Students apply knowledge to understand problems in new or unfamiliar environments. Students work in interdisciplinary teams. Students analyze, evaluate and synthesize new and complex ideas. Students develop solutions to the problems associated with the development of complex systems through science and technology for sustainability.

	Students engage external stakeholders, including experts, by applying good practices in stakeholder engagement.	intercultural team, collaborate with stakeholders and adapt to foreign social, economic, cultural and political settings.	
Learning paradigm	Solution-oriented learning (Wiek & Kay, 2015)	Transdisciplinary learning (Stauffacher et al., 2006)	Action research learning (Tejedor et al., 2018)

4. Research design

This research adopted a multi-method comparative case study approach (Yin, 1984), using the same methods of data collection across the three cases (table 3), with slight case-specific adaptations. This allows for comparison and triangulation to ensure construct validity (Creswell and Clark, 2017).

Table 3: Data collection on the three project-based sustainability courses.

Methods	**Specific Applications**	**Covered Aspects**
Observations	Class sessions (2-4 hours) Student team meetings (1,5-3 hours) Instructor team meetings (0,5-1 hour) Stakeholder meetings (2 hours) Stakeholder engagement events (2-7 hours) Cultural context (continuous)	*External researcher's perspective on:* Teaching and learning processes Teaching and learning environment Students´ dispositions and performances Institutional and cultural contexts → informed further data collection
Interviews	Individual students Individual instructors Individual stakeholders Group interviews (0,5-1,5 hours)	*Emic perspectives on:* Teaching and learning processes Teaching and learning environment Students´ dispositions and performances → informed further data collection
Focus groups	Individual teams (1 hour) Across teams (1 hour)	*Students´ reflections on:* Teaching and learning processes Teaching and learning environment Teaching and learning outcomes → concluded data collection
Photovoice	Process tracking of teams´ learning processes, in- and outside of class (continuous) Collective reflection session (combined with focus group)	*Students´ emic perspectives on*: Teaching and learning processes Teaching and learning environment Teaching and learning outcomes → concluded data collection → provided opportunity for reflection

Data collection took place in Germany, USA, Spain, Switzerland and Seychelles from March 2017 to July 2018. Research on the GSR course was continuous, with the external researcher (T.K.) being mostly present in person. Research on the tdCS course and the ARW course were planned according to the recommendations of the respective course instructor and the external researcher (T.K.) was present only for specific periods considered "key moments" of the course's teaching and learning process (table 4).

Table 4: Collected data across the three project-based sustainability courses.

Case	Observations	Interviews	Focus Groups	Photovoice
GSR	55	23	2	3 of 3 groups; 22 photos
tdCS	11	14	2	1 group; 23 photos
ARW	3	8	2	3 of 5 groups; 23 photos
Total	**69**	**45**	**6**	**7 of 9 groups; 68 photos**

4.1. Data collection

Direct, open, both participant and non-participant observations (Emerson et al., 2001/2007) were directed toward teaching and learning processes (activities and interactions), the teaching and learning environment (roles of instructors, tutors, stakeholders and physical setting) as well as the participants (students' non-cognitive dispositions and performance). They were documented in field notes in a non-standardized way. Observations were conducted on class sessions and excursions, internal student and instructor team meetings, meetings with project providers and stakeholder engagement events. Semi-structured interviews were conducted with individuals from all relevant groups (students, instructors, tutors, stakeholders). Semi-structured instructor interviews provided insights into course conditions, pedagogical approaches and instructor observations. The student interviews drew on Photovoice documentation and were informed by insights from observations and course documents. Applying Photovoice (Ciolan and Manasia, 2017), students were asked to photo-document their learning journey over the course of the semester (Konrad et al., 2020). To compare and contrast students' course impressions on the teaching and learning processes and environment, focus groups (May, 2011) concluded data collection at the end of each course, including Photovoice material (Wang and Burris, 1997). An exemplary focus group guide is provided in the Appendix. It shows the basic structure that enabled comparability across cases. Each guide accounts for case specificity for instance, the use of concept maps in the case of the ARW course (course material). A timeline of the respective course was provided during the focus groups to support students' reflections while allowing students to add key moments of their learning journey.

4.2. Data analysis

Coding preceded further qualitative data reduction (Miles et al., 2014). An interpretative competence analysis through translating students' stated learning outcomes into key competencies in sustainability (if applicable) and a reliability test by peer researchers followed. Data on learning processes were then compared and contrasted across cases, starting from synthesis on the individual case study level, i.e. after having captured the main learning processes of one case. Emerging themes from one course were documented and compared to the respective other two cases, to complement the picture of teaching and learning in project-based sustainability courses. For example, GSR course characteristics found as potential triggers of conflicts, such as relocation, teamwork and stakeholder

engagement, were used as starting points for comparing the GSR course with the other two courses. Particularities such as having tutors as part of the instructor team were equally further investigated for their impact on learning outcomes. Several iterations of zooming in and out, going into depth into one case before comparing across cases again, followed, to capture the range of similarities and differences. Contrast tables and matrices supported this analysis process.

5. Findings

Interpersonal competence was the key competence in sustainability that students in the three courses most frequently described as learning outcome (focus groups, interviews). This is in line with the learning objectives of the investigated courses (table 2; instructor interviews; see also Konrad et al., forthcoming) as well as observations made by the external researcher (T.K.), despite other key competencies being relevant for course design and delivery, too. In the tdCS course, for instance, project group foci were based upon a system map. Systems-thinking competence, however, was less a learning outcome and more a prerequisite of the tdCS course. In the ARW course, there were backcasting inputs and assignments (to develop futures-thinking competence). This was only relevant for one specific course period though, while interpersonal attitudes, knowledge and skills were developed throughout the course.

Next, specifics on the interpersonal competence developed are shown, namely, attitudes, knowledge and skills in collaborative teamwork and in impactful stakeholder engagement (figures 1 and 2). These learning outcomes are linked to the identified specific learning processes (table 5), learning environment and relevant student background.

Table 5: Identified learning processes in the three project-based sustainability courses (graduate level).

Learning Processes	Examples
Receiving input	Students received inputs on teamwork and stakeholder engagement, including on teamwork tools (e.g., code of collaboration), good teamwork practices, intercultural collaboration, stakeholder facilitation, event preparation, emotional intelligence, conflict resolution, etc.
Experiencing	Students experienced teamwork and stakeholder engagement through (participant) observation, stakeholder encounters, team meetings, team conflicts, conflict resolution sessions, successful stakeholder events, (mis-) communication with stakeholders, etc.
Reflecting	Students reflected on their observations and/or participation in teamwork and stakeholder engagement through comparing and contrasting experiences, articulating and questioning experiences, adopting a different perspective, recognizing incidents and outcomes, etc.
Experimenting	Students experimented with teamwork and stakeholder engagement tools and techniques through trial and error with teammates and in project groups, exercises in class, dry-runs prior to events, iterations from one event to the next, conducting interdisciplinary research and fieldwork, etc.

5.1. Developing competence in collaborative teamwork

Students developed attitudes, knowledge and skills for collaborative teamwork (figure 1) through a combination of the following learning processes: receiving instructors' inputs on teamwork; experiencing teamwork; reflecting on teamwork; and experimenting with different forms/methods of teamwork.

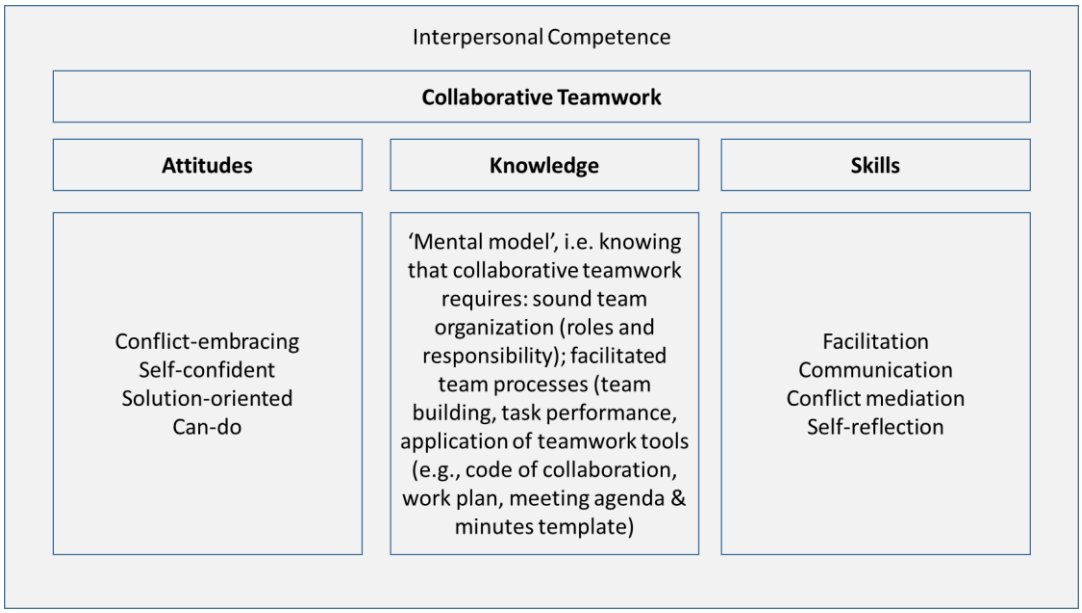

Figure 1: Teamwork attitudes, knowledge, and skills developed in the courses.

First, students developed four types of collaborative teamwork *attitude*, namely, *conflict-embracing*, *self-confident*, *solution-oriented* and *can-do* attitude. For example, conflict-embracing attitude is recognized as an important attitude for collaborative teamwork because it allows team members to acknowledge and explicitly address challenging situations inevitably occurring in complex and ambitious projects (Konrad et al., 2020). Students' development of conflict-embracing attitude (e.g. S_708, S_709, S_818) was facilitated through participating in sessions on intercultural collaboration and professional skills, including conflict resolution techniques through role-plays and active listening, i.e. *receiving input* (e.g. S1_004, S1_010; GSR observation, 28.06.17). Receiving input allowed to direct attention to group dynamics. In addition, this attitude was developed through first-hand *experiences* of and *reflections* on conflicts in teamwork resulting from different working styles, habits and personality traits such as being extroverted vs introverted (S_813, tdCS focus group, 20.07.18). Learning environments supported the development of conflict-embracing attitude in several ways: instructors provided targeted sessions and coaching on conflicts and conflict resolution (GSR observation, 22.05.17, 14.06.17; 12.09.17), encouraged adopting a conflict-embracing attitude (T_805, tdCS instructor interview, 16./18.07.18) and transferred project ownership to students; peer students engaged in collective reflection on and resolution of conflicts, which led to a mutual enforcement of adopting a conflict-embracing attitude; and an external researcher supported individual and collective reflection processes on conflicts and conflict resolution. Collaborative attitude development, therefore, requires different interactions.

Second, students developed declarative and procedural *knowledge* of collaborative teamwork. They developed a "mental model," *knowing that* collaborative teamwork requires the following: sound team organization (roles and responsibility); facilitated team processes (team building, task performance, social processes); application of teamwork tools (e.g. code of collaboration, work plan,

meeting agenda and minutes template); and so forth (figure 1; S_708, S_705, S_818, S_805). Learning specific elements of this mental model were facilitated, for instance, through the *experience* of a conflict between team members and its resolution with the help of a process-facilitator (instructor; receiving input) as well as the application of teamwork tools such as the code of collaboration, i.e. *experimenting* (GSR observation, 19.09.17). *Reflecting* on the lack of applying such tools and the detrimental effects, i.e. comparing and contrasting situations and experiences, reinforced students' insights on key components and success factors of collaborative teamwork (S_705, UPC focus group, 24.05.18). Learning environments supported the development of collaborative teamwork knowledge as follows: instructors provided targeted teamwork inputs and coaching on group dynamics; peer students engaged in discussions of good practices in teamwork; and the external researcher offered an open ear for students to process teamworking experiences. Again, different actors play different roles in supporting collaborative knowledge development (Konrad et al., in review).

Third, students developed *skills* in collaborative teamwork, namely, *facilitation*, *communication*, *conflict mediation* and *self-reflection*. For example, at the completion of the investigated courses, students were able to effectively facilitate team meetings (e.g. S1_004, S_815), applying techniques such as definition, distribution and coordination of tasks among team members. Several learning processes led to the development of this skill: students *received input* and guided exercises on teamwork techniques (GSR and ARW observations) including how to conduct team meetings; working in teams allowed all students to *experience* team meetings on a regular base; *reflection* on these experiences was enabled by peers, instructors, tutors and the external researcher; finally, the regularity of meetings allowed students to experiment with different ways of facilitating team meetings. The learning environment supported students in developing collaborative teamwork skills mostly through the project-based learning settings in which students worked in small teams on real-world sustainability issues. Facilitation skills, and in a similar way, the other skills of communication, conflict mediation and self-reflection, are *required* learning objectives, at least to some extent, to make the courses successful and fulfilling learning experiences. However, considering the accelerated timeline of learning and performing collaborative teamwork in project-based courses (such as the investigated ones), the burden on students can be, at times, too high. In the GSR course, for example, one team ultimately needed to be dissolved for project progress (GSR observations and instructor interview). This points to the importance of balancing external needs and timeline (deliverables) with the internal needs and timeline of the learners. Overall, collaborative skill development required several arenas, platforms and opportunities to enact attitudes and knowledge in practice.

5.2. Developing competence in impactful stakeholder engagement

Students also developed attitudes, knowledge and skills for impactful stakeholder engagement to some degree in all three courses (figure 2). Competence development was facilitated through a combination of the following learning processes: receiving instructors' inputs on stakeholder engagement; experiencing stakeholder engagement; reflecting on stakeholder engagement; and experimenting with different forms/methods of stakeholder engagement.

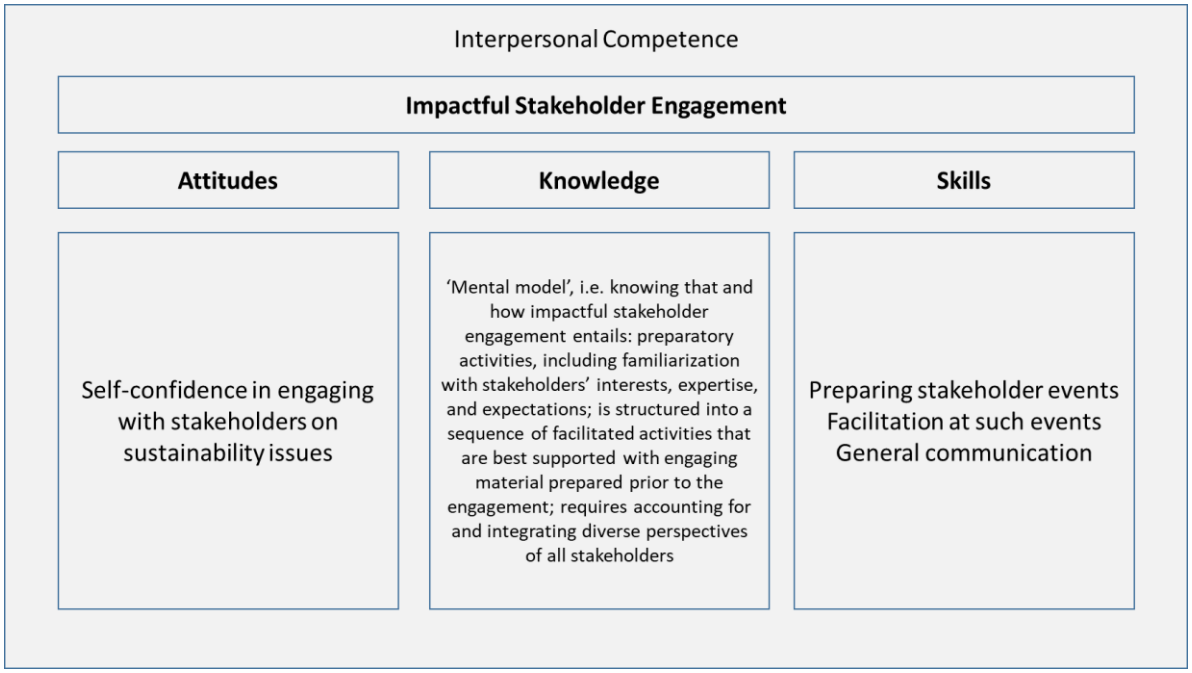

Figure 2: Stakeholder engagement attitudes, knowledge, and skills developed in the courses.

First, students developed an *attitude* of self-confidence in engaging with stakeholders, which is an important component of successful task fulfillment. Over the course of the investigated projects, an increase in students' self-confidence was observable with respect to organizing stakeholder events, presenting to stakeholders and engaging stakeholders in work on sustainability issues (e.g. S1_004, S_701, S_809, S_707, S1_002). Several learning processes facilitated the development of this attitude. Observing, i.e. *experiencing* and *reflecting* on the professional preparation of a stakeholder event and, at the event, observing expert facilitators guiding stakeholder activities and conversations [articulation] helped students noticing that stakeholder engagement requires some experience but, with the right mindset, seems to be a do-able task (S1_004, GSR focus group, 30.11.17). Particularly students with no prior stakeholder engagement experience benefited from observing experts, allowing the students to build up a self-confident *attitude*. One student stated: "I feel prepared to take on this [stakeholder event] […] because I have already experienced one that went well. So, I see how something can go well […]. Maybe I can reapply this to another context" (S1_002, GSR student interview, 31.10.17, line 20). Having a mental model of a successful stakeholder engagement facilitation develops confidence and takes away initial concerns. Instructors' *input* on how to prepare stakeholder engagements was reinforced through *experimentation*. Applying lessons learned, through reflection on experiences, i.e. transferring observed good practices into new contexts, allowed students to develop self-confidence. The learning environment facilitated students' development of this attitude in various ways. Instructors provided stakeholder engagement opportunities and coaching specific to stakeholder engagement. Together with facilitation experts, instructors modeled behavior for the students through a stakeholder engagement event. External stakeholders gave relevance to the projects, motivated students to excel and provided positive feedback. Finally, peer students, tutors and the external researcher formed a trusted learning community that boosted self-confidence, too. For this development, sufficient time is essential, as confidence is built through several reinforcing processes. First familiarizing students with stakeholder engagement, e.g. letting them observe experts in action, allows students to draw upon this experience and develop confidence by aligning their own practice with experts' practice.

Second, students developed declarative and procedural *knowledge* of impactful stakeholder engagement, most notably the build-up of a mental model – what impactful stakeholder engagement entails (what it "looks like"). Students learned that a stakeholder event calls for a broad set of preparatory activities and is structured into a sequence of facilitated activities; and that it requires accounting for and integrating diverse perspectives of all stakeholders. Assisting in a professional stakeholder engagement event and *reflection* on the *experience* (e.g. S1_002, S1_003, S_701) proved to be an effective learning process. Experience of colliding expectations and reflecting on such incidents made students became aware of the dynamics and flexibility needed for impactful stakeholder engagement (S_701, ARW focus group, 24.05.18). Similarly, this learning was facilitated through experiencing the lack of familiarity with stakeholders' interests, which resulted in miscommunication (S_705, ARW student interview, 11.04.18). Procedural knowledge was mostly built with respect to preparation and execution of stakeholder engagement events, for instance, through targeted facilitation sessions that allowed students to *experiment* with different facilitation techniques before using them at stakeholder engagement events. The learning environment facilitated the development of impactful stakeholder engagement in similar ways as outlined in the previous section on attitude development.

Third, students developed *skills* in impactful stakeholder engagement, namely, *preparing stakeholder events*, *facilitation* at such events and general *communication*. For skill development, a higher level of student activity, i.e. experimentation, is required compared to knowledge development described previously. Students' skill development was dependent on a prior mental model of impactful stakeholder engagement (discussed previously), acquired either through prior internships and jobs (e.g. S1_006, S1_007, S1_010) or through opportunities offered earlier in the course (e.g. S1_002). Skills in event preparation and execution were developed through a continuous increase in student-task difficulty (student's role at events, from experiencing to experimenting), iterations in the preparation process and feedback from instructors or experts (receiving input and reflecting). Both experienced and inexperienced students can develop these skills, with experienced students entering earlier and more smoothly into the experimentation stages based on their already existing knowledge and self-confidence gained through prior experiences. A conducive learning environment for skill development in impactful stakeholder engagement depends heavily on instructors' and stakeholders' willingness to "go the extra mile". In all investigated courses, in particular course instructors invested significant time and effort into building relationships to stakeholders that could then be leveraged in the project over the course of the semester(s). Stakeholders' awareness that students in the project are still learners is the basis for creating an atmosphere of mutual appreciation as well as offering learning opportunities for all.

5.3. Differences among the courses – nuances of interpersonal competence development

After having identified and described the main learning processes conducive to interpersonal competence development across the courses, now differences are explored and explained how they played out in the three courses. Specifics of each course are indicated for each of the four learning processes (table 6).

Table 6. Features of learning collaborative teamwork and impactful stakeholder engagement for each course.

	Receiving Input	**Experiencing** (Stakeholder Engagement)	**Reflecting**	**Experimenting**
GSR	Extensive	Sequencing approach	Occasionally	Instructor mostly present
tdCS	On-demand consultation	Partnership approach with student initiative	Regularly	Instructor often present
ARW	Targeted sessions (e.g. on emotional intelligence)	Service learning approach	Targeted	Instructor mostly absent

First, in all three cases, students' learning of collaborative competence was supported through receiving inputs from instructors. However, the specific ways differed and led to different outcomes. The GSR course included a preparatory semester with extensive input sessions on collaborative, intercultural competence and professional skills (GSR observations). Students also took a personality test which was contextualized by and discussed with the course instructors and which informed group formation. Self-awareness provides the basis for better understanding team dynamics. Teams later received additional input on team processes (plenary and specific teams) through the professional skills coach. Overall, this led to GSR students developing strong facilitation skills and conflict-embracing and solution-oriented attitudes through understanding the nature of heterogeneous teams (increased creativity). In contrast, the tdCS course offered no specific inputs on collaboration. Instead, ETH students were encouraged to collaborate with each other and students from the University of the Seychelles, following a learning-by-doing model, at times, under high pressure (three-week field phase). In some cases, this led to accelerated competence development. One student, for example, reported to have developed a can-do attitude while having uncovered his leadership skills by pushing-through during the intense field phase (S_805, tdCS focus group, 20.07.18). Instructors were available for consultation on demand when issues came up (including group dynamics), while also acting on observations in case a team seemed to be in need of support. While the GSR course often provided inputs to all students, the tdCS course offered input to the respective team in need. Competence was, therefore, built rather *ad hoc* and not systematically; yet, in a practice-oriented way. The tdCS students perceived this as challenging, but recognized it fostered self-reflexive attitude, in support of collaboration and project progress (S_802, tdCS focus group, 20.07.18). This was due to the regular reflection opportunities (table 6), i.e. the interplay of several learning processes (experiencing, reflecting on the experience, sharing reflections). In the ARW course, the students took a personality test, similar to the GSR course, letting students explore group composition possibilities (knowledge development). Student teams consulted with instructors as needed. However, for those students who were mostly familiar with conventional teaching and learning settings (lecture-based, content-focused, hierarchical) self-directed learning attitude needed to be developed. This puts emphasis on attitude development as a *condition* for further interpersonal competence development. Collaborative knowledge includes knowing how to successfully work together, including clarity on roles and responsibilities (figure 1). Students-instructors collaboration should model good collaboration practices for students. This requires, for instance, clarification of

instructor's and students' roles as needed. Students are required to take initiative in their learning and instructors are required to provide clarity on course format and requirements. To illustrate different ways of how receiving input can foster interpersonal competence development, here an example from the ARW course: an emotional intelligence session provided a targeted input mid-semester, after students had already encountered teamwork challenges (T_701, instructor interview, 10.04.18). It used exercises from theater pedagogy to develop collaborative teamwork knowledge and attitude in a playful way, processed through a reflection assignment afterwards. This session positively impacted students' collaborative attitude as shown in the reflection assignments. Making the input experiential and asking students to reflect on it provided an opportunity for collaborative attitude development.

Second, in all three cases, students' learning of impactful stakeholder engagement was supported through student-stakeholder(s) experiences, with each course following a particular approach. In the GSR course, students went through a series of staged opportunities to build up their stakeholder engagement competence. By first building knowledge and creating a mental model and then observing experts facilitating, students developed self-confident attitude. Those students engaged in facilitating the final event of the project, furthermore, could also enhance their engagement skills. The tdCS course followed a partnership approach with local partners at the University of the Seychelles (students) first virtually and later face to face. Students got input on engagement methods (such as on how to conduct expert interviews). In contrast to the GSR course, direct studentstakeholder interactions depended on the individual student's initiative to approach a stakeholder, e.g. during the first stakeholder encounter mid semester (tdCS observation, 20./21.04.18). During the fieldwork, stakeholder engagement was required and further developed facilitation skills (such as reacting with flexibility to stakeholder demands and actions; e.g. S_814). Skill development of impactful stakeholder engagement was less supervised and depended on the students' willingness to learn and prior skill level. The ARW course followed a service-learning approach. Beyond the experience of collaboration and engagement with external project providers, i.e. stakeholders, the contact with other stakeholders (linking to opportunities for experimenting) depended on the respective student project and the project partners. Through close collaboration with project partners, students improved their communication skills. However, in contrast to the GSR and tdCS courses, overall knowledge and skill development was overly dependent on the respective project partner.

Third, in all three cases, students' learning of interpersonal competence was strongly linked to opportunities to extract meaning from experiences through reflection, with each course following a particular approach. The GSR course used post-event in-class debriefings, i.e. *occasional* reflections, to derive meaning from stakeholder engagement events, inviting students to articulate their developed mental model (knowledge generation). In terms of collaborative teamwork development, formal and informal conversations with the external researcher allowed to change perspectives, too, coming to a new understanding. The tdCS course had an alumnus tutor *regularly* checking-in on students' learning processes. Students, not used to continuous reflections, came to appreciate these checking-ins as they were considered beneficial for their learning (S_816, focus group, 20.07.18) despite project pressure. The ARW course worked with *targeted* reflection assignments. In the tradition of action research, reflective phases were fully integrated throughout the course. During regular class presentations, students were invited to share insights with peers and instructor(s) (student interviews). This allowed students to analyze their own behavior in teamwork, deriving good practices, such as how to organize work internally for project progress.

Fourth, in all three cases, students benefited from opportunities to experiment within student-student(s) and student-stakeholder(s) interactions, to varying degrees facilitated through the instructor(s). In the GSR course, instructors were present as observers during teamwork in class sessions (close supervision). Also, instructors facilitated side-by-side with students and coached them in stakeholder engagement events. In the tdCS course, the instructor(s) were present during class sessions while students worked in teams, available for consultation, what allowed for input and coaching as needed. This fostered student initiative and thus became a driver of interpersonal competence development. Less coaching while experimenting was compensated by regular reflection sessions (table 6). During tdCS fieldwork, almost on a daily basis, students, tutors and instructors came together to share daily experiences. In the ARW course, students mostly worked outside of class in their teams as class-time was used for input, presentations and other activities. However, targeted input supported experimenting. As the intensity of stakeholder interaction depended on the respective student project, learning opportunities and competence development varied significantly from project to project.

5.4. Synthesis

The majority of students developed attitudes, knowledge and skills for collaborative teamwork and impactful stakeholder engagement in the three investigated project-based sustainability courses (graduate level).

Interpersonal *attitudes* seem to be most often learned through a combination of experiencing and reflecting, followed by experimenting, allowing to foster an attitude first observed and then personally applied. For example, conflict-embracing attitude (teamwork) and self-confident attitude (stakeholder engagement) can be developed through observation of modeled behavior, reflecting on one's own skill level, followed by training to reach a higher level – *if* these processes are supported by constructive feedback and encouragement. In all three courses, students were encouraged and supported to try out practices of teamwork and stakeholder engagement they have not practiced before. Successful experimentation as well as positive (collective) reflection also on failed experimentation contributed to building interpersonal attitudes. Attitude is emphasized as a moderating variable for further interpersonal competence development (knowledge and skills) to overcome the cognitive (knowledge) bias in higher education.

Not surprisingly, interpersonal *knowledge* seems to be most often learned through a combination of receiving inputs and (collective) reflection. Deeper anchoring of knowledge, in particular procedural knowledge, however, requires experience and experimentation, to come from a "knowing-that" to a "knowing-how." For example, students learned about the importance of teamwork tools (e.g. code of collaboration) through instructor input and were able to reproduce this knowledge in situations in which teamwork was ineffective or counter-productive (GSR observation, 19.09.17). However, not in all cases did this directly translate into successful teamwork, due to a lack of interpersonal attitudes or skills, as both of these domains are key to turn knowledge into action. This indicates the important link among interpersonal attitudes, knowledge and skills, forming *integrated* interpersonal competence – and the need for a broader combination of learning processes.

Interpersonal *skills* seem to be most often developed through a combination of receiving inputs and experiencing and experimenting. For instance, receiving input on teamwork tools (e.g. code of collaboration) supported several teams in experimenting with these tools and eventually led to some

level of mastery. Similarly, recruiting stakeholders (e.g. for expert interviews), followed by application/experimentation led to the development of this skill over the course of the project. Experiencing and experimenting seem to be another combination conducive to interpersonal skill development, in particular when transferring ownership from instructors to students.

Contextual factors in the learning environment such as instructors establishing relationships with stakeholders prior to the projects, student background (e.g. prior experience with stakeholder engagement), as well as time pressure are additional variables facilitating students' development of interpersonal competence as one of the key competencies in sustainability. Within this framework, interpersonal competence allows students to meaningfully engage with each other and with stakeholders. While all key competencies are required for sustainability problem-solving, interpersonal competence seems to facilitate this process in the most substantial way.

6. Discussion

The findings of this study suggest that project-based sustainability courses are a prime format for developing students' interpersonal competence due to multiple reinforcing learning processes. The findings suggest that collaborative attitude facilitates further interpersonal knowledge and skill development. This might hold true even beyond interpersonal competence development. Project-based sustainability courses have shown to develop students' key competencies in sustainability (Azeiteiro et al., 2015; Barth, 2015; Tejedor et al., 2019; Wiek et al., 2014). This study went a step further by, first, identifying and describing conducive learning processes (with regard to interpersonal competence) and, second, by shedding light on the importance of attitude, often disregarded in favor of knowledge and skills. A collaborative attitude fosters other key competence development, as they are applied in team settings. Previous studies (e.g. by Freeth and Caniglia, 2020; Konrad et al., 2020) showed that if conflicts in such settings occur, lack of conflict-embracing, i.e. collaborative, attitude might result in withdrawal from the project. This, in turn, would mean the loss of further opportunities to develop key competencies in sustainability.

This study found that receiving inputs throughout a course allows students to develop teamwork knowledge that can be applied later, helping to develop teamwork skills and also attitudes. Consultation and coaching have a similar effect, even without receiving general inputs. Furthermore, external factors such as selected student cohort (highly motivated students), time pressure (short core project phase requiring focus) and stakeholder expectations can foster teamwork competence (Oxenswärdh and Persson-Fischier, 2020). The engagement in peer (student-student) interactions is one prominent way to support teamwork competence (see further Konrad et al., in review). Complementary, targeted input sessions can trigger similar processes if followed-up with reflections and opportunities for experimenting. While students gain confidence to engage stakeholders (attitude) through experiencing student–stakeholder(s) interactions, knowledge development depends on explicit experiences in which students observe experts acting and have the chance to process insights (reflection). Skill development, e.g. in facilitation, often can be achieved only by some students, as opportunities are limited.

Other scholars, such as Roy et al. (2020) and Soini et al. (2019), identified interpersonal competence as learning outcome at the end of courses, while this study is linking competence facets to *specific* learning processes. It also demonstrates that there is the need for multiple reinforcing learning processes to develop interpersonal competence. This aligns with Kolb and Kolb's (2012) experiential

learning theory. Reflection on experience "allows the learner to re-examine and modify their previous sensemaking" (Kolb and Kolb, 2005, p. 207). Kolb and Kolb (2012, p. 1216) refer to these multiple reinforcing learning processes as follows:

> "[…] an idealized learning cycle or spiral where the learner 'touches all the bases' – experiencing, reflecting [processing input], and [experimenting] – in a recursive process that is sensitive to the learning situation and what is being learned."

This study brings this idea to the sustainability learning context and shows how it applies to the development of key competencies in sustainability, specifically, interpersonal competence, which is seen as crucial for advancing sustainability (Bickford and Wright, 2006; Činčera et al., 2019; Di Giulio and Defila, 2017; Evans, 2015; Fam et al., 2019; Freeth and Caniglia, 2020; Giangrande et al., 2019; Gulikers and Oonk, 2019). This study advances the understanding of how key competencies are being developed. It also supports instructors and administrators in course design and adaptations by providing guidance on which learning processes develop which competence (facet). Finally, the study provides support for highlighting attitude development in interpersonal learning processes.

For learning processes to be mutually reinforcing, they need to follow a specific sequence (e.g. first experiencing, then experimenting). This is relevant for learning interpersonal attitudes, knowledge or skills, as well as for the development of *integrated* interpersonal competence. The complete sequence from *receiving input* through *experiencing* to *experimenting*, accompanied by *reflections*, aligns with the theory of cognitive apprenticeship (Collins et al., 1987). From the three cases, it can be seen that students' learning is best facilitated by developing a mental model of the professional activity (e.g. stakeholder event) first before participating step-by-step in the activity (Collins et al., 1987); allowing to enter with a conducive mindset (Ade et al., 2018). This study delivers evidence for the importance of the steps of *modelling*, *scaffolding*, *coaching* and *fading* by and of the instructor in support of students' competence development, adding case-specific nuances. While *fading* is usually an ongoing strategy on the instructor-side, this comparative study showed that this can also happen quite early in the semester. However, this might potentially lead to challenges due to students' unfamiliarity with the project-based learning principle of active student engagement over an expanded time frame (Blumenfeld et al., 1991). As this is in contrast to regular university course formats (Donnelly and Fitzmaurice, 2005), it can lead to inner conflicts, as earlier studies show (Konrad et al., 2020; Singer-Brodowski, 2016).

This study demonstrates that interpersonal competence is a complex of attitudes, knowledge and skills (Wiek et al., 2011) and that for successful task performance, here collaborative teamwork and impactful stakeholder engagement, the integration of these domains matters. This is in line with other scholars (Sipos et al., 2008) while using a different terminology (*attitudes*, *knowledge* and *skills* versus *heart*, *head* and *hands*). Overall, studies on key competencies in sustainability mostly focus on students' development of *knowledge* (Singer-Brodowski, 2016) or *skills* ("head and hands"), while sidelining *attitudes* despite their importance for advancing sustainability. This is true for studies on interpersonal competence, too (Ade et al., 2018; Giangrande et al., 2019; Heiskanen et al., 2016; Soini et al., 2019). This study goes beyond that dominance, finding evidence of developed interpersonal attitudes and links to specific learning processes. As an early and rudimentary attempt in empirically anchoring the attitude component of interpersonal competence, this study offers a start for delving deeper into understanding how interpersonal competence can be comprehensively developed. Experiential learning theory (Kolb and Kolb, 2012) and cognitive apprenticeship theory (Collins et al., 1987) lend themselves to frame (interpersonal) competence development in project-

based learning courses and can serve to design such courses. Further research on interpersonal competence development in project-based sustainability courses could look into the role of the instructor, e.g. by applying Photovoice method. Further theories, such as staged self-directed learning theory (Grow, 1991/1996; Ryan and Deci, 2000), could be used for elaborating on interpersonal competence development overall.

7. Conclusions

Interpersonal competence, i.e. competence in teamwork and stakeholder engagement, is widely considered important for professionals to advance sustainability. This study provides evidence for *how* project-based sustainability courses offer prime learning opportunities for students to develop interpersonal competence as one of the key competencies in sustainability, as underpinning the others. Such courses offer students to engage in *receiving inputs*, *experiencing*, *reflecting* and *experimenting* to develop interpersonal *attitudes*, *knowledge* and *skills*. Interpersonal *attitudes* seem to be mostly developed through a combination of experiencing and reflecting, followed by experimenting. Also, collaborative attitude seems to foster knowledge, skills and overall competence development, which suggests future research needs to focus on this domain. Not surprisingly, interpersonal *knowledge* seems to be mostly developed through a combination of receiving inputs and (collectively) reflecting. And interpersonal *skills* seem to be mostly learned through a combination of receiving inputs and experimenting, or, more directly, experiencing and experimenting. Key for robust learning outcomes seems to be that project-based courses allow for, if not require, combination and mutual reinforcement of these learning processes, such as promoted by experiential learning theory. Course design can take advantage of these new insights when adopting project-based learning formats in assuring that input and experiences provided by the instructors are coupled with opportunities for (collective) reflection and precede experimentation, i.e. the active application of (experience-based) knowledge to practice. Students, mostly unfamiliar with the project-based learning format, are encouraged to take ownership of their own learning by exchanging with peers and others about input received, experiences and/or moments which allowed for experimentation, what highlights once more the critical role of attitude. Future research needs to strengthen the evidence on the specific causal links between learning processes and outcomes, as well as specify the role of numerous factors in the learning environment and student background that influence learning outcomes, too.

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References

Ade, V., Schuster, C., Harinck, F. and Trötschel, R. (2018), "Mindset-Oriented Negotiation Training (MONT): Teaching More Than Skills and Knowledge", *Frontiers in psychology*, Vol. 9, pp. 1–13.

Azeiteiro, U.M., Bacelar-Nicolau, P., Caetano, F.J.P. and Caeiro, S. (2015), "Education for sustainable development through e-learning in higher education. Experiences from Portugal", *Journal of Cleaner Production*, Vol. 106, pp. 308–319.

Backman, M., Pitt, H., Marsden, T., Mehmood, A. and Mathijs, E. (2019), "Experiential approaches to sustainability education: towards learning landscapes", *International Journal of Sustainability in Higher Education*, Vol. 20 No. 1, pp. 139–156.

Barth, M. (2015), *Implementing Sustainability in Higher Education: Learning in an Age of Transformation, Routledge studies in sustainable development*, Routledge, London, New York.

Bickford, D.J. and Wright, D.J. (2006), "Community: The Hidden Context for Learning", in Oblinger, D.G. (Ed.), *Learning spaces*, *An educase e-Book*, Brockport Bookshelf. 78., Wahington, DC, Boulder, CO, pp. 4.1.–4.22.

Birdman, J., Wiek, A. and Lang, D.J. (in review), "Developing Key Competencies in Sustainability through Project-based Learning in Graduate Sustainability Programs".

Blumenfeld, P.C., Soloway, E., Marx, R.W., Krajcik, J.S., Guzdial, M. and Palincsar, A. (1991), "Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning.", *Educational Psychologist*, Vol. 26 No. 3 & 4, pp. 369–398.

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harré, N., Jarchow, M., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P. and Zint, M. (2020), "Key competencies in sustainability in higher education—toward an agreed-upon reference framework", *Sustainability science (online)*.

Brundiers, K. and Wiek, A. (2013), "Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability", *Sustainability*, Vol. 5 No. 4, pp. 1725–1746.

Brundiers, K. and Wiek, A. (2017), "Beyond Interpersonal Competence. Teaching and Learning Professional Skills in Sustainability", *Education Sciences*, Vol. 7 No. 1.

Brundiers, K., Wiek, A. and Redman, C.L. (2010), "Real-world learning opportunities in sustainability: from classroom into the real world", *International Journal of Sustainability in Higher Education*, Vol. 11 No. 4, pp. 308–324.

Buhrmester, D., Furman, W., Wittenberg, M.T. and Reis, H.T. (1988), "Five Domains of Interpersonal Competence in Peer Relations", *Journal of Personality and Social Psychology*, Vol. 55 No. 6, pp. 991–1008.

Caniglia, G., John, B., Kohler, M., Bellina, L., Wiek, A., Rojas, C., Laubichler, M.D. and Lang, D. (2016), "An experience-based learning framework", *International Journal of Sustainability in Higher Education*, Vol. 17 No. 6, pp. 827–852.

Činčera, J., Mikusiński, G., Binka, B., Calafate, L., Calheiros, C., Cardoso, A., Hedblom, M., Jones, M., Koutsouris, A., Vasconcelos, C. and Iwińska, K. (2019), "Managing Diversity: The Challenges of Inter-University Cooperation in Sustainability Education", *Sustainability*, Vol. 11 No. 20.

Ciolan, L. and Manasia, L. (2017), "Reframing Photovoice to Boost Its Potential for Learning Research", *International Journal of Qualitative Methods*, Vol. 16 No. 1, pp. 1–15.

Clevenger, C.M. and Ozbek, M.E. (2013), “Service-Learning Assessment. Sustainability Competencies in Construction Education”, *Journal of Construction Engineering and Management*, Vol. 139 No. 12.

Collins, A., Brown, J.S. and Newman, S.E. (1987), “Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics. Technical Report 403”.

Córvers, R., Wiek, A., Kraker, J. de, Lang, D.J. and Martens, P. (2016), “Problem-Based and Project-Based Learning for Sustainable Development”, in Heinrichs, H., Martens, P., Michelsen, G. and Wiek, A. (Eds.), *Sustainability Science: An Introduction*, Springer Netherlands, Dordrecht, pp. 349–358.

Creswell, J.W. and Clark, V.L.P. (2017), *Designing and conducting mixed methods research*, SAGE Publications, Los Angeles, London, New Delhi, Singapore, Washington DC.

DeFillippi, R.J. (2001), “Introduction: Project-Based Learning, Reflective Practices and Learning”, *Management Learning. Sage Publications*, No. 32 (1), pp. 5–10.

Di Giulio, A. and Defila, R. (2017), “Enabling university educators to equip students with inter- and transdisciplinary competencies”, *International Journal of Sustainability in Higher Education*, Vol. 18 No. 5, pp. 630–647.

Donnelly, R. and Fitzmaurice, M. (2005), “Collaborative Project-based Learning and Problem-based Learning in Higher Education: a Consideration of Tutor and Student Role in Learner-Focused Strategies”, in O´Neill, G., Moore, S. and McCullin, B. (Eds.), *Emerging Issues in the Practice of University Learning and Teaching*, Dublin, pp. 87–98.

Earl, A., Van Wynsberghe, Walter, P. and Straka, T. (2018), “Adaptive education applied to higher education for sustainability”, *International Journal of Sustainability in Higher Education*, Vol. 19 No. 6, pp. 1111–1130.

Emerson, R.M., Fretz, R.I. and Shaw, L.L. (2001/2007), “Participant Observation and Fieldnotes”, in Atkinson, P., Coffey, Amanda, Delamont, S., Lofland, J. and Lofland, L. (Eds.), *Handbook of Ethnography*, SAGE Publications, Los Angeles, London, New Delhi, Singapore, pp. 352–368.

Evans, T.L. (2015), “Transdisciplinary collaborations for sustainability education: Institutional and intragroup challenges and opportunities”, *Policy Futures in Education*, Vol. 13 No. 1, pp. 70–96.

Fam, D., Clarke, E., Freeth, R., Derwort, P., Klaniecki, K., Kater-Wettstädt, L., Juarez-Bourke, S., Hilser, S., Peukert, D., Meyer, E. and Horcea-Milcu, A.-I. (2019), “Interdisciplinary and transdisciplinary research and practice: Balancing expectations of the ‘old’ academy with the future model of universities as ‘problem solvers’”, *Higher Education Quarterly*, Vol. 3 No. 1, pp. 1–16.

Freeth, R. and Caniglia, G. (2020), “Learning to collaborate while collaborating. Advancing interdisciplinary sustainability research”, *Sustainability science*, Vol. 15, pp. 247–261.

Giangrande, N., White, R.M., East, M., Jackson, R., Clarke, T., Saloff Coste, M. and Penha-Lopes, G. (2019), “A Competency Framework to Assess and Activate Education for Sustainable Development: Addressing the UN Sustainable Development Goals 4.7 Challenge”, *Sustainability (online)*, Vol. 11.

Grow, G.O. (1991/1996), “Teaching Learners to be Self-directed”, *ADULT EDUCATION QUARTERLY*, Vol. 41 No. 3, pp. 125–149.

Gulikers, J. and Oonk, C. (2019), “Towards a Rubric for Stimulating and Evaluating Sustainable Learning”, *Sustainability (online)*, Vol. 11 No. 4.

Heiskanen, E., Thidell, Å. and Rodhe, H. (2016), “Educating sustainability change agents. The importance of practical skills and experience”, *Journal of Cleaner Production*, Vol. 123, pp. 218–226.

Hernández-Barco, M., Sánchez-Martín, J., Blanco-Salas, J. and Ruiz-Téllez, T. (2020), “Teaching Down to Earth—Service-Learning Methodology for Science Education and Sustainability at the University Level: A Practical Approach”, *Sustainability (online)*, Vol. 12 No. 2.

Hilser, S. (2016), “Key Competencies to Action. Transdisciplinary Learning of Key Competencies for Sustainability”, Master Thesis, LUCSUS, Lund University, Lund, 2016.

Kolb, A.Y. and Kolb, D.A. (2005), “Learning Styles and Learning Spaces. Enhancing Experiental Learning in Higher Education”, *Academy of Management Learning & Education*, Vol. 2, pp. 193–212.

Kolb, A.Y. and Kolb, D.A. (2012), “Experiential Learning Theory”, in Norbert M. Seel (Ed.), *Encyclopedia of the Sciences of Learning.*, Boston, MA: Springer US, pp. 1215–1219.

Konrad, T., Wiek, A. and Barth, M. (forthcoming), “Developing Key Competencies in Sustainability Through Project-based Sustainability Courses - Material from a Comparative Study. Leuphana University Lüneburg. Center for Global Sustainability and Cultural Transformation. (Working Paper Series)”.

Konrad, T., Wiek, A. and Barth, M. (in review), “Learning to Collaborate from Diverse Interactions in Project-based Sustainability Courses”.

Konrad, T., Wiek, A. and Barth, M. (2020), “Embracing conflicts for interpersonal competence development in project-based sustainability courses”, *International Journal of Sustainability in Higher Education*, Vol. 21 No. 1, pp. 76–96.

Kricsfalusy, V., George, C. and Reed, M.G. (2018), “Integrating problem- and project-based learning opportunities:. assessing outcomes of a field course in environment and sustainability”, *Environmental Education Research*, Vol. 24 No. 4, pp. 593–610.

Lozano, R., Merrill, M.Y., Sammalisto, K., Ceulemans, K. and Lozano, F.J. (2017), “Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal”, *Sustainability*.

May, T. (2011), *Social Research: Issues, methods and process,* 4th ed., Open University Press, Buckingham, Philadelphia.

Miles, M.B., Huberman, A.M. and Saldaña, J. (2014), *Qualitative Data Analysis: A Methods Sourcebook*, SAGE Publications, Los Angeles, London, New Delhi, Singapore, Washington DC.

Molderez, I. and Fonseca, E. (2018), “The efficacy of real-world experiences and service learning for fostering competences for sustainable development in higher education”, *Journal of Cleaner Production*, Vol. 172, pp. 4397–4410.

Müller, P.A., Bäumer, T., Silberer, J. and Zimmermann, S. (2020), “Using research methods courses to teach students about sustainable development – a three-phase model for a transformative learning experience”, *International Journal of Sustainability in Higher Education*, Vol. 21 No. 3, pp. 427–439.

Noble, D., Charles, M.B. and Keast, R. (2017), “New development: Towards a collaborative competency framework to enhance public value in university– industry collaboration”, *Public Money & Management*, Vol. 37 No. 5, pp. 373–378.

Oxenswärdh, A. and Persson-Fischier, U. (2020), “Mapping Master Students´ Processes of Problem Solving and Learning in Groups in Sustainability Education”, *Sustainability (online)*, Vol. 12 No. 13.

Redman, A. and Wiek, A. (in review), “Competencies for advancing transformations towards sustainability”, *Ambio*.

Roy, S.G., Souza, S.P. de, McGreavy, B., Druschke, C.G., Hart, D.D. and Gardner, K. (2020), “Evaluating core competencies and learning outcomes for training the next generation of sustainability researchers”, *Sustainability science*, Vol. 15 No. 1, pp. 619–631.

Ryan, R.M. and Deci, e.L. (2000), “Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being”, *American Psychologist*, Vol. 55 No. 1, pp. 68–78.

Savage, E., Tapics, T., Evarts, J., Wilson, J. and Tirone, S. (2015), “Experiential learning for sustainability leadership in higher education”, *International Journal of Sustainability in Higher Education*, Vol. 16 No. 5, pp. 692–705.

Segalàs, J. and Tejedor, G. (2016), *Transdisciplinarity Action Research workshop for sustainable technology communities: Research Institute for Sustainability Science and Technology, Universitat Politècnica de Catalunya - Barcelona Tech, Spain*, Engineering Education for Sustainable Development (4-7 September 2016, Bruges, Belgium).

Singer-Brodowski, M. (2016), “Studierende als GestalterInnen einer Hochschulbildung für nachhaltige Entwicklung selbstorganisierte und problembasierte Nachhaltigkeitskurse und ihr Beitrag zur überfachlichen Kompetenzentwicklung Studierender. Doctoral Thesis. Leuphana University of Lüneburg.”.

Sipos, Y., Battisti, B. and Grimm, K. (2008), “Achieving transformative sustainability learning. Engaging head, hands and heart”, *International Journal of Sustainability in Higher Education*, Vol. 9 No. 1, pp. 68–86.

Skinner, K.L., Hyde, S.J., McPherson, K.B.A. and Simpson, M.D. (2016), “Improving students’ interpersonal skills through experiential small group learning”, *Journal of Learning Design*, Vol. 9 No. 1, pp. 21–36.

Soini, K., Korhonen-Kurki, K. and Asikainen, H. (2019), “Transactional learning and sustainability co-creation in a university – business collaboration”, *International Journal of Sustainability in Higher Education*, Vol. 20 No. 6, pp. 965–984.

Stauffacher, M., Walter, A.I., Lang, D.J., Wiek, A. and Scholz, R.W. (2006), “Learning to research environmental problems from a functional socio-cultural constructivism perspective. The transdisciplinary case study approach”, *International Journal of Sustainability in Higher Education*, Vol. 7 No. 3, pp. 252–275.

Tejedor, G., Segalàs, J., Barrón, Á., Fernández-Morilla, M., Fuertes, M., Ruiz-Morales, J., Gutiérrez, I., García-González, E., Aramburuzabala, P. and Hernández, À. (2019), “Didactic Strategies to Promote Competencies in Sustainability”, *Sustainability*, Vol. 11 No. 7.

Tejedor, G., Segalàs, J. and Cebrián, G. (2018), “Action research workshop for transdisciplinary sustainability science. (Correction: third author added: Sustain Sci 14, 859 (2019). https://doi.org/10.1007/s11625-018-00654-9”, *Sustainability Science*, Vol. 13 No. 2, pp. 493–502.

Thomas, I. (2009), “Critical Thinking, Transformative Learning, Sustainable Education, and Problem-Based Learning in Universities”, *Journal of Transformative Education*, Vol. 7 No. 3, pp. 245–264.

Walker, G.B. and Daniels, S.E. (2019), "Collaboration in Environmental Conflict Management and Decision-Making: Comparing Best Practices With Insights From Collaborative Learning Work", *Frontiers in Communication*, Vol. 4, pp. 1–12.

Wals, A.E.J., van der Hoeven, N. and Blanken, H. (2009), "The acoustics of social learning", *Wageningen Academic Publishers*.

Wang, C. and Burris, M.A. (1997), "Photovoice: Concept, Methodology, and Use for Participatory Needs Assessment", *Health Education & Behavior*, Vol. 24 No. 3, pp. 369–387.

Wiek, A. and Kay, B. (2015), "Learning while transforming. Solution-oriented learning for urban sustainability in Phoenix, Arizona", *Current Opinion in Environmental Sustainability*, Vol. 16, pp. 29–36.

Wiek, A., Withycombe, L. and Redman, C.L. (2011), "Key competencies in sustainability. A reference framework for academic program development", *Sustainability science*, Vol. 6 No. 2, pp. 203–218.

Wiek, A., Xiong, A., Brundiers, K. and van der Leeuw, S. (2014), "Integrating problem- and project-based learning into sustainability programs", *International Journal of Sustainability in Higher Education*, Vol. 15 No. 4, pp. 431–449.

Yin, R.K. (1984), *Case Study Research: Design and Methods*, SAGE Publications, Beverly Hills, London, New Delhi.

Zemler, L. (2016), "The convergence of societal advancement and the education of future sustainability professionals: a solution-oriented approach to place-based environmental challenges. A descriptive case study of the Master's course 'Strategic Environmental Development' of Lund University, Sweden", Master Thesis, Lund, 2016.

Appendix

GALLERY WALK-FOCUS GROUP

Course: UPC Action Research Workshop Course

Place: UPC Campus Nord **Date**: May 24, 2018

Research Question

What teaching and learning processes enabled students to develop key competencies in sustainability?

Goal

Find out what was learned in the course (key competencies)

Find out how it was learned in the course (teaching and learning processes)

Uncover causal links between the what and the how

Material

Tape

Print-Outs (timeline, photos, texts, individual skill tracing hand-out)

Table & chairs

Blank sheets & pens

Sticky notes

Recording devices

Flipchart & markers

Gallery Walk-Focus Group Guide

Time	Activity	Description of Responsibilities	Rationale	Material& Notes
60min	Arrange the room	Hang up the Photovoice photos of the three groups on the wall (chronological order) ADD NUMBERS* to each photo Hang up the timeline of the course (above or below) * Numbers: That recorded stories can be traced back to the respective photo	One row = groups´ chronological order of sent photos One Column = roughly the same time period →for comparison of different groups´ storylines Course timeline as overall reference	all print-outs, tape, blank sheets, pens, recording devices, sticky notes
[Photovoice] Introduction and Preparation Part (total: 15min)				
10min	**Welcome & Gallery Walk**	**"Welcome to this Gallery Walk-Focus Group. Part of the Photovoice method is collective meaning making – and that´s what we are doing within the next 1,5 hours, among other things. Some of the photos you see you know, others you don´t. Let's get started: I invite you to walk through the gallery, equipped with paper and pen, so you can scribble down thoughts, comments or questions you might have for your peers later. I turn on the recording devices now."**	Warm-Up phase, going mentally through the course again, comparing own experiences with other project groups	**Turn on recording devices at different places in the room!** **OBSERVE and take notes!**
5min	**First impressions**	**"Let´s come back together now: Any impressions you want to share before I ask some questions?"** (We will come back to Photovoice later)	Get an impression what can be harvested from student input	**Take notes on flipchart** **TIME Keeping!**
[Focus Group] "WHAT" - Part (total: 30min)				
10min	**Emic view on learning outcomes**	**"As you know, I am interested in *WHAT* you have learned in this course and *HOW* you have learned it. Let's start with: What do you think you have learned or improved over the last semester in the Action Research Course? Take a few**	1)Key Competencies in Sustainability	**sticky notes** if possible: put on wall/ whiteboard to cluster (along key

		minutes to think about it and write it on the sticky notes. [after 2min] **Let's share now …"**		competencies)
10min	**Future applicability of learning outcomes; Skill-Self-Assessment**	**"What do you think this course prepared you for when you think of your future workplace?"** *Follow Up Questions:* **"What are you now capable of doing that you haven´t been a semester ago?" "Can you imagine leading such sustainability projects in the future? Why/not? Please elaborate."**	1)Key Competencies in Sustainability	
5min	**Individual WHAT Activity:** **Re-visiting Concept Maps**	**"At the beginning of the course you were drawing concept maps of the competencies a change agent needs and highlighting the ones you already possess. Please have a look at these maps again. Anything you strengthened or developed in addition over the course of this semester? Take 5 minutes to think about it and feel free to adjust your concept map."** (Offer blank sheets if they want to start from scratch)	1)Key Competencies in Sustainability	**Change Agent Concept-Maps Handouts**
5min	**Transition Question**	Ask someone to share **"Has your understanding of a change agent changed? What competences does a change agent need to have?"** Follow-Up: **"Do you have developed these competencies/to what extent?"**	1)Key Competencies in Sustainability	
[Focus Group] "HOW" - Part (total: 40min) – **[Targeted Part]**				
15min	**Individual HOW Activity: Process Tracing**	**"I am also interested in *HOW* you learned what you said. So: Please select one competence or skill you think you developed or strengthened in the Action Research Course. Write it on the personal timeline in the box on the right hand side. Track your learning process by identifying *WHEN and HOW* the skill**	2)Teaching & Learning Process: Actual Activities & Interactions Causal links between learning outcomes T&L	**personal timeline**

		was developed. **Please refresh your mind by looking at your photo story and the course timeline.** **Please write down <u>everything</u> you think contributed to your learning process.** **Take about 10 minutes for this."**	processes	
5min	**1. individual learning process presentation**	Ask someone to share **"What skill did you develop in the Action Research Course? What did you write or draw on your timeline that was important in that learning process?"** Follow-Up: **"Can you tell us a bit more about your learning?"**	Unpacking the boxes of WHEN & HOW	
	Under-standing of different roles in the T&L process	If not mentioned by the students, follow-up Questions: **"What role did …** **The project providers/External stakeholders** **The instructors** **Your peers** **Previous experiences** **… play in this teaching and learning process?"**	2)Teaching & Learning Process: Interactions 3)Teaching & Learning Environment: teaching Competence; Enabling Context: Stakeholders 4)Participants: previous experience, relevant outside activity	
20min	**2. Round**	**See above**	Comparing and contrasting	
[Photovoice] Collective Meaning Making & Concluding Part (total: 5min)				
5min	**Wrap Up along photos**	**"Any comments or questions from your side to your peers? Any pictures that resonate with you?"**	Harvest stories of similarities or contrast between groups	
	Thanks	"Thanks for your active participation now and over the course of this semester. It is highly appreciated."		

Optional, depending on time:

Let each student choose one photo that resonates with her/him and let her/him share the story (*Rationale*: similarities and differences between project groups)

"No one educates anyone, nobody educates himself, men educate one another, mediated by the world."

(Paulo Freire)

*

"the potential of caring practices as *sites of empowerment*. Caring practices can be productively understood as interactivities involving a certain type of attentive communicative contact, located *between* subjects, shaped by both (…). The possibility for change lies in this interaction"

(Moriggi et al., 2020)

*

"While I consider leaders to be primarily responsible for creating conditions conducive to collaboration, all members of a collaborative team are responsible for how they engage in the team."

(Freeth, 2019)

5.3. Learning to Collaborate from Diverse Interactions in Project-based Sustainability Courses

Citation

Konrad, Theres; Wiek, Arnim; Barth, Matthias (in review): "Learning to Collaborate from Diverse Interactions in Project-based Sustainability Courses". Submitted to *Journal of Cleaner Production*.

Abstract

Project-based sustainability courses require and facilitate diverse interactions among students, instructors, stakeholders, and mentors. Most project-based courses take an instrumental approach to these interactions – so that they support the overall project deliverables. However, as courses primarily intend to build students' key competencies in sustainability, including the competence to collaborate in teams and with stakeholders, there are opportunities to utilize these interactions more directly to build students´ interpersonal competence. This study offers insights from project-based sustainability courses at universities in Germany, the U.S., Switzerland, and Spain to empirically explore such opportunities. We investigate how students develop interpersonal competence by learning from (rather than through) their interactions with peers, instructors, stakeholders, and mentors. The findings can be used by course instructors, curriculum designers, and program administrators to more deliberately use the interactions with peers, instructors, stakeholders, and mentors in project-based sustainability courses for developing students' competence to successfully collaborate in teams and with stakeholders.

Keywords: project-based learning, sustainability courses, key competencies in sustainability, interpersonal competence, interactions

1. Introduction

Project-based sustainability courses are conducive learning settings for students to develop key compe-tencies in sustainability (Wiek, Withycombe, & Redman, 2011; Wiek et al., 2014; Brundiers & Wiek, 2013; Papenfuss et al., 2019; Barth, 2015; Tejedor et al., 2019; Molderez & Fonseca, 2018). Interpersonal competence, i.e., the ability to collaborate in teams and with stakeholders, has been found to be one of the main learning outcomes of such courses (Konrad et al., 2020; Konrad et al., 2021; Heiskanen et al., 2016; Zemler, 2016; Clevenger & Ozbek, 2013). These courses constitute rich learning environments through the various interactions that students have with peers, instructors, external stakeholders, and additional actors (Stauffacher et al., 2006; Brundiers & Wiek, 2013). Most project-based courses take an instrumental approach to these interactions – so that they support producing the overall project deliverables, which ought to be useful for stakeholders (Brundiers & Wiek, 2013; Wiek et al., 2014; Kricsfalusy et al., 2018). However, as courses intend to build students' key competencies in sustainability, there are opportunities to utilize these interactions more directly to build students' interpersonal competence. This means to take advantage of the learning environment, and more specifically, of the various interactions that occur in project-based sustainability courses (Förster et al., 2019). In other words, as opposed to letting these interactions simply fulfill their function in the course projects (which, admittedly, facilitates some competence development, too), we are interested in exploring the explicit design and combination of interactions to advance students' interpersonal competence. We refer to this difference as students learning from rather than through these interactions.

This study addresses the research question how students' interactions with peers, instructors, stakeholders, and mentors in project-based sustainability courses can be utilized to support students in learning to collaborate in teams and with stakeholders (interpersonal competence). We conducted empirical and comparative research on three project-based sustainability courses at universities in Germany, the U.S., Switzerland, and Spain. The study links empirical data on learning processes elicited from students, instructors, stakeholders, and mentors, and interprets those through the lens of prominent learning theories.

The study's goal is to inform design of courses to enhance students' learning experiences and to better align learning outcomes and processes (Biggs, 1996). The findings can be used by course instructors, curriculum designers, and program administrators to more deliberately create and combine interactions for interpersonal competence development in project-based sustainability courses.

2. Research Design

Research was carried out as a comparative case study on three project-based sustainability courses of (international) master programs. Selection criteria were, for instance, that the courses simultaneously pursue (a) learning objectives, i.e. key competence development (teaching component), (b) a solution to the sustainability problem addressed in the project (solution component), and (c) support of stakeholders participating in the project (transdisciplinary component).

The investigated courses were (i) the *Global Sustainability Research* (GSR) course at Leuphana University of Lüneburg (LEU/ Germany) and Arizona State University (ASU/ USA); (ii) the *transdisciplinary Case Study* (tdCS) course at the Swiss Federal Institute of Technology (ETH/ Switzerland); and (iii) the *Action Research Workshop* (ARW) course at the Polytechnic University of Catalonia (UPC/ Spain). Key features of the courses are summarized in table 1. The courses are described in detail in Konrad et al. (2020a).

Table 1. Key features of the three project-based learning sustainability courses (Konrad et al., 2020a)

University	Arizona State University (ASU), USA & Leuphana University of Lüneburg, Germany	Swiss Federal Institute of Technology (ETH) Zurich, Switzerland	Polytechnic University of Catalonia (UPC) Barcelona, Spain
Program	Double-degree international master program: *Global Sustainability Science*	4 different master programs [10 different majors]	Master program: *Sustainability Science and Technology*
Course	*Global Sustainability Research* (GSR)	*Transdisciplinary Case Study* (tdCS)	*Action Research Workshop* (ARW)
Mandatory	Yes	No	Yes
Course duration	3 semesters (study focus: semester 3)	1 semester + field phase (3 weeks)	1 semester
Course location	Germany & Arizona	Switzerland & Seychelles	Spain
Pedagogy of place	On- and off-campus	On- and off-campus	On- and off-campus
ECTS	10+10+5	7	5
# of students	12 (2016-2017)	19 (2018)	15 (2018)
# of student groups	3 + 1	7	5

Project topic	Food economy	Waste management	Energy; Food; Housing
Stakeholder engagement	3 major events; City staff, public, food economy entrepreneurs	Continuous with peak phase; NGOs, government, businesses, citizens	Ranging from few check-ins to continuous; NGOs, members, supermarkets
# of instructors	1 (lead) + 3 [in semester 3]	1 (lead) + 1	1 (lead) + 1
# of tutors	0	ETH: 1; Seychelles: 2	0 (occasionally 1)
Expert support	City sustainability officer	Scientific experts and advisory board (local ministry, NGO and business representatives)	Faculty members, project providers

While an in-depth case study was conducted on the GSR course for over a year (Konrad et al., 2020), with a focus on the third semester at ASU, the case studies on the tdCS course and the ARW course were mostly conducted remotely, complemented by two site visits (each) for data collection.

To allow for triangulation and to ensure construct validity (Creswell & Clark, 2017), we used a mix of data collection methods, including (participant) observation of class sessions, student and instructor team meetings, stakeholder engagement events (Emerson et al., 2001/2007); semi-structured interviews (including focus groups) with students, instructors, alumni tutors, and stakeholders (May, 2011); and Photovoice for student teamwork (Wang & Burris, 1997; Konrad et al., 2020). Data collection took place from March 2017 until July 2018 by an external researcher (T.K.) who was not involved in teaching or grading any of the three courses. Data collection was approved by the relevant ethical boards and is based on written consent from all participants.

The cross-case analysis enables insights on commonalities of cases as well as their particularities (Khan & VanWynsberghe, 2008). Data was coded and first analyzed regarding similarities and differences across cases. Comparative tables were used for qualitative data reduction and pattern identification (Miles et al., 2014). Students´ stated learning outcomes were translated into key competencies in sustainability (if applicable), which subsequently underwent a reliability test. Iteratively going through data and tables allowed to map out project-based sustainability courses´ different interactions for students' interpersonal competence development.

3. Findings

Four types of interactions can facilitate learning processes for interpersonal competence development in project-based sustainability courses, namely: student-student(s), student-instructor(s), student-stakeholder(s), and student-mentor(s) interactions (Fig. 1). These interactions do not automatically facilitate students´ interpersonal competence development; at least not beyond learning-by-doing. They only constitute conscious learning opportunities if made explicit and ongoing subjects of the respective course.

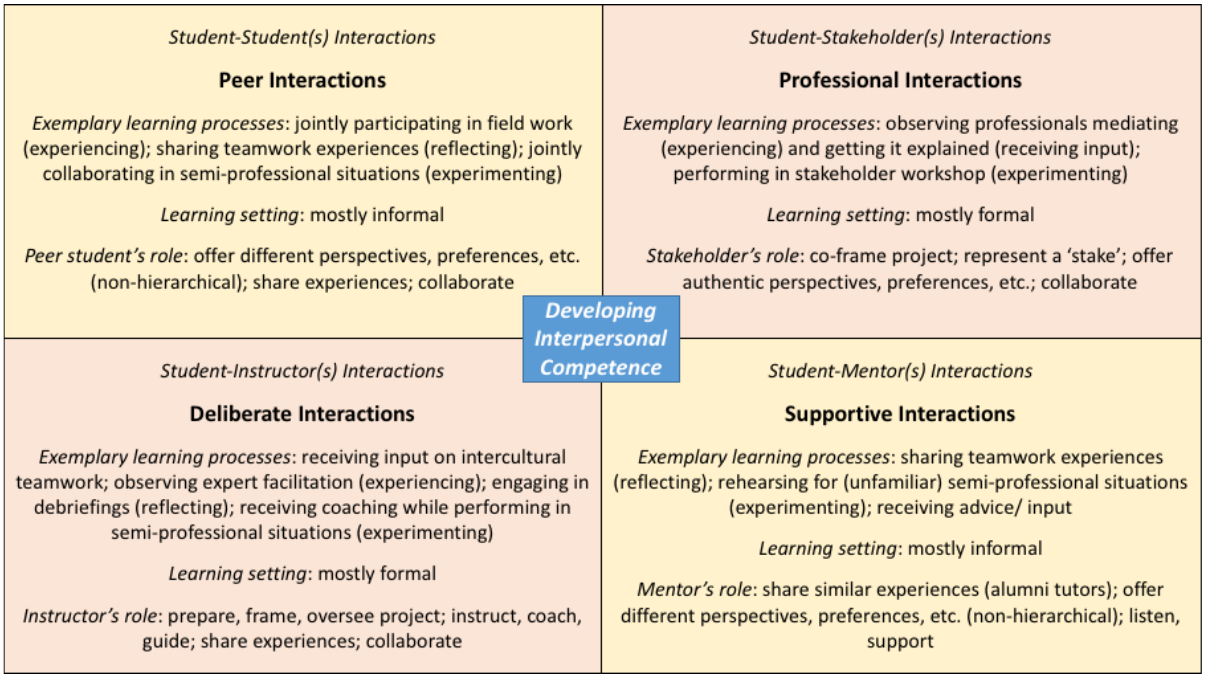

Figure 1: Types of interactions that facilitate students´ interpersonal competence development in project-based sustainability courses.

3.1. Peer Interactions – Student-Student(s) Interactions

Student-student(s) interactions can facilitate development of interpersonal competence, particularly, attitudes, knowledge, and skills for collaborative teamwork. Students collaborating in projects with peers encounter different perspectives, preferences, and styles of working – and this offers insights of relevance. A student highlighted the role of peer students for their learning of collaborative competence:

> "It was really interesting to see the […] different groups; […] seven groups, seven completely different approaches! […] I got to know my own strengths and limitations in groupwork" (S_810, tdCS focus group, 20.07.18, line 36).

Interpersonal competence development from peer learning is not limited to knowledge and skills. Also collaborative attitude can be developed as one student described in a focus group:

> "I had to learn patience and accepting that it takes longer [with] different opinions, maybe different foci also. [...] different people need different stuff […] the [international partner students] […] work differently" (S_818, tdCS focus group, 20.07.18, line 94).

Key to this learning, however, is that these student-student(s) interactions are made subjects of inquiry. Peer interactions need to be explicitly addressed as such, so that students can become aware of them and, from there, develop attitudes, knowledge, and skills in communication, facilitation, mediation, etc. For example, observing peers is not sufficient alone; it requires processing the observations (reflecting), e.g. in conversations with peers, which allows students to compare and contrast their own perspectives, preferences, and style of working with those of others. Another example is when students apply collaborative knowledge to student-student(s) interactions which allows them to develop interpersonal skills, such as facilitation, for instance, by organizing a formal meeting among team members to clarify project roles and responsibilities (S1_012, GSR observation, 19.09.17). A third example is active experimenting in the projects which can lead to the development of a collaborative attitude as one student described:

> "I think […] my role was then […] to take over the lead […] especially because other group members maybe didn't see the light at the end of the tunnel […]. I kept focusing and […] I

knew I had to do something […]. I [realized] I can do something if I really want to" (S_805, tdCS focus group, 20.07.18, line 93).

Peer students display a number of traits that support their role in utilizing peer interactions for interpersonal competence development. First, they often join with different cultural and academic backgrounds and prior experiences, i.e. they offer to each other different perspectives (S_805, tdCS focus group, 20.07.18). Second, they experience the same course and thus have a shared reference point (objective) for learning. Third, they collaborate in the project and thus share the same practice on a regular base. These traits offer plenty of opportunities for deliberation, negotiation, and collective learning.

Instructors play a pivotal role in facilitating students' learning of interpersonal competence – we will get to this in the next section. However, they also play a key role in utilizing peer interactions specifically for interpersonal competence development. Instructors can support reflections among students by organizing formal or informal exchange session in which student teams report to each other about project progress and challenges they face (tdCS, GSR, and ARW course observations and interviews). They can also support students through input sessions on collaborative competence (GSR observations and interviews; ARW observation, 10.04.18), practice sessions in conflict mediation (GSR observations and interviews; ARW focus group, 24.05.18), or targeted coaching sessions (T_805, tdCS interviews, 16./18.07.18). In all these cases, instead of simply letting student-student interactions occur, they are being made either pro-actively or re-actively, direct or indirect, a subject of study. Through this, students can, for instance, develop a conflict-embracing attitude, gain knowledge about expectation management, and practice interpersonal skills such as conflict mediation, and communication.

3.2. Deliberate Interactions – Student-Instructor(s) Interactions

Student-instructor(s) interactions can facilitate students' interpersonal competence development, both in terms of collaborative teamwork and impactful stakeholder engagement. Students receive from instructors input on interpersonal competence; experience how instructors role-model stakeholder facilitation; discuss with instructors teamwork and stakeholder engagement in formal (GSR observations) or informal (tdCS observations) sessions; and experiment with teamwork and stakeholder engagement coached by instructors.

Instructors create deliberate interactions for interpersonal competence development by stimulating and facilitating a spectrum of learning processes. First, instructors offer input on good practices of teamwork and stakeholder engagement. The GSR course, for instance, provided targeted input sessions on professional skills, intercultural and collaborative competence (GSR observations) and the ARW course on Emotional Intelligence (ARW observation, 10.04.18) allowing students to develop knowledge of collaborative teamwork. The tdCS course offered input sessions on how to conduct expert interviews in preparation of the fieldwork phase on the Seychelles (T_801, tdCS instructor interview, 07.06.18), building up skills in impactful stakeholder engagement.

Second, instructors role-model stakeholder facilitation, and coaching students in their own facilitation efforts, develops students´ stakeholder engagement skills (GSR observation, 01.09.17), while allowing students with no prior stakeholder engagement experience to build a mental model (knowledge) of this practice (S1_002, GSR focus group, 30.11.17). Through observing and reflecting on the instructor's facilitation (modeling), for instance, one student learned that facilitating stakeholder engagements requires flexibility and responsiveness:

"[Knowing what stakeholder] engagement […] feels like and where you need to be very careful to spend the time smartly […], where you need to give them leeway to take longer

than you want. […]. The question is how can you then […] react to that. How can you still maintain a friendly atmosphere even though things are not going [… according to] your plan" (S1_002, student interview 31.10.17, line 12).

Third, holding formal post-event debriefing sessions (GSR observation, 05.09.17) or informal plenaries while on fieldwork (tdCS observations), gives students the opportunity to share experiences. Such collective reflections facilitate interpersonal competence development by extracting lessons learned and motivating to change practices, e.g. communication styles.

Finally, through instant (ARW) or progressive (tdCS, GSR) transfer of project ownership from instructor(s) to students, plus subsequent coaching, students often gain self-confidence and a positive attitude towards teamwork and stakeholder engagement (tdCS instructor interviews and observations). Transfer of ownership, and with this, the opportunity to experiment with new interpersonal practices, facilitates (rapid) development of stakeholder engagement skills as necessitated by the project (e.g. S_817, S1_002, S_809, S_814, S_819).

Critical instructors' traits that facilitate interpersonal competence development include thorough preparation of the course and the project(s); clearly communicating course objectives, milestones, and boundaries; instigating and facilitating a variety of learning processes; and willingness to open up and learn themselves (T_701, ARW instructor interview, 10.04.2018).

3.3. Professional Interactions – Student-Stakeholder(s) Interactions

Student-stakeholder(s) interactions can facilitate interpersonal competence development, particularly competence in impactful stakeholder engagement. By collaborating with (ARW) and/or engaging with stakeholders (GSR, tdCS) – through observations of stakeholder events, stakeholder interviews, fieldwork, and stakeholder workshops – students encounter professional perspectives, preferences, behavior, and styles of working. Further, stakeholders call on students to perform professionally. As a result, one student demonstrated interpersonal competence (stakeholder engagement) by stating: "Preparation [for a stakeholder event …] is really knowing the audience and also being enough in the topic that […] you have a structure that guides […]. [You should also prepare] tasks for the participants to get them involved and stimulate them" (S_817, focus group, 20.07.18, line 95).

Key to this learning is that student-stakeholder(s) interactions are made subjects of inquiry. That means that student-stakeholder(s) interactions need to be complemented by opportunities for reflection, so that students become aware of these interactions and, from there, develop attitudes, knowledge, and skills in impactful stakeholder engagement. For example, the tdCS course offered intense interaction opportunities during their three-week field phase on the Seychelles. When a student reflected on them, he/she realized how such encounters can reverse deep-seated perspectives:

> "The biggest thing for me was […] to walk into complete strangers´ gardens and houses […]. As a kid you always get told: 'Stranger danger!' – 'Don't talk to strangers!'. And now […] you're the stranger people aren't supposed to be talking to." (S_814, ETH focus group II, 20.07.18, line 43).

Professional interactions can also take shape, for instance, by students partnering with external partners right at the course start, which required ongoing interactions along an entire semester (ARW observations and interviews). For example, students developed a mental model of impactful stakeholder engagement from observing experts facilitating stakeholder conversations (GSR and ARW focus groups) as demonstrated in debriefings. Or, students became aware of discrepancies between their own and stakeholders' project objectives, which required negotiations and

expectation management (S_705, ARW student group interview, 11.04.18; T_701, ARW instructor interview, 10.04.2018).

The GSR course followed a sequencing approach to stakeholder engagement, allowing students independent from the individual student project team they were in, to move from more passive roles of receiving input (training) and experiencing (observing, taking notes at stakeholder events) to more active roles of experimenting ([co-]facilitating stakeholder conversations). This can lead to building attitude (self-confidence to engage), knowledge (mental model of engagement), and skills (how to engage/facilitate).

Stakeholders have some unique traits that support their role in facilitating students' learning from professional interactions (figure 1). They display authenticity, authority, and/or professionalism; but even more so, they personify the real world and add to the project that something is 'at stake', allowing to create personal connections (ARW student interviews). These traits make it quite easy to attract students´ attention and offer plenty of opportunities for comparison of perspectives, preferences, and behavior.

Instructors play a pivotal part in facilitating students' learning from professional interactions, too. They build up, maintain, and utilize their stakeholder relationships to create a project for the students to engage with (pre-course requirement; instructor interviews). The GSR course, for instance, situated the course within an ongoing university-city partnership and research program (instructors were principal investigators) which offered students plenty of opportunities to observe, reflect, and, step-by-step, grow into more active roles in stakeholder engagement. Similarly, the tdCS course and the ARW course relied on their partnerships with businesses, NGOs, and government agencies.

3.4. Supportive Interactions – Student-Mentor(s) Interactions

Student-mentor(s) interactions can facilitate interpersonal competence development, both in terms of collaborative teamwork and impactful stakeholder engagement. In the projects, students are confronted with various new perspectives, preferences, behavior, and styles of working. This often creates discomfort, tensions, or (inner and/ or outer) conflicts (Konrad et al. 2020b). Supportive interactions bring mentors into the projects to open up reflections and conversations about these experiences. An alumni tutor stated that due to similar age range and experiences tutors are easily approachable for students and can support interpersonal competence development by active listening, inviting changes of perspective, and offering new interpretations of experiences. Mentors can also provide input based on their experiences with teamwork and stakeholder engagement. Compared to more formal learning settings with stakeholders and instructors, interactions with mentors open up an informal settings with no pressure and nothing 'at stake'. This space particularly invites students to experiment and thus supports students´ interpersonal skill development (T_804, tdCS tutor interview, 13.07.18).

Supportive interactions can help students to become aware of differences in perspectives, behaviors, strengths and weaknesses (Konrad et al. 2020c). In a reflection session with a mentor, i.e., here an external researcher who had completed a project-based course as a student, a student stated for instance: "sometimes we forget that we are in a different culture" (S1_004, GSR Photovoice session, 30.11.17). Interactions with mentors allow for revisiting experiences, so that students can derive such insights, e.g. how to communicate differently in 'a different culture'. Supportive interactions also help to rehearse for unfamiliar interpersonal situations, such as presenting to stakeholders (ARW focus group, 24.05.18).

Mentors have some traits that make their role special in learning from supportive interactions: in the case of alumni tutors as mentors they share similar experiences based on which they can provide advice; they have no power over students´ grades; their role integrates active listening, while still being able to offer input based on relevant knowledge and experience.
Instructors facilitate supportive interactions by hiring alumni as tutors to offer students additional opportunities for reflecting and experimenting that facilitates interpersonal competence development. First, student-mentor(s) interactions allow for more informal conversations compared to conversations with instructors and stakeholders. Second, mentors support students in leaving their comfort zone and thereby help fostering self-confidence (attitude) and communication skills (ARW focus group, 24.05.18).

4. Discussion

This study suggests that project-based sustainability courses are uniquely suited to develop students' interpersonal competence; even more so, if the various interactions inherent in such courses are used deliberatively, beyond just learning-by-doing. It is in line with previous findings on project-based sustainability courses (Konrad et al., 2020) that learning can occur when interactions simply happen (van Note Chism, 2006, 21). Yet, we have shown in the present study that learning can be enhanced when making these diverse interactions subjects of inquiry (ibid; cf. Brundiers et al., 2010; Stauffacher et al., 2006). Relying on the insight that learning benefits from communicative interactions (Kolb & Kolb, 2005; Stauffacher et al., 2006), it is key to offer students joint exploration, reflection, and discussion about the diverse interactions with peers, instructors, stakeholders, and mentors. Our study offers some guidance on how to facilitate such learning, which might also be applicable to the broader for development of key competencies in sustainability and sustainability education in general (Barth, 2015; Oonk, 2016).
Peer or student-student(s) interactions facilitate the development of interpersonal competence, mostly in an informal setting, e.g. through peer observation, applying good teamwork practices, and joint reflections (Donnelly & Fitzmaurice, 2005). Diversity of cultural and academic backgrounds and the resulting plurality of viewpoints and ways of doing support learning of interpersonal competence (Konrad et al., 2020; Molderez & Fonseca, 2018; Barth et al., 2007). Other scholarly work points in similar directions with concepts such as "transgressive learning" (Macintyre et al., 2020), i.e. resolving inner conflicts for learning and interpersonal competence development. Brundiers and Wiek (2013, p. 1734) highlighted that the challenging task of "self- and peer-evaluation of one's own and each team member's contributions at different stages [of the project]" supports students' interpersonal competence development.
Deliberate or student-instructor(s) interactions facilitate learning, mostly in a formal setting, from and through the course instructor(s), e.g. through coaching of teamwork (Brundiers & Wiek, 2013). Collins et al.'s (1987b) cognitive apprenticeship model envisions instructors modeling expert practice, after having provided an idea of what it is to be learned/ achieved (e.g. sample projects, practices, etc.) (Donnelly & Fitzmaurice, 2005); and then supporting students through scaffolding (Hannafin et al., 2014) and coaching (Helle et al., 2006), until, ideally, 'disappearing' when students perform tasks independently (Johari & Bradshaw, 2008). In line with this concept, our study saw the course instructors facilitate students' interpersonal competence development through delivering input, enabling experience, prompting reflection, and coaching in experimentation (Donnelly & Fitzmaurice, 2005; Stauffacher et al. (2006). However, instructors are not only active in deliberate interactions, they are instrumental in facilitating the three other types of interactions and associated learning opportunities, too. Bürgener and Barth (2018, p. 822) state that instructors are "the single most

important factor when it comes to success in students' learning and it is the teacher's competencies that create learning opportunities with the greatest potential learning outcomes." Beyond the role of course designer and facilitator (Donnelly & Fitzmaurice, 2005), they serve as supervisor, coach, and mediator, only "taking control when necessary" (Stauffacher et al., 2006, p. 262). This models versatile interpersonal practice for the students in support of their interpersonal competence development. This support is critical as "good social skills do not spring naturally from cooperative group activities" (Cheng et al., 2008, p. 217).

Professional or student-stakeholder(s) interactions facilitate learning of interpersonal competence in a formal setting. By interacting with those representing "original perspectives that matter" (Earl et al., 2018, p. 1114), operating in the real world (Brundiers & Wiek, 2013), students "participate in authentic practices and practice skills needed in real life projects" (Helle et al., 2006, p. 293), while developing personal connection, empathy, compassion, and purpose (Wiek, 2015; Müller et al., 2020; Brandt et al., 2019; Robinson & Aronica, 2009; Barth et al., 2007 ; Molderez & Fonseca, 2018). As pointed out in other studies (Schneider et al., 2019; Earl et al., 2018), students' interpersonal competence development requires going beyond simply participating in these interactions, and making them the subject of inquiry, exploration, reflection, and discussion. Brundiers and Wiek (2013, p. 1737) summarize that "inviting stakeholders directly to convey particular knowledge or skills through collaboration, tutorials, and regular feedback to students helps to build students' capacity to account for and integrate various perspectives". Student-stakeholder(s) interactions allow for applying interpersonal knowledge into practice, i.e. the practice of interpersonal skills, e.g. different communication styles (Brundiers et al., 2010). Moreover, stakeholders represent different values, beliefs, ways of thinking and doing, have a different problem understanding and/ or solution vision, all of which can trigger interpersonal competence development (Konrad et al., 2020). However, professional interactions need to be carefully developed and monitored by the instructor, for instance, through a sequencing approach to stakeholder engagement (adopted in the GSR course), which aligns with the "progressive model" of stakeholder engagement developed by Brundiers et al. (2010).

Supportive or student-mentor(s) interactions, facilitate learning of interpersonal competence in informal settings. Mentors nurture students' learning processes through listening, relating to, questioning, encouraging, and accepting (Anderson & Shannon, 1988). These supporting activities seem critical for students' interpersonal competence development because there is "general hesitation among students to actively elicit feedback (that might impact grades)" (Brundiers & Wiek, 2013, p. 1736). This presents the role of mentors as a solution to foster interpersonal competence development (and learning overall). We follow Kolb and Kolb (2005) by pointing out that the conventional didactical model of challenging students should be broadened by finding ways of rather supporting them in learning from challenging interpersonal situations that inevitably emerge in projects.

As mentioned above, course instructors play a pivotal role in facilitating that students develop interpersonal competence from these diverse interactions, using the functional interactions in project-based sustainability courses (Förster et al., 2019; Barth, 2015; Wilhelm et al., 2019; Kelly, 2006; Johari & Bradshaw, 2008). In a number of ways, instructors are the gatekeepers and enablers of learning from diverse interactions by supporting students to reflect on, articulate, and discuss the various interactions that occur in project-based sustainability courses and use the insights in developing and applying their interpersonal attitudes, knowledge, and skills. However, this requires more than just conventional content and didactical expertise on behalf of the instructor(s). It also calls for openness and willingness-to-learn. Bickford and Wright (2006, 4.17) suggest that "the most

effective way faculty can appreciate the possibilities of a learning community is […] to experience being a student again". Our study therefore suggests for instructors not to take on the role of the learning facilitator for students but to join the learning community and utilize the interactions to develop their interpersonal competence themselves.

A main barrier to leveraging interactions for interpersonal competence development is the dominant pattern at universities to put less emphasis on, and offer less institutional support for, teaching in comparison to research (Singer-Brodowski, 2016). This leads to or consolidates the practice of utilizing project-based sustainability courses for generating more research outputs – at the expense of facilitating deep learning experiences for students. Shifting institutional priorities, however, is a major undertaking and has been documented as a persistent challenge of advancing learning in project-based sustainability courses in particular (Wiek et al., 2014), and sustainability implementation in higher education in general (Weiss & Barth, 2019).

5. Conclusions

Interactions among students, instructors, external stakeholders, and mentors as they regularly (and inevitably) occur in project-based sustainability courses can be leveraged for students' interpersonal competence development, even more so when deliberatively designed and made the subjects of inquiry. Four types of interactions occur in project-based sustainability courses, namely, peer or student-student(s), deliberate or student-instructor(s), professional or student-stakeholder(s), and supportive or student-mentor(s) interactions. Admittedly, they offer learning opportunities for interpersonal competence simply when they happen; but even more so, when students receive inputs on them, experience them, reflect on them, and experiment with them (combining doing and reflection). Instructors play a pivotal role in designing these interactions specifically for developing interpersonal competence (not just for project deliverables). Thereby, instructors face challenges of expectation management, discomfort from tensions and conflicts, as well as institutional barriers. A limitation of this study is the lack of an appropriate assessment that would have more precisely captured students' competence facets and levels (pre- and post-course). Future research could focus on the role of instructors and how they can best be supported to facilitate students' development of key competence development from diverse interactions.

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References

Anderson, Eugene M.; Shannon, Anne Lucasse (1988): Toward a Conceptualization of Mentoring. In: *Journal of Teacher Education*, S. 38–42.

Aronica, Lou; Robinson, Ken (2009): The Element. How finding your passion changes everything. New York: Viking (Penguin Group).

Barth, Matthias (2015): Implementing Sustainability in Higher Education. Learning in an Age of Transformation. London, New York: Routledge (Routledge studies in sustainable development).

Barth, Matthias; Godeman, Jasmin; Rieckmann, Marco; Stoltenberg, Ute (2007): Developing Key Competencies for Sustainable Development in Higher Education. In: *Int J of Sus in Higher Ed* 8 (4), S. 416–430.

Bickford, Deborah J.; Wright, David J. (2006): Community: The Hidden Context for Learning. In: Diana G. Oblinger (Hg.): Learning spaces. Wahington, DC, Boulder, CO: Brockport Bookshelf. 78. (An educase e-Book), p. 4.1.–4.22.

Biggs, John (1996): Enhancing teaching through constructive alignment. In: *Higher Education* 32 (3), S. 347–364. DOI: 10.1007/BF00138871.

Brandt, Jan-Ole; Bürgener, Lina; Barth, Matthias; Redman, Aaron (2019): Becoming a competent teacher in ESD. Learning outcomes and processes in teacher education for sustainable development. In: *International Journal of Sustainability in Higher Education* 20 (4), S. 630–653.

Brundiers, Katja; Wiek, Arnim (2013): Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability. In: *Sustainability* 5 (4), S. 1725–1746. DOI: 10.3390/su5041725.

Brundiers, Katja; Wiek, Arnim; Redman, Charles L. (2010): Real-world learning opportunities in sustainability: from classroom into the real world. In: *International Journal of Sustainability in Higher Education* 11 (4), S. 308–324. DOI: 10.1108/14676371011077540.

Bürgener, Lina; Barth, Matthias (2018): Sustainability competencies in teacher education. Making teacher education count in everyday school practice. In: *Journal of Cleaner Production* 174, S. 821–826. DOI: 10.1016/j.jclepro.2017.10.263.

Cheng, Rebecca Wing-yi; Lam, Shui-fong; Chan, Joanne Chung-yan (2008): When high achievers and low achievers work in the same group: the roles of group heterogeneity and processes in project-based learning. In: *The British journal of educational psychology* 78 (Pt 2), S. 205–221. DOI: 10.1348/000709907X218160.

Clevenger, Caroline M.; Ozbek, Mehmet E. (2013): Service-Learning Assessment. Sustainability Competencies in Construction Education. In: *Journal of Construction Engineering and Management* 139 (12), A4013010. DOI: 10.1061/(ASCE)CO.1943-7862.0000769.

Collins, Allan; Brown, John Seely; Newman, Susan E. (1987): Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics. Technical Report 403.

Creswell, J. W.; Clark, V. L. P. (2017): Designing and conducting mixed methods research. Los Angeles, London, New Delhi, Singapore, Washington DC: SAGE Publications.

Donnelly, Roisin; Fitzmaurice, Marian (2005): Collaborative Project-based Learning and Problem-based Learning in Higher Education: a Consideration of Tutor and Student Role in Learner-

Focused Strategies. In: G. O´Neill, S. Moore und B. McCullin (Hg.): Emerging Issues in the Practice of University Learning and Teaching. Dublin, S. 87–98.

Earl, Allison; Van Wynsberghe; Walter, Pierre; Straka, Timothy (2018): Adaptive education applied to higher education for sustainability. In: *International Journal of Sustainability in Higher Education* 19 (6). DOI: 10.1108/IJSHE-08-2017-0131.

Emerson, Robert M.; Fretz, Rachel I.; Shaw, Linda L. (2001/2007): Participant Observation and Fieldnotes. In: Paul Atkinson, Coffey, Amanda, Sara Delamont, John Lofland und Lyn Lofland (Hg.): Handbook of Ethnography. Los Angeles, London, New Delhi, Singapore: SAGE Publications, S. 352–368.

Förster, Ruth; Zimmermann, Anne B.; Mader, Clemens (2019): Transformative teaching in Higher Education for Sustainable Development: facing the challenges. In: *GAIA - Ecological Perspectives for Science and Society* 28 (3), S. 324–326. DOI: 10.14512/gaia.28.3.18.

Hannafin, Michael J.; Hill, Janette R.; Land, Susan M.; Lee, Eunbae (2014): Student-Centered, Open Learning Environments: Research, Theory, and Practice. In: J. Michael Spector, M. David Merrill, Jan Elen und M. J. Bishop (Hg.): Handbook of Research on Educational Communications and Technology, Bd. 12. New York, NY: Springer New York, S. 641–651.

Heiskanen, Eva; Thidell, Åke; Rodhe, Håkan (2016): Educating sustainability change agents. The importance of practical skills and experience. In: *Journal of Cleaner Production* 123, S. 218–226. DOI: 10.1016/j.jclepro.2015.11.063.

Helle, Laura; Tynjälä, Päivi; Olkinuora, Erkki (2006): Project-Based Learning in Post-Secondary Education – Theory, Practice and Rubber Sling Shots. In: *Higher Education* 51 (2), S. 287–314. DOI: 10.1007/s10734-004-6386-5.

Johari, Abbas; Bradshaw, Amy C. (2008): Project-based learning in an internship program: A qualitative study of related roles and their motivational attributes. In: *Educational Technology Research and Development* 56 (3), S. 329–359. DOI: 10.1007/s11423-006-9009-2.

Kelly, Patricia (2006): Letter from the oasis: Helping engineering students to become sustainability professionals. In: *Futures* 38 (6), S. 696–707. DOI: 10.1016/j.futures.2005.10.005.

Khan, Samia; VanWynsberghe, Robert (2008): Cultivating the Under-Mined: Cross-Case Analysis as Knowledge Mobilization. In: *Forum: Qualitative Research* 9 (1).

Kolb, Alice Y.; Kolb, David A. (2005): Learning Styles and Learning Spaces. Enhancing Experiental Learning in Higher Education. In: *Academy of Management Learning & Education,* Vol. 2, pp. 193-212.

Konrad, Theres; Wiek, Arnim; Barth, Matthias (2020a): Developing Key Competencies in Sustainability Through Project-based Sustainability Courses - Material from a Comparative Study. Leuphana University Lüneburg. Center for Global Sustainability and Cultural Transformation. (Working Paper Series).

Konrad, Theres; Wiek, Arnim; Barth, Matthias (2020b): Embracing conflicts for interpersonal competence development in project-based sustainability courses. In: *International Journal of Sustainability in Higher Education* 21 (1), S. 76–96. DOI: 10.1108/IJSHE-06-2019-0190.

Konrad, Theres; Wiek, Arnim; Barth, Matthias (2020c): Processes of Interpersonal Competence Development – Insights from a Comparative Study of Project-Based Sustainability Courses. (in review).

Kricsfalusy, Vladimir; George, Colleen; Reed, Maureen G. (2018): Integrating problem- and project-based learning opportunities: assessing outcomes of a field course in environment and sustainability. In: *Environmental Education Research* 24 (4), S. 593–610.

Macintyre, Thomas; Chaves, Martha; Monroy, Tatiana; Zethelius, Margarita O.; Villarreal, Tania; Tassone, Valentina C.; Wals, Arjen E. J. (2020): Transgressing Boundaries between Community Learning and Higher Education: Levers and Barriers. In: *Sustainability* 12 (7), S. 2601. DOI: 10.3390/su12072601.

May, Tim (2011): Social Research. Issues, methods and process. 4th ed. Buckingham, Philadelphia: Open University Press.

Miles, Matthew B.; Huberman, A. Michael; Saldaña, Johnny (2014): Qualitative Data Analysis. A Methods Sourcebook. Los Angeles, London, New Delhi, Singapore, Washington DC: SAGE Publications.

Molderez, Ingrid; Fonseca, Elsa (2018): The efficacy of real-world experiences and service learning for fostering competences for sustainable development in higher education. In: *Journal of Cleaner Production* 172, S. 4397–4410. DOI: 10.1016/j.jclepro.2017.04.062.

Müller, Patrick A.; Bäumer, Thomas; Silberer, Jan; Zimmermann, Stefan (2020): Using research methods courses to teach students about sustainable development – a three-phase model for a transformative learning experience. In: *International Journal of Sustainability in Higher Education* 21 (3), S. 216. DOI: 10.1108/IJSHE-08-2019-0252.

Oonk, Carla (2016): Learning and teaching in the Regional Learning Environment. Enabling students and teachers to cross boundaries in multi-stakeholder practices. Doctoral Thesis. Wageningen University & Research.

Papenfuss, Jason; Merritt, Eileen; Manuel-Navarrete, David; Coutier, Scott; Eckard, Bonnie (2019): Interacting Pedagogies: A Review and Framework for Sustainability Education. In: *Journal of Sustainability Education* Vol 20.

Schneider, Flurina; Giger, Markus; Harari, Nicole; Moser, Stephanie; Oberlack, Christoph; Providoli, Isabelle et al. (2019): Transdisciplinary co-production of knowledge and sustainability transformations: Three generic mechanisms of impact generation. In: *Environmental Science & Policy* 102, S. 26–35. DOI: 10.1016/j.envsci.2019.08.017.

Singer-Brodowski, Mandy (2016): Studierende als GestalterInnen einer Hochschulbildung für nachhaltige Entwicklung : selbstorganisierte und problembasierte Nachhaltigkeitskurse und ihr Beitrag zur überfachlichen Kompetenzentwicklung Studierender. Doctoral Thesis. Leuphana University of Lüneburg.

Stauffacher, M.; Walter, A. I.; Lang, D. J.; Wiek, A.; Scholz, R. W. (2006): Learning to research environmental problems from a functional socio-cultural constructivism perspective. The transdisciplinary case study approach. In: *International Journal of Sustainability in Higher Education* 7 (3), S. 252–275.

Tejedor, Gemma; Segalàs, Jordi; Barrón, Ángela; Fernández-Morilla, Mónica; Fuertes, M.; Ruiz-Morales, Jorge et al. (2019): Didactic Strategies to Promote Competencies in Sustainability. In: *Sustainability* 11 (7), S. 2086. DOI: 10.3390/su11072086.

van Note Chism, Nancy (2006): Challenging Traditional Assumptions and Rethinking Learning Spaces. In: Diana G. Oblinger (Hg.): Learning spaces. Wahington, DC, Boulder, CO: Brockport Bookshelf. 78. (An educase e-Book), 2.1-2.12.

Wang, Caroline; Burris, Marry Ann (1997): Photovoice: Concept, Methodology, and Use for Participatory Needs Assessment. In: *Health Education & Behavior* 24 (3), S. 369–387.

Weiss, Marie; Barth, Matthias (2019): Global research landscape of sustainability curricula implementation in higher education. In: *International Journal of Sustainability in Higher Education* 20 (4), S. 570–589. DOI: 10.1108/IJSHE-10-2018-0190.

Wiek, Arnim (2015): Solving Sustainability Problems. Tools for a New Generation of Professionals: School of Sustainability, Arizona State University, Tempe, AZ.

Wiek, Arnim; Xiong, Angela; Brundiers, Katja; van der Leeuw, Sander (2014): Integrating problem- and project-based learning into sustainability programs. In: *International Journal of Sustainability in Higher Education* 15 (4), S. 431–449. DOI: 10.1108/IJSHE-02-2013-0013.

Wilhelm, Sandra; Förster, Ruth; Zimmermann, Anne (2019): Implementing Competence Orientation: Towards Constructively Aligned Education for Sustainable Development in University-Level Teaching-And-Learning. In: *Sustainability* 11 (7), S. 1891. DOI: 10.3390/su11071891.

Zemler, Lindsey (2016): The convergence of societal advancement and the education of future sustainability professionals: a solution-oriented approach to place-based environmental challenges. A descriptive case study of the Master's course 'Strategic Environmental Development' of Lund University, Sweden. Master Thesis, Lund.

6. Discussion

The research presented in this thesis identified three overarching empirically-grounded and theoretically-supported moderating variables of interpersonal competence development in project-based sustainability courses. Each moderating variable has already been separately presented and discussed as follows:

Sub-chapter 5.1. (figure 10: P1) contributes with the insight that

- Interpersonal competence development is fostered through both inner and outer conflicts, if participants are willing and able to embrace these conflicts as learning opportunities. This requires a conflict-embracing attitude, i.e. a willingness to learn.

Sub-chapter 5.2. (figure 10: P2) contributes with the insight that

- Interpersonal competence development requires a sequence of learning processes that complement one another and link the 'doing' with 'reflecting upon the doing', again highlighting the importance of attitude. Further, four specific processes are linked to specific competence facets (attitudes, knowledge, skills) and domains (collaborative teamwork, impactful stakeholder engagement).

Sub-chapter 5.3. (figure 10: P3) contributes with the insight that

- Interactions in project-based sustainability courses (labeled as peer, supportive, deliberate, and professional) support interpersonal competence development, particularly if they are made explicit subjects of inquiry by reflecting upon experiences in/through interactions.

Synthesized findings (Chapter 5) are now discussed in the light of teaching and learning theories (figure 10) and other empirical studies to provide evidence-based and theoretically supported insights into interpersonal competence development in project-based sustainability settings. The role of emotions, attitudes, the instructor(s) and trust are also discussed, as they are strongly related to the moderating variables of interpersonal competence development identified in the research process.

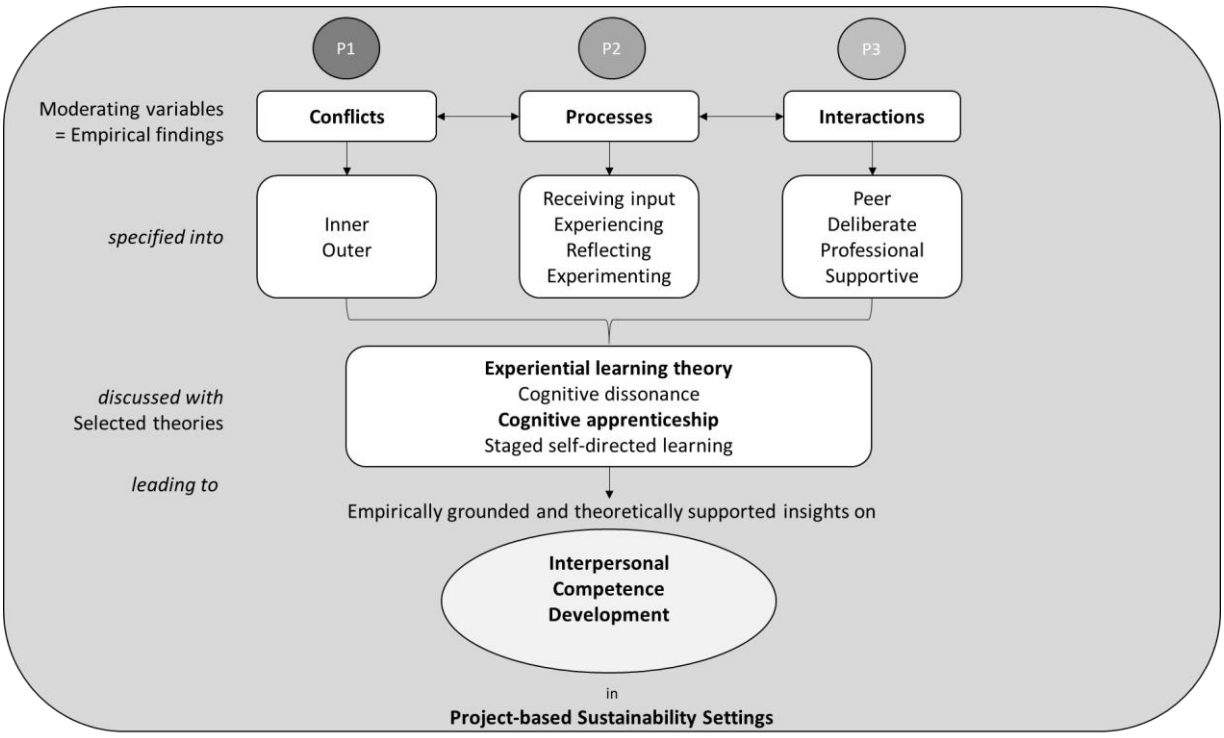


Figure 10: Interpersonal competence development in project-based sustainability courses; evidence-based and theoretically supported.

While **conflicts** in day-to-day life might have rather negative connotations, as they are often associated with uncomfortable feelings, they are acknowledged as potentially productive by teaching and learning theories. The term 'conflict' is used by writers and researchers in experiential learning theory[26] (Kolb & Kolb, 2012), while transformative learning theory (Mezirow, 2000) refers to 'disorienting dilemmas', a phrase that is not unlike the 'emotional discomfort', discussed in cognitive dissonance theory (Festinger, 1957). Similarly, transgressive learning theory, as described by Macintyre (2019), intentionally "invites diversity and dissonance in order to deepen learning, recognizing multiple ways of knowing and being in the world" (p. 96). As Illeris (2003) points out "most great steps forward in the development of [...] society have taken place when someone did not accept a given truth or way of doing or understanding things" (p. 404). This suggests that transformation or, in other words, learning on the societal, institutional, and personal level, is linked to conflict, dissonance, dilemmas, difficulties, and discomfort (Freeth, 2019; Leal Filho et al., 2021). Irrespective of the terms used, they all suggest that a person (to stay on the individual level of the learner) experiences an emotional response to encountered circumstances – to sometimes, "crisis-like situation[s] caused by challenges experienced as urgent and unavoidable, making it necessary to change oneself in order to get any further" (Illeris, 2003, p. 402). On different levels, the current Covid-19 pandemic could deliver proof of this proposition[27].

With the increasing complexity of the world and the uncertainty of the future, **emotions** are getting more attention within sustainability science, with regard to transformation processes, including learning processes aimed at developing change agent competencies (Barth, 2015; Moriggi et al., 2020). Barth (2015) postulated that "[t]he better we understand the relationship between emotions and cognition, the better we can support competence development" (p. 89). In the first article of this cumulative thesis, relocation to another place, multi-cultural and multi-disciplinary teamwork, and stakeholder engagement were identified as circumstances triggering certain emotional reactions, or inner conflicts; which themselves can lead to interpersonal competence development when dealt with constructively (Konrad et al., 2020). The findings presented in this thesis support the idea that the "value and durability of the learning result is closely related to the emotional dimension of the learning process." (Illeris, 2003, p. 401). Therefore, what matters is that there is time space, and willingness to engage with processes triggered through different interactions (Konrad et al., 2020; Konrad et al., 2021; Konrad et al., in review).

Willingness relates to what the second article of this dissertation explored in more detail: the importance of **attitude** in learning and competence development (Konrad et al., 2021; see also Barth, 2015). Willingness, attitude, inner states and mindsets of the learner – overall, the affective-emotional-motivational or 'heart' domain – have not yet received sufficient attention within sustainability, education, and transformation research and their intersections (Brundiers & Wiek, 2017; Frank, 2020; Niedlich et al., 2020; Sipos et al., 2008; Soini et al., 2019; Woiwode et al., 2021). Frank (2020), reflecting on his own learning process within his doctoral research, writes "conflicts are primarily affective-motivational issues, and they need to be addressed at this level. The starting point

[26] "Learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world. Conflict, differences, and disagreement are what drive the learning process." Kolb and Kolb (2012, 1216).

[27] As Leal Filho et al. (2021) state, "with the right action, the COVID-19 crisis can mark the rebirthing of society as we know it today to one where we protect present and future generations" (p. 5).

is to become self-aware of one's personal inner states and processes" (p. 84). Self-awareness, or having a self-reflective attitude, has been found to be crucial for better understanding team dynamics (Konrad et al., 2021), for effective education (Frank, 2020), and in supporting transformations in general (Woiwode et al., 2021). Mindfulness practices (Frank, 2020), Emotional Intelligence sessions including exercises from theater pedagogy (Konrad et al., 2021; Tejedor et al., 2018), dialogue and (self-) reflection (Woiwode et al., 2021), as well as having space and time specifically reserved for engaging with experiences that trigger certain emotions are all ways of becoming more self-aware (Konrad et al., 2021). "[S]elf-reflexivity can result in self-transformation" (Horlings et al., 2020, p. 480). Having a team composed of one or more self-aware or self-reflective individuals that look out for one another, (e.g. through regular emotional check-ins, at the beginning (and ending) of meetings) and where individuals dare to make internal happenings transparent, can positively impact collaboration, and support both transformation and individual and group/ social learning (Caniglia et al., 2020; Konrad et al., 2021 Woiwode et al., 2021). Learning is linked to the "social environment and quality of relationships" (Kolb & Kolb, 2005, 207; see also Frank, 2020). The atmosphere, or the 'space' created, leads to different interactions and contributes to social sustainability (Frank, 2020; Freeth & Caniglia, 2020; Konrad et al., 2020; Konrad et al., in review; Rosenberg, 2015). At the same time, with such attention to team dynamics, which includes attention towards oneself and the intrapersonal sphere (see self-care, Brundiers & Wiek, 2017; Woiwode et al., 2021), learning opportunities resulting from the project itself can be better engaged in and benefitted from (Freeth & Caniglia, 2020; Konrad et al., 2020). Freeth et al. (2019) showed how a lack of attention to affective-social domains or the lack of a collaborative attitude can turn into people´s withdrawal from the project instead of working in integrated ways. Caniglia et al. (2020) found that for individuals, communities and societies to flourish people need to experiment and learn together, which does not mean that there needs to be agreement all the time. Working in integrated ways implies "engaging with conflict and contestation collaboratively when navigating the emergent dynamics of intricate action and capacity building processes" (Caniglia et al., 2020, p. 5), a viewpoint that aligns with the findings presented here (Konrad et al., 2020). This requires interpersonal, or collaborative, competence and highlights the importance and value of (re-)designing project-based sustainability courses so that they allow for interpersonal, collaborative competence development.

Key characteristics of project-based sustainability courses are that they require an active student role in which students work on a given societal challenge in small teams (see e.g. Birdman et al., in review). The doing, or action, seems to be in the foreground. However, as Budwig (2015) highlights, "[l]earning goes well beyond doing" (p. 103). Experiential learning theory, although the name seems to emphasize experience, sees experience only as a starting ground for learning (Zull, 2002). Learning, or knowledge, is understood as the transformation of experience (Kolb & Kolb, 2005) or as Sol et al. (2017) say, "[t]hrough reflexivity an experience becomes transformative, in that it involves an expansion of one's perception of the world, which can be noticed when actors attach new significance and meaning to an aspect of the world" (p. 6). The second article of this cumulative thesis (Konrad et al., 2021) provides substantial evidence in support of what teaching and learning theories (Kolb & Kolb, 2012; Macintyre, 2019; Mezirow, 2000) postulate, namely that "reflections individuals make to synthesize learning are all central to the process" (Budwig, 2015, p. 103). The second article of this thesis described additional processes, including receiving input, experimenting, and, as already stated, reflecting (Konrad et al., 2021). Action, therefore, calls for reflection; feeling calls for thinking; and experience calls for abstraction (Kolb & Kolb, 2005; Kolb & Kolb, 2012). In order

to stress the importance of these processes, I suggest the term 'Refl-Action' – making the implicit and tacit more explicit (Budwig, 2015). What matters is not only that certain learning processes occur, but that they are meaningfully combined and follow a certain sequence (ibid.) for attitude, knowledge, or skill development in collaborative teamwork and/or impactful stakeholder engagement (Konrad et al., 2021). Cognitive apprenticeship provides such a sequential approach (Collins et al., 1987). Through input and first observations, students can first develop a mental model of what is to be learned/ done. Then, step-by-step, through scaffolding and coaching, increasing student ownership, and steadily decreasing guidance and support from the instructor side during the learning process; students become more and more self-directed learners and do-ers (Budwig, 2015; Holmén, 2020; Kolb & Kolb, 2005; Konrad et al., 2021; Konrad et al., in review; Ryan & Deci, 2000; Stauffacher et al., 2006; van de Pol et al., 2010). Designing "environments that assist in the creation of new knowledge by others" is what Budwig (2015) refers to as "guided emergence" (p. 102), underlining the leadership role of instructors.

The gradually fading role of the instructor in student-centered, project-based sustainability courses, however, does not imply that student-instructor interactions are becoming less important simply because their role is subject to change (Collins et al., 1987; Konrad et al., in review; Müller et al., 2020; Ryan & Deci, 2000; van de Pol et al., 2010). In fact, it is the deliberate design and facilitation of such courses and project-based sustainability settings overall, the creation and maintenance of and care for a safe, trustful, respectful learning community (Budwig, 2015; Kolb & Kolb, 2005; Holmén, 2020), that are crucial for students´ interpersonal competence development. In addition to facilitating student-instructor interactions that allow for learning processes to take place, instructors are also partially responsible for providing supportive, peer, and professional interactions (Konrad et al., in review). This requires careful pre-course planning as well as presence and commitment throughout the course, thus demonstrating the level of time and energy investment required on the instructor side for successful project-based sustainability courses (ibid.). As this research shows, this is often underestimated by instructors themselves (Konrad et al., 2020), a problem exacerbated by the fact that teaching and sustainability efforts, as such, often get little attention and support in research-oriented universities (Leal Filho et al., 2021; Singer-Brodowski, 2016).

Each interaction triggers different learning processes. Because the combination of learning processes, such as experiencing, reflecting, and then experimenting, is so important for development of such things as collaborative attitude (Konrad et al., 2021), interactions that trigger specific learning processes are key to allow for this learning (Konrad et al., in review). Making the different interactions explicit subjects of inquiry – through the process of reflecting – allows course participants to harvest lessons learned from each interaction, and should be a cornerstone in project-based sustainability courses aimed at developing interpersonal competence. Shared reflection (i.e. articulation, deliberation, dialogue, discussion, conversation) is stressed by learning theorists as well as by authors of other empirical studies as key to learning and collaboration overall (Barth, 2015; Budwig, 2015; Caniglia et al., 2020; Kolb & Kolb, 2005; Woiwode et al., 2021). This proved to be true for interpersonal competence development as well (Konrad et al., 2021). In addition to providing spaces for students to experiment based upon their pre-course competence levels and the knowledge and input they acquire in-course, actively making space for the process of reflecting in interaction with mentors, peers, stakeholders, and (not least) instructors is crucial. However, as Kolb and Kolb (2005) highlight, this is not necessarily an easy undertaking:

> "Conversational Learning presents the dimensions of spaces that allow for good conversation. It is more likely to occur in spaces that integrate thinking and feeling, talking and listening, leadership and solidarity, recognition of individuality and relatedness, and

> discursive and recursive processes. When the conversational space is dominated by one extreme of these dimensions, for example, talking without listening, conversational learning is diminished." (p. 208)

In students´ future workplaces, within or outside academia, it is likely that different onto-epistemological assumptions come together, and sometimes clash (Caniglia et al., 2020; Holmén, 2020). (Re-)designing courses so that such encounters can be fruitful instead of dreadful support nothing less than (human) life on Earth as students are prepared to be able to collaborate on complex tasks. This might imply the need to develop the willingness and skills to sometimes 'sit in the fire' together (Mindell, 1995/2014). Lewin posited (based upon his concept of 'life space') that "behavior is a function of person and environment" (Kolb & Kolb, 2005, 199). The careful design of learning environments, broadly defined as the "whole range of components and activities within which learning happens" (Barth, 2015, p. 89) brought to life by the interactions that take place there (Konrad et al., in review) is, therefore, a key point of intervention for instructors and course and curriculum designers (Barth, 2015; Budwig, 2015; Kolb & Kolb, 2005) in order to better plan for interpersonal competence development. Works by scholars such as Robinson and Aronica (2009) who referred to 'tribes'; Mitchell et al. (2020) who discussed 'spaces and conditions'; and Wenger (2000) who coined the term 'communities of practice'; all point in the direction of re-designing social learning environments such as project-based sustainability settings to allow for collaborative learning and competences to emerge and develop. Bringing one´s attitudes, knowledge, and skills to the surface within a learning community – a space that fosters different interactions allows for different learning processes to complement one another for learning – which leads to the flourishing of its individual members, including the development of (interpersonal) competence. Therefore, interpersonal competence development can be seen as emancipatory (Budwig 2015; Frank 2020; Holmen 2020; Mitchell and Wals 2020).

An additional facet that this research uncovered, but did not address in detail, is the role of trust in interpersonal competence development. Trust, defined as "a firm belief in the reliability, ability, strength or truth of someone or the expectation that others will act in an agreeable way without the need for intervening" (Slater & Robinson, 2020, p. 5) seems to be crucial to interpersonal competence development. Key competencies reveal themselves in practice (Barth, 2015) and therefore require an individual to be daring to engage in situations of different encounters. In a recent review of the literature on trust, Niedlich et al. (2020) have started to unpack trust to reveal its different dimensions within the educational system. They point out, for instance, that the willingness of students to open up and talk about experiences such as conflicts depends on established trust relationships (ibid.; see also Frank, 2020). Mitchell et al. (2020), applying a systems perspective on learning and collaboration, state that the

> "Capacity to respond to complex and wicked challenges – be it dealing with power inequity, uncertainty, lack of resources – emerges from a healthy learning system. A healthy learning system generates a certain degree of trust and safety, so that people will more easily open up to one another and are less frightened of being held accountable for 'errors' or alternative views that disrupt the normal. Moreover, a healthy network [learning environment] is resilient. Opposites and differences, which inevitably manifest themselves in a process of transformation, do not result in a group falling apart or in the stagnation of the learning process but instead will trigger reflection as opposed to impulsive (re)actions." (p. 5)

In line with our findings, this demonstrates that a conflict-embracing attitude in a 'healthy' (i.e. safe and trustful learning) environment provides for learning opportunities while allowing participants to move forward together on the particular sustainability challenge a group has set out to work on (Konrad et al., 2020; Mitchell et al., 2020). Based on a multi-case study, what this dissertation has shown aligns further with Holmén´s (2020) finding from his investigation of the Challenge Lab at Chalmers University, Sweden. A 'safe space', constituted by a trusted learning community (e.g. of peers, professionals, mentors, and instructors) that provides support and sequencing approaches allows for learning and change by acknowledging the affective dimension. This means that conflicts are not left to smolder, but instead, are constructively dealt with (Holmén, 2020; Konrad et al., 2020; Konrad et al., 2021; Konrad et al., in review). Bai et al. (2016) posited that "Anthropocene futures are dependent on many processes and interactions" (p. 354). The future state of the world depends on the ability and willingness of people to collectively embrace difficulties. And, as "the future is an emergent property shaped by individual and collective choices, decisions and actions at all levels." (ibid., p. 352) creating fruitful learning environments and conditions in which people can experience, reflect, give and receive, and experiment – perform, thrive, learn together, developing interpersonal competence – is essential.

7. Contributions

Now that the individual articles (5.1.; 5.2.; 5.3.) and the overall learning outcomes, or findings, of this doctoral research have been synthesized and discussed, the question remains – *What can this dissertation contribute? What are its practical implications, within and beyond the field of sustainability higher education?*

Interpersonal competence, defined as a key competence in sustainability (Wiek, Withycombe, & Redman, 2011) and elaborated on in general for sustainability professionals (Brundiers & Wiek, 2017), includes, e.g., the ability to motivate oneself and others, to collaborate, and to engage (with) stakeholders. This thesis contributes by specifying what attitudes, knowledge, and skills fall under the overall categories of collaborative teamwork and impactful stakeholder engagement, two facets of interpersonal competence. As these competencies are required in other professions as well; in the following section, the practical implications of the findings presented here are discussed - first, for sustainability higher education, as this was the focus of this research; and, second, for additional areas beyond the immediate field of study.

7.1. Practical implications within the field of sustainability higher education

Based on the research presented here, project-based sustainability course design for interpersonal competence development can be improved in three particular ways, namely in terms of how (i) *conflicts* are dealt with, (ii) how *processes* complement one another, and how (iii) *interactions* can be made explicit subjects of inquiry.

(i) Conflicts

Overall, conflicts usually occur where a heterogeneous group of people needs to work together (Barth, 2015; Freeth & Caniglia, 2020; Tuckman, 1965). However, it is not the occurrence of conflicts, per se, that leads to interpersonal competence development, but rather, *how* these conflicts are dealt with. What matters for learning from inner and outer conflicts (for definitions, see 5.1.) is that they are; *first*, identified at the source; *second*, accepted as challenges to be overcome before they get out of control (danger of cascading effects); *third*, embraced as learning opportunities; and, *fourth*, viewed through the lens of learning outcomes (Konrad et al., 2020), all of which are facilitated by a learning environment characterized by trust and safety that allows for dialogue and reflection (Niedlich et al., 2020; Woiwode et al., 2021). Applying such a *conflict-embracing attitude* fosters individual interpersonal competence development and enhances collaboration and, therefore, project progress.

For course designers and/or instructors this means it is important to actively incorporate, for instance, interactive *input* sessions on intercultural and interpersonal competence, including professional skills (Brundiers & Wiek, 2017), into the course (Konrad et al., 2021). Such sessions can serve as preparation for potentially arising conflicts. The provision of tools (e.g. the code of conduct template) and the application of methods, such as role-plays, to simulate and hypothetically experience conflict situations, allow students to slowly but steadily build up a conflict-embracing attitude and further develop interpersonal knowledge and skills to constructively deal with conflicts as they arise. Also, reflection assignments related to specific experiences can support the development of self-reflection skills which can further contribute to the development of a conflict-embracing attitude that acknowledges the challenges that come with group heterogeneity and help participants work through resulting conflicts. As already indicated, it is not the occurrence of conflicts that matters for learning, but rather what is done with them when they occur, leading to the second contribution of this research: processes.

(ii) Processes

Overall, there are several processes that have been shown to be conducive to interpersonal competence development (figure 8, Chapter 5). However, it is not their random occurrence that leads to interpersonal competence development, and more specifically to attitude, knowledge, and/or skill development in collaborative teamwork and impactful stakeholder engagement. It is *how* these processes are combined that determines the extent to which they foster one or more of the mentioned interpersonal competence facets and/or domains. What matters for the development of specific skills or competencies is, therefore, the meaningful *combination of different learning processes*.

Not only have four learning processes for interpersonal competence development been specified here, they have been further linked to specific learning outcomes, i.e. to either attitude, knowledge, or skill development of collaborative teamwork or impactful stakeholder engagement (Konrad et al. 2021).

If a course designer and/or instructor seeks to help students develop *interpersonal attitudes,* this study suggests the need to plan courses and curricula that combine *experiencing*, e.g. modelled behavior, i.e. collaborative attitudes in action, and *reflecting*, or deducting lessons from such experiences. Opportunities for *experimenting* will allow students to apply lessons learned, i.e. attitudes observed and experienced, in practice (Kolb and Kolb), ultimately supporting the development of interpersonal attitudes. Similarly, if a course designer and/or instructor's intent is to help students develop *interpersonal knowledge*, e.g. mental models of collaborative teamwork and/or impactful stakeholder engagement, this study further suggests the need to combine, again, *experiencing* good practices (modelled behavior), and *reflecting* upon these experiences in order to gain insights from them. Further, this study has shown how delivering *input* on both collaborative teamwork and impactful stakeholder engagement can further empower students to follow opportunities to *experience* and *experiment* with peers and/or stakeholders (Collins et al. 1987; Kolb and Kolb). Finally, if a course designer and/or instructor wishes to support students in developing *interpersonal skills*, this study suggests a course must combine *inputs* with subsequent opportunities for *experimenting*, i.e. applying knowledge in practice (Collins et al. 1987).

What matters for developing comprehensive interpersonal competence is a meaningful *sequence* and *complementation* of learning processes, balancing action and reflection for learning, adding to 'learning by doing' opportunites for 'learning *from* (reflecting upon the) doing'. The meaningful combination of learning processes can be moderated through different interactions that typically occur in project-based sustainability courses.

(iii) Interactions

Overall, there are diverse interactions at the core of project-based sustainability courses (figure 8, Chapter 5) that can lead to interpersonal competence development simply through 'learning by doing'. However, interpersonal competence development can be further enhanced by making these interactions explicit subjects of inquiry. Individually or jointly *reflecting* upon the various interactions that occur allows students to uncover their own and other people´s attitudes, knowledge, and skills which can support their own interpersonal competence development. This links to the aforementioned learning processes, requiring that action be complemented with reflection (Kolb & Kolb, 2012).

For course designers and/or instructors, this means they must actively incorporate opportunities for reflection into the course. This can be done through the deliberate creation and combination of interactions, each of which has the potential to trigger specific learning processes. While in student-

student and student-stakeholder interactions the 'doing' is often in the foreground, student-instructor interactions can, for instance, be used to complement the 'doing' with 'reflecting upon the doing' through the creation of reflection opportunities. Course plenaries or specific event debriefings, in which certain experiences are brought to a meta-level, can support students in abstracting meaning from those interactions, i.e. experiences, leading to interpersonal competence development. Further, the inclusion of alumni tutors into the course, i.e. student-mentor interactions, can provide for additional opportunities to reflect (Krütli et al., 2018). Active listening to course alumni as they share their course experiences can support current students to better deal with conflicts that may potentially occur in the diverse interactions that take place in project-based learning environments.

What matters for interpersonal competence development through interactions is, as in the case of conflicts, not simply their occurrence but, what is done with them. Bringing interactions to a meta-level through exchange and discussion – *reflection* – increases the learning effect from these interactions through actively deriving lessons learned, turning them into explicit attitudes, knowledge, or skills of collaborative teamwork and/or impactful stakeholder engagement, and empowering students to be(come) competent change agents.

7.2. Practical implications beyond the field of sustainability higher education

Despite this research having been conducted within the field of sustainability higher education, a look at related project-based learning settings, such as interdisciplinary sustainability research collaborations (Fam et al., 2019; Freeth & Caniglia, 2020), suggests that the findings presented here with regard to interpersonal competence development for (educating future) change agents might also be of relevance beyond the field of sustainability higher education.

Freeth (2019) found that discomfort, e.g. triggered through differences, often hampers project collaboration and – instead of working interdisciplinarily together, i.e. actually being able to embrace conflicts leading to creative co-creation, researchers may withdraw and continue their work separately (Freeth et al., 2019). This fails to leverage the high degree of potential that diverse teams promise, and subverts the agenda of a project that was intended to be interdisciplinary (Caniglia et al., 2020). The above outlined practical implications for interpersonal competence development in project-based sustainability courses can, therefore, as well be of practical relevance outside of sustainability higher education – such as in other project-based learning *settings*, like sustainability research projects. As interpersonal competence comprises attitudes, knowledge, and skills in collaborative teamwork and impactful stakeholder engagement, sustainability professionals, who potentially have not themselves undertaken such targeted courses, can benefit from a conflict-embracing attitude that applies the above-mentioned approach to constructively dealing with conflicts that may occur in interactions with, e.g., peers (colleagues) and/or stakeholders. As many sustainability professionals also work in interdisciplinary teams on projects, such actors in "real-world" workspace settings can benefit from combining active processes, i.e. 'the doing', with reflective processes that support continuous learning from one´s own practice. Intentionally creating peer- and/or supportive interactions in the workplace will allow sustainability professionals to continuously share and reflect on their own practices. This can be seen as a (pre-)condition for improving one´s own interpersonal competence, while simultaneously improving collaboration and therefore, project progress overall.

A conflict-embracing attitude is key wherever humans collaborate, be it on the (sustainability) course, research project, or other professional level. Wherever people work together, in teams and with stakeholders, working on futures not yet known, they will continually be confronted with

uncertainty and need to adapt, as (and in) teams, accordingly. The conscious composition of learning processes, i.e. the careful combination of diverse interactions, can support individual and group learning processes and, in turn, project progress. More precisely this means, for a student, researcher, working group, and/or organization, it is important to provide time to think and reflect in addition to doing and experimenting. It is time for Refl-Action. Focusing on the *process*, i.e. the *quality of interactions in collaboration and engagement*, will ultimately enhance the outcome – of students´ learning journeys, (student) research projects and other work towards sustainability transitions and transformations.

8. Conclusions

This dissertation empirically confirms and theoretically supports what has already been claimed: That project-based sustainability courses are conducive to the development of interpersonal competence. This thesis further contributes with explanations of *why* this is the case and thereby provides a pedagogical foundation for interpersonal competence development, as one of the key competencies in sustainability.

Three interlinked moderating variables which are supportive to interpersonal competence development in project-based learning settings were identified and operationalized to inform conscious, targeted design of teaching and learning environments. These moderating variables are *interactions* (which can be further broken down into peer, deliberate, professional, and supportive), teaching and learning *processes* (such as receiving input, experiencing, reflecting, and experimenting), and *conflicts* that typically occur in project-based learning settings. In the case of each of the three moderating variables, it is not enough to simply recognize *that* they occur but to be conscious of *how* they are dealt with/what is done with them. What matters for interactions that trigger specific processes, is that they are purposefully combined in ways that they complement one another (combining the doing with thinking about the doing), and made explicit subjects of inquiry. What matters for conflicts is that these are embraced as learning opportunities. The contribution of this dissertation is therefore a comprehensive understanding of interpersonal competence and its development, derived from triangulating multiple methods and perspectives, upon which its operationalization is based.

While the findings presented here are based upon a comparative multi-case study in the field of sustainability higher education, these findings can further inform other project-based learning settings, such as inter- and transdisciplinary research projects at higher education institutions. This dissertation is insofar situated within the field of sustainability (research), as here, collaboration, i.e. interpersonal competence, is a key asset. Sustainability scientists need to collaborate with one another in multidisciplinary projects and integrated ways if we are serious with what we set out to do: not only investigating, but also actively contributing to a human presence on Earth within a just and safe operating space for humanity.

Concluding remark and invitation

This thesis started with three visions, or learning objectives, for the reader. While *constructive alignment* suggests to think learning outcomes, approaches, and assessment together (Biggs, 1996), I did not plan for an appropriate assessment tool to measure the degree to which my visions unfolded. However, maybe you – now equipped with a bit of *input* from my part – will let me know about your *experiences,* of having turned insights gained from the presented research into practice. Feel free to dare to *experiment* and then, let´s *reflect* and evaluate *together*.

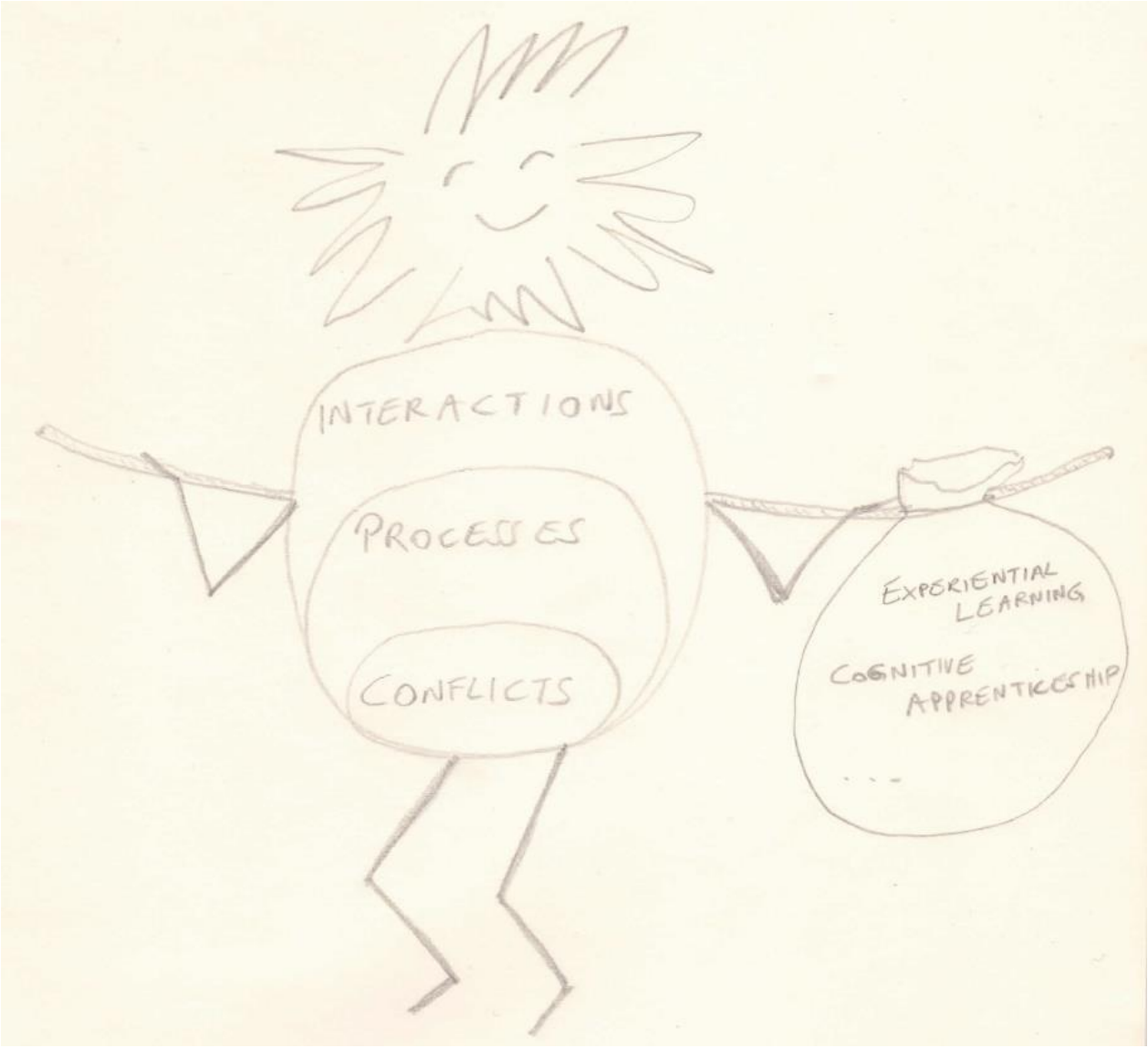


Figure 11: Ready! (source: own elaboration)

9. Critical reflections

Here, limitations of this research are outlined (9.1.); methods applied for this research are critically reflected upon (9.2.); and finally, a 'view from outside' on the role of the researching subject is given (9.3.). This thesis concludes with an outlook (10.) and presents reflections derived from this research that might deserve further attention in future research (see appendices).

9.1. On limitations

Limitations of this dissertation comprise the lack of appropriate competence assessment tools, although the participatory action research method Photovoice delivered interesting insights. However, these focused more on the learning processes than on outcomes. Future studies could support and enhance present findings with targeted pre- and post-course assessment tools as well as with the application of Photovoice on the instructor side. This would potentially provide an even more comprehensive picture on what it actually entails to educate interpersonally competent future change agents. The implementation of Photovoice on the instructor side might also fill gaps at the institutional level in terms of ways to provide instructors the support they need to better prepare them to design and facilitate such interactive, student-centered, demanding teaching and learning formats as project-based learning sustainability courses with the intention to empower future change agents (figure 15, Appendix 5). While this thesis delivered contributions to the design of meaningful learning environments in terms of interactions, other parts of the teaching and learning environment were neglected and should, therefore, be investigated in future research to complement the findings presented here.

9.2. On methods

Observations

For the assessment of competence development, observation can be considered a valid method as competencies reveal themselves in action (Barth, 2015). For conducting empirical research, i.e. for my own learning process, observation as a form of experience consituted the basis for my own experiential learning cycle. Having undergone a project-based sustainability course myself as a student prior to commencing this research – aligning with Kolb and Kolb´s (2005) proposition that all learning is re-learning – course observations as a form of experience allowed me to adapt my own mental model of project-based sustainability courses. While observations intend to capture *what is* and notes are taken directly in the field or immediately afterwards, field notes are still taken and processed by an individual with potential biases ('researcher effects', see Miles et al., 2014). Conversations, including joint reflections with peer PhD researchers (of the Educating Future Change Agents research team), further triggering self-reflection, allowed me as the researcher to question my own assumptions and hypotheses (captured as memos), and to develop new ones. Through following replication logic, initial assumptions could be further tested in additional cases (linking to Kolb and Kolb´s (2012) active experimentation).

What can speak against this method is that is time-consuming. However, in terms of experiential learning theory (ibid.) my experience of almost ethnographically studied project-based sustainability courses (in particular the GSR course) provided a strong foundation for abstracting what interpersonal competence development in such contexts implies.

Photovoice on the student side

There were (and are) several reasons that speak in favor of applying the Photovoice method, especially in the context of sustainability higher education, and particularly in the context of project-based learning sustainability courses. Photovoice implies agency and, therefore, is in line with self-directed, student-centered teaching and learning approaches (Chio & Fandt, 2007). Photovoice is basically a win-win-win method, as it is simultaneously a teaching, a learning, and a research tool.

As a *teaching and learning* tool, it first allows students to get to *know* and *use* a participatory qualitative research method, potentially fostering specific knowledge and skill development. Second, students´ learning processes are supported through required (self-) reflection, a skill (development) which is encouraged by taking or selecting and reflecting upon visuals documenting students´ concerns, issues, frustrations, encounters, etc. Third, through this student activity and bringing in one´s own 'voice' and creativity, it can be empowering (potentially leading to a more self-confident attitude).

As a *research* tool, it first allows participants to track processes, particularly those that are otherwise hard to observe, as learning might take place in moments and circumstances inaccessible to researchers (Ciolan & Manasia, 2017). Second, it facilitates group discussions. Also, the fact that most students of present case studies have smartphones, made the application of this method a 'low-hanging fruit' without being overly demanding on the research participants.

Overall, Photovoice, by giving active voice to the participants, allows to gain insights and answers it would otherwise be hard to find questions for. Through this open, inductive nature, there was the potential to cover several aspects of the conceptual frame, however, no guarantee.

Does conducting a case study speak against the use of this method, originally stemming from participatory action research? No, as it was introduced at the course beginnings as part of their learning journey, and agreed upon by the course instructors as the potential benefits for student learning were recognized.

Focus groups

Enriching focus groups by providing a timeline of course events assisted students in accessing memories of relatively distant course experiences, i.e. those that occurred near the beginning of the course. This effect was further enhanced by the combination of the timeline with the Photovoice method, i.e. photos triggered different memories than purely questions would have triggered. As a research tool, Photovoice-enriched focus groups, as well as individual and group interviews with students during the semester (partially making use of photos as well), not only provided valuable insights for this research, but simultaneously offered moments for reflection, i.e. potentially learning moments for the students. Taking into account researcher effects, it can still be argued that for both the research as well as for the students´ learning processes, the applied methods are useful and justified. While not limiting this research, my role and impact through the application of these interactive methods needs to be acknowledged and reflected. As the comparison with other cases showed, my role could be compared to the one of alumni tutors.

9.3. On the role of the researcher

> "Researchers are not just knowledge makers or more conservatively, knowledge holders (a dominating paradigm in Western knowledge systems), but transformation makers and facilitators, and hence consciously or not, they are changing their own roles, identities and values in the process."
>
> (Pereira et al., 2019)

'A view from outside'

In reflecting upon the researcher´s role, i.e. taking a step back to reflect on my own role in this adventurous journey called dissertation, several points should be acknowledged:
First, I myself was a student in a similar project-based sustainability course, embedded in an international Master program. This gave me, on the one hand, first-hand experience of what this can be like, while, on the other hand, required actively and constantly questioning my observations and assumptions against my own bias.

Second, being, or by now, having been, close in age to the participating students, plus having the shared experience of participating in a project-based sustainability course, allowed me to easily connect to students. Being close, engaging in interactions, while trying to 'staying outside', or in other words, becoming an insider, while trying to maintain the viewpoint of an outsider, is a known challenge of qualitative social researchers, and cultural and social anthropologists in particular. While interacting with participating instructors was a rather easy undertaking, too, thanks to established networks, age differences and the lack of shared experience partially resulted in a different relationship compared to that with the students.

Third, in addition to age and experience, background, rank and hierarchy, even if not consciously or actively pursued, and as we have learned – *attitude* – impact (research) processes, too. That is why I also called this dissertation an adventurous journey: It was a process, as a PhD researcher, to discover my own voice, seeing myself as an expert of something, and acknowledging that ultimately everybody has something to contribute, including myself[28]. I learnt how to make an argument for something, which led to the implementation of Photovoice in my own as well as in my peers´ research designs. I did not manage to implement Photovoice on the instructor-side, though. There are still things to be learned.

Fourth, months after having submitted the papers of this cumulative thesis, and during a writing pause from this framework paper, while being busily engaged in a new project-based setting, preparing e.g. a visioning session for a newly founded association, I woke up one morning and it occurred to me to see myself from the outside. I noticed that, after having researched interpersonal competence development based upon the earlier described units of analysis, I was about to undergo myself the process of interpersonal competence development. After observations and observations and observations of project-based learning settings (and the experience of being part of one); and analysis of, reflection on, articulation and abstractions of these observations and overall experiences, i.e. after quite some *time of refl-action*, I was about to give myself, as well as being given, space to *experiment*. I underwent the described learning processes for interpersonal competence

[28] As John O´Donohue said in *The Inner Landscape of Beauty*: We are all just "ex-babies" (between minutes 9 and 10; https://www.youtube.com/watch?v=aqalrRkYP14; 28.01.2021).

development myself. Although it would have been nice to be ‘done’ earlier with this thesis in some regards, I conclude that this time in between writing the preliminary last sentence of this thesis in August 2020, and picking this framework paper up again after some months of experiences and reflections, is ultimately what makes this dissertation complete. Because by now I can not only tell about what my research showed. I can also tell, from personal experience, observation, and introspection, that the findings presented in this dissertation apply to other contexts, too.

Lastly, how I´d like to see this thesis from the ‘outside’: I hope that *heart*, *head*, and *hands* of the researcher can be found in there. With outlining the intervening conditions, i.e. my onto-epistemological foundations, my *attitudes*, or mindset, were made transparent. My conceptual foundations, i.e. the *knowledge* having initially informed this research, was presented, too. The strategies, how I went about this research, i.e. my *skills*, shaped this study. Further, shaping this thesis informed by developed (interpersonal) *attitudes* (such as can-do, self-confident, daring), *knowledge* (e.g. of teaching and learning theories), and *skills* (such as applying methods like Photovoice and Grounded Theory) is my attempt to ‘walk the talk’, applying my own findings in another context; to model how to put scientific insights into practice, overcoming the so often encountered knowledge-to-action-gap.

Figure 12: Further 'views from outside' on my role and conduct as a researcher, instructor, peer PhD student, and collaborator can be inquired by reaching out to my estimated peers. Jan-Ole Brandt, Jodie Birdman, and Marie Weiß needed to deal with my inputs, experienced me in different states (of mind and in geographical terms), triggered some of my reflections, and dared to experiment together with me in several contexts over the last years. THANK YOU.

10. Outlook

This dissertation closes with the preliminary insight that *trust* is a basis for interpersonal competence development in project-based sustainability courses. Instructors´ trust in students´ competencies (or, in their competence development) implies that students need to take *ownership* – of the project and the challenges and conflicts, i.e. learning opportunities, it provides. As competencies cannot be taught, but only be developed, becoming self-directed and self-motivated learners is crucial. What instructors´ trust can do is to spark an *attitude* of becoming *daring* in students – daring to engage in project-based learning sustainability courses´ diverse interactions, the processes these trigger, and the conflicts that may arise. Trust has started to get attention in the educational literature and may be worth delving deeper into for truly creating empowering learning environments that allow students to unleash their (interpersonal) potential.

Acknowledging the power of visuals, not at last through my own research with the application of Photovoice method, I suggest to let this method find broader application within sustainability and educational sciences and particularly at their intersection.

The appendices offer several preliminary visualizations which potentially invite for further dialogue and research. Presenting the findings of this dissertation in a different way in the following appendices, using metaphors, is an attempt to make research accessible to a wider audience, too.

Appendices

APPENDIX 1

Developing Interpersonal Competence through Project-based Sustainability Courses – Material from a Comparative Study

Citation
Konrad, Theres; Wiek, Arnim; Barth, Matthias (2020) "Developing Interpersonal Competence through Project-based Sustainability Courses – Material from a Comparative Study". Working Papers in Higher Education for Sustainable Development. No. 4/2020. Leuphana University Lüneburg, Center for Global Sustainability and Cultural Transformation.

Abstract
English
As part of the Educating Future Change Agents project, one case study investigated three project-based sustainability courses regarding the link between learning outcomes, i.e. what students learn in such courses, and processes, i.e. how they learn, as well as the enabling or hindering learning environment. This working paper provides detailed case descriptions of the three project-based sustainability courses at (1) Leuphana University of Lüneburg (Germany) and Arizona State University (USA), (2) the Swiss Federal Institute of Technology (Switzerland), and (3) the Polytechnic University of Catalonia (Spain). It captures contextual conditions, learning environment, teaching and learning formats, and student cohorts of the courses to increase transparency of the research and provide context for the empirical results.
Key words: key competence development, project-based learning sustainability courses, teaching and learning processes and environments, case study, sustainability higher education

1. Introduction

1.1. The Educating Future Change Agents Project

The Educating Future Change Agents (EFCA) project produced empirical insights on how higher education can support students' development of key competencies in sustainability. The project was conducted 2016-2020 as a joint research project between Leuphana University of Lüneburg, Germany and Arizona State University, Tempe, Arizona, USA. The project was structured into five studies, which conducted in-depth research on course, curriculum, and institutional levels. The specific cases were selected to capture a high degree of similarity and difference within and across cases and to represent the field of sustainability education, namely, education of sustainability professionals, teachers, and entrepreneurs.

All studies were grounded in a shared analytical framework that informed both data collection and analysis. Based on this framework, each study adopted its own suite of research methods appropriate for the respective research questions, while still coordinating and sharing insights on methods among the studies. Each study produced a set of results specific to the specific case(s) and contexts. In the final phase of the project, results from the individual studies were synthesized to offer general insights for researchers, educators, and administrators in the field of sustainability education.

Results of the EFCA project have been published and can be found on ResearchGate: https://www.researchgate.net/project/Educating-Future-Change-Agents. This working paper series provides additional background material to facilitate deeper understanding of the research. The working papers offer thorough case documentation and in-depth information on instruments and analytical steps.

1.2. The Comparative Case Study on Project-based Sustainability Courses

Focusing on the course-level of the EFCA project, this working paper covers research on three project based sustainability courses at (1) Leuphana University of Lüneburg and Arizona State University (ASU), (2) the Swiss Federal Institute of Technology (ETH), and (3) the Polytechnic University of Catalonia (UPC). The study addressed the question of how students develop interpersonal competence, as a key competence in sustainability, in project-based sustainability courses.

The courses at Leuphana/ASU, ETH, and UPC were selected to compare and contrast pioneering courses to derive specific as well as generalizable insights. The three cases display variance in terms of learning objectives, teaching and learning approach, and context. A comparative study allows for more generalizable insights compared to single case studies (Barth & Thomas, 2012). To enhance transparency, reliability, and understanding of the findings, detailed insights into case specifics are presented here (Yin, 1984).

This working paper describes each case, i.e. course, along the same structure, including learning objectives, teaching and learning approach, course outline (sequence of activities), and participating student cohort. The working paper concludes with a comparative table that highlights similarities, differences, and methods applied across cases. The findings of this case study are published in three scientific journal articles (Konrad et al., 2020; Konrad et al., 2021; Konrad et al., in review).

Acknowledgements

We acknowledge support from the EFCA research team. Special thanks go to all course participants, i.e. students, instructors, tutors, stakeholders, and participating faculty. The authors acknowledge funding from the Lower Saxony Ministry of Science and Culture and Volkswagen Foundation for the grant “Educating Future Change Agents – Higher Education as a Motor of the Sustainability Transformation” (A115235) through the program “Science for Sustainable Development”.

2. Description of Cases

2.1. The Global Sustainability Research (GSR) Course (Case 1)

The Global Sustainability Research (GSR) course is a joint endeavor between Arizona State University and Leuphana University of Lüneburg within the international dual-degree master program Global Sustainability Science (GSS). It is formally embedded in the joint Center for Global Sustainability and Cultural Transformation (CGSC)[29], launched in 2015. The GSR course is a mandatory project-based course that is structured into multiple parts and spans over three semesters.

Context of the case study

To provide context to this case study, we briefly summarize relevant aspects of the German and U.S. higher education systems.

[29] https://global.asu.edu/center-global-sustainability-and-cultural-transformation [13.05.20]

In the 2000s, most German universities adopted the suggested changes of the Bologna Declaration and replaced Diploma or Magister degrees with bachelor/undergraduate and master/graduate degrees. The European Credit Transfer and Accumulation System (ECTS) was introduced as part of an agreement to simplify the transfer of courses and degrees among universities in Europe. One credit in the ECTS is the equivalent of 25-30 hours, with an academic year consisting of 60 ECTS credits, or 1,500-1,800 hours of work. Enrollment at a university in Germany is subject to completed university preparatory school and exam (Abitur) or equivalent. Most universities in Germany are public and study fees are generally less than 500€/semester (360€/semester at Leuphana). Most graduate students at German universities are full-time students. Leuphana had 10,000 students enrolled in year 2018-2019, 1,000 of whom study sustainability graduate and undergraduate programs[30].

Most universities in the U.S. follow a credit system in which one Credit Point (CP) corresponds to one hour of instructional time per week, plus two hours of student work, translating 1 CP into 3 hours total time per week. A typical course is 3 CP and graduate students pursue 4 courses per semester, i.e., 12 CP. Enrollment in a graduate program requires a certificate of completed secondary school (or similar). In some cases, a Graduate Requirement Exam (GRE) is required and/or a university-specific entry exam. As of fall term 2021, the GRE will no longer be required at ASU. Tuition varies significantly across and within universities. For Arizona residents, for instance, graduate study fees at ASU's School of Sustainability are more than $12,000 per year. Students cover tuition through scholarships, student loans, working for the university, e.g. as teaching or research assistants, or other work. ASU is the largest public university in the U.S. with more than 75,000 students and more than 7,000 full-time master students (fall 2019). The School of Sustainability has more than 500 undergraduate students and more than 70 graduate students enrolled in master programs (fall 2019)[31].

The international, dual-degree Master's Program Global Sustainability Science (GSS) was jointly developed by ASU and Leuphana (see Birdman et al., 2020). As a dual-degree program, workload is higher compared to single-degree master programs. Students attend mandatory and elective courses as well as the project-based GSR course (Fig. 1). The GSS program includes for all students a mandatory semester abroad (Semester 2 or 3 respectively) and concludes with a master thesis in semester four at the respective home university.

[30] https://www.leuphana.de/en/university/history/sustainability/faculty-of-sustainability.html [28.07.20]
[31] https://sustainability.asu.edu [28.07.20]

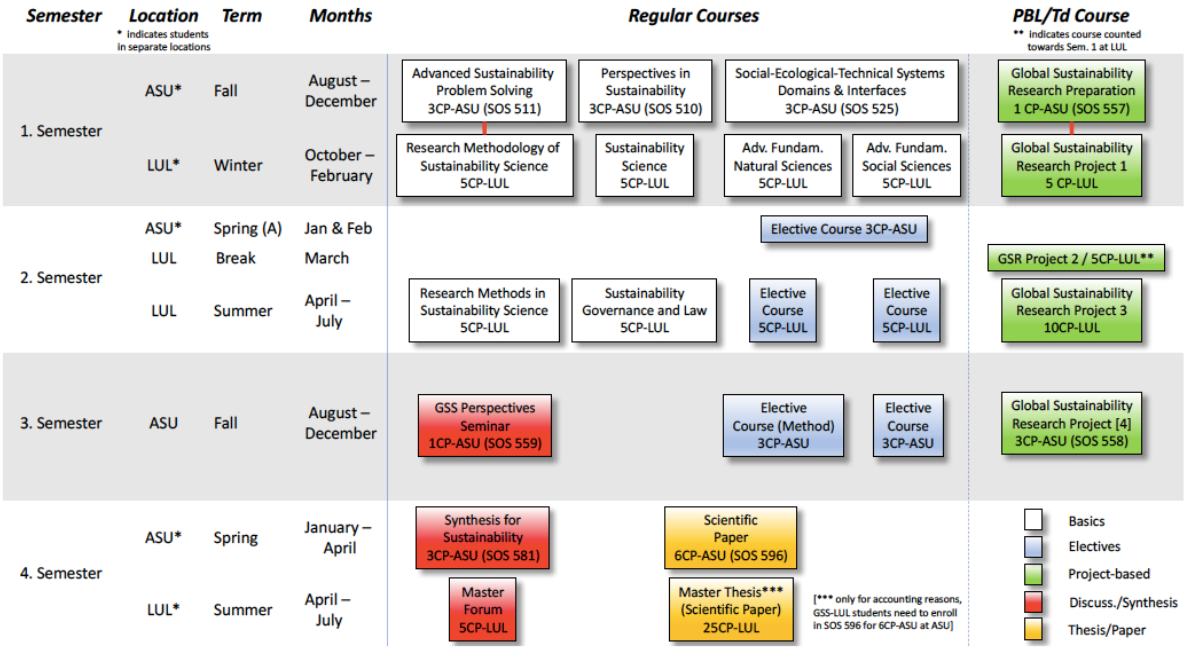


Figure 1: Overview of the Global Sustainability Science (GSS) program

General features of the Global Sustainability Research (GSR) course

The GSR course spans three semesters (Semester 1-3) and takes place in both locations. It starts in semester one at the respective home university, continues at Leuphana in semester two, and concludes at ASU in semester three (Fig. 1). Students receive intercultural, collaborative, as well as professional training in the GSR course. After first virtual encounters during semester one, students collaborate in person in the GSR course during semesters two and three.

The GSR course consists of 10 + 10 + 5 ECTS (Leuphana) or 1 + 3 + 3 CP (ASU). For semester 3 at ASU, for instance, this translates into a workload of 180 working hours, including 45 contact/coaching hours, over 15 weeks (August-December). Per week this refers to 12 working hours, including 3 contact/coaching hours.

The design of the GSR course builds upon an international sustainability education pilot project (Wiek et al., 2013; Caniglia et al., 2018) and various project-based learning collaborations between ASU and Leuphana (Wiek et al., 2014; Withycombe Keeler et al., 2016). It has been formed over several years and utilizes project-based, experiential, and professional learning pedagogies (Brundiers & Wiek, 2013; Wiek et al., 2013; Wiek et al., 2014; Caniglia et al., 2016; Caniglia et al., 2018). The general features of the course are summarized in table 1.

Table 1: General features of the GSR course

COURSE TITLE	Global Sustainability Research
DURATION	3 semesters
STRUCTURE	Semester 1 – at respective home university (ASU or Leuphana) Semester 2 – all at Leuphana (April-July) Semester 3 – all at ASU (August-December) [case study focus]
STUDENTS	10-20 GSS students (open to select graduate students from other master programs)
LEARNING OBJECTIVES	Theoretical, methodical, and professional skills for transformational research in sustainability

ASSESSMENT	1. Project deliverables 2. Teamwork 3. Stakeholder engagement 4. Project report

Learning objectives

The main objective of the GSR course is that students learn to conduct a transformational sustainability research project within a frame of reference and thereby develop key competencies in sustainability (Wiek, Withycombe, & Redman, 2011; Caniglia et al., 2017). Students are expected and supported to collaborate in mixed teams from both universities and engage stakeholders in the project. Developing professional skills in sustainability (Brundiers & Wiek, 2017) is an integral learning objective of the GSR course.

Specific features of the GSR course 2016-17

The GSR project course 2016-17 was linked to ongoing research projects and focused on local food economy solutions. The goal was to conceptualize and pilot a so-called "Mobile Solution Studio", i.e., a flexible facility that uses data, visuals, narratives, etc. in various engagement activities (during semester 3 at ASU) to enable and empower decision makers and other stakeholders to implement sustainability solutions (Lang et al., 2016; Lang et al., 2017). The guiding research question was: How can a mobile solution studio foster capacity for implementing sustainability solutions in general, and local food economy solutions in particular, in Lüneburg and Tempe? This case study focuses on semester three (Tab. 2) of the GSR course for comparability with the other two (one-semester) courses (ETH, UPC).

Table 2: Specific features of the GSR course 2016-2017, semester 3

STUDENTS	12 GSS students
ASSESSMENT	Delivery of (i) an interactive capacity-building process template, (ii) data-based descriptions of sustainable food business and economy solutions, (iii) a functional capacity-building tool (3 teams) Active participation in teamwork and coaching Facilitation of one or more stakeholder engagement sessions, in which the aforementioned components were integrated, applied, and tested Project report

Pedagogical approach of the GSR course 2016-17

Over 15 weeks students met twice per week for 1,5 hours each. Class time was used for interactive, collaborative working and input sessions by instructors, external guest speakers, and supporting faculty. The course followed a sequenced scaffolding approach:

(1) A facilitation training prepared students for their first stakeholder event.
(2) Students participated in the event (Withycombe Keeler et al., 2018) as table or room observers, and/or receptionists. Students were able to observe good practices of impactful stakeholder engagement, for which they were debriefed afterwards in class.
(3) Students co-facilitated a public engagement event (at "First Friday" in Phoenix) together with instructors. This was debriefed afterwards in class, too.

(4) Students worked in teams (4 students each) on project deliverables, (i) an interactive capacity-building process template, (ii) data-based descriptions of sustainable food business and economy solutions, and (iii) a functional capacity-building tool (Tab. 2). In-class presentations and team coaching accompanied this phase.
(5) Run-throughs, dry-runs, and revisions of deliverables, including facilitation practice, prepared students for the main stakeholder capacity-building event.
(6) Students co-facilitated the main capacity-building event, which provided students with opportunities to perform as facilitators, note takers, (solution) experts, receptionists, and overall event manager. The event was followed by instructor debriefings, report writing, and a reflective focus group (with an external researcher).

Table 3: Sequences of activities in the GSR course 2016-17, semester 3 at ASU

Session	Focus Areas
00	Pre-course: Facilitation Training, **Event #1** with City of Tempe staff in Tempe
01	**Course introduction**: course objectives, structure, time line, etc.
02	**Familiarizing** / Planning of deliverables / **Preparation Event #2**
03	Familiarizing / Planning of deliverables / Preparation Event #2 **Event #2** with public in Phoenix
04	**Working on deliverables**, teamwork and coaching sessions
05	Working on deliverables
06	Working on deliverables + **integration**
07	Working on deliverables + integration
08	**Run-Throughs**
09	**Refining deliverables & integration**
10	Refining deliverables & integration
11	Refining deliverables & integration
12	**Dry-Run(s)**
13	**Event #3** with food economy stakeholders in Tempe
14	**Processing data, preparing report**
15	Processing data, preparing report
16	**Synthesis, report writing, and reflections**

The teaching and learning approach was based on two pillars: First, tailored support for student teams provided by three instructors plus a professional skills advisor, available for consultation and responsible for review, mediation, etc. Second, several local project partners, most notably the Sustainability Director of the City of Tempe, and about 30 local food economy stakeholders were involved in research and project activities providing professional resources and real-world application context. A series of stakeholder engagement events provided opportunities for observation and practice experience with increasing task difficulty (from observation to note-taking to facilitation).

The teaching and learning approach can be described as guiding and supportive, i.e., instructors giving direction and coaching project teams along the process. All students entered semester 3 with prior initial training on conflict mediation and intercultural collaboration (semester 2).

Participants

The GSR course cohort (2016-2017) consisted of 12 students from four countries (USA, Mexico, Germany, South Africa) – 7 female and 5 male students between 25 and 35 years in age with academic backgrounds ranging from political science to natural science and tourism studies. The majority of students brought relevant experiences from previous work, volunteering, and/or international travel to the course.

2.2. The transdisciplinary Case Study (tdCS) course (Case 2)

The transdisciplinary Case Study (tdCS) course is available to all master students of the Swiss Federal Institute of Technology (ETH) Zurich, Switzerland. Particularly, students pursuing a master´s program within the Department of Environmental Systems Science (D-USYS) are encouraged to apply. The tdCS course is formally embedded within the Transdisciplinary Laboratory (TdLab), launched in 2013 and situated within the Institute of Environmental Decisions (IED)[32]. The tdCS case study is an elective one-semester course and consists of two phases: the Zurich phase (entire semester) and the following field phase (three weeks).

Context of the case study

To provide context to this case study, we briefly summarize relevant aspects of the Swiss higher education system.

In 1999, Switzerland signed the Bologna Declaration, which led to a comprehensive reform of academic degree programs at all higher education institutions in Switzerland, including the shift to the two-tier study system, i.e. bachelor and master. The European Credit Transfer and Accumulation System (ECTS) was introduced as part of an agreement to simplify the transfer of courses and degrees among universities in Europe. One credit in the ECTS is the equivalent of 25-30 hours, with an academic year consisting of 60 ECTS credits, or 1,500-1,800 hours of work.

Enrollment at a Swiss university is subject to completed university preparatory school and exam or equivalent (Baccalaureate or a Federal Vocational Baccalaureate). Both public and private universities claim student fees. The average tuition fees at public universities ranged from 400 to 3,700 EUR/year for a bachelor or master program (1,200 EUR at ETH) in 2019. ETH had more than 22,000 students enrolled, 7,000 of whom in master programs in 2019.

The international master course “transdisciplinary Case Study” (tdCS) builds upon more than 10 years of transdisciplinary, project-based sustainability education (Krütli, Pohl et al., 2018; Stauffacher et al., 2006).

General features of the transdisciplinary Case Study (tdCS) course

The tdCS course typically takes place in the second semester, every other year with focus on the Seychelles. Students train intercultural, collaborative, as well as professional competencies. After first virtual encounters with bachelor students of the University of the Seychelles, students

[32] https://ied.ethz.ch/about.html [20.03.20]

collaborate in person during the field phase on the Seychelles. The tdCS course consists of 7 ECTS. Over 14 weeks (February-May) students meet weekly (Wednesday afternoons) for four hour sessions, with two hours additional homework/preparation time. The field phase lasts for 15 working days (8 working hours/day). With two additional validation workshop days this adds up to 220 hours for the full course. The general features of the course are summarized in table 4.

Table 4: General features of the tdCS course

COURSE TITLE	Transdisciplinary Case Study
DURATION	1 semester + field phase
STRUCTURE	Zurich phase: 14 weeks with 4 hours weekly sessions + 2 days: workshop in April with stakeholders from the Seychelles for joint project framing Seychelles phase: 3 weeks
STUDENTS	Max. 25, ideal 20 [cohort 2018: 19 students]
LEARNING OBJECTIVES	Understand a case in its context; apply transdisciplinary methods, skills and knowledge in the real world; manage research activities independently; work in inter-disciplinary and -cultural teams; and adapt to foreign social, economic, cultural and political settings
ASSESSMENT	Continuous self-assessment of competence development: First, at the course start (self-assessment); then course assessment around mid-semester, end-of-semester, and end-of-field phase, including a 30 minutes instructors-student-conversation with individual feedback

Learning objectives

The main objective of the tdCS is that students develop an understanding of "a case and its context from a variety of perspectives, and to extract multiple ways of framing, analysing and developing potential solutions for the problem at hand."[33] Students learn to define relevant research questions for a (wicked) sustainability problem; select and apply tools and methods to collect, analyze, and interpret data to answer research questions; apply transdisciplinary methods and overall knowledge in the real world; independently manage research activities; work in an interdisciplinary and intercultural team; collaborate with stakeholders; and adapt to foreign social, economic, cultural and political settings[34]. Students are expected to collaborate in mixed teams from both universities and engage stakeholders during their respective project. Developing professional skills in sustainability is therefore a potential learning outcome of the tdCS course.

Specific features of the tdCS course 2018

The tdCS course 2018 had focused on waste management in small island developing states. The goal was to build upon the first tdCS on the Seychelles (2016) and advance insights and solutions for sustainable waste management. Focus areas were waste collection and sorting, feasibility of recycling, hazardous waste flow, anaerobic digestion, incineration, financial mechanisms and implementation of plans (Krütli, Nef et al., 2018). Each of the project teams developed their own research question and design.

[33] https://tdlab.usys.ethz.ch/teaching/tdcs.html [20.03.2020].
[34] https://tdlab.usys.ethz.ch/teaching/tdcs.html [20.03.2020]

Pedagogical approach of the tdCS course

During the semester, students meet weekly for four hours in the TdLab. Similar to the flipped classroom model, students do some preparation outside of class, so that class time can be used for interactive, collaborative working sessions. The design of the course can be described as follows:

(1) An introduction to the case study and a first virtual encounter of collaboration partners at the University of the Seychelles (UniSey) prepares the ground for further collaboration. The focus lies on research project orientation with desk research (reading) and preparation of research ideas, including preliminary research questions (week 1 to 7).

(2) In week 8, local stakeholders from the Seychelles (e.g. representatives from ministries and the private sector) take part in a validation and framing workshop at ETH. Joint problem framing through constructive feedback and project hand-over from instructors to students take place, beginning with students guiding through the pre-prepared workshop-agenda. Team building is finalized. Field visits off-campus complement these workshop days.

(3) Research plans are adapted according to the validation workshop and the fieldwork is being prepared (weeks 10-14).

(4) The field phase on the Seychelles (three weeks) takes place, structured into data collection (week 1), data collection and data analysis (week 2), and data reporting, i.e. report writing and dissemination[35] of results (week 3).

Table 5: Sequences of activities in the tdCS course (Zurich phase)

Session	Focus Areas
01	**Introduction** topic, methodology, case area
02	Introduction topic, methodology, case area + **Case understanding** (readings, presentations by ETH experts); **Teaming up/collaboration with students from UniSey**
03	Case understanding (readings, presentations by ETH experts); **System (module related) analysis & contextualization**; Teaming up/collaboration with students from UniSey
04	Case understanding (readings, presentations by ETH experts); System (module related) analysis & contextualization; Teaming up/collaboration with students from UniSey
05	Case understanding (readings, presentations by ETH experts); **Develop research question; Outline research plans**; System (module related) analysis & contextualization; Collaboration with students from UniSey
06	Case understanding (readings, presentations by ETH experts); Develop research question; Outline research plans; System (module related) analysis & contextualization; Collaboration with students from UniSey
07	**Develop research question; Outline research plans**; System (module related) analysis & contextualization; Collaboration with students from UniSey
08	Develop research question; Outline research plans; System (module related) analysis & contextualization; **Planning fieldwork (stakeholder contacts, methods, etc.)**; Collaboration with students from UniSey **2 extra days for validation workshop** [project hand-over to students; final team building, field visits off-campus]

[35] https://ethz.ch/content/dam/ethz/special-interest/usys/tdlab/docs/csproducts/cs18-report.pdf

09	**Outline research plans**; System (module related) analysis & contextualization; Planning fieldwork (stakeholder contacts, methods, etc.); Collaboration with students from UniSey
10	System (module related) analysis & contextualization; Planning fieldwork (stakeholder contacts, methods, etc.); Collaboration with students from UniSey
11-13	Continued
14	Planning fieldwork (stakeholder contacts, methods, etc.); Teaming up/collaboration with students from UniSey; **Final preparation of fieldwork activities**

Student team support (coaching) is offered by one instructor plus one alumnus tutor during the Zurich phase. For the Seychelles phase, a second alumnus tutor is available for consultation. Additionally, several academic experts (on the topical focus of waste), and local undergraduate students from the University of the Seychelles, as well as faculty and local stakeholders are involved in research and project activities providing professional resources and real-world application context. Further, an advisory board of local experts from the Seychelles provides regular feedback during the field phase after students´ presentations of research progress. Depending on the student project students need to engage with the local population (e.g. household surveys) or facilitate workshops (e.g. with people from the ministry). Results are presented in a public event, organized by the instructor. Students get familiarized and then facilitate and lead the project. The teaching and learning approach of the tdCS at ETH is described in Stauffacher et al. (2006).

Participants

The 2018 cohort consisted of 19 students, from eight countries (Switzerland, Germany, Netherlands, Italy, South Africa, Lebanon, Colombia, Japan). There were 10 female and 9 male students between 22 and 32 years in age. The majority of students brought relevant experiences of either previous work, volunteer and/or travel to the course. Seven students each from two master programs (Environmental Science and Environmental Engineering) participated in the tdCS 2018, as well as four students from the Agricultural Sciences program and one student from the program Area Development and Infrastructure.

2.3. The Action Research Workshop (ARW) course (Case 3)

The Action Research Workshop (ARW) course[36] is offered at the Polytechnic University of Catalonia (UPC) Barcelona, Spain, within their Master's degree in Sustainability Science and Technology[37]. The ARW course is a mandatory one-semester project-based course that is structured into several phases (following the Action Research cycles).

Context of the case study

To provide context to this case study, we briefly summarize relevant aspects of the higher education system in Spain.

In 1999, Spain signed the Bologna Declaration, which led to the introduction of the European Credit Transfer System (ECTS), and to changes of various aspects of teaching and learning practices. The

[36] https://www.upc.edu/content/master/guiadocent/pdf/ing/480042 [16.04.2020]

[37] https://www.upc.edu/en/masters/sustainability-science-and-technology [16.04.2020]

European Credit Transfer and Accumulation System (ECTS) was introduced as part of an agreement to simplify the transfer of courses and degrees among universities in Europe. One credit in the ECTS is the equivalent of 25-30 hours, with an academic year consisting of 60 ECTS credits, or 1,500-1,800 hours of work.

Enrollment at a university in Spain is subject to completed university preparatory school and the associated exam (Bachillerato). Most universities in Spain are public, and constrained by greater regulation and stricter control mechanisms than private universities despite operation within the same legal framework (i.e. being assigned the same main tasks, namely, teaching, research and knowledge transfer) (de la Torre García, Eva M., 2018). Average tuition fees at public universities range from 2,000 – 3,500 EUR (2,200 EUR / year for a master´s degree at UPC) in 2019. UPC has almost 28,000 students enrolled, with 6,000 bachelor and master students, as well as 500 doctoral students graduating[38]. The international Master's Program Sustainability Science and Technology is described in Segalàs and Tejedor (2016).

General features of the Action Research Workshop (ARW) course

The ARW course takes place in the second semester. It is a mandatory five credit (ECTS) unit offered during spring term (February to June). This translates into a total study time of 125 hours. Key characteristics are project-oriented research-based teaching and learning in collaboration with real world partners who the students engage with over the length of the entire semester. Project work starts by identifying a stakeholder need, linking academia and praxis. The course is offered in English and each year between 1-5 exchange students join the course, increasing its heterogeneity (Erasmus students but also students from outside Europe, particularly Latin America). As stakeholders are not necessarily fluent in English, this often requires adaptations, e.g. in terms of the project defense (e.g. presentations in Spanish; reports written in English).

The design of the ARW course builds upon several years of research and practice (Segalàs and Tejedor, 2016; Tejedor et al., 2019). The general features of the course are summarized in table 6.

Table 6: General features of the ARW course

COURSE TITLE	Action Research Workshop on Sustainability Science and Technologies (referred to as Action Research Workshop course)
DURATION	1 semester
STRUCTURE	**15 weeks with 3 hours weekly sessions** + team specific arrangements with external project partners
STUDENTS	15 students (cohort 2018)
LEARNING OBJECTIVES	Theoretical, methodical, and professional skills for sustainability research and practice
ASSESSMENT	Comprehensive Action Research project report (assessed by instructors) Client 'report' (this can e.g. be a policy brief). Project providers decide on the concrete deliverable, i.e. it can also be a video (assessed by the project providers/clients; assessment rubrics provided to them); [Deliverables 1 and 2 together make 80% of the grade] Final project defense [10%, clients involved] Individual Course Assignments (e.g. Concept maps, backcasting, and post-Emotional-Intelligence-Reflection-assignment; 10%]

[38] https://www.upc.edu/en/the-upc/the-institution [05.08.20]

Learning objectives

The main objective of the ARW course is that students learn how to "apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts"[39] related to their field of study. Further, students shall be able to describe, solve, "prevent and / or alleviate the problems and dysfunctions associated with the processes of development of environmental socio-economic systems with their own approaches to science and technologies of sustainability."[40] Teamwork, i.e. being "able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available"[41], is another learning objective. At the end of the course, students ought to be aware of and critically analyze "the organisations, strategies, local, national, European and International policies on sustainability and sustainable social development."[42] Students will further have an understanding of sustainable development in the long-term and the role technology plays in it. Further learning objectives include skills in foresight, forecasting, backcasting and scenario analysis[43]. Students are expected to collaborate in teams and with external project providers, further developing professional skills in sustainability.

Specific features of the ARW course 2018

The topical foci of the ARW 2018 ranged from energy to food to housing and built upon previous work of the project providers, some of which participate annually in the ARW project course. Students worked in five teams (three of which participated in this research) of three students each. In contrast to the other two case studies, there was no overarching research question across individual student projects. One team focused on food waste and how it can be minimized by collaborating with food suppliers, supporting people in need. Another one worked on energy infrastructure and policies, analyzing national consumption and creating maps of grassroots initiatives. The third team worked closely with an energy sovereignty organization, partaking, for instance, in a Delphi process.

Pedagogical approach of the ARW course

Over 15 weeks students meet weekly for three hours in a room organized on campus by the instructor(s). Class sessions are usually used for input, e.g. on different participatory research methods, feedback on project progress presentations, to which external project partners are invited (see table below). At the beginning and at the end of the course students get a self-assessment rubric to foster their self-reflection. The last session is further used to ask for general feedback and reflections about the course and learning informally (short conversation). Additionally, students are asked to assemble their comments, criticisms, and contributions in a short document. The course is composed of three phases:

(1) *Project constitution and problem framing*. Team building activities (including a personality test to support group formation), and presentation of project proposals by external project providers, i.e. stakeholders, lead to project choice by students. Introduction to Action

[39] https://www.upc.edu/content/master/guiadocent/pdf/ing/480042 [17.04.20]
[40] Ibid.
[41] Ibid.
[42] Ibid.
[43] Ibid.

Research Methodology, initial research on problem and stakeholders supports the framing of problem and project (weeks 1-4).

(2) *Project design and integration strategy*. Defining a workable research question, developing project design and integration strategy, i.e. students working on their intervention plan presentation to stakeholders, instructors, and peers for feedback and validation. Inputs on backcasting and concept maps. Emotional Intelligence session (week 9): Experiencing and reflecting interactive theater pedagogies to learn about own and others´ behavior in a group context (purposefully placed mid semester once students have already encountered collaboration-related difficulties)[44]. Working sessions and selected input (weeks 5-11).

(3) *Revision of the generated new knowledge*. Contributions to societal and scientific progress. Finalizing analysis and present and discuss findings with invited stakeholders (project partners). Reviewing work. Final presentation, i.e. project defense, in front of stakeholders, instructor(s), peers.

Table 7: Sequences of activities in the UPC course (following three phases)

Session	Focus Areas
01	**Introduction** Input: Action Research Theory Individual & group task: do and discuss personality test
02	**Beginning of phase 1- Project constitution and problem framing** **Teambuilding** after presentation by project managers (**external project partners present**)
03	**Problem Framing** Input: Action Research Methodology Group task: Cycle 1 - Research question definition and planning Outcome: Grouping + Project selection
04	**Problem Framing** Input: Action Research Tools: Inquiry Group task: Gather data on the problem and stakeholder
05	**Beginning of phase 2 – Project design and integration strategy** **Research Question** Input: Action Research Tools: Backcasting Group task: Define research question Individual task: Backcasting exercise
06	**Research Question** Presentation of Research question and discussion (**external project partners invited**) Input: Action Research Tools: Concept maps Group task: Framing research question Individual task: Concept maps exercise Outcome: Result of phase 1: Research question
07	**Project design and integration strategy** **Working session** Group task: Cycle 2 - Intervention Planning

[44] The Emotional Intelligence session was further described in Segalàs and Tejedor (2016).

08	**Project design and integration strategy** Presentation of intervention planning and discussion (**external project partners invited**) Group task: Reframe intervention planning Outcome: Plan for cycle 2
09	**Project design and integration strategy** Emotional intelligence Group task: Apply intervention planning Individual task: Engage with own feelings
10	**Project design and integration strategy** Input: Action Research Tools: Complexity Group task: Apply intervention planning
11	**Project design and integration strategy** Working Session (external project partners invited) Group task: Apply intervention planning
12	**Beginning of phase 3 – Revision of the generated new knowledge. Contributions to societal and scientific progress** Working Session Group task: Analysis of results
13	**Presentation of results and discussion** (**external project partners invited**) Group task: Cycle 3 – Evaluation Outcome: Results of phase 2
14	**Working Session** Group task: Evaluation of interaction
15	**Project Defense** (**external project partners present**) Group task: Celebrate Outcome: Project report - project outcomes and presentation

The teaching and learning approach is based on the following pillars: First, tailored input from one main instructor and supporting faculty, leading sessions based on their expertise. Second, local project providers share their expertise too, while providing professional resources and real-world application context. Further, student teams are supported by formative feedback through regular in-class presentations with external project partners as well. Moreover, as student teams work on different projects these presentations allow to get insights into peer group´s team and project work. ARW students usually meet on individually scheduled times outside of class for course / project work. Due to close collaboration with external project partners, depending on the respective project, students further participate at their organizations´ meetings and gatherings, fieldtrips, etc. The primary experiential teaching and learning approach is service-learning also referred to as "community-based learning" (McIlrath et al., 2016, p. 5) which enables learning in action for society, through the planning and implementation of projects that respond to real needs (Tejedor et al., 2019). The teaching and learning approach has further been described by Tejedor et al. (2019).

Participants

The 2018 cohort consisted of 15 students, from four countries (Spain, Colombia, Chile, Germany). There were 8 female and 7 male participants between 21 and 33 years in age. The majority of students worked part-time in addition to their full-time study program.

3. Case Comparison

The three project-based sustainability courses at Leuphana/ASU, ETH, and UPC show various differences and similarities (Tab. 10). Differences include: The GSR course at Leuphana/ASU extends over three semesters with one semester for all students at their respective partner university; it is also still fairly new (compared to the other ones) and thus undergoes more changes than the other two. The tdCS course at ETH has a short culminating field phase abroad (Seychelles). The ARW course at UPC is based on immediate collaboration with stakeholders. In general, though, all courses follow the same three aims: similar learning objectives (teaching component), solutions to sustainability problems (solution component), and stakeholder engagement (transdisciplinary component). In all courses, students work in small teams in a problem-based and solution-oriented way. The tdCS and the GSR course also require synthesis among individual project groups due to working within the same overarching research project (waste management and local food economies respectively). While many students brought either prior work, travel, and/or volunteer experience to the course, most students of the UPC case study also worked simultaneously to their studies. The need for evidence-supported insights on innovative teaching and learning formats was highlighted by students' unfamiliarity with project-based learning. Table 8 und table 9 summarize how and what data was collected. Findings are presented in Konrad et al. (2020), Konrad et al. (2021), and Konrad et al. (in review).

Table 8: Methods applied across cases to allow for comparison (Konrad et al., 2021)

Methods	**Specific Applications**	**Covered Aspects**
Observations	Class sessions (2-4 hours) Student team meetings (1,5-3 hours) Instructor team meetings (0,5-1 hour) Stakeholder meetings (2 hours) Stakeholder engagement events (2-7 hours) Cultural context (continuous)	*External researcher's perspective on:* Teaching and learning processes Teaching and learning environment Students´ dispositions and performances Institutional and cultural contexts → informed further data collection
Interviews	Individual students Individual instructors Individual stakeholders Group interviews (0,5-1,5 hours)	*Emic perspectives on:* Teaching and learning processes Teaching and learning environment Students´ dispositions and performances → informed further data collection
Focus groups	Individual teams (1 hour) Across teams (1 hour)	*Students´ reflections on:* Teaching and learning processes Teaching and learning environment Teaching and learning outcomes → concluded data collection
Photovoice	Process tracking of teams´ learning processes, in- and outside of class (continuous) Collective reflection session (combined with focus group)	*Students´ emic perspectives on*: Teaching and learning processes Teaching and learning environment Teaching and learning outcomes → concluded data collection → provided opportunity for reflection

Table 9: Total data set

Case	Observations	Interviews	Focus Groups	Photovoice
GSR	55	23	2	3/3 groups; 22 photos
tdCS	11	14	2	1 group; 23 photos
ARW	3	8	2	3/5 groups; 23 photos
Total	**69**	**45**	**6**	**7/9 groups; 68 photos**

Case selection was informed by Brundiers and Wiek's (2013, p. 1731) process model of project-based learning courses with the following criteria:

1. Faculty establishes stakeholder networks to draw upon and collaborate with during their project-based learning courses.
2. Courses start with a phase of orientation (including reading up on relevant literature) before, at different stages of the courses, project framing takes place.
3. Courses move beyond problem analysis and work hands-on in solution-oriented research either in collaboration with or engaging stakeholders.
4. Courses engage students individually but particularly in team working activities, with coaching support.
5. Faculty, faculty support (e.g. tutors, experts), students and externals coordinate their efforts through a project management structure.
6. Course aims at simultaneously fulfilling learning objectives (teaching component), providing solutions to the problem at hand (solution component), and taking care of the needs of specific stakeholders (transdisciplinary component).

Table 10: Basic features of the three project-based sustainability courses (Konrad et al.,2021)

University	Arizona State University (ASU), USA & Leuphana University of Lüneburg, Germany	Swiss Federal Institute of Technology (ETH) Zurich, Switzerland	Polytechnic University of Catalonia (UPC) Barcelona, Spain
Program (2 years, 4 semesters/ terms)	Double-degree international master program: *Global Sustainability Science*	4 different master programs [10 different majors]	Master program: *Sustainability Science and Technology*
Course	*Global Sustainability Research* (GSR)	*Transdisciplinary Case Study* (tdCS)	*Action Research Workshop* (ARW)
Mandatory	Yes	No	Yes
Course duration	3 semesters (study focus: semester 3)	1 semester + field phase (3 weeks)	1 semester
Course location	Germany & Arizona	Switzerland & Seychelles	Spain
Pedagogy of place	On- and off-campus	On- and off-campus	On- and off-campus
ECTS	10+10+5	7	5
# of students	12 (2016-2017)	19 (2018)	15 (2018)
# of student groups	3 + 1	7	5
Project topic	Food economy	Waste management	Energy; Food; Housing
Stakeholder engagement	3 major events; City staff, public, food economy entrepreneurs	Continuous with peak phase; NGOs, government, businesses, citizens	Ranging from few check-ins to continuous; NGOs, members,

			supermarkets
# of instructors	1 (lead) + 3 [in semester 3]	1 (lead) + 1	1 (lead) + 1
# of tutors	0	ETH: 1; Seychelles: 2	0 (occasionally 1)
Expert support	City sustainability officer	Scientific experts and advisory board (local ministry, NGO and business representatives)	Faculty members, project providers

References

Barth, M. and Thomas, I. (2012), "Synthesising case-study research – ready for the next step?", *Environmental Education Research*, Vol. 18 No. 6, pp. 751–764.

Birdman, J., Barth, M. and Lang, D.J. (2020), "Case description: Competence Across Curricula: A Comparison of Three Graduate Sustainability Programs", *Working Papers in Higher Education for Sustainable Development. Leuphana University Lüneburg. Center for Global Sustainability and Cultural Transformation.*, No. 3.

Brundiers, K. and Wiek, A. (2013), "Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability", *Sustainability*, Vol. 5 No. 4, pp. 1725–1746.

Brundiers, K. and Wiek, A. (2017), "Beyond Interpersonal Competence. Teaching and Learning Professional Skills in Sustainability", *Education Sciences*, Vol. 7 No. 1.

Caniglia, G., John, B., Bellina, L., Lang, D.J., Wiek, A., Cohmer, S. and Laubichler, M.D. (2018), "The glocal curriculum. A model for transnational collaboration in higher education for sustainable development", *Journal of Cleaner Production*, Vol. 171, pp. 368–376.

Caniglia, G., John, B., Kohler, M., Bellina, L., Wiek, A., Rojas, C., Laubichler, M.D. and Lang, D. (2016), "An experience-based learning framework", *International Journal of Sustainability in Higher Education*, Vol. 17 No. 6, pp. 827–852.

Caniglia, G., Luederitz, C., Groß, M., Muhr, M., John, B., Withycombe Keeler, L., Wehrden, H. von, Laubichler, M., Wiek, A. and Lang, D. (2017), "Transnational collaboration for sustainability in

higher education. Lessons from a systematic review", *Journal of Cleaner Production*, Vol. 168, pp. 764–779.

de la Torre García, Eva M. (2018), "Public and private universities: evolution of productivity and impact of the crisis. "la Caixa" Social Observatory Award for the best article in the field of Education", *Social Observatory of "la Caixa"*.

Konrad, T., Wiek, A. and Barth, M. (in review), "Learning to Collaborate from Diverse Interactions in Project-based Sustainability Courses".

Konrad, T., Wiek, A. and Barth, M. (2020), "Embracing conflicts for interpersonal competence development in project-based sustainability courses", *International Journal of Sustainability in Higher Education*, Vol. 21 No. 1, pp. 76–96.

Konrad, T., Wiek, A. and Barth, M. (2021), "Processes of Interpersonal Competence Development – Insights from a Comparative Study of Project-Based Sustainability Courses", *International Journal of Sustainability in Higher Education*, Vol. 22 No. 3.

Krütli, P., Nef, D., Zumwald, M., Haupt, M., Harlay, J. and Stauffacher, M. (Eds.) (2018a), *Waste Management in the Seychelles – Pathways for Systemic Change: USYS TdLab Transdisciplinary Case Study 2018*.

Krütli, P., Pohl, C. and Stauffacher, M. (2018b), "Sustainability Learning Labs in Small Island Developing States. A Case Study of the Seychelles", *GAIA - Ecological Perspectives for Science and Society*, Vol. 27 No. 1, pp. 46–51.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M. and Thomas, C.J. (2012), "Transdisciplinary research in sustainability science. Practice, principles, and challenges", *Sustainability Science*, Vol. 7 No. S1, pp. 25–43.

Lang, D.J., Wiek, A., Luederitz, C., Wehrden, H. von and Laubichler, M. (2016), *Bridging the Great Divide in Sustainability Science: Linking High-Performance Modeling and Transition Experiments to Foster Transformational Change towards Sustainability.*, Project Proposal. Center for Global Sustainability and Cultural Transformation, Leuphana University of Luneburg, Luneburg, Germany and Arizona State University, Tempe.

Lang, D.J., Wiek, A. and Wehrden, H. von (2017), "Bridging divides in sustainability science", *Sustainability Science*, Vol. 12 No. 6, pp. 875–879.

McIlrath, L., Aramburuzabala, P., Opazo, H., Tuytschaever, G., Stark, W., Mikelic, N. and Meijs, L. (2016), "Europe Engage Survey of Civic Engagement and Service-Learning Activities within the Partner Universities—Europe Engage.".

Segalàs, J. and Tejedor, G. (2016), *Transdisciplinarity Action Research workshop for sustainable technology communities: Research Institute for Sustainability Science and Technology, Universitat Politècnica de Catalunya - Barcelona Tech, Spain*, Engineering Education for Sustainable Development (4-7 September 2016, Bruges, Belgium).

Stauffacher, M., Walter, A.I., Lang, D.J., Wiek, A. and Scholz, R.W. (2006), "Learning to research environmental problems from a functional socio-cultural constructivism perspective. The transdisciplinary case study approach", *International Journal of Sustainability in Higher Education*, Vol. 7 No. 3, pp. 252–275.

Tejedor, G., Segalàs, J., Barrón, Á., Fernández-Morilla, M., Fuertes, M., Ruiz-Morales, J., Gutiérrez, I., García-González, E., Aramburuzabala, P. and Hernández, À. (2019), "Didactic Strategies to Promote Competencies in Sustainability", *Sustainability*, Vol. 11 No. 7.

Wiek, A., Bernstein, M.J., Laubichler, M., Caniglia, G., Minteer, B. and Lang, D.J. (2013), "A Global Classroom for International Sustainability Education", *Creative Education*, Vol. 04 No. 04, pp. 19–28.

Wiek, A., Withycombe, L. and Redman, C.L. (2011), “Key competencies in sustainability. A reference framework for academic program development”, *Sustainability science*, Vol. 6 No. 2, pp. 203–218.

Wiek, A., Xiong, A., Brundiers, K. and van der Leeuw, S. (2014), “Integrating problem- and project-based learning into sustainability programs”, *International Journal of Sustainability in Higher Education*, Vol. 15 No. 4, pp. 431–449.

Withycombe Keeler, L., Beaudoin, F., Lerner, A., John, B., Beecroft, R., Tamm, K., Wiek, A. and Lang, D. (2018), “Transferring Sustainability Solutions across Contexts through City–University Partnerships”, *Sustainability*, Vol. 10 No. 9, p. 2966.

Withycombe Keeler, L., Wiek, A., Lang, D.J., Yokohari, M., van Breda, J., Olsson, L., Ness, B., Morato, J., Segalàs, J., Martens, P., Bojórquez-Tapia, L.A. and Evans, J. (2016), “Utilizing international networks for accelerating research and learning in transformational sustainability science”, *Sustainability Science*, Vol. 11 No. 5, pp. 749–762.

Yin, R.K. (1984), *Case Study Research: Design and Methods*, SAGE Publications, Beverly Hills, London, New Delhi.

APPENDIX 2

Food for thought I

Sustainability Science engages in solution-oriented research, envisioning and engaging in processes of change. However, appropriate conditions for change and transformation to unfold haven fallen short (Caniglia et al., 2020)[45]. Woiwode et al. (2021) stress that little attention has been paid so far to inner transformations for sustainability. Scholars such as Dlouhá et al. (2019), Freeth (2019), Horlings et al. (2020), Kahane (2017), Scharmer (2018), and others have started to unpack the power of introspection and the inner, personal dimension of sustainability for outer change. Here I present some preliminary visuals which pay tribute to the, thus far, rather neglected 'inner dimension' of sustainability, which deserves further exploration and elaboration in the future, not at last to support interpersonal competence development at the course-level (figure 13).

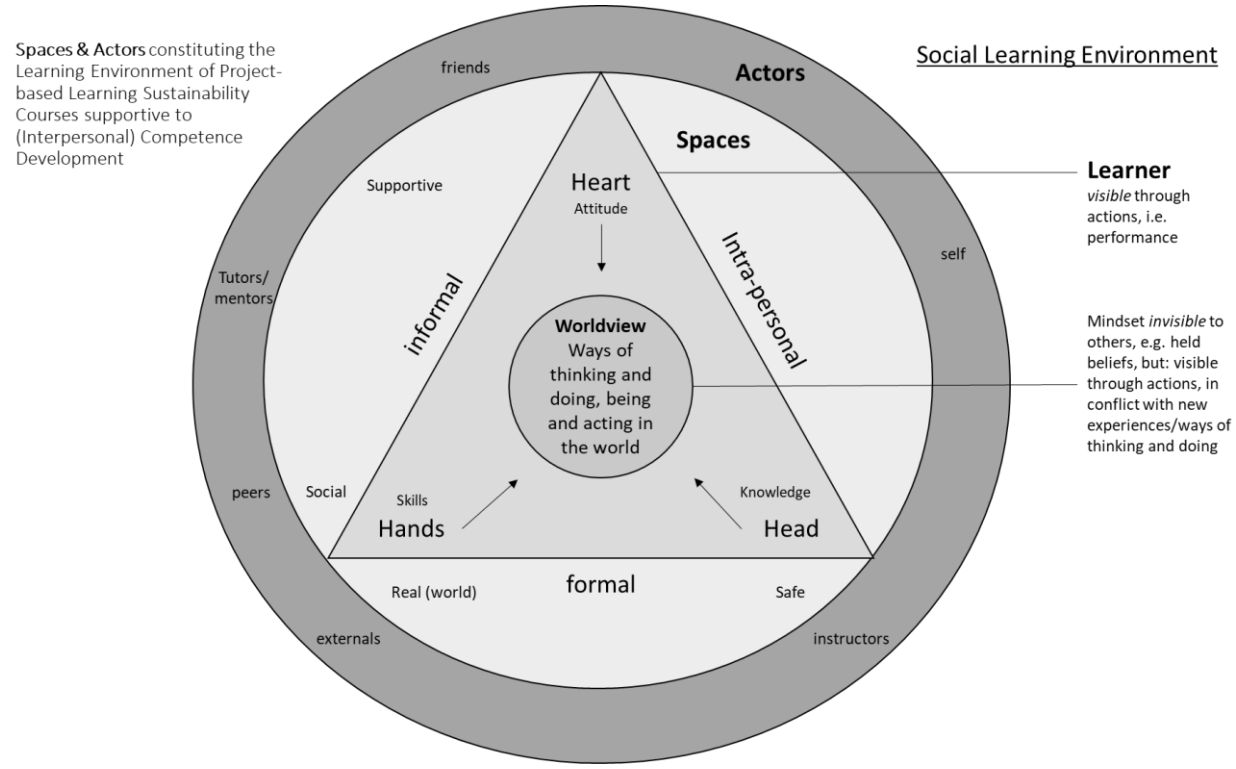


Figure 13: Preliminary visualization of the intrapersonal dimension in the context of interpersonal competence development in project-based sustainability courses (bird´s eye perspective). (source: author´s elaboration)

[45] For a distinction between change and transformation see Macintyre (2019).

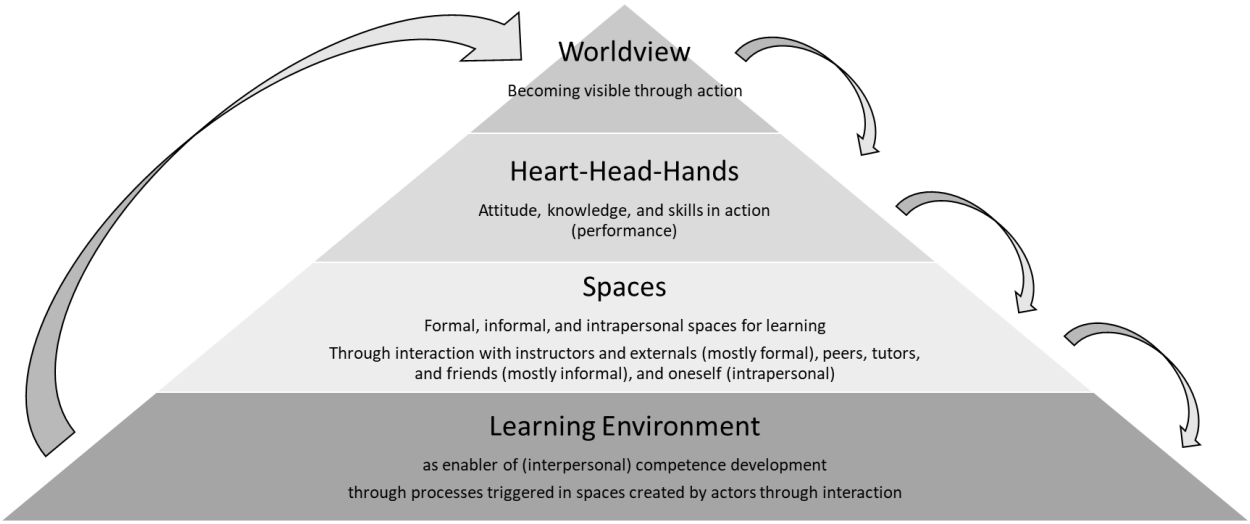


Figure 14: Preliminary visualization of the intrapersonal dimension in the context of interpersonal competence development in project-based sustainability courses (side view). (source: author´s elaboration)

APPENDIX 3

Thoughts on food I

Related to the previous two visuals (to be seen as *food for thought*): Out of the environment, or, in other words: out of healthy, fertile grounds grow healthy plants. What we need to take care of as educators is, therefore, the environment, or the soil. Everybody is constituting the social environment, so worldview impacts environment and vice versa (figure 14). In February 2020 I published a blog post picking up on this metaphor:

Why farmers are role models, e.g. for educators[46]

Imagine farmers do not do their job properly. What shall we eat?

Imagine farmers do not think ahead. What they want to eat, to harvest, to produce, to see growing, to share with their community. What then?

It´s getting spring. Time to think what I want to plant this season (a Brokkoli just reminded me, thanks for that). Time to think what I need for that. For instance: Good, healthy soil – and seeds. Latter one depending on what I want to harvest. Certain aspects crucial for farming, like the amount of sunlight and water, I can only partially influence, e.g. in looking for a space where I have easy access to both. Favorable conditions. In the end, however, it also depends on the weather. That´s out of my control. Still, what I as a farmer can do is to ponder about and to create conducive conditions for growing. Whatever I want to grow – it starts with a vision.

I know that a field with high plant and species diversity is ultimately more resilient.
I know that monocultures and mechanization might seem to produce high yields – However: Ever thought about the (hidden) costs and longterm consequences? Where to grow once the soil is exploited?

While working on a biodynamic community-supported farm, the main farmer described himself as a steward of the land. Ultimately, we are all caretakers. Farmers of some piece of land. And educators? – Caretakers of fertile learning processes and environments. Like in permaculture, what matters is the design. Thinking and planning prior to actually getting your hands earthy (not dirty) – to then let the plants grow together, benefitting from each other.

A farmer cannot take over the plant´s growth. What the farmer can do and needs to do is being attentive – attentive to the plant´s needs during the growing process. What farmers and educators can do is creating favorable, fertile conditions allowing seeds to sprout and take shape, evolve, grow, thrive. Becoming a plant. Nourishing all of us.

Imagine educators do not do their job properly. *How will our future look like?*

[46] This blog post was posted on February 16 2020 and can be seen a one of my personal reflections during this research process: https://pollinatorthereskonrad.wordpress.com/2020/02/16/blog-post-18-why-farmers-are-role-models-for-educators/

APPENDIX 4

Thoughts on food II

A little recipe at the end[47]

"Metaphors provide a way to understand our understandings and how we use language. (…) Metaphors both reveal and conceal, but because we live in language it is sometimes difficult to reflect on our metaphors-in-use. The strategy of mirroring particular metaphors or metaphor clusters thus holds open the possibility for reflection and learning. (…) By exploring metaphors, we can make part of our language use 'picturable' and thus rationally visible, publicly discussable and debatable, as well as socially useful as a practical resource 'with which and through which we can think and act'"

(Ison, 2010, p. 80)

SO WHAT

… do we need to bake 'the bread of interpersonal competence'?

As with every bread, we need flour.

TRUST for interpersonal competence development is like *flour* for the bread – the basic ingredient. Without it, there won´t be any (interpersonal competence) bread.

What makes the bread rise?

Yeast, luke-warm water (it also works with cold water or other liquid, however it slows down the process), and salt (but not too much, as it can kill the yeast).

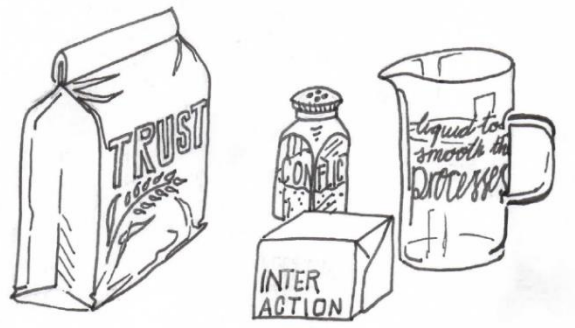
INTERACTIONS are the *yeast* of the interpersonal competence bread. The key lever to get interpersonal competence development going. Depending on the type of bread you want to bake (you know, there are baguettes, farmer-style, etc.) you add more or less interaction types (peer, deliberate, professional, supportive) to the dough.

Without water or a bit of *liquid*, the yeast and the flour are "stuck" – a good measurement of liquid, or a meaningful combination of **LEARNING PROCESSES**, smoothes the baking process, especially the kneading part. And, here the focus really lies on the right balance, i.e. combination.

Last but not least, what would a bread taste like without a tiny little bit of salt? **CONFLICTS** are the *salt* – they make it tastier. However, too much can be tricky, but even then you can still eat it as there are ways to deal with it.

Maybe, what holds true in my kitchen also goes for baking interpersonal competence bread: Wouldn´t be the same and so exciting without IMPROVISATION (based on my competencies!).

Happy baking! I hope you enjoy the process and the outcome alike!



(With thanks to Katinka Mustelin for the illustration.)

[47] To *Paul, the baker*. I have learned a lot. Thank you.

APPENDIX 5

Food for thought II

> "failure is also an important part of the learning process: new learning outcomes will only come about if we accept failures in our existing approaches, reflect on them, and seek out new ways of problem solving. Although this seems to be commonplace enough, there is far too often a general tendency for 'best practice' approaches and 'success stories' that often neglect the existence of failure. Accepting failure as a natural and necessary part of the learning process constitutes a dual process of seeing the failure of specific approaches as a result still worth reporting on and, second, of accepting such reporting as a respectable contribution to the shared learning process."
>
> (Barth 2015, p. 172)

In this sense, what you are finding here is a further initial thought I brought to paper. Neither do the previous ones in the appendices, nor this here claim to be finished or complete. Neither a success, nor a failure. What it is once more: potential *food for thought* which can only be thought-provoking if it is put out there. An invitation to exploration and experimentation.

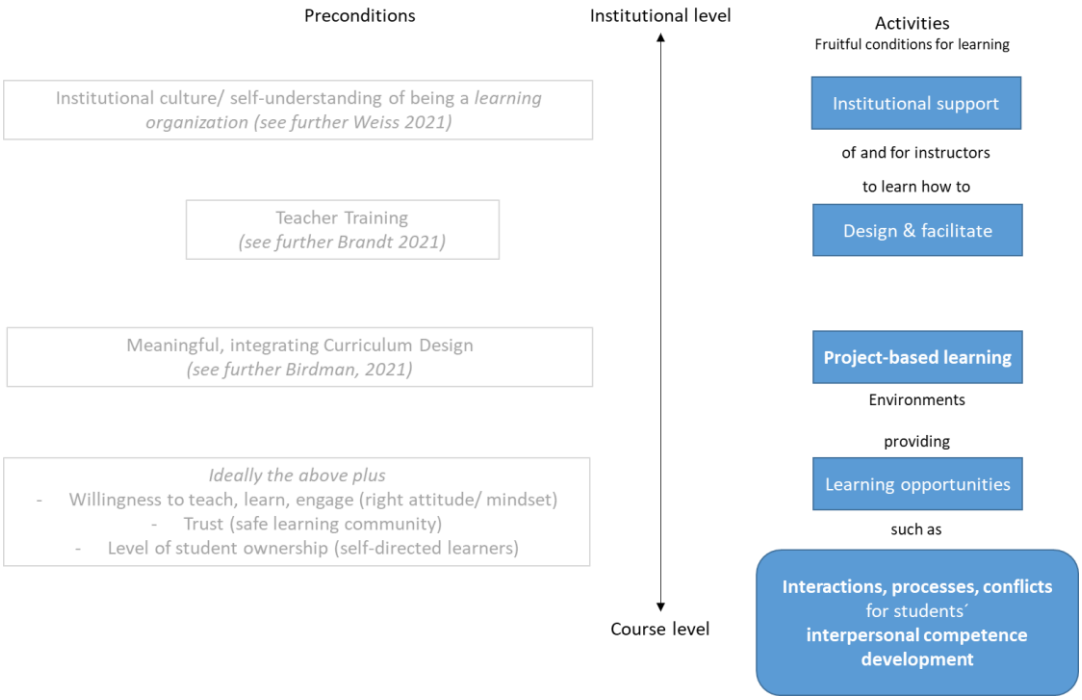


Figure 15: This thesis´ findings within the wider education system. (source: author´s elaboration)

References

Anderson, E. M., & Shannon, A. L. (1988). Toward a Conceptualization of Mentoring. *Journal of Teacher Education*, 38–42.

Argyris, C., & Schön, D. A. (1996). *Organizational Learning II: Theory, Method, and Practice*. Addison-Wesley Series Publishing Company, Inc.

Ayers, J. (2020). Competence Literate but Context Lacking? Investigating the Potential of Study Abroad Programs to Promote Sustainability Competence Acquisition in Students. *Sustainability*, *12*(13), 5389. https://doi.org/10.3390/su12135389

Backman, M., Pitt, H., Marsden, T., Mehmood, A., & Mathijs, E. (2019). Experiential approaches to sustainability education: towards learning landscapes. *International Journal of Sustainability in Higher Education*, *20*(1), 139–156. https://doi.org/10.1108/IJSHE-06-2018-0109

Bai, X., van der Leeuw, S., O'Brien, K., Berkhout, F., Biermann, F., Brondizio, E. S., Cudennec, C., Dearing, J., Duraiappah, A., Glaser, M., Revkin, A., Steffen, W., & Syvitski, J. (2016). Plausible and desirable futures in the Anthropocene: A new research agenda. *Global Environmental Change*, *39*(3), 351–362. https://doi.org/10.1016/j.gloenvcha.2015.09.017

Barnard, A., & Spencer, J. (Eds.). (1996/2002). *Encyclopedia of Social and Cultural Anthropology. Routledge*.

Barth, M. (2015). *Implementing Sustainability in Higher Education: Learning in an Age of Transformation*. *Routledge studies in sustainable development*. Routledge.

Barth, M., Bruhn, A., Lam, D. P.M., Bergmann, M., & Lang, D. J. (2020). Capacity building for transformational leadership and transdisciplinarity. *GAIA - Ecological Perspectives for Science and Society*, *29*(3), 195–197. https://doi.org/10.14512/gaia.29.3.12

Barth, M., Godeman, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing Key Competencies for Sustainable Development in Higher Education. *International Journal of Sustainability in Higher Education*, *8*(4), 416–430.

Barth, M., & Michelsen, G. (2013). Learning for change: An educational contribution to sustainability science. *Sustainability Science*, *8*(1), 103–119. https://doi.org/10.1007/s11625-012-0181-5

Barth, M., & Rieckmann, M. (2016). State of the Art in Research on Higher Education for Sustainable Development. In M. Barth, G. Michelsen, M. Rieckmann, & I. (E.) Thomas (Eds.), *Routledge Handbook of Higher Education for Sustainable Development* (pp. 100–113).

Barth, M., & Thomas, I. (2012). Synthesising case-study research – ready for the next step? *Environmental Education Research*, *18*(6), 751–764. https://doi.org/10.1080/13504622.2012.665849

Bawden, R. (2010). The Community Challenge: The Learning Response. In C. Blackmore (Ed.), *Social Learning Systems and Communities of Practice* (pp. 39–56). Springer London.

Bickford, D. J., & Wright, D. J. (2006). Community: The Hidden Context for Learning. In D. G. Oblinger (Ed.), *An educase e-Book. Learning spaces* (pp. 4.1.–4.22). Brockport Bookshelf. 78.

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, *32*(3), 347–364. https://doi.org/10.1007/BF00138871.

Birdman, J. (2020). Pushing the boundaries: experience-based learning in early phases of graduate sustainability curricula. *International Journal of Sustainability in Higher Education*, *22*(1), 237–253. https://doi.org/10.1108/IJSHE-08-2019-0242

Birdman, J., Barth, M., & Lang, D. J. (2020). Case description: Competence Across Curricula: A Comparison of Three Graduate Sustainability Programs. *Working Papers in Higher Education for Sustainable Development. Leuphana University Lüneburg. Center for Global Sustainability and Cultural Transformation.*(3).

Birdman, J., Wiek, A., & Lang, D. J. (in review). Developing Key Competencies in Sustainability through Project-based Learning in Graduate Sustainability Programs. *International Journal of Sustainability in Higher Education*.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, *26*(3 & 4), 369–398.

Brandt, J.-O. (2021). *A Matter of Connection: Competence Development in Teacher Education for Sustainable Development* [Doctoral thesis], Leuphana Universität Lüneburg.

Brandt, J.-O., Bürgener, L., Barth, M., & Redman, A. (2019). Becoming a competent teacher in ESD: Learning outcomes and processes in teacher education for sustainable development. *International Journal of Sustainability in Higher Education*, *20*(4), 630–653.

Brundiers, K., Barth, M., Cebrián, G., Cohen, M., Diaz, L., Doucette-Remington, S., Dripps, W., Habron, G., Harré, N., Jarchow, M., Losch, K., Michel, J., Mochizuki, Y., Rieckmann, M., Parnell, R., Walker, P., & Zint, M. (2020). Key competencies in sustainability in higher education—toward an agreed-upon reference framework. *Sustainability Science (Online).* Advance online publication. https://doi.org/10.1007/s11625-020-00838-2

Brundiers, K., & Wiek, A. (2013). Do We Teach What We Preach? An International Comparison of Problem- and Project-Based Learning Courses in Sustainability. *Sustainability*, *5*(4), 1725–1746. https://doi.org/10.3390/su5041725

Brundiers, K., & Wiek, A. (2017). Beyond Interpersonal Competence: Teaching and Learning Professional Skills in Sustainability. *Education Sciences*, *7*(1). https://doi.org/10.3390/educsci7010039

Brundiers, K., Wiek, A., & Redman, C. L. (2010). Real-world learning opportunities in sustainability: from classroom into the real world. *International Journal of Sustainability in Higher Education*, *11*(4), 308–324. https://doi.org/10.1108/14676371011077540

Budwig, N. (2015). Concepts and tools from the learning sciences for linking research, teaching and practice around sustainability issues. *Current Opinion in Environmental Sustainability*, *16*, 99–104. https://doi.org/10.1016/j.cosust.2015.08.003

Buhrmester, D., Furman, W., Wittenberg, M. T., & Reis, H. T. (1988). Five Domains of Interpersonal Competence in Peer Relations. *Journal of Personality and Social Psychology*, *55*(6), 991–1008.

Bürgener, L., & Barth, M. (2018). Sustainability competencies in teacher education: Making teacher education count in everyday school practice. *Journal of Cleaner Production*, *174*, 821–826. https://doi.org/10.1016/j.jclepro.2017.10.263

Caniglia, G., John, B., Bellina, L., Lang, D. J., Wiek, A., Cohmer, S., & Laubichler, M. D. (2018). The glocal curriculum: A model for transnational collaboration in higher education for sustainable

development. *Journal of Cleaner Production*, *171*, 368–376. https://doi.org/10.1016/j.jclepro.2017.09.207

Caniglia, G., John, B., Kohler, M., Bellina, L., Wiek, A., Rojas, C., Laubichler, M. D., & Lang, D. (2016). An experience-based learning framework. *International Journal of Sustainability in Higher Education*, *17*(6), 827–852. https://doi.org/10.1108/IJSHE-04-2015-0065

Caniglia, G., Luederitz, C., Groß, M., Muhr, M., John, B., Withycombe Keeler, L., Wehrden, H. von, Laubichler, M., Wiek, A., & Lang, D. (2017). Transnational collaboration for sustainability in higher education: Lessons from a systematic review. *Journal of Cleaner Production*, *168*, 764–779. https://doi.org/10.1016/j.jclepro.2017.07.256

Caniglia, G., Luederitz, C., Wirth, T. von, Fazey, I., Martín-López, B., Hondrila, K., König, A., Wehrden, H. von, Schäpke, N. A., Laubichler, M. D., & Lang, D. J. (2020). A pluralistic and integrated approach to action-oriented knowledge for sustainability. *Nature Sustainability*, *70*, 8. https://doi.org/10.1038/s41893-020-00616-z

Capra, F. (2009). Foreword. In A. E.J. Wals (Ed.), *Social learning towards a sustainable world: Principles, perspectives, and praxis* (pp. 13–15).

Cebrián, G., Junyent, M., & Mulà, I. (2020). Competencies in Education for Sustainable Development: Emerging Teaching and Research Developments. *Sustainability*, *12*(2), 579. https://doi.org/10.3390/su12020579

Cheng, R. W.-y., Lam, S.-f., & Chan, J. C.-y. (2008). When high achievers and low achievers work in the same group: The roles of group heterogeneity and processes in project-based learning. *The British Journal of Educational Psychology*, *78*(Pt 2), 205–221. https://doi.org/10.1348/000709907X218160

Chio, V. C. M., & Fandt, P. M. (2007). Photovoice in the Diversity Classroom: Engagement, Voice, and the “Eye/I” of the Camera. *Journal of Management Education*, *31*(4), 484–504. https://doi.org/10.1177/1052562906288124

Ciolan, L., & Manasia, L. (2017). Reframing Photovoice to Boost Its Potential for Learning Research. *International Journal of Qualitative Methods*, *16*(1), pp. 1–15. https://doi.org/10.1177/1609406917702909

Clevenger, C. M., & Ozbek, M. E. (2013). Service-Learning Assessment: Sustainability Competencies in Construction Education. *Journal of Construction Engineering and Management*, *139*(12). https://doi.org/10.1061/(ASCE)CO.1943-7862.0000769

Collins, A., Brown, J. S., & Newman, S. E. (1987a). Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics: Technical Report 403.

Collins, A., Brown, J. S., & Newman, S. E. (1987b). Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics: Technical Report 403.

Cook, K., & Quigley, C. (2013). Connecting to Our Community: Utilizing Photovoice as a Pedagogical Tool to Connect College Students to Science. *International Journal of Environmental and Science Education*, *8*(2), 339–357. https://doi.org/10.12973/ijese.2013.205a

Corbin, J., & Strauss, A. (1990). Grounded Theory Research: Procedures, Canons and Evaluative Criteria. *Zeitschrift Für Soziologie*, *19*(6), 418–427.

Cortese, A. D. (2003). The Critical Role of Higher Education in Creating a Sustainable Future: Higher education can serve as a model of sustainability by fully integrating all aspects of campus life. *Planning for Higher Education*, 15–22.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. SAGE Publications.

Dahm, R., Byrne, J., & Wride, M. A. (2019). Interdisciplinary Communication Needs to Become a Core Scientific Skill: BioEssays. *WILEY Periodicals, Inc*.

DeFillippi, R. J. (2001). Introduction: Project-Based Learning, Reflective Practices and Learning. *Management Learning. Sage Publications*(32 (1)), 5–10.

Dlouhá, Heras, Mulà, Salgado, & Henderson (2019). Competences to Address SDGs in Higher Education—A Reflection on the Equilibrium between Systemic and Personal Approaches to Achieve Transformative Action. *Sustainability*, *11*(13), 3664. https://doi.org/10.3390/su11133664

Donnelly, R., & Fitzmaurice, M. (2005). Collaborative Project-based Learning and Problem-based Learning in Higher Education: a Consideration of Tutor and Student Role in Learner-Focused Strategies. In G. O´Neill, S. Moore, & B. McCullin (Eds.), *Emerging Issues in the Practice of University Learning and Teaching* (pp. 87–98).

Earl, A., Van Wynsberghe, Walter, P., & Straka, T. (2018). Adaptive education applied to higher education for sustainability. *International Journal of Sustainability in Higher Education*, *19*(6), 1111–1130. https://doi.org/10.1108/IJSHE-08-2017-0131

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (2001/2007). Participant Observation and Fieldnotes. In P. Atkinson, Coffey, Amanda, S. Delamont, J. Lofland, & L. Lofland (Eds.), *Handbook of Ethnography* (pp. 352–368). SAGE Publications.

Ettling, D. (2012). Educator as Change Agent: Ethics of Transformative Learning. In E. W. Taylor, P. Cranton, & and Associates (Eds.), *The Handbook of Transformative Learning: Theory, Research, and Practice* (pp. 536–551). John Wiley & Sons, Inc.

Evans, T. L. (2015). Transdisciplinary collaborations for sustainability education: Institutional and intragroup challenges and opportunities. *Policy Futures in Education*, *13*(1), 70–96. https://doi.org/10.1177/1478210314566731

Evans, T. L. (2019). Competencies and Pedagogies for Sustainability Education: A Roadmap for Sustainability Studies Program Development in Colleges and Universities. *Sustainability*, *11*(5526). https://doi.org/10.3390/su11195526

Fam, D., Clarke, E., Freeth, R., Derwort, P., Klaniecki, K., Kater-Wettstädt, L., Juarez-Bourke, S., Hilser, S., Peukert, D., Meyer, E., & Horcea-Milcu, A.-I. (2019). Interdisciplinary and transdisciplinary research and practice: Balancing expectations of the 'old' academy with the future model of universities as 'problem solvers'. *Higher Education Quarterly*, *3*(1), 1–16. https://doi.org/10.1111/hequ.12225

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford University Press.

Förster, R., Zimmermann, A. B., & Mader, C. (2019). Transformative teaching in Higher Education for Sustainable Development: facing the challenges. *GAIA - Ecological Perspectives for Science and Society*, *28*(3), 324–326. https://doi.org/10.14512/gaia.28.3.18

Frank, P. (2020). *DEVELOPINGAFFECTIVE-MOTIVATIONALCOMPETENCEWITHINEDUCATIONFORSUSTAINABLECONSUMPTIONTHROUGHSELF-REFLEXIVELEARNINGACTIVITIES.*

Freeth, R., Clarke, E. A., & Fam, D. (2019). Engaging creatively with tension in collaborative research: Harnessing the "I" and "we" through dialogue. In V. A. Brown, J. A. Harris, & D. Waltner-Toews (Eds.), *Independent thinking in an uncertain world: A mind of one's own.* Routledge.

Freeth, R. (2019). FORMATIVE ACCOMPANYING RESEARCH WITH COLLABORATIVE INTERDISCIPLINARY TEAMS: Doctoral Dissertation. Leuphana University of Lüneburg.

Freeth, R., & Caniglia, G. (2020). Learning to collaborate while collaborating: Advancing interdisciplinary sustainability research. *Sustainability Science*, *15*, 247–261. https://doi.org/10.1007/s11625-019-00701-z

Freire, P. (2007). *Pedagogy of the Oppressed*. Continuum.

Gaia Education. (2017/2018). *Module I: Building Community & Embracing Diversity: Gaia Education Design for Sustainability Programme*.

Gant, L. M., Shimshock, K., Allen-Meares, P., Smith, L., Miller, P., Hollingsworth, L. A., & Shanks, T. (2009). Effects of Photovoice: Civic Engagement Among Older Youth in Urban Communities. *Journal of Community Practice*, *17*(4), 358–376. https://doi.org/10.1080/10705420903300074

Giangrande, N., White, R. M., East, M., Jackson, R., Clarke, T., Saloff Coste, M., & Penha-Lopes, G. (2019). A Competency Framework to Assess and Activate Education for Sustainable Development: Addressing the UN Sustainable Development Goals 4.7 Challenge. *Sustainability (Online)*, *11.* https://doi.org/10.3390/su11102832

Göpel, M. (2016). *The Great Mindshift: How a New Economic Paradigm and Sustainability Transformations go Hand in Hand*. Springer Open.

Gulikers, J., & Oonk, C. (2019). Towards a Rubric for Stimulating and Evaluating Sustainable Learning. *Sustainability (Online)*, *11*(4). https://doi.org/10.3390/su11040969

Haan, G. de (2010). The development of ESD-related competencies in supportive institutional frameworks. *International Review of Education*, *56*(2-3), 315–328. https://doi.org/10.1007/s11159-010-9157-9

Hannafin, M. J., Hill, J. R., Land, S. M., & Lee, E. (2014). Student-Centered, Open Learning Environments: Research, Theory, and Practice. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology* (Vol. 12, pp. 641–651). Springer New York. https://doi.org/10.1007/978-1-4614-3185-5_51

Hardin, R., Bhargava, A., Bothner, C., Browne, K., Kusano, S., Golrokhian, A., Wright, M., Zeng, P. Z., & Agrawal, A. (2016). Towards a revolution in sustainability education: Vision, architecture, and assessment in a case-based approach. *World Development Perspectives*, *1*, 58–63. https://doi.org/10.1016/j.wdp.2016.05.006

Heinrichs, H., Martens, P., Michelsen, G., & Wiek, A. (Eds.). (2016). *Sustainability Science: An Introduction*. Springer Netherlands. https://doi.org/10.1007/978-94-017-7242-6

Heiskanen, E., Thidell, Å., & Rodhe, H. (2016). Educating sustainability change agents: The importance of practical skills and experience. *Journal of Cleaner Production*, *123*, 218–226. https://doi.org/10.1016/j.jclepro.2015.11.063

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-Based Learning in Post-Secondary Education – Theory, Practice and Rubber Sling Shots. *Higher Education*, *51*(2), 287–314. https://doi.org/10.1007/s10734-004-6386-5

Hernandez, K., Shabazian, A. N., & McGrath, C. (2014). Photovoice as a Pedagogical Tool: Examining the Parallel Learning Processes of College Students and Preschool Children through Service Learning. *Creative Education*, *05*(22), 1947–1957. https://doi.org/10.4236/ce.2014.522219

Hernández-Barco, M., Sánchez-Martín, J., Blanco-Salas, J., & Ruiz-Téllez, T. (2020). Teaching Down to Earth—Service-Learning Methodology for Science Education and Sustainability at the University Level: A Practical Approach. *Sustainability (Online)*, *12*(2). https://doi.org/10.3390/su12020542

Hilser, S. (2016). *Key Competencies to Action: Transdisciplinary Learning of Key Competencies for Sustainability* [Master Thesis]. LUCSUS, Lund University, Lund.

Holmén, J. (2020). *Navigating Sustainability Transformations: Backcasting, transdisciplinarity and social learning* [Doctoral thesis]. CHALMERS UNIVERSITY OF TECHNOLOGY, Gothenburg, Sweden.

hooks, b. (1994). *Teaching to transgress: Education as the practice of freedom*. Routledge.

Horlings, L. G., Nieto-Romero, M., Pisters, S., & Soini, K. (2020). Operationalising transformative sustainability science through place-based research: the role of researchers. *Sustainability Science*(15), 467–484. https://doi.org/10.1007/s11625-019-00757-x

Illeris, K. (2003). Towards a contemporary and comprehensive theory of learning. *International Journal of Lifelong Education*, *22*(4), 396–406. https://doi.org/10.1080/02601370304837

Ison, R. (2010). Traditions of Understanding: Language, Dialogue and Experience. In C. Blackmore (Ed.), *Social Learning Systems and Communities of Practice* (Vol. 22, pp. 73–87). Springer London. https://doi.org/10.1007/978-1-84996-133-2_5

Jerneck, A., & Olsson, L. (2020). Theoretical and Methodological Pluralism in Sustainability Science. In T. Mino & S. Kudo (Eds.), *Science for Sustainable Societies. Framing in Sustainability Science* (Vol. 26, pp. 17–33). Springer Singapore. https://doi.org/10.1007/978-981-13-9061-6_2

Johari, A., & Bradshaw, A. C. (2008). Project-based learning in an internship program: A qualitative study of related roles and their motivational attributes. *Educational Technology Research and Development*, *56*(3), 329–359. https://doi.org/10.1007/s11423-006-9009-2

John, B., Caniglia, G., Bellina, L., Lang, D. J., & Laubichler, M. (2017). *The Glocal Curriculum: A Practical Guide to Teaching and Learning in an Interconnected World* [sic!] Critical Aesthetics Publishing.

Johnson, D. W., & Johnson, R. T. (1979). Conflict in the Classroom: Controversy and Learning. *Review of Educational Research*, *49*(1), 51–70. https://doi.org/10.2307/1169926

Kahane, A. (2017). *Collaborating with the Enemy: How to Work with People You Don´t Agree with or Like or Trust*. Berret-Koehler Publishers, Inc. "A REOS Partners Publication.".

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., McCarthy, J. J., Schellnhuber, H. J., Bolin, B., Dickson, N. M., Faucheux, S., Gallopin, Gilberto C., Grübler, A., Huntley, B., Jäger, J., Jodha, N. S., Kasperson, R. E., Mabogunje, A., . . . Svedin, U. (2001). Sustainability Science. *Science*, *292*(5517), 641–642.

Kelly, P. (2006). Letter from the oasis: Helping engineering students to become sustainability professionals. *Futures*, *38*(6), 696–707. https://doi.org/10.1016/j.futures.2005.10.005

Khan, S., & VanWynsberghe, R. (2008). Cultivating the Under-Mined: Cross-Case Analysis as Knowledge Mobilization. *Forum: Qualitative Research*, *9*(1).

Kolb, A. Y., & Kolb, D. A. (2005). Learning Styles and Learning Spaces: Enhancing Experiental Learning in Higher Education. *Academy of Management Learning & Education*, *Vol. 2*, pp. 193–212.

Kolb, A. Y., & Kolb, D. A. (2012). Experiential Learning Theory. In Norbert M. Seel (Ed.), *Encyclopedia of the Sciences of Learning.* (pp. 1215–1219).

Konrad, T., Wiek, A., & Barth, M. (in review). Learning to Collaborate from Diverse Interactions in Project-based Sustainability Courses.

Konrad, T., Wiek, A., & Barth, M. (2020). Embracing conflicts for interpersonal competence development in project-based sustainability courses. *International Journal of Sustainability in Higher Education*, *21*(1), 76–96. https://doi.org/10.1108/IJSHE-06-2019-0190

Konrad, T., Wiek, A., & Barth, M. (2021). Processes of Interpersonal Competence Development – Insights from a Comparative Study of Project-Based Sustainability Courses. *International Journal of Sustainability in Higher Education*, *(preliminary) 22*(3).

Kricsfalusy, V., George, C., & Reed, M. G. (2018). Integrating problem- and project-based learning opportunities:: assessing outcomes of a field course in environment and sustainability. *Environmental Education Research*, *24*(4), 593–610.

Krütli, P., Nef, D., Zumwald, M., Haupt, M., Harlay, J., & Stauffacher, M. (Eds.). (2018). *Waste Management in the Seychelles – Pathways for Systemic Change: USYS TdLab Transdisciplinary Case Study 2018.*

Krütli, P., Pohl, C., & Stauffacher, M. (2018). Sustainability Learning Labs in Small Island Developing States: A Case Study of the Seychelles. *GAIA - Ecological Perspectives for Science and Society*, *27*(1), 46–51. https://doi.org/10.14512/gaia.27.S1.11

Lang, D. J., Wiek, A., Luederitz, C., Wehrden, H. von, & Laubichler, M. (2016). *Bridging the Great Divide in Sustainability Science: Linking High-Performance Modeling and Transition Experiments to Foster Transformational Change towards Sustainability.* Project Proposal. Center for Global Sustainability and Cultural Transformation, Leuphana University of Luneburg, Luneburg, Germany and Arizona State University, Tempe.

Lang, D. J., Wiek, A., & Wehrden, H. von (2017). Bridging divides in sustainability science. *Sustainability Science*, *12*(6), 875–879. https://doi.org/10.1007/s11625-017-0497-2

Leal Filho, W., Price, E., Wall, T., Shiel, C., Azeiteiro, U. M., Mifsud, M., Brandli, L., Farinha, C. S., Caeiro, S., Salvia, A. L., Vasconcelos, C. R., Sousa, L. O. de, Pace, P., Doni, F., Veiga Avila, L., Fritzen, B., & LeVasseur, T. J. (2021). Covid-19: The impact of a global crisis on sustainable development teaching. *Environment, Development and Sustainability*, 1–22. https://doi.org/10.1007/s10668-020-01107-z

Lotz-Sisitka, H., Wals, A. E. J., Kronlid, D., & McGarry, D. (2015). Transformative, transgressive social learning: rethinking higher education pedagogy in times of systemic global dysfunction. *Current Opinion in Environmental Sustainability*, *16*, 73–80. https://doi.org/10.1016/j.cosust.2015.07.018

Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2019). Teaching Sustainability in European Higher Education Institutions: Assessing the Connections between Competences and Pedagogical Approaches. *Sustainability*, *11*(1602).

Lozano, R., Merrill, M. Y., Sammalisto, K., Ceulemans, K., & Lozano, F. J. (2017). Connecting Competences and Pedagogical Approaches for Sustainable Development in Higher Education: A Literature Review and Framework Proposal. *Sustainability*.

Macintyre, T. (2019). *The transgressive gardener : Cultivating learning-based transformations towards regenerative futures.* https://doi.org/10.18174/505808

Macintyre, T., Chaves, M., Monroy, T., Zethelius, M. O., Villarreal, T., Tassone, V. C., & Wals, A. E. J. (2020). Transgressing Boundaries between Community Learning and Higher Education: Levers and Barriers. *Sustainability*, *12*(7), 2601. https://doi.org/10.3390/su12072601

Mannay, D. (2010). Making the familiar strange: can visual research methods render the familiar setting more perceptible? *Qualitative Research*, *10*(1), 91–111.

May, T. (2011). *Social Research: Issues, methods and process* (4th ed.). Open University Press.

Metcalf, H. C., & Urwick, L. (Eds.). (1942/2003). *Early sociology of management and organizations: v. 3*. *Dynamic administration: The collected papers of Mary Parker Follett*. Routledge. http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10100571

Meza Rios, M. M., Herremans, I. M., Wallace, J. E., Althouse, N., Lansdale, D., & Preusser, M. (2018). Strengthening sustainability leadership competencies through university internships. *International Journal of Sustainability in Higher Education*.

Mezirow, J. (2000). Learning to Think Like an Adult: Core Concepts of Transformation Theory. In J. Mezirow &. Associates (Ed.), *Learning as Transformation: Critical Perspectives on a Theory in Progress* (pp. 3–33). Jossey-Bass Inc.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook*. SAGE Publications.

Mindell, A. (1995/2014). *Sitting in the Fire: Large group transformation using conflict and diversity*. Deep Democracy Exchange.

Mitchell, R., Wals, A., & Brockwell, A. J. (2020). *Mobilising capacities for Transforming Education for Sustainable Futures: Opening spaces for collaborative action and learnin: TESF Background Paper Series*. Bristol, TESF.

Molderez, I., & Fonseca, E. (2018). The efficacy of real-world experiences and service learning for fostering competences for sustainable development in higher education. *Journal of Cleaner Production*, *172*, 4397–4410. https://doi.org/10.1016/j.jclepro.2017.04.062

Moriggi, A., Soini, K., Franklin, A., & Roep, D. (2020). A care-based approach to transformative change: ethically-informed practices, relational response-ability & emotional awareness. *Ethics, Policy & Environment*, *12*(3), 1–18. https://doi.org/10.1080/21550085.2020.1848186

Müller, P. A., Bäumer, T., Silberer, J., & Zimmermann, S. (2020). Using research methods courses to teach students about sustainable development – a three-phase model for a transformative learning experience. *International Journal of Sustainability in Higher Education*, *21*(3), 427–439. https://doi.org/10.1108/IJSHE-08-2019-0252

Nelson, T., & Cassell, J. A. (2012). Pedagogy for survival: an educational response to the ecological crisis. In A. E.J. Wals & P. B. Corcoran (Eds.), *Learning for sustainability in times of accelerating change* (pp. 63–75). Chapter 3.

Niedlich, S., Kallfaß, A., Pohle, S., & Bormann, I. (2020). A comprehensive view of trust in education: Conclusions from a systematic literature review. *Review of Education*, *14*(1), 1. https://doi.org/10.1002/rev3.3239

Noble, D., Charles, M. B., & Keast, R. (2017). New development: Towards a collaborative competency framework to enhance public value in university– industry collaboration. *Public Money & Management*, *37*(5), 373–378. https://doi.org/10.1080/09540962.2017.1328799

Ojala, M. (2016). Facing Anxiety in Climate Change Education: From Therapeutic Practice to Hopeful Transgressive Learning. *Canadian Journal of Environmental Education*, *21*, 41–56.

Ojala, M. (2017). Hope and anticipation in education for a sustainable future. *Futures*, *94*, 76–84. https://doi.org/10.1016/j.futures.2016.10.004

Oonk, C. (2016). *Learning and teaching in the Regional Learning Environment: Enabling students and teachers to cross boundaries in multi-stakeholder practices* [Doctoral Thesis]. Wageningen University & Research.

Oxenswärdh, A., & Persson-Fischier, U. (2020). Mapping Master Students´ Processes of Problem Solving and Learning in Groups in Sustainability Education. *Sustainability (Online)*, *12*(13). https://doi.org/10.3390/su12135299

Papenfuss, J., Merritt, E., Manuel-Navarrete, D., Coutier, S., & Eckard, B. (2019). Interacting Pedagogies: A Review and Framework for Sustainability Education. *Journal of Sustainability Education*, *Vol 20*.

Paulus, T. (1972). *hope for the flowers.*

Pereira, L., Frantzeskaki, N., Hebinck, A., Charli-Joseph, L., Drimie, S., Dyer, M., Eakin, H., Galafassi, D., Karpouzoglou, T., Marshall, F., Moore, M.-L., Olsson, P., Siqueiros-García, J. M., van Zwanenberg, P., & Vervoort, J. M. (2019). Transformative spaces in the making: key lessons from nine cases in the Global South. *Sustainability Science*, *4*(3), 113. https://doi.org/10.1007/s11625-019-00749-x

Porter-O´Grady, T. (2004). Embracing Conflict: Building a Healthy Community. *Health Care Management Review*, *29*(3), 181–187.

Raworth, K. (2012). A Safe and Just Space for Humanity: Can we live within the doughnut? *Oxfam Discussion Papers*.

Redman, A. (2020). *Assessing the Development of Key Competencies in Sustainability* [Dissertation]. Arizona State University.

Remington-Doucette, S. M., Hiller Connell, K. Y., Armstrong, C. M., & Musgrove, S. L. (2013). Assessing sustainability education in a transdisciplinary undergraduate course focused on real-world problem solving. *International Journal of Sustainability in Higher Education*, *14*(4), 404–433. https://doi.org/10.1108/IJSHE-01-2012-0001

Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures*, *44*(2), 127–135. https://doi.org/10.1016/j.futures.2011.09.005

Robinson, K., & Aronica, L. (2009). *The Element: How finding your passion changes everything*. Viking (Penguin Group).

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., & …Foley, J. A. (2009). A safe operating space for humanity. *Nature*, *Vol 461*.

Rosenberg, M. B. (2015). *A Language of Life*. 3rd Edition. PuddleDancer Press.

Roy, S. G., Souza, S. P. de, McGreavy, B., Druschke, C. G., Hart, D. D., & Gardner, K. (2020). Evaluating core competencies and learning outcomes for training the next generation of sustainability researchers. *Sustainability Science*, *15*(1), 619–631. https://doi.org/10.1007/s11625-019-00707-7

Ryan, R. M., & Deci, e. L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *American Psychologist*, *55*(1), 68–78.

Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., & Rockström, J. (2019). Six Transformations to achieve the Sustainable Development Goals. *Nature Sustainability*, *2*(9), 805–814.

Savage, E., Tapics, T., Evarts, J., Wilson, J., & Tirone, S. (2015). Experiential learning for sustainability leadership in higher education. *International Journal of Sustainability in Higher Education*, *16*(5), 692–705.

Schaltegger, S., Hansen, E. G., & Spitzeck, H. (2016). Corporate Sustainability Management. In H. Heinrichs, P. Martens, G. Michelsen, & A. Wiek (Eds.), *Sustainability Science: An Introduction.* Springer Netherlands.

Scharmer, O. C. (2018). *The Essentials of Theory U: Core Principles and Applications*. Berrett-Koehler Publishers.

Schneider, F., Giger, M., Harari, N., Moser, S., Oberlack, C., Providoli, I., Schmid, L., Tribaldos, T., & Zimmermann, A. (2019). Transdisciplinary co-production of knowledge and sustainability transformations: Three generic mechanisms of impact generation. *Environmental Science & Policy*, *102*, 26–35. https://doi.org/10.1016/j.envsci.2019.08.017

Schor, J. (2012). Foreword. In A. E.J. Wals & P. B. Corcoran (Eds.), *Learning for sustainability in times of accelerating change* (pp. 15–18).

Segalàs, J., & Tejedor, G. (2016). *Transdisciplinarity Action Research workshop for sustainable technology communities: Research Institute for Sustainability Science and Technology, Universitat Politècnica de Catalunya - Barcelona Tech, Spain*. Engineering Education for Sustainable Development (4-7 September 2016, Bruges, Belgium).

Singer-Brodowski, M. (2016). Studierende als GestalterInnen einer Hochschulbildung für nachhaltige Entwicklung : selbstorganisierte und problembasierte Nachhaltigkeitskurse und ihr Beitrag zur überfachlichen Kompetenzentwicklung Studierender.: Doctoral Thesis. Leuphana University of Lüneburg.

Sipos, Y., Battisti, B., & Grimm, K. (2008). Achieving transformative sustainability learning: Engaging head, hands and heart. *International Journal of Sustainability in Higher Education*, *9*(1), 68–86.

Skinner, K. L., Hyde, S. J., McPherson, K. B.A., & Simpson, M. D. (2016). Improving students' interpersonal skills through experiential small group learning. *Journal of Learning Design*, *9*(1), 21–36.

Slater, K., & Robinson, J. (2020). Social Learning and Transdisciplinary Co-Production: A Social Practice Approach. *Sustainability*, *12*(18), 7511. https://doi.org/10.3390/su12187511

Soini, K., Korhonen-Kurki, K., & Asikainen, H. (2019). Transactional learning and sustainability co-creation in a university – business collaboration. *International Journal of Sustainability in Higher Education*, *20*(6), 965–984. https://doi.org/10.1108/IJSHE-11-2018-0215

Sol, J., van der Wal, Merel M., Jelle Beers, P., & Wals, A. (2017). Reframing the future: the role of reflexivity in governance networks in sustainability transitions. *Environmental Education Research*, 1–23.

Stauffacher, M., Walter, A. I., Lang, D. J., Wiek, A., & Scholz, R. W. (2006). Learning to research environmental problems from a functional socio-cultural constructivism perspective: The transdisciplinary case study approach. *International Journal of Sustainability in Higher Education*, *7*(3), 252–275.

Steinemann, A. (2003). Implementing Sustainable Development through Problem-Based Learning. *JOURNAL of PROFESSIONAL ISSUES in ENGINEERING EDUCATION and PRACTICE*, 216–224.

Strauss, A., & Corbin, J. (1990). *Grounded Theory: Grundlagen Qualitativer Sozialforschung: (Originalausgabe: Basics of Qualitative Research; Grounded Theory Procedures and Techniques)*. BELTZ PsychologieVerlagsUnion.

Tejedor, G., Segalàs, J., & Cebrián, G. (2018). Action research workshop for transdisciplinary sustainability science: (Correction: third author added: Sustain Sci 14, 859 (2019). https://doi.org/10.1007/s11625-018-00654-9. *Sustainability Science*, *13*(2), 493–502. https://doi.org/10.1007/s11625-017-0452-2

Tejedor, G., Segalàs, J., Barrón, Á., Fernández-Morilla, M., Fuertes, M., Ruiz-Morales, J., Gutiérrez, I., García-González, E., Aramburuzabala, P., & Hernández, À. (2019). Didactic Strategies to Promote Competencies in Sustainability. *Sustainability*, *11*(7). https://doi.org/10.3390/su11072086

Terrón-López, M.-J., Velasco-Quintana, P. J., Lavado-Anguera, S., & Espinosa-Elvira, M. d. C. (2020). Preparing Sustainable Engineers: A Project-Based Learning Experience in Logistics with Refugee Camps. *Sustainability*, *12*(12), 4817. https://doi.org/10.3390/su12124817

Thích Nhất Hạnh. (2017). *The Art of Living: Peace and Freedom in the Here and Now*. HarperCollins Publishers.

Thomas, I., & Day, T. (2014). Sustainability capabilities, graduate capabilities, and Australian universities. *International Journal of Sustainability in Higher Education*, *15*(2), 208–227. https://doi.org/10.1108/IJSHE-05-2012-0046

Tikly, L., Batra, P., Duporge, V., Facer, K., Herring, E., Lotz-Sisitka, H., McGrath, S., Mitchell, R., Sprague, T., & Wals, A. (2020). *Transforming Education for Sustainable Development: Foundations Paper (extended background paper for consultation).* https://doi.org/10.5281/ZENODO.3952649

Tilbury, D. (2016). Student Engagement and Leadership in Higher Education for Sustainability. In M. Barth, G. Michelsen, M. Rieckmann, & I. Thomas (Eds.), *Routledge Handbook of Higher Education for Sustainable Development* (pp. 273–286).

Tuckman, B. W. (1965). DEVELOPMENTAL SEQUENCE IN SMALL GROUPS. *Psychological Bulletin 1965 Vl 63 N 6*, *63*(6), 384–399.

UNESCO. (2015). *Rethinking Education: Towards a global common good?*

UNESCO (2016). UNESCO Competency Framework: Learn, Develop, Excel.

UNESCO. (2017). *Education for Sustainable Development Goals: learning objectives.*

UNESCO. (2020). *Education for Sustainable Development: A roadmap: #ESDfor2030*. Paris, France.

United Nations. (2015). *TRANSFORMING OUR WORLD: THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT*.

United Nations General Assembly. (1987). *Our Common Future: Report of the World Commission on Environment and Development* [Official Records of the General Assembly, forty-second Session, supplement No. 25 (A/42/25)].

van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in Teacher–Student Interaction: A Decade of Research. *Educational Psychology Review*, *22*(3), 271–296. https://doi.org/10.1007/s10648-010-9127-6

van Note Chism, N. (2006). Challenging Traditional Assumptions and Rethinking Learning Spaces. In D. G. Oblinger (Ed.), *An educase e-Book. Learning spaces* (2.1-2.12). Brockport Bookshelf. 78.

Vare, P., Arro, G., Hamer, A. de, Del Gobbo, G., Vries, G. de, Farioli, F., Kadji-Beltran, C., Kangur, M., Mayer, M., Millican, R., Nijdam, C., Réti, M., & Zachariou, A. (2019). Devising a Competence-Based Training Program for Educators of Sustainable Development: Lessons Learned. *Sustainability*, *11*(7), 1890. https://doi.org/10.3390/su11071890

Vare, P., & Scott, W. (2007). Learning for a Change. *Journal of Education for Sustainable Development*, *1*(2), 191–198. https://doi.org/10.1177/097340820700100209

Wang, C., & Burris, M. A. (1997). Photovoice: Concept, Methodology, and Use for Participatory Needs Assessment. *Health Education & Behavior*, *24*(3), 369–387.

Weiss, M., & Barth, M. (2019). Global research landscape of sustainability curricula implementation in higher education. *International Journal of Sustainability in Higher Education*, *20*(4), 570–589. https://doi.org/10.1108/IJSHE-10-2018-0190

Weiss, M., Barth, M., & Wehrden, H. von (in review). The patterns of curriculum change processes that embed sustainability in higher education institutions.

Wenger, E. (2000). Communities of practice and social learning systems. *Organization*, *7*(2), 225–246.

Wiek, A. (2015). *Solving Sustainability Problems: Tools for a New Generation of Professionals*. School of Sustainability, Arizona State University, Tempe, AZ.

Wiek, A., Bernstein, M. J., Foley, R. W., Cohen, M., Forrest, N., Kuzdas, C., Kay, B., & Withycombe Keeler, L. (2015). Operationalising Competencies in Higher Education for Sustainable Development. In *Handbook of Higher Education for Sustainable Development* (pp. 241 - 260). Routledge.

Wiek, A., Bernstein, M. J., Laubichler, M., Caniglia, G., Minteer, B., & Lang, D. J. (2013). A Global Classroom for International Sustainability Education. *Creative Education*, *04*(04), 19–28. https://doi.org/10.4236/ce.2013.44A004

Wiek, A., & Kay, B. (2015). Learning while transforming: Solution-oriented learning for urban sustainability in Phoenix, Arizona. *Current Opinion in Environmental Sustainability*, *16*, 29–36. https://doi.org/10.1016/j.cosust.2015.07.001

Wiek, A., Ness, B., Schweizer-Ries, P., Brand, F. S., & Farioli, F. (2012). From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science*, *7*(S1), 5–24. https://doi.org/10.1007/s11625-011-0148-y

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science*, *6*(2), 203–218. https://doi.org/10.1007/s11625-011-0132-6

Wiek, A., Withycombe, L., Redman, C., & Mills, S. B. (2011). Moving Forward on Competence in Sustainability Research and Problem Solving. *Environment: Science and Policy for Sustainable Development*, *53*(2), 3–13. https://doi.org/10.1080/00139157.2011.554496

Wiek, A., Xiong, A., Brundiers, K., & van der Leeuw, S. (2014). Integrating problem- and project-based learning into sustainability programs. *International Journal of Sustainability in Higher Education*, *15*(4), 431–449. https://doi.org/10.1108/IJSHE-02-2013-0013

Wilhelm, S., Förster, R., & Zimmermann, A. (2019). Implementing Competence Orientation: Towards Constructively Aligned Education for Sustainable Development in University-Level Teaching-And-Learning. *Sustainability*, *11*(7), 1891. https://doi.org/10.3390/su11071891

Withycombe Keeler, L., Beaudoin, F., Lerner, A., John, B., Beecroft, R., Tamm, K., Wiek, A., & Lang, D. (2018). Transferring Sustainability Solutions across Contexts through City–University Partnerships. *Sustainability*, *10*(9), 2966. https://doi.org/10.3390/su10092966

Withycombe Keeler, L., Wiek, A., Lang, D. J., Yokohari, M., van Breda, J., Olsson, L., Ness, B., Morato, J., Segalàs, J., Martens, P., Bojórquez-Tapia, L. A., & Evans, J. (2016). Utilizing international networks for accelerating research and learning in transformational sustainability science. *Sustainability Science*, *11*(5), 749–762. https://doi.org/10.1007/s11625-016-0364-6

Woiwode, C., Schäpke, N., Bina, O., Veciana, S., Kunze, I., Parodi, O., Schweizer-Ries, P., & Wamsler, C. (2021). Inner transformation to sustainability as a deep leverage point: fostering new avenues for change through dialogue and reflection. *Sustainability Science*, *46*(2), 30. https://doi.org/10.1007/s11625-020-00882-y

Yin, R. K. (1984). *Case Study Research: Design and Methods*. SAGE Publications.

Yin, R. K. (2009). *Case study research: Design and methods* (Fourth Edition). *Applied social research methods series: Vol. 5*. SAGE Publications.

Zemler, L. (2016a). *The convergence of societal advancement and the education of future sustainability professionals: a solution-oriented approach to place-based environmental challenges: A descriptive case study of the Master's course 'Strategic Environmental Development' of Lund University, Sweden* [Master Thesis]. Lund University – University of Manchester - University of the Aegean – Central European University, Lund.

Zull, J. E. (2002). The art of changing the brain.: Enriching teaching by exploring the biology of learning. *Va: Stylus Pub*, *1st ed. Sterling*, pp.13-29.

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Theres

Lüneburg, February 7 2021

Why the title "Time for Refl-Action"?

Time is needed to allow for both *reflection* and *action*. This research has shown the relevance of this at the personal level, for students in university sustainability courses that seek to foster interpersonal competence development and learning. This is true on the societal level as well. The time we live in requires nothing less than that we reflect upon our actions if we want to stop reproducing detrimental habits that lead to and leave us in situations of crisis. If our vision is to live in a just and safe world within planetary boundaries, we need to be(come) daring enough to 'stop, look, and then go'. Being at a standstill and standing still are not the same thing. Making the conscious effort to take time for reflection is a useful precondition for further steps. It is through reflection that we derive meaning from experiences which, in turn, informs the actions needed to co-create a present and a future that allows diverse species to thrive. In this sense, it is high *time for 'Refl-Action'*, because we are in urgent need of change, and change can start with(in) me.