

## Article

# Learning to Collaborate from Diverse Interactions in Project-Based Sustainability Courses

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**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/collaborative competence; interactions



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## 1. Introduction

A just and safe future within planetary boundaries [1,2], as aimed for with the Sustainable Development Goals (SDGs) [3], requires partnerships, collaborative efforts, and leadership [4,5]. Higher education plays a crucial role in educating future change agents that are knowledgeable and skilled in collaboration [6–9] as sustainability professionals need to be able to effectively collaborate in inter- and transdisciplinary settings [10]. This calls for educational opportunities to develop key competencies in sustainability, such as interpersonal or collaborative competence [11–13]. As there is a call for innovative teaching and learning approaches [14,15], the question is on what teaching and learning environments are conducive to such competence development [16].

In general, project-based sustainability courses are conducive settings for students to develop key competencies in sustainability [7,14,15,17–21]. They are characterized by students working in interdisciplinary teams while developing solutions to real-world sustainability problems in cooperation with stakeholders [21,22]. Balancing instruction and student ownership allows for hands-on learning [6,8,16]. Interpersonal competence, i.e., the ability to collaborate in teams and with stakeholders, is one of the main learning outcomes of such courses [6,16,18,23]. It can be fostered by facilitating collective reflection of experiences with all involved project participants [6,16]. This aligns with Kolb and Kolb's [24] learning cycle, emphasizing that the creation of new knowledge takes place through the transformation of experience.

Research has demonstrated that project-based sustainability courses constitute rich learning environments through the various interactions that students have with peers, instructors, external stakeholders, and additional actors [7,17,25]. 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 [15,17,26]. However, as courses primarily intend to build students' key competencies in sustainability [13], 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 [27] as well as the opportunities for reflection on the different interactions [16].

As opposed to letting interactions simply fulfill their function in the course projects (which, admittedly, facilitates some competence development, too), we are interested in exploring the explicit characteristics and combination of interactions to advance students' interpersonal competence. This study addresses the research question of 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 graduate 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 to provide a basis for interpersonal competence development. The study's goal is to inform the design and facilitation of courses to enhance students' learning experiences and to better align learning outcomes and processes.

## 2. Research Design

Research was carried out as a comparative case study [28] on three project-based sustainability courses of (international) master programs. Selection criteria were that the courses pursue (a) key competence development as learning objective (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. [29].

While an in-depth case study was conducted on the GSR course for over a year [23] 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.

The one-semester GSR course (at ASU) was embedded within an ongoing international research project. The course's focus was on supporting the local food economy in Tempe, Arizona, by planning, organizing, preparing for, and executing a local stakeholder engagement event, co-facilitated by the students. This capacity-building event allowed participants to understand the local food economy holistically, to introduce transferrable solutions, and to connect food entrepreneurs locally.

The tdCS course encompassed a preparatory semester in Switzerland and three weeks of fieldwork on the Seychelles. There, in collaboration with local students and an advisory board, students conducted research on the island's waste management, including stakeholder engagement events [30].

**Table 1.** Key features of the three project-based learning sustainability courses. Data from [29].

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: <i>Global Sustainability Science</i>	4 different master programs [10 different majors]	Master program: <i>Sustainability Science and Technology</i>
Course	<i>Global Sustainability Research (GSR)</i>	<i>Transdisciplinary Case Study (tdCS)</i>	<i>Action Research Workshop (ARW)</i>
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

The one-semester ARW course offered students different projects to choose from, each introduced and led by a local project provider. While one group supported a local NGO on energy infrastructure, another group focused on elimination of food waste by cooperating with a local association.

To allow for triangulation and to ensure construct validity [31], we used a mix of data collection methods, including (participant) observation of class sessions, student and instructor team meetings, stakeholder engagement events [32]; semi-structured interviews (including focus groups) with students, instructors, alumni tutors, and stakeholders [33]; and Photovoice method for student teamwork [23,34]. 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.

Observations were open, direct, and mostly non-participant and unstructured, while the semi-structured interviews followed an interview guideline informed by previous observations. Inspired by Grounded Theory [35], data was analyzed to inform further data collection. The Photovoice method [34] was introduced at the beginning of the courses to let students track their group's learning processes. At the completion of the courses, the photos were utilized to trigger course memories and compare course experiences, within and across project groups, to allow for authentic student voices and perspectives [36].

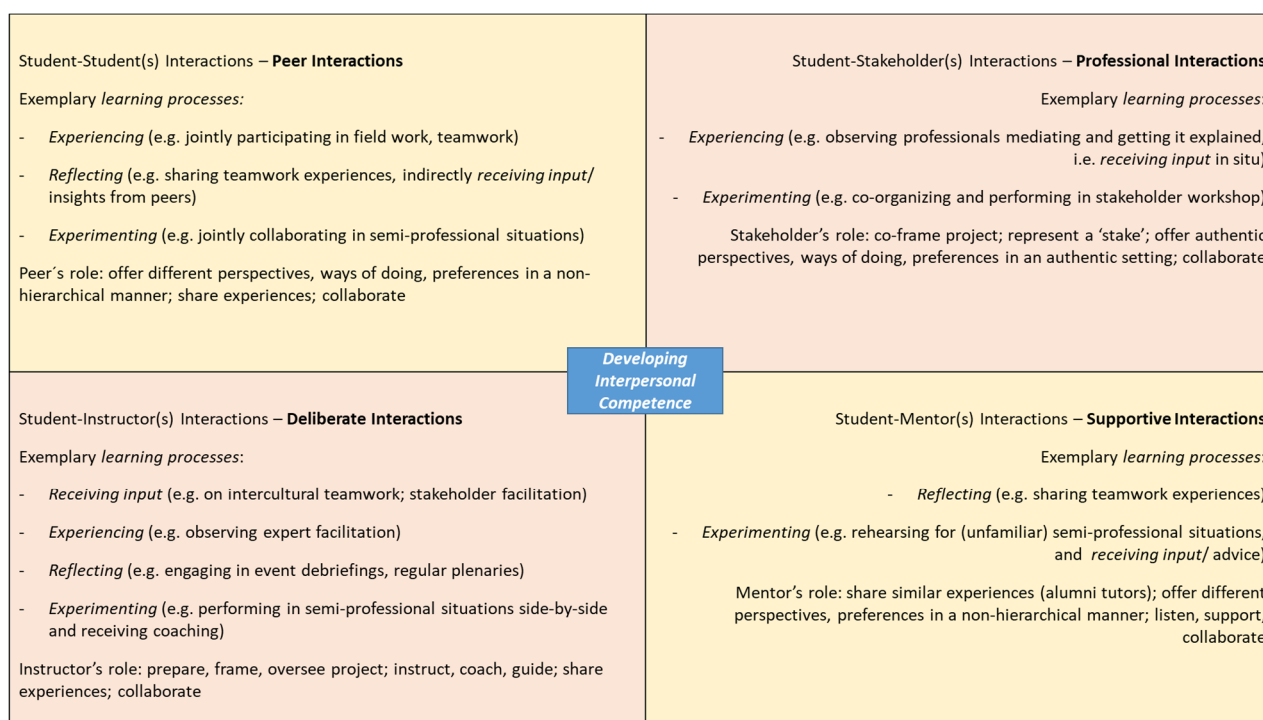
The cross-case analysis was utilized, which enables insights on commonalities of cases as well as their particularities [37]. Data was coded and first analyzed regarding similarities and differences across cases. Data was analyzed deductively and inductively, letting new themes emerge from the data. Comparative tables were used for qualitative data reduction and pattern identification [38].

Students' stated learning outcomes were translated into key competencies in sustainability (if applicable; referring to Wiek et al.'s [13] framework), which subsequently underwent a reliability test. Brundiens and Wiek's [11] elaboration on professional skills allowed further specification of interpersonal competence which was proved to be a main

learning outcome of the courses (see also [18,23]). Iteratively going through data and tables allowed to map out the courses' different interactions for students' interpersonal competence development and are presented in the following.

### 3. Outcomes

Typically, four types of actors participate in project-based sustainability graduate courses: students, instructors, stakeholders, and mentors/tutors (alumni, PhD students). These actors constitute four different types of interaction, which can facilitate learning processes for interpersonal competence development. These are student–student(s) (Section 3.1), student–instructor(s) (Section 3.2), student–stakeholder(s) (Section 3.3), and student–mentor(s) interactions (Section 3.4) (Figure 1). Identified learning processes are *receiving input*, *experiencing*, *reflecting*, and *experimenting*, as outlined in Konrad et al. [18]. While all learning processes might be triggered in all four interactions, to allow for developing specific facets of interpersonal competence, learning processes need to be purposefully combined. While interactions implicitly facilitate students' interpersonal competence development, they only constitute conscious learning opportunities if made explicit subjects of inquiry, i.e., if they are reflected on and discussed.



**Figure 1.** Types of interactions that facilitate students' interpersonal competence development in project-based sustainability courses (learning processes (in italics) are based on [18]).

#### 3.1. Peer Interactions

*Student–student(s) interactions* can facilitate the 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)

This learning was supported by regular exchange among student groups. This means that not only the teamwork setting allows for interpersonal competence development, but the exchange among peers about their group work, too. Such exchanges took place in all three courses. The GSR and tdCS course had several groups working on one umbrella project, while the ARW course had different individual student projects. Students went through the same cycles of planning, acting, and reflecting, which constituted shared experiences and the basis for reflection and exchange.

Interpersonal competence development from peer learning is not limited to knowledge and skills. In addition, 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 specified interpersonal competence learning outcomes see [18]). 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. This can take place informally, e.g., during breaks, and/or private encounters. Yet, the GSR instructors introduced student trios with one member from each of the groups. This fostered exchange and interpersonal competence development from peer interactions.

Another example for interpersonal competence development through peer interaction 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 further 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 as we have indicated. 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 reactively toward 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. The following quote illustrates the link between learning outcome (conflict-embracing attitude as part of collaborative attitude) and learning processes triggered through peer interactions:

“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, 30 November 2017, line 267)

What led to S1\_011’s competence development was the combination of experiencing of, reflecting on, and experimenting with peer interactions.

### 3.2. Deliberate 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 (both facets); 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 (for a specification see [11]), intercultural, and collaborative competence (GSR observations; see [39]). The ARW course offered a session on Emotional Intelligence (ARW observation, 10.04.18), which started with an input on the multi-faceted concept of intelligence and then focused on experiencing. Exercises from theater pedagogy [9], facilitated by the instructor, allowed students to grasp what collaborative teamwork entails and subsequent reflections (oral and written) deepened the insights. One of the exercises (“el huevo frito”) asks students to stand in a circle with one student after the other entering the center and stating what they add to the ‘still life’ by mimicking what they stated (e.g., a fork, a table, a napkin, salt). If students moved simultaneously, the exercise needed to restart. The exercise conveyed the importance of carefully listen to each other to move forward together, and be aware of one’s own steps for others to understand.

Second, instructors role-model stakeholder facilitation. 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). The tdCS course, for instance, 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. 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 from experiences made and motivating to change practices, e.g., communication styles. This demonstrates the importance of spaces for reflection to learn for future action, consciously building up and becoming aware of one's own skill repertoire, knowledge base, and mindset.

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 (to all involved); 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* 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, ways of working, and preferences. Further, stakeholders call on students to perform professionally as something real, not hypothetical, is at stake. 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)

The key here 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, provided for in other interaction types (Figure 1). Reflection upon student–stakeholder interactions supports students to become aware of the attitudes, knowledge, and skills applied or required in professional interactions. For example, the tdCS course offered intense interaction opportunities during their three-week field phase on the Seychelles. When a student reflected on them, they 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). Learning, i.e., interpersonal competence development, can also be supported by reflecting on what could have been done differently.

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; 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. A student stated, for instance:

"It's 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, 21 September 2017, line 44)

While professional interactions offer opportunities to experience and overcome personal challenges, reflection on the experiences allows for becoming aware of the value.

Similarly, the tdCS course and the ARW course relied on their partnerships with businesses, NGOs, and government agencies, built up over the years and through personal commitment.

### 3.4. Supportive 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, styles of working, preferences. This often creates discomfort, tensions, or (inner and/or outer) conflicts [23]. Supportive interactions bring mentors into the projects to open up reflections and conversations about these experiences. An alumnus 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 (Figure 1). 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 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. 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 appropriately 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) or initiating a conversation with an instructor (GSR observation, 01.09.17).

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).

### 3.5. Synthesis

The four interaction types are distinguished by the actor a student engages with. Peer and supportive interactions (Figure 1, in yellow) represent rather non-hierarchical (informal) ways of interactions; therefore, they allow for an intense exchange about experiences based on shared experiences of peers and alumni tutors. Deliberate and professional interactions (Figure 1) represent rather formal ways of interactions, therefore offering different ways of communicating and interacting.

What all four—peer, deliberate, professional, and supportive interactions—have in common is that they offer a student different, authentic, and potentially new perspectives, in terms of how to work together, how to communicate, how to deal with differences and conflicts, or how to approach a task. This can lead to inner and outer conflicts which bear the potential to change one’s own ways of thinking and doing, and hence develop one’s interpersonal competence if embraced (see further [23]).

While peer, deliberate, and professional interactions offer particularly *opportunities to experience* the above, supportive interactions, for instance, can support competence development through offering *opportunities for reflection*, to complement a learning process (experiential learning cycle). Otherwise, an experience might remain vague in terms of its learning outcomes unless they are explored. This can take place either individually (e.g., through reflection questions; tdCS) or together in class (an example is the shared reflection of the Emotional Intelligence activities right afterwards orally and via written reflection assignments; ARW). All courses investigated for this study accounted actively for opportunities for reflection, acknowledging its importance for further steps in terms of the project, which ultimately depended on students’ interpersonal competence (development).

Each interaction type accounts for specific learning processes (Figure 1). Student–stakeholder interactions provide mainly opportunities to experience and experiment. For a learning cycle to be complete, students need to be given the opportunity to derive meaning from these experiences to allow for conscious further experimentation and interpersonal skill development. Instructors can deliberately look after such opportunities for reflection in several ways: First, in offering reflection opportunities themselves, with peers (e.g., event debriefs/GSR; class presentations and discussions/ARW; evening plenaries/tdCS), or, second, by including alumni tutors into the course which can constitute a rather informal while still targeted space for reflection and learning.

As elaborated earlier [18], learning processes need to be purposefully combined to allow for attitude, knowledge, and skill development in collaborative teamwork and impactful stakeholder engagement. The different interaction types are the moderating variables to trigger and navigate these processes. While theoretically all interaction types could provide for all mentioned learning processes (receiving input, experiencing, reflecting, experimenting), typically, as this study showed, each interaction type is key for

specific processes. For conscious interpersonal competence development to take place, it is the instructors or course designers' challenge to ensure that processes triggered through diverse interaction are combined in a meaningful way. Hereby (Figure 1) the instructor has several options: Foster reflective peer interactions, include mentors (tutors), and brief stakeholders (expectation management). Furthermore, all participants of project-based sustainability courses be(come) life-long learners and embrace so called inner and outer conflicts as chances to further develop ones' own interpersonal competence. For that, a collaborative mindset is key [18,23].

#### 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 deliberately, beyond just learning-by-doing. It is in line with previous findings on project-based sustainability courses that learning *can* occur when interactions simply happen [40] (p. 21). Yet, we have shown in the present study that learning can be enhanced when making these diverse interactions subjects of inquiry [25,40,41]. Relying on the insight that learning benefits from communicative interactions [25,42], 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 [14,43].

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 [44]. Diversity of cultural and academic backgrounds and the resulting plurality of viewpoints and ways of doing support learning of interpersonal competence [19,23,45]. Other scholarly work points in similar directions with concepts such as “transgressive learning” [46], i.e., resolving inner conflicts for learning and interpersonal competence development. Brundiers and Wiek [17] (p. 1734) highlight 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. Ferreira et al. [7] (p. 980) further state that the “aim is making students the engines of their own training” and that “they have an important role in sustainability, since students acting as ‘green’ examples to their fellow students might also be effective, as the attitude comes from peers, and not just from staff ‘telling them what to do’”.

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 [11]. Collins et al.'s [47] *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.) [44], and then supporting students through *scaffolding* [48] and *coaching* [49], until, ideally, ‘disappearing’ when students perform tasks independently [50]. 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 [25,44]. 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 [51] (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 [44], they serve as supervisor, coach, and mediator, only “taking control when necessary” [25] (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” [52] (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” [53] (p. 1114) operating in the real world [17], students “participate in authentic practices and practice skills needed in real life projects” [49] (p. 293), while developing personal connection, empathy, compassion, and purpose [19,45,54,55]. As pointed out in other studies [53,56], students’ interpersonal competence development requires going beyond simply participating in these interactions, and making them the *subject* of inquiry, exploration, reflection, and discussion. Brundiens and Wiek [17] (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 [41]. Moreover, stakeholders represent different values, beliefs, ways of thinking and doing, and have a different problem understanding and/or solution vision, all of which can trigger interpersonal competence development [23]. 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 Brundiens et al. [41]. This model suggests, first, to bring the world into the classroom (e.g., through guest visits); second, to visit the world; third to simulate the world (practice interactions in a safe space); and fourth, to enter the world and address real-world challenges [23,41].

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 [57]. 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)” [17] (p. 1736). This presents the role of mentors as a solution to foster interpersonal competence development (and learning overall). We follow Kolb and Kolb [42] 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 [14,27,50,58,59]. 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 [60] (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.

This study indicates which learning processes typically occur in which interaction type (Figure 1) and provides guidance on utilizing these interactions to develop interpersonal/collaborative competence [24]. Professional interactions, for example, offer opportunities for learning interpersonal competence through, for instance, experiencing professionals’ behavior and experimenting with ways to engage professionals in a workshop (and reflecting on it) [16,18]. This study indicates different ways of how interactions can support interpersonal competence development in project-based sustainability courses, by combining them so that they allow learning processes to complement each other.

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 [61]. 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 and participants overall. 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 [15], and sustainability implementation in higher education in general [62].

## 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 deliberately designed, combined, and made the subjects of inquiry, i.e., made explicit through articulation in (shared) reflection. 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 reflecting upon the doing). 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. Implications of this study are an overview of interaction types and the learning processes triggered through these, what supports the purposeful combination of learning processes through fostering certain interactions. 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). Additionally, an assessment capturing instructors' competence levels and development could deliver relevant insights. 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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