Key Competencies to Action

Transdisciplinary Learning of Key Competencies for Sustainability

Stefan Hilser

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LUCSUS
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Submitted October 3, 2016

Supervisor: Barry Ness, LUCSUS, Lund University

Abstract

Purpose: According to literature there is a set of six key competencies that distinguish sustainability professionals, including researchers, from professionals and researchers in other fields, making them "systemic problem solvers, change agents, and transition managers". However, there is lack of empirical evidence, first, that these skills are necessary and sufficient for sustainability problem solving, and second, that current sustainability programs and courses convey these skills. This thesis aims to contribute to closing this gap.

Design/Methodology/Approach: The thesis follows a case study approach, looking at the transdisciplinary Knowledge to Action course module of the LUMES Master's programme. The study is designed as a mixed methods study containing quantitative as well as qualitative elements. Semi-structured interviews with the course instructors and focus group interviews with students helped to contextualize the research. The results served as input for an ex-post self-assessment survey on key competencies. The survey results were analysed with the help of descriptive statistics and visual analysis. Document analysis was used to further compare the results to the aims and expectations of the course.

Findings: LUMES students acquired all the competencies with varying degrees, systems-thinking being developed least and interpersonal competence being developed the most. The key competencies are well integrated into the teaching activities and the learning outcomes. Interpersonal competence is most developed through the course across project activities and phases, underscoring its cross-cutting nature. Real-life activities are only slightly more helpful in developing the key competencies. The five activities that contributed the most to the development across the key competencies are Problem Definition, Content Development, Impact Evaluation, Report Writing and Field Research, with only interpersonal competence having a quite distinct set of activities. Further, difficulty of and involvement in project activities as well as overall project success were found to have an effect on competence acquisition.

Research Limitations/Implications: Focus on a single case, subjective self-assessment and lack of corroboration through extra-academic project partners limit the generalizability of the research results. However, it shows that the integration of the key competencies into sustainability curricula is possible and needs to further be fostered in the future. The findings further underscore the importance of real-life experience for the acquisition of key competencies and shows which activities should receive further attention. Future research needs to go even more in depth in order to determine the usefulness of the (teaching) activities for the development of key competencies in more detail. A comparative case study would also contribute to a better understanding of the connection between curricula, learning outcomes and the key competencies.

Originality/Value: This thesis contributes to the theoretical development of sustainability education and provides an empirical basis for further development of the key competencies framework. It further provides insights into how current transdisciplinary course modules can contribute to the development of these competencies.

Keywords: Key Competencies, Transdisciplinarity, Higher Education, Knowledge to Action, LUMES

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Last, but not least, I'd like to thank my interview partners and survey participants for taking their time and providing me with the information I needed.

List of Abbreviations

Abbreviation	Full Name	Description
B18	Batch 18	LUMES students from 2014-16
B19	Batch 19	LUMES students from 2015-17
ECTS	European Credit Transfer System	
K2A	Knowledge to Action	Transdisciplinary teaching module
LUMES	Lund University Master's in Environmental Studies and Sustainability Science	
RQ/RQs	Research Question(s)	

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1 Introduction

1.1 Thesis Rationale

Science plays an important role in the quest for sustainable development (Kates et al., 2001). "The wicked nature of sustainability issues" (Smith & Wals, 2012, p. 12) is characterized by indeterminacy, value-ladedness/normativity, controversy, uncertainty and complexity (Peters & Wals, 2013). Sustainability Science is "essential for progress towards sustainability" (Spangenberg, 2011, p.275). It is a different kind of science that seeks creative solutions to these wicked problems (Jerneck et al., 2011) and aims for transformational change (Wiek, Ness, Schweizer-Ries, Brand, & Farioli, 2012).

To address these problems and in order to achieve such transformational change, there has been an increasing demand for change agents for sustainability (Hesselbarth & Schaltegger, 2014) and a "need for sustainability leaders" (MacDonald & Shriberg, 2016, p. 361). There is an increasing number of sustainability programmes that aim at building capacity for sustainability and claim to educate such leaders, or "systemic problem solvers, change agents, and transition managers" (Wiek, Withycombe, Redman, & Mills, 2011, p. 4), in order to meet that demand.

According to literature there is a set of six key competencies that distinguish sustainability professionals, including researchers, from professionals and researchers in other fields (Barth, Godemann, Rieckmann, & Stoltenberg, 2007; Wiek, Bernstein, Foley, & Cohen, 2015; Wiek, Withycombe, & Redman, 2011). These key competencies include:

- Systems-Thinking Competence,
- Anticipatory Competence,
- Normative Competence,
- Strategic Competence,
- Interpersonal Competence, and
- Integrated Problem-Solving Competence.

Some studies have been undertaken on the acquisition of individual key competencies (e.g. Claesson & Svanström, 2015; Hiller Connell, Remington, & Armstrong, 2012) or the complete set of competencies (e.g. Remington-Doucette & Musgrove, 2015; Zemler, 2016), and empirical evidence is slowly building. However, there is lack of empirical evidence, first, that these skills are necessary and sufficient for sustainability problem solving, and second, that current sustainability programs and courses convey these skills (Remington-Doucette, Hiller Connell, Armstrong, & Musgrove, 2013; Wiek, Withycombe, Redman, et al., 2011). Regarding the latter, reliable assessment approaches for

the acquisition of key competencies in sustainability are still missing (Cebrián & Junyent, 2015; Remington-Doucette et al., 2013), possibly hampering professional development. There is also a lack of research on the role of learning outcomes and curricula in sustainability in post-secondary education (Vaughter, Wright, McKenzie, & Lidstone, 2013).

Despite providing a systematic description of intended learning outcomes there is a lack of understanding of how competencies for sustainability can be conveyed (Schneidewind, Singer-Brodowski, Augenstein, & Stelzer, 2016, p. 11f). Weinert (2001 as cited in Wiek & Lang, 2016) even claims that "key competencies can 'be learnt, but hardly be taught'" (as cited in Wiek & Lang, 2016, p. 329). Therefore, "[r]esearch that evaluates the development of sustainability competencies through formal and informal real-world learning opportunities is needed" (Anderson, 2015, p. 25f).

1.2 Research Aim(s) and Questions

This thesis aims to assess the importance of key competencies for achieving change towards sustainability and the acquisition of key competencies in sustainability programmes. It does so by assessing the acquisition of key competencies in sustainability by students of the Lund University Master's in Environmental Studies and Sustainability Science (LUMES) through one relevant course in the program: The Knowledge to Action (K2A) course. LUMES was launched in 1997 and has since developed into an international 2-year Master's programme within the Lund University Centre for Sustainability Studies (LUCSUS). The programme is focussed on sustainability, with the "intention of producing graduates with capacities to create change" (LUCSUS, 2016). They intend to do so by providing an "international, interdisciplinary setting" and "real world learning opportunities" (ibid). One of these real world learning opportunities is the K2A course. The course is a compulsory module during the whole second semester with a duration of a little more than six months, awarded with 5 ECTS. It gives the students the opportunity to form groups and engage with stakeholders from outside academia in a project of their own choice. Details of the K2A course regarding its aims, structure and processes will be further described under chapter 2.2 Knowledge to Action Course.

This thesis' aims are pursued through the following research questions:

1. What key competencies in sustainability do the LUMES students acquire through the K2A course, and to what extent? What are the influencing factors for their successful acquisition?
2. Which are the key components of the K2A course that enable competence acquisition?
3. Which of the key competencies did the students consider as most relevant for the success of their project?

The thesis intends to contribute to the theoretical development of sustainability education and an in increased real-life impact of sustainability education. It hopes to do so in several ways. Capturing the current state of assessment approaches and empirical evidence produced in studies on the acquisition of the key competencies in sustainability will allow me to draw conclusions regarding my choice of methods as well as enable me to reflect on their suitability and known limitations. As a result, this study will produce empirical evidence on how to reliably assess the key competencies in sustainability.

Through the assessment, I hope to be able to increase the impact of sustainability education by informing instructors on how to improve the conveyance of the key competencies through their course design and how to reliably assess them. I further hope that this will help in enhancing the societal impact through sustainability education, directly through the course module as well as through equipping future change agents with the competencies they need.

2 Approach

The study employs a mixed methods approach, using qualitative and quantitative methods and applying them to a single in-depth case study. As a case study is an explicative strategy, that is context sensitive and able to grasp the complexity of the real world and has special importance in "practice-oriented fields of research" (Johansson, 2003, p. 4). Thus, a case study approach is in line with some of the main features of sustainability science, being context sensitive (Gibbons, 1999; Wiek et al., 2012), action-oriented (Kates, 2011; Schneidewind et al., 2016; Wittmayer & Schäpke, 2014) and addressing problems that are complex in nature (Palma & Pedrozo, 2015; Wiek et al., 2012). Further, the mixed methods approach helps to enhance the completeness of the account given and to triangulate the findings (Bryman, 2011).

2.1 Analytical Framework: Key Competencies in Sustainability

In the wake of the recent rise of comprehensive higher education sustainability programmes, Wiek, Withycombe and Redman (2011) conducted a literature review of key competencies in sustainability and synthesized the existing literature. The result was a set of five key competencies, namely systems-thinking, anticipatory, normative, strategic and interpersonal competence. Only recently a sixth key competence called integrated problem-solving, which so far was only contained implicitly on a meta-level, has been added to the other five competencies (Wiek, Bernstein, Foley, Cohen, et al., 2015). The key competencies are considered as an important framework for the successful design and assessment of academic programmes and the development of a "recognizable profile" (Wiek, Withycombe, & Redman, 2011, p. 204) for the field of sustainability, helping to promote ''problem

solvers, change agents, and transition managers" (ibid). Key competencies distinguish themselves from regular competencies by "being critically important for *sustainability* efforts" (Wiek, Withycombe, & Redman, 2011, p. 204 italics in original) and particular to the field. The key competencies distinguishing such change agents are outlined below. The following definitions were taken from Wiek, Withycombe and Redman (2011).

Systems-Thinking Competence

> *"Systems-thinking competence is the ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks" (Wiek, Withycombe, & Redman, 2011, p. 207).*

Anticipatory Competence

> *"Anticipatory competence is the ability to collectively analyze, evaluate, and craft rich ''pictures'' of the future related to sustainability issues and sustainability problem-solving frameworks" (Wiek, Withycombe, & Redman, 2011, p. 207ff).*

Normative Competence

> *"Normative competence is the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets." (Wiek, Withycombe, & Redman, 2011, p. 209).*

Strategic Competence

> *"Strategic competence is the ability to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability." (Wiek, Withycombe, & Redman, 2011, p. 210).*

Interpersonal Competence

> *"Interpersonal competence is the ability to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving." (Wiek, Withycombe, & Redman, 2011, p. 211).*

Figure 1 shows how the key competencies in connection with a "sustainability research and problem-solving framework" (Wiek, Withycombe, & Redman, 2011, p. 206). Systems-Thinking Competence is relevant in the initial phase of identifying and analysing the problem. Anticipatory Competence is important to draw pictures of future scenarios and develop visions. In order to develop visions, normative competence is necessary to define what's desirable, after having defined the undesirable present state. Strategic Competence serves relates to the development of sustainability transition strategies that help moving from a current undesirable state into a desirable future state. Interpersonal competence is required throughout the whole process.

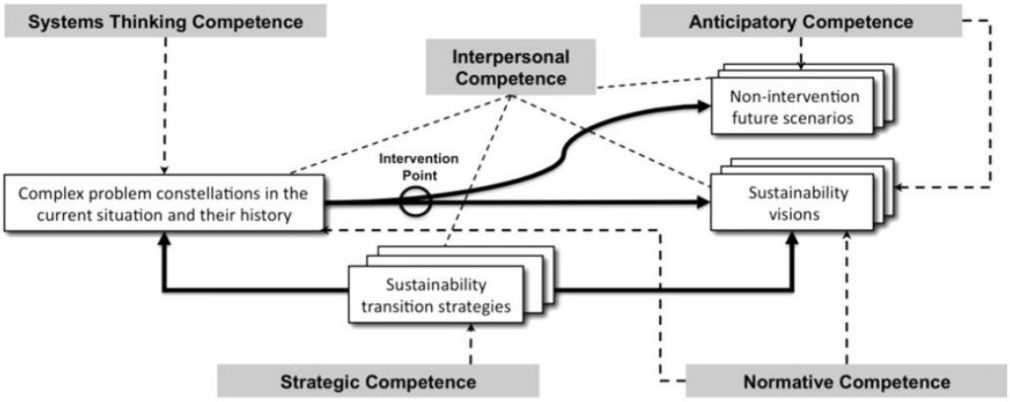

Figure 1: Key Competencies in Sustainability combined with an integrated sustainability research and problem-solving framework, Wiek, Withycombe and Redman (2011)

Integrated Problem-Solving Competence

In another article by Wiek et al. (2015) attempting to operationalise the five key competencies previously identified, the authors further identify integrated problem-solving as a critical sixth competence implicit in another article by Wiek, Withycombe, Redman et al. (2011) on the five initial key competencies. They describe it as "the meta-competence of meaningfully using and integrating the five key competencies for solving sustainability problems and fostering sustainable development" (Wiek, Bernstein, Foley, Cohen, et al., 2015, p. 243). This sixth key competence will not be further analysed, due to several reasons outlined under the Limitations section.

2.2 Knowledge to Action Course

2.2.1 Justification

As already mentioned in the introduction, the K2A course is a transdisciplinary real world learning opportunity that seeks to contribute to the programme's objective to "produc[e] graduates with capacities to create change" (LUCSUS, 2016). According to Palma and Pedrozo (2015) inter- and transdisciplinarity are "key elements that can help educational institutions, coordinators and professors to integrate sustainability in education and to promote transformative learning" (p. 659). They consider "interactive, experiential and participatory learning" (ibid, p. 660) as a way to promote such transformative learning. As the key competencies are based on literature inspired by transformative learning approaches (Wiek, Withycombe, & Redman, 2011), it makes sense to choose a teaching module rooted in transdisciplinarity. Therefore, the Knowledge to Action (K2A) course of the LUMES programme can be considered a suitable case for this study.

I chose this particular case based on an information-oriented selection, with the purpose "[t]o maximize the utility of information from small samples and single cases […] on the basis of expectations about [its] information content" (Flyvbjerg, 2006, p. 230). As a network member, I expect to have what Nahapiet and Ghoshal (1998) call "privileged access to information and to opportunities" (p. 243), giving me easier access to interview partners, as well as documents in order to gain deeper insights. Further, as reflexivity is needed for science that aims to be transformational it seemed logical for me to choose the LUMES K2A course, as I am a LUMES student myself that already experienced the course structure and process of the K2A course.

2.2.2 Aims, Structure and Processes

The course syllabus states three learning outcomes for the K2A course. It states that "[o]n completion of the course, the student shall demonstrate the ability

- to critically reflect on theoretical and methodological approaches of transdisciplinarity as ways of bridging the knowledge-action gap;
- to carry out and evaluate projects related to persistent sustainability challenges through real-world learning opportunities, and
- interact and communicate with different stakeholder groups" (LUCSUS, 2013, p. 1)

The course continuously runs over a period of approximately six months and always in parallel to other courses, starting with Social Theory, followed by Sustainability Science, Governance of Sustainability, Urban and Rural Systems and Sustainability and Economy and Sustainability, as seen in

Table 1 below. According to the project guidelines provided to the students, the project consists of three phases, namely:

- Scoping and Design (Project Proposal)
- Implementation
- Evaluation (Project Report) (Boda & Elmqvist, 2014, p. 1)

A closer look at the syllabus reveals the following set of formal learning activities that are designed to contribute to the achievement of the above stated learning outcomes. The course starts with an introduction, where past projects are presented and the students form their project groups. They further have to write several project proposals, that are regularly updated after receiving feedback from their peers, as well as the teachers on two occasions. These activities are further complemented by literature seminars that aim to help students in "Theorizing academy's role in social change" and on how to "'[Do]' knowledge to action" (see Annex E). The course is finished by the writing of the final report on the project and a project fair, where the students present their projects to staff members of LUCSUS and their fellow LUMES students.

Table 1: Timeline of the K2A course, combining activities, learning outcomes, project phases and parallel course modules. Adapted from K2A Student Guide *(Boda & Elmqvist, 2014)*, Course Syllabus (LUCSUS, 2013) and Study Schedule (Annex E), own illustration.

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
K2A: Teaching activities	Course Intro: Past projects/forming groups	Turn in finalized groups and project concept for approval	1.First project proposal draft 2. Teacher Feedback 3. Peer Feedback	1. Literature Seminar 1 2. Revised Report 3. Teacher Feedback		1. Literature Seminar 2	1. Revised Report 2. Peer Feedback 2	1. Final Report 2. Project Fair
Relevance for Learning Outcomes								
Learning Outcome 1								
Learning Outcome 2								
Learning Outcome 3								
Project Phases								
K2A: Scoping and Design								
K2A: Implementation								
K2A: Evaluation								
Parallel programme courses								
Social Theory								
Sustainability Science								
Governance								
Urban Rural								
Economy								

2.3 Methods

2.3.1 Overview

As a first step I conducted a qualitative review of literature of current assessment approaches and empirical evidence produced in studies on the acquisition of the key competencies in sustainability, in order to identify existing approaches and inform my own research design. Following this review, I conducted semi-structured interviews with the course instructors to gain deeper insights. I further analysed official documents to complement these insights. In order to assess the conveyance of key competencies, I first conducted focus group interviews, which then, together with the previously obtained information, fed into the survey design. Throughout the process I will use my personal experience as a former student of the K2A course to critically reflect on the information and results obtained. **Table 2** provides an overview of the methods chosen and how they intend to contribute to answering the research questions.

Table 2: Overview of research methods, their question(s)/content and their connection to the research questions. Symbols: X = direct connection; (X) = indirect connection; - = no connection in answering the research questions (RQs).

Method	**Question(s)/Content**	**Answering RQs**		
		RQ1	RQ2	RQ3
Document Analysis	➢ **Syllabus:** Learning Outcomes ➢ **Student Guidelines:** Representation of Key Competencies in project phases ➢ **Course Evaluation:** Helpfulness of in-class activities, problems faced during course	(X)	(X)	-
Interview	How do the courses aims, structure and processes relate to the key competencies? ➢ Are they complementary or ➢ Are they mutually exclusive or ➢ Not a focus/not covered? If yes, which ones and why?	X	X	-
Focus-Group Interview	➢ What were the activities that you conducted during the K2A project? ➢ What were the barriers that you faced?	-	(X)	-
Survey	How successful was your project in terms of societal impact? Please describe a situation that was crucial for the success/lack of success of your project.	-	-	X
	In which phases of the project did the events/situations take place?	-	X	-
	How important do you think the key competencies were/would have been for a successful outcome in this situation?	-	-	X
	How involved were you in the following activities? How difficult you think they were?	X	X	-
	How helpful was each of the activities in developing your key competencies?	X	X	-
	How do the [teaching] activities contribute to the learning outcomes?	X	X	-

2.3.2 Qualitative Literature Review

The qualitative literature review revealed a variety of assessment approaches and pedagogies, ranging from post-, to pre- and post, to multi-stage assessments. These also ranged from more teacher centred (e.g. examination of writing samples, observations) to more student centred assessment approaches (e.g. self-, or peer-assessment). Some of the approaches have the dual function of assessment and pedagogy (e.g. reflective journaling). Given the circumstances of the research, an ex-post self-assessment survey with closed Likert-scale as well as free text questions was chosen as the main method for addressing the research questions.

As already mentioned the qualitative literature review mainly served the purpose of identifying existing assessment approaches that then informed my own research design. Even though the Literature was of a qualitative nature, some quantitative data has been included as well. Google Scholar citations of 'Key competencies in sustainability: a reference framework for academic program development' by Wiek, Withycombe and Redman (2011) served as starting point for the review. The search yielded 404[1] documents out of which 385 were left after removing duplicates. From this list approximately 337 could be obtained/accessed. To further reduce the number of papers to be examined, I used Mendeley's search function to filter those articles that at least mention several or all five key competencies, which reduced the number of papers to 75. I tried to further narrow down the number of papers by focusing on papers that dealt with the key competencies in an empirical manner. Out of these papers, those that and were situated in the context of (transdisciplinary) learning in the field of (higher) education, were considered particularly relevant and analysed more in depth. There is a variety of approaches that were used in assessing either the acquisition of key competencies (e.g., Zemler, 2016), or the importance and role of key competencies in the job market (e.g. Anderson, 2015; Sarpin, 2015).

Out of these approaches, the most traditional assessment approach found in relation to the key competencies is summative assessment through document analysis of individual assignments, such as final papers, or theses (e.g. Albiz, 2015). This assessment approach is very teacher-centred. Remington-Doucette et al. (2013) also used a more teacher-centred approach, assessing student's acquisition of key competencies (systems-thinking, normative and strategic competencies) through classroom case analyses, using structured rubric/answer keys.

Albert, von Haaren, Vargas-Moreno and Steinitz (2015) use interviews as part of their "multi-stage

[1] Search has been conducted on the 20th July 2016

and in-process evaluation research" (p. 6874), assuming that statements in interviews reflect the learning of students. This approach is again, rather teacher-centred.

One of the most popular approaches to assessing the acquisition of key competencies are surveys. The papers reviewed used different forms of surveys, ranging from ex-post (e.g. Heiskanen, Thidell, & Rodhe, 2016; Hesselbarth & Schaltegger, 2014), to a mix of pre- and post (e.g. Savage, Tapics, Evarts, Wilson, & Tirone, 2015; Vega-Marcote, Varela-Losada, & Álvarez-Suárez, 2015), or a "multi-stage and in-process evaluation research" as used by Albert et al. (2015, p. 6874), which according to the authors can't be found in literature so far. While some surveys focus on a more quantitative approach, using closed, Likert-scale type questions and answers (e.g. Hesselbarth & Schaltegger, 2014; Meyer et al., 2016), others focus on the qualitative aspect by using open ended questions and coding of survey responses as an assessment approach (e.g. Trippel, 2013), while some studies combine qualitative and quantitative elements (e.g. Albert et al., 2015; Savage et al., 2015). Most of the surveys were rather student centred and designed as a form of self-assessment, and only few using the survey format in a teacher centred manner.

Another strand of assessment methods, which has a strong formative component and which in my opinion fulfils the dual function of assessment and pedagogy are continuous reflective approaches. These include amongst others researcher's journals (Bernat, 2014), learning logs (Gosselin, Cooper, Bonnstetter, & Bonnstetter, 2013), reflective journaling (Gardiner & Rieckmann, 2015), multi-stage reflection papers (Clevenger & Ozbek, 2013), a reflective report (Gordon & Thomas, 2016), or autoethnographic reflection (Meyer et al., 2016).

Other approaches that aim for more in-depth insights into the context of students' learning are in-vivo examinations and participant observation (Albert et al., 2015; Wiek & Kay, 2015), observing behaviours and real-life interactions of students. The most student centred approach found in the literature review are peer-assessments (e.g. Iwaniec, Childers, VanLehn, & Wiek, 2014; Wiek & Kay, 2015). However, it is my understanding that so far the results of these examples of peer-assessment activities have not been used as a source for research purposes.

Based on these findings, and given the temporal limitations (outlined under chapter 5. Limitations), I chose an ex-post self-assessment approach, as a means to include an assessment of the contribution of the key competencies to the societal impact of the student projects.

2.3.3 Document Analysis

Two types of documents have been analysed in relation to the key competencies, the official course documents and students' evaluation of the course. The official documents comprise the course syllabus, student guidelines and the study schedule. The syllabus contains information about the learning outcomes, course content and a reading list. The student guidelines contain instructions, information about the structure of the project, some tips regarding project implementation and a suggested framework for the writing of the proposals and reports, including some guiding questions.

The students' course evaluation is an official feedback survey sent out to the students at the end of the course. It contains open ended as well as Likert-type scale questions, asking about the positive and negative aspects of the K2A course. These two documents served the interpretation of the results and the corroboration of the interviews and helped to inform parts of the survey.

Additionally, I will try to identify factors enabling acquisition of the key competencies. This can be done either through additional survey questions, or the analysis of the feedback forms handed in by the students at the end of the course.

2.3.4 Interview with course instructors

In an attempt to create an integrated competence framework for sustainable entrepreneurship in higher education, Lans, Blok and Wesselink (2014) tried to map the overlap of two competence frameworks from two different, but related fields of sustainability. They did this through in-depth focus group discussions with teachers from the respective fields. I intended to do something similar in order to map the overlap between the K2A course content, structure and pedagogy and the key competencies. As my thesis is focusing on a single module and not a field as a whole, I decided to conduct a semi-structured interview with the two K2A course instructors.

The interview served two major purposes. The first one was to gather information about the content and structure of the course and how they relate to the key competencies and to gain a better and in-depth understanding of the course in line with the contextual nature of the case study approach. This served to triangulate findings from the other sources and helped to inform the discussion of the results and their possible implications. The second purpose was to involve the instructors, ensuring their standpoints and possibly conflicting goals are accounted for, increasing the credibility, relevance and legitimacy of the research outcomes. A further benefit was to provide them with a platform for reflection.

The interview followed a seven step process and was structured in the following way. In step one I quickly introduced the rationale of my thesis and the research aims in general. The second step explaining the aims of the interview to give them a general idea of the nature of the interview as an explorative rather than an assessment endeavour. This was pointed out to reduce the risk of a social desirability bias and to enable an open dialogue. In the third step I described the interview process for them, outlining the remaining four steps. Step four focussed on questions regarding course structure, content and learning outcomes and the instructors' understanding of their course and the underlying concepts. Step five asked them about the past and intended future changes. Step six was looking into the relation of aforementioned things with the key competencies. Lans et al (2014) tried to answer similar questions with the help of focus groups revolving around the focal questions "'do you recognise these competencies in your specific programme and/or course you teach?'" and "'where do these sets of competencies overlap?" (p. 41). As a last step I intended to synthesize the results into a summary of the main points, due to time constraints, this was not possible anymore and instead the instructors offered to draw the connections between their approach and the key competencies, based on a template I developed as part of my interview guide (see Annex A). The results can be seen in Annex B. This was corroborated by the document analysis.

2.3.5 Focus-Group Interviews

The Focus-Group Interviews served as a form of pre-study to gain a better understanding of the students' experience and to define a set of core activities that served as input for the survey for further analysis.

2.3.5.1 Justification and aims of the method

Focus group interviews are compatible with the chosen case study approach. It is also a suitable method for gathering in-depth qualitative data about a given case (Stewart, Shamdasani, & Rook, 2016). It further has been used as well in the context of key competencies and sustainability. For example, Gardiner and Rieckmann (2015) in a study on the *Use of Reflective Journals in the Operationalisation and Development of Anticipatory Competence* used focus groups as a means to triangulate findings from an inductive coding exercise of reflective journals. Wesselink et al. (2015) in their study on individual competencies of CSR managers fostering sustainable change in business, tried to identify a set of "practical core tasks of CSR implementation" (p. 500), assessing the relationship between core tasks and competencies. They did this through reusing interview data from previous research instead of focus group interviews. The identification of core tasks is helpful "to operationalise competencies in a more concrete way" (Wesselink et al., 2015, p. 498), something that is considered necessary for the development of curricula and course design (Wiek, Bernstein,

Foley, Cohen, et al., 2015). Based on this information, I decided to use the focus group method as a way to identify the core activities conducted by the LUMES students throughout their K2A project work and the barriers they faced. I focussed on only two aspects to avoid having too many questions which would only yield superficial results (Stewart et al., 2016).

The focus group interviews and its outcomes served as an entry point for gaining better understanding of the activities conducted in this particular context as well as a direct input for the survey. The activities identified through the process were complemented with the teaching activities identified through the course syllabus under chapter 2.2.2 Aims, Structure and Processes.

2.3.5.2 Design

The focus groups design followed the moderating process as outlined by Lewis-Beck, Bryman and Liao (2004). First, a short introduction was given where I presented my research very briefly, followed by a description of the process of the focus group interviews and closed by a statement of confidentiality, in order to assure the students that their responses will only be used for academic purposes and that all information will be anonymized to protect their identity.

I took the role of a moderator and note taker at the same time, trying to answer any eventual question that might come up during the process, while intervening as little as possible into the discussion, to reduce the potential bias in terms of my own experience.

After the introduction, the actual interviews took place, consisting of two elements. The first element was a short period of time, where the students were asked to write down the activities they conducted and barriers they faced throughout their projects, giving them time to reflect on the process, before they were shared and discussed. The second element consisted of the students sharing what they had written down on a white board and everyone else was allowed to add and/or comment on what has been said. This also allowed them to write things down they did not feel comfortable to share with the group, such as conflicts in their project group. This benefit was explicitly pointed out to the participants. This was also a way to create trust and to remove communication barriers, as a process to begin focus groups (Lewis-Beck et al., 2004).

I conducted two focus group interviews on the seventh of September 2016. Focus group one, consisted of seven students from four different project groups that participated in the focus group. The first focus group was structured in two parts, the first part focussing on the activities conducted by the students as part of their K2A projects and the second part focussing on the barriers they faced throughout the projects. The session lasted a total of one hour and four minutes. Focus Group two consisted of eight students from seven different project groups. For an overview, see **Table 3**.

The process for focus group two was structured slightly different, combining the two parts about activities and barriers into a single one, lasting one hour and five minutes. I did this after realizing in the first session that it is more intuitive to name barriers directly in relation to activities. Only two K2A project groups were not present during any of the focus group interviews.

Table 3: Basic information on the two focus groups, including no. of participants, gender, number of different projects represented, date and time and duration of the focus group.

	Focus Group 1	Focus Group 2	Total
No. of participants	7	8	15
No. of female/male participants	4/3	5/3	9/6
No. of projects represented	4/12	7/12	10/12
Date/Time	07.09.2016, 12:15-13:19	07.09.2016, 16:15-17:20	
Duration [h]	1:04	1:05	2:09

Compiling the activities mentioned by the participants, the following themes emerged as a result of a qualitative inductive coding process with several iterative steps, resulting in eleven distinct activities, namely Project Administration, Content Development, Desk Research, Impact Evaluation, Experimentation, Field Research, Networking, Presentation(s), Problem Definition, Teaching/Instructing and Team-building.

I used Microsoft Excel to list each of the activities in a separate row of the first column. In the second column, I then wrote the code in the cell next to each activity. After that I copied the categories from the second column to a separate sheet and removed all the duplicates. The shortened coding list was then tested with the original list of activities and checked, if they still fit. After adapting them I consolidated them once more and tested them against the original list of activities. **Table 4** shows a summary of the previously identified in-class activities and the aforementioned real-life activities.

Table 4: List of compiled real-life activities from inductive coding of focus group statements (for further details see Annex D) and in-class activities of the K2A projects, compiled from the K2A study schedule (see Annex E)

Real-Life Activities	**In-Class Activities**
Project Administration	Course Intro: Past projects/forming groups
Content Development	Writing Project Proposal(s)
Desk Research	Teacher Feedback
Impact Evaluation	Peer Feedback
Experimentation	Literature Seminar(s)
Field Research	Writing Final Report
Networking	Project Fair
Presentation(s)	
Problem Definition	
Teaching/Instructing	
Team-building	

2.3.6 Student Survey

2.3.6.1 Justification and aims of the method

As identified in the qualitative literature review, one of the most popular approaches to assessing the acquisition of key competencies are surveys.

A self-assessment survey was chosen for several reasons. First, the key competencies in sustainability are a concept that is still under development with only recent attempts to further operationalize them (i.e. Wiek, Bernstein, Foley, & Cohen, 2015). The lack of operationalization makes it hard to define measurable indicators that could be assessed. Second, due to the large variety of different student projects it would have been difficult to develop another assessment approach that could be applied across all these projects and that would allow for comparison of results.

2.3.6.2 Design

The survey has been designed to include qualitative as well as quantitative elements. I used a basic plan of Surveygizmo (https://app.surveygizmo.com) to create the survey online. The survey has been structured into four different sections that aim to help in answering the research questions. The survey was supposed to take around 40-45 minutes, according to an estimate by the software. The survey consisted of a mix of mostly multiple choice as well as open ended questions. Whenever a question required the students to draw connections to any of the key competencies, the definitions were provided as a reminder and aid to ensure proper understanding of the key competencies. They were further provided with a statement of confidentiality in the invitation via email and/or Facebook to participate in the survey as well as in the introduction part of the survey. It guaranteed them

privacy and ensured that their answer will solely be used for the purpose of my scientific work (incl. my Master's thesis and eventual scientific publications) and as input for the improvement of the K2A course. It further ensured them that in all cases, data will be used in anonymous form and that whenever individual quotes are used, they will be anonymized and it will be ensured that they don't contain any personal details that could reveal the students' identity.

In the first part students were asked to provide some general information, regarding their age, gender, country of origin, previous occupation, year of study and K2A project group membership. The second part asked the students about their project's societal impact, the key situations of the project and the importance of the key competencies. The third part asked them about their involvement in different activities of the K2A course and project work. The last part asked them about their opinion, how the activities they were involved in contributed to their acquisition of key competencies. For more details on the content of each section and their relationship to the research questions, see **Table 2** above.

2.3.6.3 Sample

The survey has been sent out to a total of 85 students, out of which 40 belong to Batch 18 (B18) and 45 to Batch 19 (B19) of the LUMES programme. The survey has been open from the 13th to the 24th of September for a total of twelve days. Over the course of twelve days I sent out several reminders via the LUMES student coordinator as well as the Facebook groups of Batch 18 and 19. Due to the low response rate of sample group B18 (6 respondents), their results were excluded from further analysis and the following data is based on the responses from B19. For sample group B19 the response rate was 67%. Out of a total of 30 responses, eight (27%) were referred via Facebook and 22 (73%) via email. Overall I consider the sample (n=30) as representative of the whole population of LUMES B19 students (N=45). The sample consisted of 17 (57%) female and 12 (40%) male participants and 1 (3%) participant that didn't identify with or didn't want to specify their gender. This distribution is very close to the original distribution of the whole group of LUMES B19 students, with 53% (n=24) females and 47% (n=21) males, with an average age of 24.9 years. Further the distribution regarding participants' country of origin is also fairly accurate, with some nationalities not being represented, partially due to their small number.

Table 5: Sample data for survey, including no. of persons and their response rate, gender distribution and deviation of the sample from the total population of LUMES B19 students.

	Population LUMES B19	Sample	Response Rate/Deviation
Number of persons	N=45	n=30	67%
Female	n=24 (53%)	n=17 (57%)	+4%
Male	n=21 (47%)	n=12 (40%)	-7%

3 Results

The overall structure of the results section follows the design of the research questions. The first section will present the results answering questions regarding the students' competence acquisition and the factors influencing it. This will be followed by the results regarding the key components of the K2A course and how they contribute to the development of the key competencies. This section will start by outlining the course aims, structure and processes and the expectations of the course instructors and their understanding of how they relate to the key competencies, complemented by official course documents. The second part of this section will present the survey results answering the question, which activities actually contribute to the development of the key competencies. In the third section I will present the results regarding the relevance of the key competencies for the success of the projects. The results section will be closed with a summary, combining information regarding course aims, structure and processes with the results from the survey.

The results of chapters 3.1 and 3.2 are based on activities that individual participants were involved in. Therefore, activities that were rated with *Not involved at all* were not included in the calculations of the following values, yielding a data set of n=524 activities.

3.1 RQ1: Competence Acquisition and Influencing Factors

3.1.1 Which key competencies are acquired and to what extent?

Overall it can be said that the K2A course has been helpful for student's acquisition of key competencies, with interpersonal competence being the most prominent. The acquisition of key competencies is also influenced by students' degree of involvement and the difficulty of the activities. Unsurprisingly, increasing involvement in the activities leads to an increase in learning. Overall, an increase in the perceived difficulty of the task had a positive effect on competence acquisition, except for interpersonal competence, which showed a decline in competence acquisition with increasing difficulty.

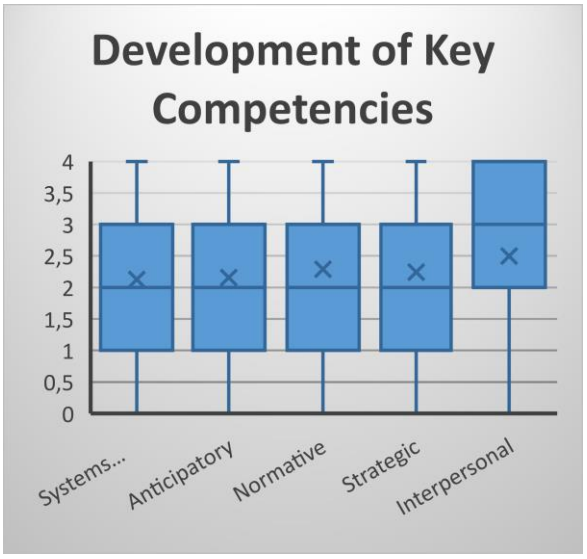

Figure 2: Development of key competencies across all activities (n=524) on a scale of 0 = Not at all to 4 = Extremely, shown in mean, median, 25th and 75th percentile.

The average contribution to the development of the key competencies is highest for interpersonal competence with an average of 2.50, followed by

normative competence with 2.28, strategic competence with 2.24, anticipatory competence with 2.16 and systems-thinking competence with an average of 2.12. An overview, further showing the median, 25th and 75th percentile can be seen in Figure 2.

3.1.2 What is the influence of students' involvement in activities and their perceived difficulty on the development of the key competencies?

The average percentage of students involved in each of the activities is surprisingly high with 97%, meaning that all the students were involved in almost all activities. The average degree of involvement across all activities has been 3.27 out of a maximum of four.

The degree of involvement in activities also shows a clear trend, as illustrated in Figure 3. Of all the activities that were rated as *Slightly involved*, 9% were rated as *Extremely helpful* and 18% as *Moderately helpful* in developing the key competencies. Of all the activities that were rated as *Extremely involved*, 25% were rated as *Extremely helpful* and 24% as *Moderately helpful* in developing the key competencies. This shows a positive correlation between the degree of involvement and the successful development of the key competencies.

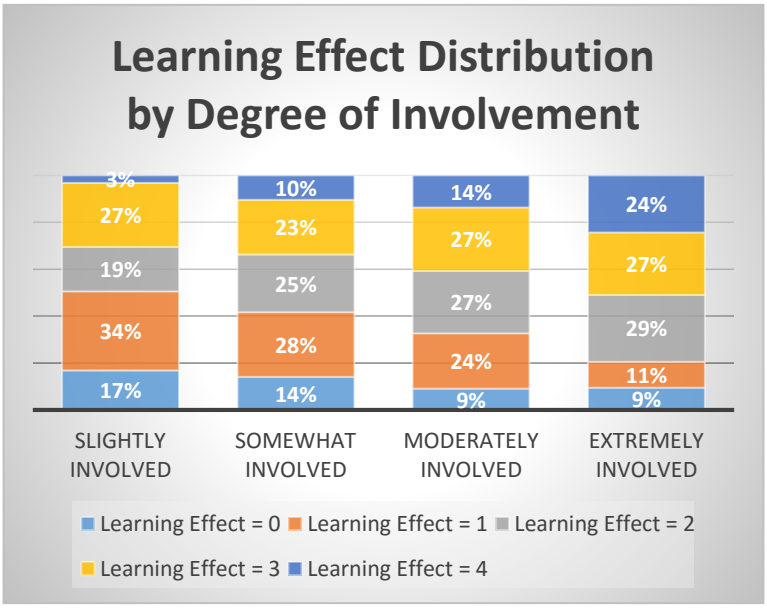

Figure 3: Learning effect distribution in % by degree of involvement on a scale of 0 = Not at all involved to 4 = Extremely involved

Another factor that influences the development of the key competencies is the perceived difficulty of the activities. As can be seen in Figure 4, there is a clear linear relationship between the level of difficulty and the development of key competencies. For systems-thinking, anticipatory, normative and strategic competence this relationship is positive, meaning the more difficult the activity the higher the learning outcome. For interpersonal competence this relationship is negative, meaning the more difficult the activity, the lower the learning outcome.

3.2 RQ2: Key Components Enabling Competence Acquisition

This chapter will answer the research question, which are the key components of the K2A course that enable competence acquisition? It does so by first answering the question which key competencies do the instructors expect to be conveyed and where and how in the course are they represented? The second part of this chapter will then present the evidence on the helpfulness of the in-class and real-life activities for the development of the key competencies.

3.2.1 Expected Contributions of Activities

This section presents to what extent the key competencies are represented in the learning outcomes from the course syllabus as well as in the student guidelines for the K2A course. The results of this section are grouped by key competencies and are structured as follows. First comes a short overview how many of the in-class activities are connecting each of the key competencies with learning outcomes. This is based on the matrix designed for the interview with the course instructors that has been filled out by one of the course instructors and is attached in Annex B. The matrix, outlining the connections of activities, learning outcomes and key competencies, indicates how well the key competencies are represented in each of the activities as well as the learning outcomes. A summary of the matrix across activities is provided in **Table 6**. This is followed by exemplary quotes from the student guidelines that have been coded according to each key competence it reflects.

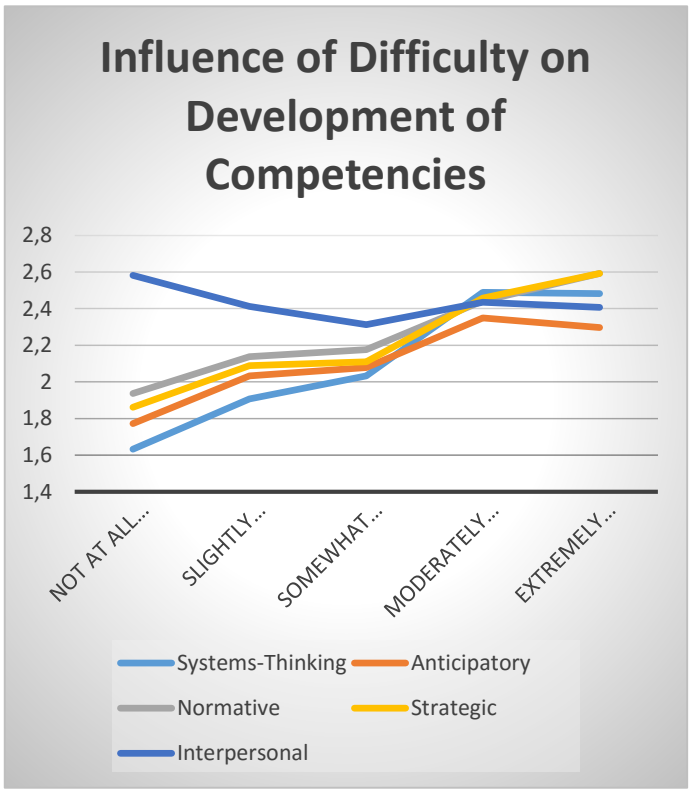

Figure 4: Influence of the difficulty of the task on its helpfulness for the development of the key competencies on a scale of 0 = Not at all helpful to 4 = Extremely helpful.

Table 6: Number of in-class activities connecting competencies and learning outcomes

Learning Outcome(s)	Systems-Thinking	Anticipatory	Normative	Strategic	Interpersonal
LO1	6/7	5/7	1/7	5/7	1/7
LO2	4/7	1/7	0/7	4/7	5/7
LO3	0/7	0/7	5/7	0/7	5/7

Systems-thinking competence is mostly represented in learning outcomes one and two, being represented by 6/7 (read: six out of seven), respectively 4/7 of the teaching activities being related to them. Systems-Thinking competence doesn't relate to learning outcome three. In the course guide Systems-Thinking is also present throughout the K2A student guidelines in the form of guiding questions, or tips such as:

- "Does the problem feature tensions between social, economic, environmental domains as well as inter-linkages across global, national, local levels?" (Boda & Elmqvist, 2014, p. 1)
- "Develop a sophisticated understanding of the problem, including various framings and dominant explanations" (ibid, p. 2).

Anticipatory competence is less present in the learning outcomes, but shows a similar pattern to systems-thinking competence, with a majority of 5/7 of the teaching activities being related to learning outcome one, and 1/7 to learning outcome two, while there is no relation to learning outcome three. Anticipatory Competence is not as prominent in the student guidelines as Systems-Thinking Competence, but there are still guiding questions and statements that relate to it:

- "Does the problem impact future generations?" (ibid, p. 1)
- Or that for evaluation purposes it can be "helpful to articulate possible pathways forward, even if they extend beyond the length of the K2A course itself" (ibid, p. 2).

Normative competence is mostly represented in learning outcome three, with 5/7 of the teaching activities being related to this category. Only 1/7, respectively 0/7 of the teaching activities relevant for normative competence relate to learning outcomes one and two. In the student guidelines it can mostly be found in the suggested framework for the report under the sections *3. Purpose and goals* and *6. Monitoring and evaluation framework*.

Otherwise it is rather implicit in the rest of report in questions such as:

- "Is the problem pressing because it is quickly getting worse, even irreversible?" (ibid, p. 1),
- "Does the problem result in harm that threatens socio-ecological viability and integrity?" (ibid, p. 2), both focussing on Systems-Thinking Competence, but also implicitly requiring the student to make a judgement about a desirable or undesirable state of a system.

Strategic competence is mostly represented in learning outcomes one and two, being represented by 5/7, respectively 4/7 of the teaching activities being related to them. Strategic competence doesn't relate to learning outcome three. Strategic Competence is present in most of the report and often quite explicit and in on case actually relating to one of the parallel courses:

- "Theorize possible (multiple) strategies for addressing your identified problem (remember Social Theory!)" (ibid, p. 2), or instructions regarding the time plan
- "Explain how far you are in the project process and what you have done so far. Explain if and how your project will continue after the completion of the course" (ibid, p. 3).

Out of the teaching activities 5/7 are expected to contribute to both learning outcomes two and three by conveying interpersonal competence. Only 1/7 are expected to do so for learning outcome one. Statements relating to interpersonal competence are also present in several places of the student guide, with tips such as:

- "Are there other projects wanting similar things as you? How can you contribute/collaborate and what can you add?" (ibid, p. 2), encouraging students to interact with other stakeholders, or reflection on the group work process
- "Explain how the work is divided between the members of the team. Are you too few or too many in the group? How will you ensure a constructive working atmosphere within the group?" (ibid, p. 3).

When looking at the matrix in Annex B, one can also see that almost all in-class activities cover each of the five key competencies investigated when looking at their contribution across the learning outcomes. There are only two activities that are not expected to be of particular relevance to the development of all key competencies. These include the course introduction, which is not relevant for normative competence and the project fair, which is not tailored to any of the key competencies. So overall it can be said that all the key competencies are connected to the learning outcomes.

3.2.2 Activity Contribution to Development of Key Competencies

This chapter will present the evidence on the helpfulness of the in-class and real-life activities for the development of the key competencies and will answer the following questions:

- Which activities contribute the most to the development of the key competencies and how much?
- Is there a difference between the effectiveness of in-class teaching activities and real-life experiences/activities?

3.2.2.1 Contribution of In-Class activities

Continuing with the focus on the teaching activities from the previous chapter, I start by looking at the helpfulness of in-class activities in developing each of the key competencies. Figure 5 provides an overview of all the in-class activities and how helpful they were for the development of the students' key competencies. It shows the activities mean, median, as well as the 25th and 75th percentile, the local minimum and maximum and the outliers. The activities are sorted by their average helpfulness across key competencies in a descending order.

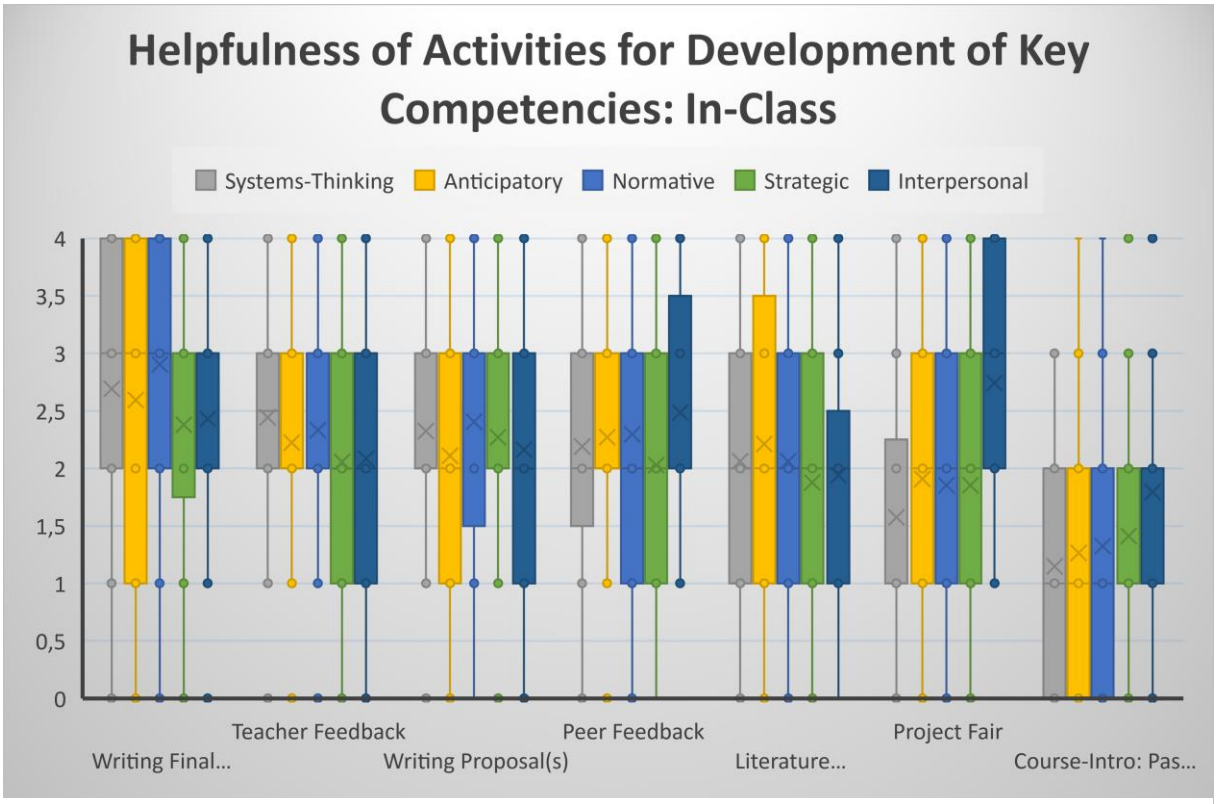

Figure 5: Helpfulness of In-Class Activities for the Development of the Key Competencies on a scale of 0 = Not at all helpful to 4 = Extremely helpful; shown as mean, median, 25th and 75th percentile.

The most helpful activity of the in-class activities is writing the final report with an average of 2.69, followed by Teacher Feedback (2.44), Writing Proposal(s) (2.32), Peer Feedback (2.19), Literature seminar(s) (2.06), the Project Fair (1.57) and the Course Introduction (1.15). Additional information is

provided through the formal course evaluation handed out to the students at the end of the course. It provided two questions that in their nature are close enough to the survey's formulation and thus allow for a comparison between them. For the course evaluation students were asked the following two questions:

- Are you satisfied with the feedback you got from the teachers during the process of the project work? (1 = not at all satisfied; 5 = very satisfied)
- To what extent did the literature seminar on the course literature contribute to your learning? (1=very little; 5=to a great extent)

These questions can be compared to the survey question "How helpful did you feel was each of the activities in developing your [insert key competence]?", building the average across all key competencies.

There is a rather large difference in the assessment of the value of the teacher feedback sessions. In the course evaluation it scored an average of 3.20[2], while the survey question regarding teacher feedback only scored an average of 2.31. The literature seminars scored an average of 2.10 in both the course evaluation[3] as well as in the survey.

Looking at each of the key competencies, Systems-Thinking Competence is mostly conveyed through Writing the Final Report (2.69), Teacher Feedback (2.44) and Writing the Proposal (2.32). Anticipatory Competence is also conveyed best through Writing the Final Report (2.60), Peer Feedback (2.27) and Teacher Feedback (2.22), closely followed by the Literature Seminar(s) (2.21). Normative Competence is conveyed best through Writing the Final Report (2.90), Writing Proposal(s) (2.41) and Teacher Feedback (2.33). Strategic Competence is not conveyed as much compared to the other competencies, being conveyed best through Writing the Final Report (2.38). Interpersonal Competence is conveyed best through the Project Fair (2.74) and Peer Feedback (2.49).

3.2.2.2 Contribution of real-life activities

The most helpful activity of the real-life activities was Problem Definition, followed by Content Development, Desk Research, Impact Evaluation, Field Research, Networking, Presentation(s), Experimentation, Teaching/Instructing, Project Administration and Team-building, as can be seen in Figure 6.

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[2] Based on N=19 respondents. Original value of 4.2 adjusted from a 1-5 to a 0-4 Likert-type scale. Also note the difference in wording compared to the survey (1= not at all satisfied; 5= very satisfied vs. 0=Not at all helpful; 4= Extremely helpful)

[3] Based on N=16 respondents. Original value of 3.1 adjusted from a 1-5 to a 0-4 Likert-type scale. Also note the difference in wording compared to the survey (1= very little; 5= to a great extent vs. 0=Not at all helpful; 4= Extremely helpful)

Looking at each of the key competencies a few trends become visible. Systems-Thinking Competence is conveyed best through participation in the Problem Definition Phase and through Content Development, followed by Desk Research, Impact Evaluation and Field Research, while all the other activities are below an average score of two. A similar picture can be seen for Anticipatory Competence, with the exception of Experimentation also scoring above an average of two. The

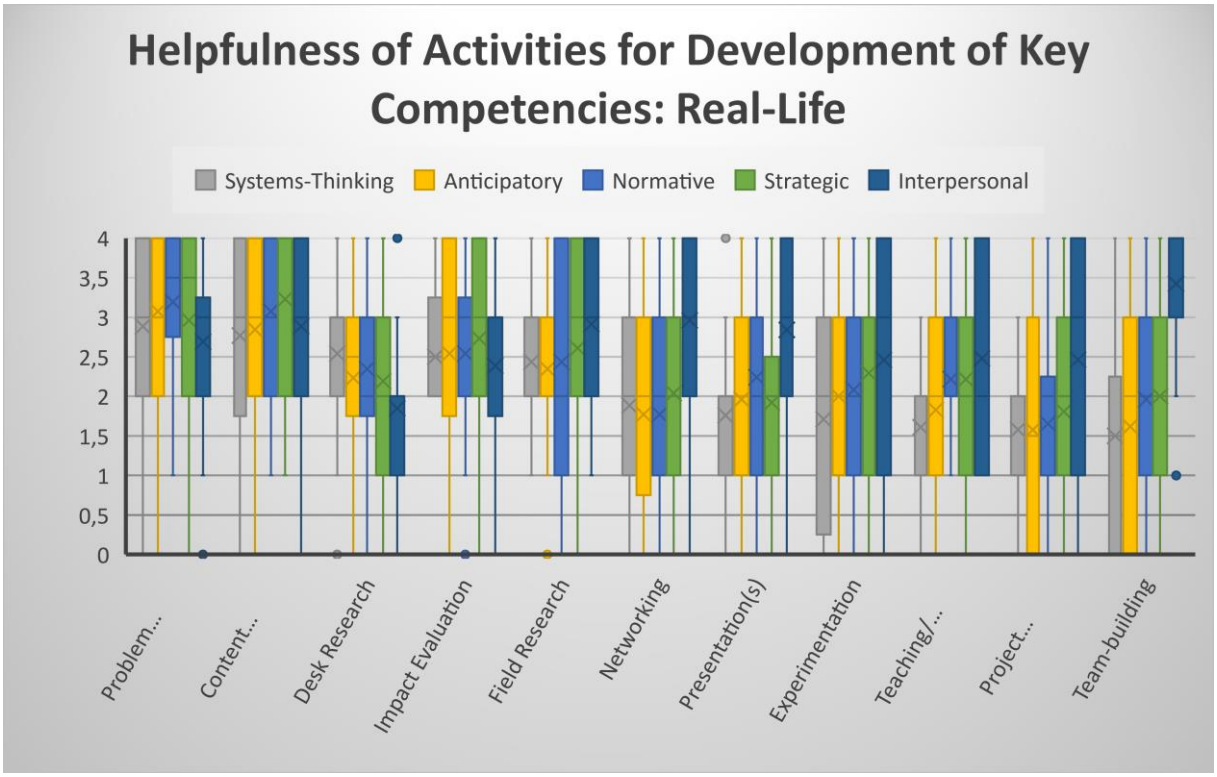

Figure 6: Helpfulness of Real-Life Activities for the Development of the Key Competencies on a scale of 0 = Not at all helpful to 4 = Extremely helpful; shown as mean, median, 25th and 75th percentile.

helpfulness of the Problem Definition is highest for the Normative Competence, closely followed by Content Development. The helpfulness of Content Development is highest for developing Strategic Competence, but Problem Definition, Impact Evaluation and Field Research are also high in their helpfulness for developing Strategic Competence. What stands out is that Interpersonal Competence scores rather high on average across almost all activities, except for Desk Research, with Team-building being the most helpful for its development.

3.2.2.3 Contribution by in-class vs real-life

In total one can say that the K2A course activities score an average helpfulness of 2.26 across all the activities together. The real-life activities, with an overall average of 2.32 across all activities, contribute more to the development of the key competencies than the in-class activities with an overall average of 2.17. The biggest differences can be seen between the real-life activities' contribution to the development of Strategic Competence and Interpersonal Competence. While Real-Life activities contribute an average of 2.37 to Strategic Competence and 2.61 to Interpersonal

Competence, in-class activities only contribute an average of 2.05 and 2.32 respectively. The full comparison of these numbers can be found in Table 7 below.

Table 7: Average Helpfulness of Real-Life and In-Class Activities for the Development of the Key Competencies

	Systems-Thinking	**Anticipatory**	**Normative**	**Strategic**	**Interpersonal**	**Total**
Real-Life	2.13	2.17	2.31	2.37	2.61	2.32
In-Class	2.10	2.14	2.24	2.05	2.32	2.17
Total	2.12	2.16	2.28	2.24	2.50	2.26

3.2.3 Summary

The results of the survey have shown that the key competencies are mostly conveyed through a core set of activities. The five activities with the highest contribution to the development of the key competencies are the following, in descending order with the mean included in brackets behind them. The activity that on average is most helpful in developing key competencies is problem definition (2.94), followed by content development (2.90), writing final report (2.66), impact evaluation (2.53) and field research (2.53).

These five activities appear on top of the list in varying orders for anticipatory, normative and strategic competence. Systems-Thinking Competence shows only one variation, containing Desk Research instead of Field Research. The interpersonal competence shows a set of top five activities that contribute to its development that is quite different from the other key competencies. Interpersonal competence only contains Field Research as one of the top five activities that contribute to its development. The others are Team-Building, Networking, Presentation(s) and the Project Fair. A summary of the top five activities can be found in

Table **8** below.

Team-building contributes the most to the development of interpersonal competence, with an average of 3.4, followed by networking with 2.97, field research with 2.81, participation in the project fair with 2.77 and the development of content with 2.73.

However, despite the distinctly different set of top five activities, students developed their interpersonal competence across almost all activities. Only two activities do not seem to contribute to the development of the students' interpersonal competence, namely Desk Research and the course introduction, with an average of 1.85 and 1.79 respectively.

Table 8: Top Five Activities in Terms of Helpfulness for the Development of Key Competencies.

No.	Systems-Thinking		Anticipatory		Normative		Strategic		Interpersonal	
1.	Problem Definition	2.97	Problem Definition	3.07	Problem Definition	3.10	Content Development	3.17	Team-building	3.40
2.	Content Development	2.80	Content Development	2.80	Content Development	3.00	Problem Definition	2.97	Networking	2.97
3.	Writing Report	2.80	Writing Report	2.57	Writing Report	2.90	Impact Evaluation	2.73	Field Research	2.81
4.	Desk Research	2.57	Impact Evaluation	2.50	Impact Evaluation	2.53	Field Research	2.63	Project Fair	2.77
5.	Impact Evaluation	2.53	Field Research	2.33	Writing Proposal(s)	2.50	Writing Report	2.53	Content Development	2.73
			Peer Feedback	2.33						

3.3 RQ3: Relevance of Key Competencies for Success

This section will present the results regarding the importance of the key competencies for crucial situations during the each of the project phases. After providing some general information about the data presented. The results of this section are based on the survey question asking the participants for two crucial situations during their project and categorize them, in which phases of the project they took place. The phases were taken from the student guidelines and are called scoping and design, implementation and evaluation (Boda & Elmqvist, 2014). The results are based on a total of n=58 situations (2 situations per respondent), where multiple answers were possible.

Looking at the importance of the key competencies for a successful outcome in crucial situations following results were found. More than 21 crucial situations were categorized as belonging to the initial scoping phase of the projects, while the majority of 42 situations was categorized as belonging to the implementation phase and only 7 situations as belonging to the evaluation phase. Situations that were categorized as belonging to more than one phase were included in both categories.

In the scoping as well as the implementation phase, the interpersonal competence has been identified as the most important one by the students with an average importance of 3.14 and 3.57 respectively. During the evaluation phase, normative competence has been identified as the most important with an average importance of 3.29.

The phase in which Systems-Thinking Competence is most relevant for a successful mastery of crucial situations is the scoping phase. Except for the scoping phase, Systems-Thinking competence is of little importance compared to the other key competencies. Anticipatory Competence is most

important for resolving crucial situations in the implementation phase. Normative competence is of high importance, especially during the scoping and even more during the evaluation phase. Strategic Competence seems to be most important dring the implemenation phase as well, while being equally important as Systems-Thinking Competence during the scoping phase and the second most important during the evaluation phase, after normative competence. Interpersonal Competence is the most crucial competence during the scoping as well as the implementation phase. A summary of these results in numbers is given in Table 9.

Table 9: Crucial Situations (n=58) of the K2A projects and the average importance of the key competencies for their successful mastery on a scale from 0 = Not at all important to 4 = Extremely important.

Total number of situations (n=58)	Number of situations	Average Importance				
		Systems-Thinking	Anticpatory	Normative	Strategic	Interpersonal
Scoping	21	2.52	2.38	2.95	2.52	3.14
Implementation	42	2.19	2.64	2.48	2.69	3.57
Evaluation	7	2.00	2.29	3.29	2.57	2.43

Going back to the student guidelines, looking at the three described phases and their foci on each of the key competencies I found the following. In the scoping phase, the K2A guidelines put particular emphasis on Systems-Thinking, with few elements relating to normative and anticipatory competence. While elements relating to strategic and interpersonal competence are absent in the guidelines for the scoping phase, they are very prominent in the implementation phase. The evaluation is focussing on the report that is meant to be a critical reflection of the previous phases of the project. As the focus lies on both previous phases, it comes as no surprise that the instructions and the suggested framework for structuring the report encompass all five key competencies. Systems-Thinking is only present in one statement of the evaluation part, anticipatory three times, normative six times, strategic five times and interpersonal three times.

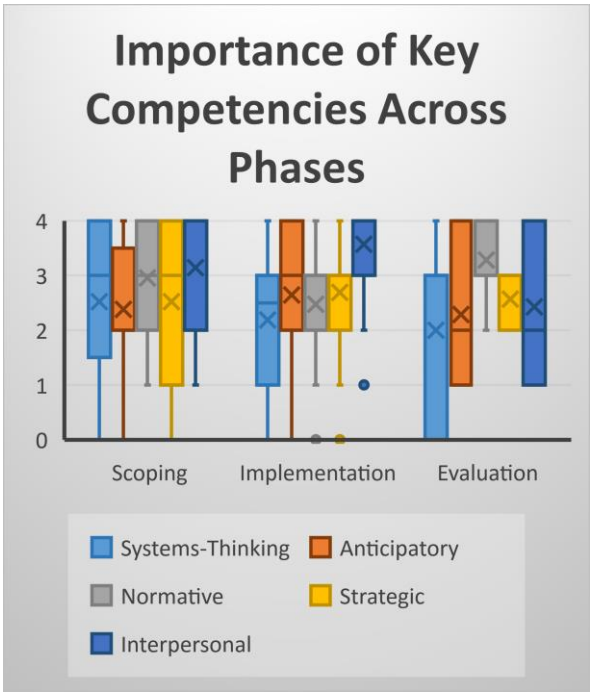

Figure 7: Importance of key competencies in crucial situations (n=58) across phases on a scale from 0 = Not at all important to 4 = Extremely important; mean, median, 25th and 75th percentile.

4 Discussion

4.1 RQ1: Competence Acquisition and Influencing Factors

The rising concept of competence based education has been criticized in the past as being too ambiguous in the definition of the term competence (Hyland, 1993) and often too reductionist in its focus (Hyland, 2006). The latter in my eyes is not the case for the key competencies by Wiek, Withycombe and Redman (2011), as they are rather broad and encompassing in my eyes. For the former I have to admit that even after conducting my research on key competencies that my understanding of the term competence remains vague. However, ambiguity can also be useful in "facilitating consensus, flexibility, and compliance" (Widmaier & Glanville, 2015, p. 367). Together with the encompassing nature of the key competencies this may allow for their application and comparison across many different fields and disciplines.

4.1.1 Systems-Thinking Competence

The overall development of Systems-Thinking during the K2A course is rather low compared to the other ones. This might be because students already have acquired a certain level of systems-thinking competence through previous course modules. Also, while still somewhat important for crucial situations in the scoping phase of the projects, systems-thinking competence becomes less crucial during implementation and evaluation of the project. This is also reflected in the student guide, where systems-thinking can almost exclusively be found in the description of the scoping phase of the project, as well as the instructors understanding of the course as represented in Annex B. Interestingly enough Systems-Thinking Competence is mostly conveyed through Writing the Final Report which is written towards the end of the project. However, the fact that the report is a reflection of previous steps and the emphasis given to it, as evident in the two required drafts and a final version of the report, explains why this activity is valuable for most of the key competencies.

4.1.2 Anticipatory Competence

Anticipatory Competence is only slightly more developed throughout the K2A course than Systems-Thinking Competence, even though it is represented to a lesser degree in the learning outcomes as well as in the student guide. Anticipatory Competence is most important for resolving crucial situations in the implementation phase, though Strategic and Interpersonal are still more important

in that phase. This is surprising, as Anticipatory Competence is mostly absent in the student guidelines.

4.1.3 Normative Competence

The strong connection of normative competence and learning outcome three makes sense, as "interact[ion] and communicat[ion] with stakeholder groups" (LUCSUS, 2013) requires the students to justify their choices. This is also the case for most in-class activities as students will have to answer questions regarding the purpose of the chosen project. It also makes sense that it is mostly required in crucial situations in the evaluation phase as well as the scoping phase. The scoping phase of transdisciplinary research ideally involves a collaborative problem framing, requiring the integration of contradicting values and definition of common goals (Lang et al., 2012), which is a normative exercise. This also fits the survey data, showing that problem definition is the most helpful activity for developing normative competence. The evaluation phase requires the students to make judgements on what they have achieved, which is also an inherently normative exercise. This also fits the data indicating that writing the final report is the most helpful activity for developing normative competence

4.1.4 Strategic Competence

There seems to be a gap between the third learning outcome and strategic competence that I didn't expect. Strategic competence needs to address questions of who to target and at which level of intervention, which in my eyes inherently requires interaction with stakeholders in their different roles and functions.

4.1.5 Interpersonal Competence

The key competence that was developed the most throughout the K2A course across all the activities was interpersonal competence. Zemler (2016) found the same in her research on the Strategic Environmental Development course, which is a transdisciplinary course module of the Master of Science program in Environmental Policy and Management at the International Institute for Industrial Environmental Economics at Lund University. Further, interpersonal competence was also the most important for the successful mastery of crucial situations in most phases. Interpersonal competence is developed across almost all activities and to a higher average degree than all the other key competencies. This supports the view of Wiek, Withycombe and Redman (2011) that interpersonal competence is cutting "across the other four key competencies" (p. 212). A surprising fact was the negative influence of difficulty on interpersonal competence. This may indicate a

possible need for more preparation for conflict situations. A possible explanation is that maybe the student groups are too diverse in terms of cultural and educational/professional background.

4.2 RQ2: Key Components Enabling Competence Acquisition

Looking at the conveyance of the key competencies through a set of core activities provided a good way to connect the key competencies to the learning outcomes, and according to Wesselink et al. (2015) helps to contextualize them. The identification of core tasks is further helpful "to operationalise competencies in a more concrete way" (Wesselink et al., 2015, p. 498), something that is considered necessary for the development of curricula and course design (Wiek, Bernstein, Foley, Cohen, et al., 2015). This would be a suitable approach for other courses or programmes and learning outcomes that do not explicitly refer to the key competencies.

4.2.1 Main Activities

The high average involvement rate of 97% across all activities and the high average score of involvement of 3.27 indicate that the students are highly engaged in their projects and that they shared their responsibilities equally. However, this could also mean that the list of activities might need further differentiation.

4.2.1.1 Problem Definition

Problem Definition is the activity with the biggest contribution to the students' acquisition of key competencies. As the courses aim is to promote critical thinking on transdisciplinarity, it should ideally, according to (Lang et al., 2012) involve the stakeholders into the problem formulation. However, this has been an issue for the students and instructors. A problem that the instructors struggled with is that the students mostly think of a project in terms of solutions and what they want to do, which is also supported by some of the students' views:

- „Though you said it very often, I feel that we could work more on identifying the problem before the solution. In our group, this worked very well. But many other groups focused on a solution they liked in the beginning and then tried to figure out the exact problem"

Students also mentioned during the focus groups that this has led to problems in some cases where students tried to find partners for collaboration when they already had a fix idea of the solution.

Including stakeholders in the process might strengthen the students' interpersonal and normative competence even more. On the other hand, the inclusion of outside stakeholders might increase the difficulty of activities, due to the eventual use of different language possibly having a negative effect

on interpersonal competence. Therefore, it would make sense to include the stakeholders, if the interaction could be facilitated by the instructors. For example, Albert et al. (2015) conducted a scenario-based planning workshop for their students, with a clearly pre-defined scope and procedure, limiting the student's freedom to choose, but also "minimized time needed for orientation and enabled an immediate start of the planning process" (p. 6888). However, this was partially required through the short duration of only one week. Brundiers and Wiek (2013) also point out the importance of pre-structuring the problem together with the stakeholders, before the course.

However, in the case of the K2A course, the students' freedom to choose should not be limited, as it is one of the major factors for motivation as indicated by the instructors in the interview and quotes from the evaluation report on what the students liked the most about the course:

- "I really like the openness of the course. We could come up with our own ideas and experience the strengths and weaknesses of them directly."
- "I really enjoyed the freedom of choice as well as the literature seminars."

A compromise could be found by establishing relationships to stakeholders and have students, instructors and stakeholders search for problems together. This could eventually be in the form of a workshop or a fair that takes place before the students start the project formation process. Another option would be the use of the Sustainability Forum in Lund, whose task it is to "[support] researchers and research groups concerning communication and dialogue, and [provide] a channel for stakeholders seeking collaboration, research support and information from LU [Lund University]" (Lund University Sustainability Forum, 2015). Regular interaction with potential partners for collaboration in the K2A course could increase trust (Vangen & Huxham, 2008) and also help to create a common language spoken amongst the partners, which is a key aspect during the scoping phase (Lang et al., 2012, p. 29).

4.2.1.2 Content Development

The high degree of helpfulness of content development for developing the key competencies came as a surprise to me. This may be due to the fact that developing content forces one to select and summarize what is to be included or not. This is supported by findings of Albert et al. (2015) that the conversion of preliminary results "seemed to be particularly useful in forcing greater precision and another loop of revision" (p. 6887). This might be due to the value of boundary objects in transdisciplinary education for student's learning (Barth & Michelsen, 2013).

4.2.1.3 Writing Final Report

Writing the final report constitutes the most important in-class activity, whose "most important aim […] is to be critical to the design and implementation of the project work and to discuss the project in relation to experience and in dialogue with academic literature" (Boda & Elmqvist, 2014, p. 2). A lot of attention is paid to writing the report throughout the course, which is evident through the mandatory hand-in of several draft versions as seen in **Table 1**. This might have a guiding function, that keeps students on track and serves them as a reminder to also work on the K2A project despite the commitments to other programme courses.

4.2.1.4 Others

The rather large difference in the assessment of the value of the teacher feedback sessions between course evaluation and the survey as shown in chapter 3.2.2 allows for several possible interpretations. The time that has passed changed the perception of the students regarding the helpfulness of the activity, which is not impossible, as the feedback sessions only take half an hour. Another explanation is that the different ways in which the questions are asked and framed had a bigger influence than expected. However, this should then also reflect in the evaluation of the literature seminar, which was not the case. The third possible explanation is that the key competencies don't fully cover the benefits of the teacher feedback sessions.

4.2.2 Real-Life vs. In-Class Activities

Comparing real-life and in-class activities one not only sees, as evidenced in Table 7, that real-life activities on average contribute more to the development of students' key competencies, but also that most activities that are more likely to be found in the implementation phase, with the exception of Content Development, score lower than activities that are at the beginning or the end of a project. This comes as a surprise, considering that the majority of crucial situations takes place in the implementation phase. This implies a gap and a potential need for shifting the teachers' attention to facilitating real-life activities or coaching them. Possibly a stronger focus should be training the students in how to interact with stakeholders, as indicated by the negative effect of difficulty on the students learning regarding interpersonal competence. This might mean that they lack the capacity to deal with conflicts. This could eventually be mitigated by introducing them earlier to the concepts of transdisciplinarity (Lang et al., 2012) and action-research (Glassman & Erdem, 2014; Wittmayer & Schäpke, 2014), presented in the literature seminars, which in my eyes would also fit well into the sustainability science course, as two of the readings (see, Funtowicz & Ravetz, 1993; Lang et al., 2012) for the first literature seminar can also be found on the reading list for this course. This could strengthen the integration of the course into the overall structure of the programme.

Opposed to my findings that real-life activities contribute more to student learning than in-class activities, Anderson (2015) in her thesis on "*Developing Key Sustainability Competencies through Real-World Learning Experiences"* found that the key competencies were developed equally through real-world experience and university teaching. Nevertheless, I come to the same conclusion as Barth et al. (2007) "that formal as well as informal learning settings at universities are relevant for developing competencies for sustainable development" (p. 427). I come to this conclusion, because the in-class activities provide an opportunity for reflection on the practical experience, something that is needed for the students' learning process and evaluation of the experience (Albert et al., 2015; Cörvers, Wiek, de Kraker, Lang, & Martens, 2016; Schneidewind et al., 2016). Being given the opportunity to reflect is something the students also value in the K2A course:

- "I like that you can put your knowledge in to concrete real actions, and then reflect about what you learn from that process and gain even more knowledge"
- "Appreciated that we had so much time at the end to reflect and write the report"

But they also acknowledge, that the current structure can be a hindrance to be able to do so:

- "[T]he social theory course, the economy course and the governance course, are so jammed with different assignments […] so we had no time […] to think about what we learn so we could reflect and understand it..."

A possible solution to address the issues above could be the use of reflective journaling as a form of pedagogy as well as assessment approach, which fits well into the first learning outcome of the course that "[o]n completion of the course, the student shall demonstrate the ability to critically reflect on theoretical and methodological approaches of transdisciplinarity as ways of bridging the knowledge-action gap" (Boda & Elmqvist, 2014).

This would provide them a crucial opportunity for what Cörvers et al. (2016) call "learning by reflection" (p. 343). Additionally, this could help to better integrate the K2A course into the current structure and the other courses running in parallel. In the Social Theory course for example, continuous reflective assignments are already well integrated and could be widened in scope by requiring the students to explicitly connect their learning for the Social Theory course to the K2A course. This could strengthen the crucial connection of theory and practice and at the same time serve as a source for assessing the student learning and improving the course. This could potentially also reduce the stress caused by the current structure, because reflective journaling has shown to improve students project management skills and make team work more effective and less stressful (Loo & Thorpe, 2002), keeping them on track through regular assignments and reducing the need to prioritize one course over the other, as evidenced in one of the quotes above.

4.3 RQ3: Importance of Key Competencies for Success

During the scoping and implementation phase, interpersonal competence is the most important key competence, especially in the implementation phase. Again, this could be strengthened by including stakeholders at an earlier stage. Normative competence is most important during the evaluation phase, which makes sense as one has to reflect on and judge one's own project success. However, it is not as relevant in the problem definition phase, which contradicts the "sustainability research and problem-solving framework" (Wiek, Withycombe, & Redman, 2011, p. 206) for the key competencies. This poses the question if either normative competence is overrated in the problem definition phase, or in my eyes more likely why the students don't consider it necessary? Another finding that didn't exactly match was the rather low importance of systems-thinking competence in the scoping phase, considering the strong emphasis it has in terms of connections to the learning outcomes as well as in the student guidelines for the scoping phase. Overall, the results all reflect quite well the expectations of the course instructors and come thus as no surprise.

4.4 Other

With all the focus on students learning and project success, one more finding is of interest. The study also found that the success of the project and the development of the key competencies are correlated, but as opposed to the perceived difficulty the relationship is of a non-linear nature, as seen in Figure 8. Projects that were categorized at the opposing ends of the success spectrum (either *Not at all successful*, or *Very successful*) had less of a learning impact on students than projects that were in between and categorized as either *Not very successful* or *Somewhat successful*. This tension between learning and success has been pointed out by the instructors during the interview.

Figure 8: Relationship between the perceived success of the project and the Development of Key Competencies

There are two possible interpretations for low values in competence development for projects that were categorized as *Very successful*. Either they already had the key competencies and thus

didn't really improve them, but were still successful, or the project was not very ambitious and didn't challenge the students enough. The latter option is further supported by the findings illustrated in Figure 4 that the learning increases with the difficulty of the task.

5 Limitations & Suggestions for Future Research

5.1 General

There are certain things that could be improved, if similar research is to be carried out again. This thesis only evaluates the K2A course, but none of the other course modules that run in parallel. This limits the transferability of the results to other transdisciplinary courses, as the effect of these parallel courses has not been assessed in relation to the key competencies as of yet. Therefore, future assessment would need to include them as well. To do so, future assessments of the K2A course would benefit from a "multi-stage and in-process evaluation research" (Albert et al., 2015, p. 6874) as conducted by Albert et al. (ibid). This would allow for a clearer distinction between the parallel running course modules and their impact on the process. Another method that could enhance the quality and depth of such an evaluation/assessment approach is the aforementioned reflective journaling as used by Gardiner and Rieckmann (2015). A pre- or even multi-stage process was not feasible considering the asynchronous schedules of the K2A course and the thesis writing process. The same counts for the assessments through case analysis, in-vivo observation and ongoing reflection activities (e.g. reflective journaling). Therefore, out of the given approaches, an ex-post self-assessment survey with closed Likert-scale as well as free text questions has been chosen as the main method for addressing the research questions. An assessment of the final papers (group reports) has not been considered feasible for three reasons. One, the diverse nature of the projects makes it hard to develop a simple grading rubric for them. Two, the key competencies are not explicitly required in the report, which limits the assessment of the key competencies. Three, I was lacking the confidence in knowledge and skills to develop such a rubric and conduct such an assessment by myself.

Another limitation to the generalizability of this thesis is the sole focus on one transdisciplinary module. Future research would benefit from a comparative assessment of several teaching modules rooted in transdisciplinarity in order to increase generalizability of findings and improve the empirical basis for the key competencies.

Further work on the learning outcome matrix would be helpful to improve the understanding the connections between the current learning outcomes and the key competencies. This matrix could serve as a boundary object that helps to connect different strands of transdisciplinary learning.

Another factor limiting not only this thesis, but possibly future endeavours of this kind as well, is the problem of properly assessing societal impact of the projects, as it is hard to define, partially due to the nature of sustainability as a sometimes ill-defined concept with a long-term perspective, but also due to the large diversity of student projects, which didn't allow for a uniform definition of success.

Another issue that has to be addressed, is the omission of the sixth key competence of integrated problem-solving, which hasn't been analysed due to several reasons. First, I find it hard to understand the difference between the strategic competence as the ability to "design and implement interventions, transitions, and transformative governance strategies toward sustainability" that essentially "is about being able to 'get things done' " (Wiek, Withycombe, & Redman, 2011, p. 210) and integrated problem-solving competence that is described as "using and integrating the five key competencies for solving sustainability problems" (Wiek, Bernstein, Foley, Cohen, et al., 2015, p. 243). They both sound to me like getting things done. This requires further clarification, if integrated problem-solving is to be included into the set of key competencies. Second, as the authors consider integrated problem-solving competence a meta-competence, I think it is safe to consider this competence as an emergent one. Therefore, I decided to exclude it from my research design and further analysis.

5.2 Interview

The instructors of the K2A course were given the core article on key competencies by Wiek, Withycombe and Redman (2011) as well as Wiek et al. (2015) for further details. However, they were only forwarded to them with comparably short notice so they didn't have the chance to gain a more in-depth understanding on how they relate to their framing of the course. After the initial part of the interview, that was meant to give me a better understanding of the approach the instructors take with regards to transdisciplinarity and their teaching, this turned out to be a problem. It turned out that the instructors use a different terminology and don't explicitly use the framing of the key competencies. Due to the lack of time it was not possible to discuss this further. This form of language barrier could have been prevented, if I had given more information to the interviewees at an earlier stage.

5.3 Focus Group and Survey

It would have been beneficial to conduct focus group interviews with each of the project groups, in order to get better and in-depth understanding of the groups' activities and context specific information that would help explain differences in their responses. One problem I faced with regards to organizing this was that people only came back by the end of August and when lectures started

again, the different schedules by all the students in different elective courses made it difficult to schedule the focus group interviews. The fact that the two focus groups were conducted in a slightly different fashion might affect the answers given by some of the students, but as the focus groups were conducted for exploratory purposes, this effect is considered negligible. After conducting the focus groups, the list of activities could have been sent out to the participants for feedback and further validation. However, as the sample was quite representative and as I had personal experience with the activities myself, I consider the list of activities as valid.

The self-assessment survey is inherently limited to and by the students' perceptions. There is the possibility that the students taking the survey may have a different understanding of the codes that were created based on their information provided through the focus groups interviews. When looking at strategic, interpersonal and integrated problem-solving competence, where other stakeholders are involved, their view is omitted. Future research on the topic would benefit from including their views. One should particularly include external stakeholders with a clear mission and intent to be agents of change and what they consider the key competencies for the change agents they employ. This would help to increase the social robustness of the key competencies outside academia and increase employability of sustainability graduates. It would further enhance the understanding of the key competencies by adding a non-academic perspective of practitioners that could help to further operationalize the key competencies.

6 Conclusion

LUMES students acquired all of the key competencies, but with varying degrees. Systems-thinking Competence is the least developed, despite the emphasis put on it by the course instructors. Interpersonal competence developed by far the most through the K2A module across almost all phases and activities, supporting claims that it is cutting "across the other four key competencies" (Wiek, Withycombe, & Redman, 2011, p. 212). An influencing factor for competence acquisition was perceived difficulty of the task, which increased the competence development with increasing difficulty, with exception of interpersonal competence, where the relationship was reversed.

Despite not being explicitly framed according to the key competencies the K2A course's aims structure and processes connect well with each other and provide a coherent picture. This is also reflected in the perceived importance of the key competencies in different phases and the helpfulness of specific activities.

Overall the key competencies are perceived as important for a successful completion of real world learning opportunities, provided through the K2A course. Outstanding again was interpersonal

competence as the most important competence in crucial situations during scoping and implementation. Normative competence was also considered highly important during the scoping and the evaluation phases.

The scoping phase, or more concrete the activity of Problem Definition as one of the most crucial phases but also most helpful activities for the development across all the key competencies, should include stakeholders as a means to better apply transdisciplinary principles and create a common understanding, avoiding problems in getting stakeholders interest. This could be facilitated by establishing and institutionalizing relationships with engaged stakeholders, without compromising the students' freedom to choose, as it is a major source of motivation for them. Additionally, putting an earlier emphasis on ways of transdisciplinary forms of collaborative research, possibly through the literature seminar, could help to further reduce such issues. This would also help to better integrate the K2A course into the overall structure of the programme. Another step to achieve this, could be the use of reflective journaling as a pedagogic tool for students to better connect the other course modules to the K2A course. This could also have benefits regarding the students time management and reduce the competition between the parallel courses by using synergies.

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Appendix

Annex A

Instructors Interview Guide

Step 1: Introducing my research

Thank you two for participating in this interview session and helping me with my thesis.

Excerpt from my current thesis proposal:

There is an increasing number of sustainability programmes that aim at building capacity for sustainability and claim to educate such leaders, or "systemic problem solvers, change agents, and transition managers" (Wiek, Withycombe, Redman, et al., 2011), in order to meet that demand.

According to literature there is a set of six key competencies that distinguish sustainability professionals, including researchers, from professionals and researchers in other fields (Barth et al., 2007; Wiek, Bernstein, Foley, & Cohen, 2015; Wiek, Withycombe, & Redman, 2011). These key competencies include

- systems thinking competence,
- futures thinking competence,
- values competence,
- strategic competence,
- interpersonal competence, and
- integrated problem-solving competence.

Some studies have been undertaken on the acquisition of individual key competencies (e.g., Hiller Connell et al., 2012; Claesson & Svanström, 2015) or the complete set of competencies (e.g., Remington-Doucette and Musgrove, 2015; Zemler, 2016), and empirical evidence is slowly building up. However, there is lack of empirical evidence, first, that these skills are necessary and sufficient for sustainability problem solving, and second, that current sustainability programs and courses convey these skills (Wiek, Withycombe, Redman, et al., 2011). Regarding the latter, reliable assessment approaches for the acquisition of key competencies in sustainability are still missing, and this lack hampers professional development.

Step 2: Aims of the interview

The aims of this interview are to

- Explore the relationships between course content, structure, learning outcomes and key competencies
- Collect contextual information for a more in-depth analysis, discussion and tailored recommendations
- Eventually provide a reflective platform for the instructors on their assumptions about the course design and its intended impact.

The aim is not to

- Evaluate your performance as instructors
- Evaluate the quality of the course design

Step 3: Describing the process

As a first step I would like to discuss with you the course structure and content and how they relate to the Learning Outcomes. This includes your understanding of key terms and focal topics/themes that you emphasize during your teaching activities.

As a second step I would like to discuss with you the changes you made to the course since last year and changes that you intend or would like to see.

As a third step I would like to discuss with you, how the aforementioned things relate to the key competencies suggested by Wiek, Withycombe and Redman (2011). Where do they overlap and enhance each other? What are the key competencies that are not covered and why?

As a last step, we will try to synthesize all the three steps and formulate a summary of the main points. (If this is not possible, due to time constraints, I will do the summary myself and send it to them for verification)

Step 4: Course Structure, Content and Learning Outcomes

Guiding questions:

- Please explain your understanding of transdisciplinarity. Do you use a specific definition of transdisciplinarity in your course?
- Do you put emphasis on particular elements of transdisciplinarity?
- Can you explain the Learning Outcomes more detailed?
- How do the content and structure of the course relate to the Learning Outcomes?

Step 5: Changes: Past & Future

Guiding Questions:

- Did you change anything of the course compared to the previous years?

- If Yes, why?
- If No, why not?

- What would you like to change in the future?
- What would you change, if the course was given more credits?

Step 6: Relationships to Key Competencies

Guiding Questions:

- How do the structure, content and learning outcomes relate to the key competencies?
  - Are they complementary or
  - Are they mutually exclusive or
  - Not a focus/not covered? If yes, which ones and why?
- Are there other key competencies that you think are not covered by Wiek, Withycombe and Redman (2011)?

Step 7: Summary

		How does the activity contribute to the learning outcomes?		Systems-Thinking Competence	Anticipatory Competence	Normative Competence	Strategic Competence	Interpersonal Competence	Integrated Problem-Solving Competence
Pre-course: Exploring assumptions in student projects for social change	LO1								
	LO2								
	LO3								
Pre-course: Mini-K2A Project Assignment	LO1								
	LO2								
	LO3								
Course Intro: Past projects/forming groups	LO1								
	LO2								
	LO3								
Turn in finalized groups and project concept for approval	LO1								
	LO2								
	LO3								
First project proposal draft	LO1								
	LO2								
	LO3								
Teacher Feedback	LO1								
	LO2								
	LO3								
Peer Feedback 1	LO1								
	LO2								

		How does the activity contribute to the learning outcomes?		Systems-Thinking Competence	Anticipatory Competence	Normative Competence	Strategic Competence	Interpersonal Competence	Integrated Problem-Solving Competence
	LO3								
Literature Seminar 1	LO1								
	LO2								
	LO3								
Revised Proposal	LO1								
	LO2								
	LO3								
Teacher Feedback 2	LO1								
	LO2								
	LO3								
Literature Seminar 2	LO1								
	LO2								
	LO3								
Peer Feedback 2	LO1								
	LO2								
	LO3								
Final Report	LO1								
	LO2								
	LO3								
Project Fair	LO1								
	LO2								
	LO3								

Annex B: Relationships between In-Class Activities, Learning Outcomes and Key Competencies

		Systems-Thinking	Anticipatory	Normative	Strategic	Interpersonal
Course-Intro: Past projects/ Forming groups		**X**	**X**	**-**	**X**	**X**
	LO1	X	X	-	X	-
	LO2	-	-	-	-	X
	LO3	-	-	-	-	-
Writing Proposal(s)		**X**	**X**	**X**	**X**	**X**
	LO1	X	X	-	X	-
	LO2	X	-	-	X	X
	LO3	-	-	X	-	X
Teacher Feedback		**X**	**X**	**X**	**X**	**X**
	LO1	X	X	-	X	-
	LO2	X	-	-	X	X
	LO3	-	-	X	-	X
Peer Feedback		**X**	**X**	**X**	**X**	**X**
	LO1	X	X	-	X	-
	LO2	X	-	-	X	X
	LO3	-	-	X	-	X
Literature Seminar(s)		**X**	**X**	**X**	**X**	**X**
	LO1	X	-	X	-	X
	LO2	-	X	-	X	-
	LO3	-	-	X	-	X
Writing Final Report		**X**	**X**	**X**	**X**	**X**
	LO1	X	X	-	X	-
	LO2	X	-	-	X	X
	LO3	-	-	X	-	X
Project Fair		**-**	**-**	**-**	**-**	**-**
	LO1	-	-	-	-	-
	LO2	-	-	-	-	-
	LO3	-	-	-	-	-

Annex C: Focus Group Guide

Step 1: Introducing my research

Hello everybody and thanks a lot for helping me and joining the focus group. The focus group discussion we will have will take no longer than 45 Minutes. Before I explain the details of the process, let me first quickly explain what my research is about.

The aim of my research is to investigate a certain set of key competencies important for Sustainability Science and how they are conveyed through the K2A course and the formal and informal components and activities.

I want to explore the relationships between the key competencies and all the activities you conducted and the barriers that you had to face. This information will then serve as input for the survey I created that will be sent out to all of you and your classmates as soon as possible after the focus group interviews. This is what the focus group is about. It is not about judging or assessing you in any way, but is merely a form of brainstorming and compiling activities and barriers. So there are no right or wrong answers.

Step 2: Describing the Process

The focus group discussion will therefore be structured in two parts. The first part will look at the activities and the second part will look at the associated barriers.

Session one will start with you reflecting on the activities that you conducted throughout your K2A project. These activities should not only reflect the outcomes (such as: “we produced a how to guide”), but also the processes that were required for a certain activity/outcome (e.g. writing the guide, having feedback/review sessions, designing a layout/graphs, etc.)

You will have around five minutes to write them down on a piece of paper. After that we will collect the activities and discuss them for around 10-15 minutes.

We will then do the same for the barriers. You will be given five minutes to write them down and then we will discuss them a bit more in depth. If you feel uncomfortable discussing certain barriers, such as personal issues you don’t have to do so. However, I please ask you to still write them down, because this will help me to at least validate my own experiences from our batch.

Step 3: Confidentiality

The results will only be used for academic purposes and as input for course improvement. Information and details regarding your identity will be will be treated confidentially. Wherever individual quotes are used, they will be anonymized and it will be ensured that they don't reveal any personal details that could reveal your identity.

This also applies to eventual topics written down on the papers that you don't feel comfortable discussing.

Step 4: Conducting the focus group interviews

1. Hand out the pieces of paper (and pens)
2. Meanwhile, remind them of the details of the task from Step 1-3
3. Remind them of the time limit of five minutes
4. Have them start writing down activities and after five minutes, ask them, if they need a little more time
    a. If necessary, add a maximum of two minutes
    b. If not necessary, continue with next step
5. Collect ideas and write them on a white board (in a mind mapping fashion)
    a. If people are hesitant, designate one person who starts and have each person state one additional item.
    b. Otherwise let it unfold organically
6. If necessary
    a. ask them for more details on the activities
    b. Extend the time of discussion, though not beyond 15 minutes
7. Repeat number 2.-6. to collect barriers
8. Collect the papers

Step 5: Closing of Focus Group

Thank you everybody for helping me out, I really appreciate your help. As a next step I will try to group the different types of activities and incorporate them into the survey, which I will send out by the end of the week. For the surveys it is **particularly important** that as many of your classmates fill it out, so please encourage them to do so in a timely manner.

Annex D: Coded Activities & Descriptions

	Final Code	Description/Info text in survey	List of Activities falling under the Code
Real-World			
	Project Administration	Organizing of group or stakeholder meetings and events, taking minutes as well as financing and resources.	➢ Organizing external speaker ➢ Planning (project plan, creating a project timeline) ➢ Organizing events (scheduling, location, food) ➢ Organizing group meetings ➢ Organizing stakeholder meetings ➢ Apply for funding ➢ Note taking
	Content Development	e.g. the production of posters, flyers, movies etc.	➢ Producing movies (script writing, filming, acting, editing) ➢ Compiling cookbook ➢ Designing/Layouting (maps, flyers, posters)
	Desk Research	Secondary data gathering, e.g. through (online) journal articles, websites, etc.	➢ Literature Research ➢ Desk Research ➢ Online Research
	Impact Evaluation	Evaluation of the societal impact (e.g. through pre-/post surveys).	➢ Conducting surveys (pre/post) ➢ Evaluation ➢ Analysing survey/interview
	Experimentation	Practical trial/testing of project (components) through gaining own experience.	➢ Testing of different tools techniques and approaches ➢ Trying out recipes/Cooking sessions ➢ Gardening/Painting practice
	Field Research	Primary data gathering, including expert interviews, etc.	➢ Interviews ➢ Expert feedback ➢ Conducting an online poll ➢ Feedback from participants
	Networking	Activities that widen the circle of stakeholders/participants.	➢ Information sharing with stakeholders ➢ Using network ties ➢ Networking ➢ Reaching out (via email, phone, social media) ➢ Recruiting participants
	Presentation(s)	Excluding peer feedback sessions and Project Fair!	➢ Presentations ➢ Presentations for stakeholders
	Problem Definition	This refers to the process of scoping and d esigning the research project.	➢ Problem identification/justification ➢ Create common understanding of problem ➢ Topic definition ➢ Defining the scope of the problem
	Teaching/Instructing	e.g. development of a lecture.	➢ Designing lesson plans and lectures ➢ Cooking sessions for teaching

	Team-building	Activities that aimed to strengthen group coherence.	➢ Group dinner ➢ Gardening/Painting as a group activity
In-Class			
	Course Intro: Past projects/forming groups		
	Writing Project Proposal(s)		
	Teacher Feedback		
	Peer Feedback		
	Literature Seminar(s)		
	Writing Final Report		
	Project Fair		

Annex E: Study Schedule

LUMES Knowledge to Action
Lund University (Nov 18, 2015) - June 3, 2015

Knowledge to Action
Study Schedule

Day	Date	Time	Venue	Title	Teacher	Parallel Course
Wed	Nov. 18	10-12	Ostrom	Formal course introduction: Past project ideas and forming groups	Chad, David, Batch 18	Social Theory
Fri	Dec. 18	17:00	L@L	Turn in finalized groups and project concept for approval		
Thurs.	Jan. 7	17:00	L@L	First project proposal draft due		Sustainability Science
Mon	**Jan. 11**	**9-17**	**Wägner**	Teacher feedback- 30 min/group (assigned times)	Chad/David	
Fri	Jan. 15	17:00	L@L	Submit revised proposal		
Wed.	**Jan. 21**	**10-12**	**Carson**	**Peer feedback session 1**	Chad + ½ groups	
		13-15	**Carson**	**Peer feedback session 1**	David + ½ groups	
Fri	Feb. 5	10-12	Carson	Literature Seminar 1	Chad + ½ groups	Governance
		10-12	Carson	Literature Seminar 1	David + ½ groups	
Wed	Feb. 10	17:00	L@L	Submit revised report		
Fri	**Feb. 12**	**9-17**	**Wägner**	**Teacher feedback- 30 min/group**	Chad/David	
Fri	Apr. 15	10-12	Carson	Literature Seminar 2	Chad + ½ groups	Urban/Rural
		10-12	Carson	Literature Seminar 2	David + ½ groups	
Mon	May, 16	17:00	L@L	Submit revised report		
Tues.	**May, 24**	**9-12**	**Carson**	**Peer feedback session 2**	Chad + ½ groups	K2A
		9-12	**Carson**	**Peer feedback session 2**	David + ½ groups	
Sun.	May, 29	23:59	L@L	Final Report Due		
Thurs.	**June, 2**	**13-17**	**3rd Floor**	**Final Presentation Fair and Wrap Up**	All	

Attendance:

Consistent, regular class attendance and fully engaged participation is expected from all students in LUMES. Attendance at the sessions where key course activities take place (marked **BOLD** in the course calendar) is compulsory to pass the course. If students miss a compulsory activity, owing to circumstances beyond their control, e.g. accident, sudden illness or similar situation, they will have an opportunity to make up the activity if they submit appropriate documentation the circumstance (in advance wherever possible). This also applies to students who miss teaching owing to activities in an elected position as student representative.

Literature list: (all available through LU Library online)

Lit. seminar 1: Theorizing academy's role in social change

Post-normal science:

- Funtowicz, S. O. & Ravetz, J. R. (1993) *Science for the Post-Normal Age.* Futures. Sept. 739-755.

Transdisciplinarity:

- Lang, D., J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C. J. (2012) *Transdisciplinary research in sustainability science: practice, principles and challenges.* Sustainability Science, 7 (Suppl. 1): 25-43.

PAR:

- Glassman, M. & Erdem, G. (2014) Participatory action research and its meanings: vivencia, praxis, conscientization. Adult Education Quarterly. 64(3) 206–221.

Lit. seminar 2: "Doing" knowledge to action

Boundary work:

- Guston, D. H. (2001) Boundary Organizations in Environmental Policy and Science: An Introduction. Science, Technology, & Human Values 26(4):399-408.

Transdisciplinarity:

- Polk, M. (2014) *Achieving the promise of transdisciplinarity: a critical exploration of the relationship between transdisciplinary research and societal problem solving.* Sustainability Science. xx(xx): xx-xx.

PAR:

- Wittmayer, J. & Schäpke, N. (2014) *Action, research and participation: roles of researchers in sustainability transitions.* Sustainability Science. xx(xx): xx-xx. doi: 10.1007/s11625-014-0258-4