
Competences for climate change education in a virtual mobility setting

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Abstract: Students, citizens and professional practitioners have significant roles in addressing climate change issues. This requires additional competences over and above disciplinary scientific knowledge and related technical skills. This paper introduces two innovative, complementary competences in relation to climate change education, i.e., ‘transboundary’ and ‘intervention’ competences. The authors describe the open access Masters track of the ‘Lived experience of climate change’, in which these innovative competences can be acquired.

For transboundary competence, the diversity of perspectives on the climate change issue is a crucial element in the learning process and outcome. By relating the diversity of their own perspectives on ‘lived experience’, students are encouraged to relate abstract scientific knowledge to knowledge gained through personal, local and social experience, across the boundaries of scientific disciplines and communicating with a diverse group of stakeholders.

Intervention competence focuses on the ‘problem-solving’ aspect in countering climate change, as a next step following transboundary competence. This involves political-strategic thinking, combined with personal and individual goal-directedness (strategic decision making), appreciating the importance of networking or the professional labour market, and paying attention to policy assessments and policy scenarios in climate change issues.

The authors regard these two additional competences, intervention competence and transboundary competence, as crucial and inseparable elements in a climate change curriculum.

Keywords: climate change in higher education; competences in higher education; virtual mobility; European citizenship; transboundary competence; intervention competence.

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1 Introduction

Climate change and the claim of human-induced contribution to global warming is the subject of fierce contemporary debate, at all levels in society, including scientists, politicians, citizens, students and all kinds of (civic) organisations (Hulme, 2009). In a recent world survey among more than 1,000 students from 43 countries (22 from Europe), students expressed their desire for more and better coverage of climate change education in their university programmes [Leal Filho, (2010), Tables 5 and 7, p.12 and p.16]. In higher education, developing a curriculum that educates, trains, and prepares students for this complex future practice in an optimal way is both a challenge and a source of debate and dissent.

When one examines the parallels between climate change and sustainability education (UNESCO, 2010; Leal Filho, 2010), one observes that the learning and teaching challenges and problems relating to these two subjects appear to be comparable. There is a broad consensus on the fact that the acquisition of predominantly meteorological,

geo-physical, geo-chemical and technical knowledge in itself is insufficient in an educational programme on human-induced climate change. This is because the complexity and dynamics of the climate change issue require additional knowledge and skills in addition to the aforementioned sciences. Building on the same parallels between climate change and sustainability education as mentioned above, there is also consensus that climate change education should include at least the following aspects in its programme (curriculum and/or courses)(UNESCO, 2004, 2010):

- raising awareness of the different levels of, and perspectives on, human-induced environmental problems and challenges (different temporal and spatial scales; economic, political, societal and cultural diversity)
- taking an interdisciplinary approach.

However, this is more or less where the consensus on what curricula should contain ends. The current curriculum discussion shows a great and widely diverging variety of perspectives and foci (cf. Corcoran and Wals, 2004). Instead of trying to choose one 'best' perspective or focus, the authors therefore propose to take this diversity of perspectives and foci as the starting point when rethinking the curriculum. Wilson et al.'s (2011a) concept of the 'lived experience of climate change' (LECH-e) allows for, and explains, the existence of several perspectives at the same time. Therefore, the concept of the 'LECH-e' is given a central place in a Master's track on (human-induced) climate change, as developed with a group of eight European universities in the LECH-e project. The authors consider this concept to be important and perhaps even crucial for our domain, where it can be used to expand knowledge and for designing possible solutions and actions.

In order to define and operationalise the 'lived experience' in learning goals and outcomes of climate change education, the authors use the concept of 'competence'. The authors provide a brief overview of existing concepts of competence and their definitions, and make a synergetic choice, in which the various options to define competence are combined to a broader and more comprehensive definition. De Kraker et al. (2007a) have already described key competences (such as the transboundary competence) in relation to sustainable development in higher education. In this paper the authors extend these competences by introducing 'intervention competence', which focuses on the ability to formulate a diversity of possible solutions and actions in the climate change domain.

The competences are being developed for a Master's track, designed in an open access virtual learning environment. As suggested above, this will eventually allow citizens from all over the world open access to the curriculum resources. Some of them can even become actively involved in those parts of the courses where communication with the 'outside world' is required. Public access to the knowledge developed is expected to contribute to the strengthening of civic awareness and active citizenship, thus broadening the legitimacy of democratic formulation of public policies.

This paper contains four sections, in which the authors consecutively:

- address different views on the concept of 'competence'
- comment on current competences for climate change in higher education and operationalise additional competences in this domain

- describe competence development in a virtual learning environment for a Master's track on human-induced climate change that allows students and citizens from different European universities to interact
- present and discuss our conclusions.

2 Views on competences in higher education and lifelong learning

Although the concept of 'competence' is increasingly being adopted within higher education and lifelong-learning, very different opinions exist on what it actually means. Boon and Van der Klink (2003) describe some of the main definitional and theoretical interpretations of 'competence' (see Table 1). Firstly, as can be gauged from Table 1, there are differences between countries concerning the meaning of competence, its interpretation in the UK being quite different from that in Germany or the USA. In Germany for example, competence refers to the holistic concept of the capacity of a person to act; in the USA, competency refers to those traits of an individual that contribute to excellent performance.

Table 1 Views and definitions of the competence concept

<i>Perspective</i>	<i>Position</i>	<i>Difference in definition</i>
Country	Germany	<i>Kompetenz</i> refers to the capacity of a person to act. It is more holistic than <i>competency</i> or <i>competence</i> , comprising not only content or subject knowledge and ability but also core and generic abilities [Delamare Le Deist and Winterton, (2005), pp.27–46].
	UK	<i>Competence</i> refers to collectively agreed occupational standards such as National Vocational Qualifications (Mansfield and Mitchell, 1996).
	USA	<i>Competency</i> refers to behaviour and personal traits that contribute to excellent performance (e.g., Spencer and Spencer, 1993).
Field of application	Training and education	In education and training, competences are defined as clusters of skills and knowledge which can be learned.
	Selection	In selection practice, competencies are perceived partly as trainable and partly as rather stable traits that are difficult to alter.
	Performance assessment	In performance assessment practice, competencies are defined as the output of a task.
Underlying learning theory	Cognitivism	Emphasises links between competencies and observable and measurable performance. Stronger focus on top-down development of competency-based systems.
	Constructivism	Stresses values and beliefs as important components of competencies. Stronger focus on workers' participation in the development of competency-based systems.

Secondly, the interpretation depends on the learning theory used (see Box 1). For example, those who advocate a cognitive theory of learning emphasise other aspects of the concept of competence than those who approach learning from a constructivist learning theory. Finally, one can describe 'competence' on the basis of the area of

application, since the purpose for which the concept of competence is used determines the nuances of the definition. In educational settings, for instance, definitions are used in which competences are regarded as trainable, whereas in selection procedures in companies, more stable personal traits are considered to be important aspects of the concept of competence. These different views on competence, as listed in Table 1, underline that competence is a fuzzy concept, which requires shared understanding and proper definition before it can be put into practice.

Box 1 Short explanation of cognitive learning theory and constructivist learning theory

The cognitive theory of learning looks at how the brain processes information and interprets new experiences; from this theory it is very important to structure the learning environment to organise learning in a way that uses the brain in an optimal and balanced way.

The constructivist learning theory states that all knowledge is constructed by the learner; all knowledge comes forth from the permanent accommodation and assimilation of new experiences by the learner. For the teacher this approach means that he or she has to challenge students to develop skills to analyse new information.

The issue of achieving a shared interpretation of the concept of competence has often been raised (see for example Eraut, 1994; Weinert, 2001). For example, Van Merriënboer et al. (2002) have stressed the importance of proper and consistent communication of the definitions of competences used.

Since the LECH-e Master's track aims at developing competences in an educational setting, the definition of competence adopted in this paper includes the notion that these are 'clusters of skills and knowledge which can be learned.' This is closer to the German use of the word than the British or American. The authors add to the definition that the competence should be used to perform tasks in authentic work environments, thereby meeting the standards or success criteria required by these environments in real life. This entails that one adds the assessment part and the occupational aspect of competence present in the American and British definitions. This approach enables the authors to compose a relatively complete description of competences for higher education. A comprehensive and thorough definition is important in the communication to students and is crucial in developing a reliable assessment (or examination).

The need to achieve agreement on the concept of competences is also recognised at a European level. For example, the European qualification framework aims to describe national educational structures in terms of both cognitive skills and competencies, described in terms of responsibility and autonomy (European Communities, 2008).

In addition, there is also progress at a European level in defining the most important competences for lifelong learning, as is demonstrated in the 'European key competences for lifelong learning', which are considered crucial for Europeans in their roles as citizens and employees. These competences are described as follows: 'key competences for lifelong learning are a combination of knowledge, skills and attitudes appropriate to the context. They are particularly necessary for personal fulfilment and development, social inclusion, active citizenship and employment' (European Union Legislation, 2006).

So far, eight key competences have been defined (European Union Legislation, 2006):

- 1 communication in the mother tongue
- 2 communications in foreign languages

- 3 mathematical competence and basic competences in science and technology
- 4 digital competence
- 5 learning to learn
- 6 social and civic competences
- 7 sense of initiative and entrepreneurship
- 8 cultural awareness and expression.

The EU recognises that there is some overlap between the eight domains and that they cannot be measured at the same level; also the eight competences should be adapted, as appropriate, to specific cultural, linguistics, and social circumstances of knowledge skills and attitudes in certain domains [European Legislation, (2006), p.4].

For the Master's track of the 'LECH-e', which relates to informed and active citizens and professionals in the field of climate change issues, it is the European definition of *civic competence* which is relevant: "civic competence, and particularly knowledge of social and political concepts and structures (democracy, justice, equality, citizenship and civil rights), equips individuals to engage in active and democratic participation".

The above educational and 'learning theory' aspects of competence definition are only a part of the definition; to complete the definition it is necessary to apply it to the content, in this case to human-induced climate change. This content aspect will be the subject of the next section, where the authors describe specific competences for climate change education.

3 Transboundary and intervention competences in climate change education

The climate change world survey recently conducted by Leal Filho (2010) shows that the implementation of climate change education at universities is characterised by problems and needs. One of the survey results is that the 'ecological, social and economic aspects deserve a special emphasis (...) instead of a focus on technical aspects as has traditionally been the case' [Leal Filho, (2010), p.13 and p.18]. The choices the authors make in designing and developing our Master's track on climate change are in accordance with these findings.

The authors acknowledge the body of knowledge about climate change that is available within the natural sciences. For this (conventional) part of learning outcomes and competences in the Master's track, one can use a *cognitivist* definition (and examination or assessment). However, additional abilities such as communicating, cooperating and negotiating are crucial to make allowance for the existing diversity of perspectives, standpoints and personal (individual) experiences regarding human-induced climate change. Besides that, there will be a plethora of personal and individual tendencies and preferences regarding subsequent actions, which can be taken by the students and professionals in their professional practice and in real life. Here, social learning and performing comes into play, which can be better described using a *constructivist* approach (Johnson and Johnson, 1994; Leeuwis, 2002; Stoof et al, 2002). In the LECH-e Master's track, the authors therefore use a combination of the cognitivist and constructivist approaches to define our competences.

As indicated above, Master's students should not only familiarise themselves with the body of knowledge from the natural sciences on climate change but also:

- become aware of the diversity of perspectives on the issue
- learn to understand that the LECH-e is strongly determined by both physical and socio-cultural contexts (Wilson et al., 2011a)
- learn to study the LECH-e as a multi-dimensional concept in an interdisciplinary manner, integrating approaches from both natural and social science disciplines
- learn to appreciate the value of contextual knowledge gained through personal, social and local experience, alongside 'conventional' scientific knowledge about climate change.

To be able to develop these additional competences, students should be exposed to a range of perspectives on climate change and its impacts, arising from the diversity of contexts, experiences and disciplinary approaches. To use this diversity as a source of inspiration and for better, socially robust solutions instead of conflict and political deadlock, students should learn to think, communicate, collaborate and learn across the boundaries of the different perspectives. The authors refer to this ability for communicative engagement across boundaries as 'transboundary competence' (De Kraker et al., 2007b).

The core overall question the LECH-e project addresses in the development of the Master's track is: 'To what extent can the diversity of knowledge about climate change from the natural and social sciences, together with the 'lived experiences', be used to inform policy making and action at all scales?' (Wilson et al., 2011a).

In terms of competences to be developed, the authors' goals imply both the above-mentioned *transboundary competence* and the ability to inform policy and practice on the basis of acquired knowledge about climate change. This means that students not only learn about the science of climate change, but also are able to critically engage in discussing how scientific knowledge can contribute to the solution of the societal problems that climate changes creates and are able to propose solutions or intervention strategies. The authors refer to this *intervention competence* as the ability to make the step from studying a problem to formulating ways and options to intervene. A more formal and complete definition of the intervention competence in the LECH-e climate change Master's track is:

'the ability to devise or propose, independently and after consultation with relevant actors, one or several sustainable solution(s) for a climate change problem and indicate its consequences for the biophysical and socio-cultural environment.'

Intervention competence primarily requires insight into the nature of scientific knowledge and how it can and cannot contribute to solving complex societal problems. It also requires knowledge of not only the biophysical aspects of climate change issues, but also their social, economic, political and cultural dimensions. Intervention competence focuses on the 'problem-solving' aspect in countering climate change, rather than its fundamental knowledge production. These aspects involve:

- political-strategic thinking, combined with personal and individual goal-directedness (strategic decision making)
- appreciating the importance of networking or the professional labour market
- paying attention to policy assessments and policy scenarios in climate change issues.

Intervention competence prepares students for their future roles both as professionals in the field and as active citizens (Lansu et al., 2006). It can therefore be seen as the lynchpin between science and scientific knowledge at a university on the one hand and personal action and change processes in society on the other. By stressing the importance of the 'lived experience', citizens and employees will be able to link their own experience to both science and abstract and remote government policies. In addition, they learn how to appreciate the diversity of different 'lived experiences', and accept the existence of a multitude of different 'best solutions'.

The authors regard these two additional competences, intervention competence and transboundary competence, as crucial and inseparable elements in a climate change curriculum. Without intervention competence, climate change education would not meet the universities' social responsibility requirement, and without transboundary competence, intervention competence would run the risk of yielding narrow, 'technicist' solutions.

4 Competence-based climate change education in a virtual learning environment

The learning goals of the LECH-e Master's track set a number of challenges for the educational approach, in terms of both didactic framework and learning environment. Given the emphasis on developing intervention and transboundary competences, the authors consider a competence-based learning approach to be the most appropriate for the didactic framework. In the following the principles of this approach are described and how these are put into practice, allowing for practical activities and reflection in a realistic context.

In a competence-based approach, learning should focus on the integrative competences required in professional life, and not on the acquisition of isolated skills and pieces of knowledge. The best way to acquire these competences appears to be in a learning environment that combines actual practice in an authentic or realistic context and explicit reflection on what and how to learn from this practice (Könings et al., 2005).

As a general consequence of this approach, the LECH-e Master's track puts a strong emphasis on in-course activities (Wilson et al., 2011b), many of which are related to the development of intervention and transboundary competences (see for example Box 2). Overall, the students are expected to spend more than 50% of their study time on workbook activities, which involve applying the concepts discussed in the textbook to case studies, developing integrated views on the basis of a variety of sources and discussing these with fellow students and reflecting on different perspectives (see for example Box 3). The final assessment matches and complements these in-course activities.

Box 2 Compulsory group activities in the LECH-e Master's track1 *Carbon footprint calculation*

The aim of this activity is for you to calculate and compare carbon footprints.

Carbon footprint calculation combines the collection of both qualitative and quantitative data and quite simple 'models' have been developed for this purpose. Furthermore, the activity encourages you to think of how you could impact on your personal lived experience of climate change.

2 *Cost-benefit analysis (CBA) of a climate change adaptation project*

The aim of this activity is for you as one student team to develop a CBA on a climate related project from a particular perspective, which you then compare with CBAs derived from other perspectives (developed by the other student teams). Through a moderated discussion and negotiation process a common CBA will be attempted.

3 *Policy brief on the lived experience of climate change*

The aim of this major activity is to build on previous activities to:

- a create a collective (with other students) policy brief on the relevance of lived experience for the evolving European Commission policy on climate change
- b develop skills of working with others and generating knowledge with others from different traditions and cultures through e-learning communities
- c articulate lived experience knowledge

Box 3 Quotes from student discussions in the LECH-e virtual learning environment

"The aspect of the introduction that resonated most with me was the multitude of different perspectives on climate change and the way in which the same set of quantitative data can be interpreted (or an interpretation can be debunked) in different ways to justify vastly different political standpoints."

Student JH

"I found it interesting that climate modelling will always be framed by the values and knowledge framework of the modeller and what they find important. It is inevitable that we have to simplify and screen information to make it manageable and in doing so we inevitably let our values and beliefs guide what we find important."

Student KM

"I think it is useful to see that each knowledge tradition has its own area of expertise and language and the challenge is in translating between, and learning from each other.

Science is inherently reductionist in its approach aspiring to a universally applicable understanding of processes in the natural world. In contrast indigenous knowledge typically offers a micro level understanding of one setting. Built up over a long period indigenous knowledge also integrates the relationship between humans and their environment in a way which science misses."

Student SM

"The lived experience of Kenyan pastoralists is intrinsically interwoven with intentional development interventions and it is very intriguing to observe the contrasting perceptions. The Maasai consider their traditional semi-nomadic lifestyle to be environmentally sustainable whereas the above mentioned NGOs regard 'overdependence on livestock' as damaging. I don't know enough about Kenya to make a normative judgement call, but I feel that this illustrates how important it is for western development actors to keep an open mind."

Student JH

In order to develop transboundary competence, students are made aware of the diverse perspectives on climate change that originate from the diversity of geographical, cultural, social and economic conditions under which people live. Students are provided with, and have to actively look for, accounts of LECH-e from a variety of contexts (e.g., a central 'Water Case Study' that elicits different perspectives on two highly contrasting river systems, the Rhine and the Nile). The importance of transboundary competence is explained to the students and is explicitly presented as a learning goal. In the final assessment paper, the students are required to provide evidence of participation, in and engagement with fellow students, (from a variety of backgrounds) in each of the formal group work activities and, drawing on the discussions they have held with fellow students, to reflect critically on the value of transboundary competence with respect to climate change.

The specific development of intervention competence involves students learning to view climate change issues from multi-disciplinary angles (natural sciences, economics, political sciences and sociology), and learn to integrate these in the normative context of sustainable development. Extensive attention is given to both the natural and social science methods of knowledge production and their implications for the reliability and applicability of scientific knowledge about climate change. Students are guided in their attempts to integrate natural and social science approaches and to combine these with lived experiential knowledge. This should yield results that are more meaningful for climate change policy and practice. Throughout the curriculum, the overarching question that is addressed is how the diversity of knowledge about climate change can be used to inform policy making and action. This is again emphasised in the final assessment, where students have to write a report from the perspective of a researcher and critically review the challenges faced when incorporating lived experience alongside conventional knowledge in policy discussions about climate change in the context of sustainable development.

As indicated above, an important feature of a competence-based learning environment is that it provides an authentic or realistic context for the activities the students have to perform. To achieve this, the authors base the design of the learning environment on the principles of virtual mobility. Virtual mobility is defined as 'using information and communication technologies (ICTs) to obtain the same benefits as one would have with physical mobility, but without the need to travel' (eLearningEuropa.info). Using modern ICTs in a web-based integrated virtual learning environment allows the formation of 'learning communities' (De Kraker et al., 2007b). In these communities, students from a variety of universities and Master's programmes across Europe are exposed to an authentic diversity of perspectives and are asked to perform tasks aimed at understanding, elaborating and debating different perspectives. In the LECH-e Master's track, the diversity of backgrounds of the students is in effect much larger than one would expect on the basis of the geographical distribution of the universities currently involved (Belgium, Germany, Netherlands, Portugal and UK). Reasons are that many students have prior work experience (e.g., as a researcher or policy maker) or combine their studies with professional work, and frequently live or study in a different country than from where they originate. This results in a learning environment that enables the students to communicate, collaborate and reflect with other students, with teachers and supervisors and with those with experiential knowledge of climate change from a broad diversity of backgrounds.

The use of a virtual mobility-based learning environment also enables the introduction of an authentic context for the development of intervention competence. This is achieved by organising an *electronic stakeholder discussion forum*. The forum discussion runs for one month and in it invited stakeholders (professional practitioners and policy makers) engage with students and university staff in discussions on the concept of the 'LECH-e' and its potential to inform policy makers and practice. The stakeholders are given access to all of the educational resources the students are studying, including a complete module on the 'LECH-e'.

The virtual mobility-based learning environment thus enables one to organise discussions between and among students, teachers and stakeholders with highly diverse backgrounds, which would be almost impossible to achieve in a face-to-face setting. Studies into the effectiveness of competence development in virtual learning environments indicate that their practical, economic and environmental advantages are not achieved at the cost of educational effectiveness. According to Barth (2007), these environments may even provide better opportunities for structured group discussions and reflection processes, both individually and collectively. Furthermore, not only are the financial costs of the virtual environment very low, the energy costs and associated greenhouse gas emissions are much lower as well (a factor 6 to 9 lower), compared to the face-to-face alternative (Roy et al., 2008; Pérez Salgado, 2008). This can be considered a major asset especially for a Master's track on climate change. This is an additional reason for our decision to use an e-learning environment.

The educational design of the LECH-e Master's track, including the learning materials and the virtual learning environment, is currently being evaluated in a pilot (May–October 2011). More than 30 students from six European universities are actively involved in this pilot, most of them as part of an accredited course. Staff members from their home universities are tutoring the students, whereas module authors serve as subject matter specialists. Various means are employed to evaluate this pilot. The use of the virtual learning environment is being tracked, discussions in the electronic forums are recorded for quantitative and qualitative analysis, dedicated forums are provided in which students can comment on the learning materials or the learning environment, and questionnaires will be sent to both the students and educational staff involved. The assessments of the students' final papers will also be included in the evaluation, as these will reveal the extent to which competences have been developed.

5 Conclusions

The idea of human-induced climate change is being hotly debated at all levels in present-day society, among students, policy makers, citizens and university scientists. In a worldwide survey, Leal Filho (2010) identified a lack of substantial and systematic attention to climate change issues in university programmes. In addition, his survey identified both needs and problems that arise when implementing serious university programmes.

The LECH-e project addresses this problem by introducing the concept of the 'lived experience of climate change', as described by Wilson et al. (2011a). This concept encourages students to relate abstract scientific knowledge to knowledge gained through personal, local and social experience, across the boundaries of scientific disciplines. A

group of eight European universities have co-designed and developed a joint Masters track entitled ‘The lived experience of climate change’ (LECH-e). In the design of the Masters track, the project adopts a comprehensive competence-based approach, which provides the required integrative attitude and the links with real-life performance.

The present paper focuses on two innovative competences, which the authors consider to be pivotal to education on human-induced climate change at a Master’s level. Transboundary competence develops the ability to think, communicate, collaborate and learn across the boundaries of the different perspectives. With intervention competence, the student’s ability to transform academic knowledge into one or more sustainable solution(s) with respect to a climate change problem is developed. Both competences are being developed using a virtual learning environment with open access to the learning materials. This enables students, professionals and citizens to interact with each other in parts of the curriculum. A pilot is currently underway with a selected group of students and stakeholders. The LECH-e project team will evaluate and report on its results, and adapt the Master’s track according to the findings.

Climate change education can benefit from the integrative approach proposed in this paper. The introduction of the concept of ‘the lived experience’ in university programmes connects abstract and distant scientific knowledge with personal, local and cultural diversity. By adding ‘intervention competence’ to university programmes, students are encouraged to propose and enact realistic and sustainable solutions to human-induced climate change challenges, in relation with relevant actors and stakeholders.

The authors would like to encourage the use of this integrative approach with intervention strategies in other domains. Up to now, this approach has been hardly addressed in a pedagogically consistent way.

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