Climate Change Management

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Climate Literacy and Innovations in Climate Change Education

Distance Learning for Sustainable Development

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Preface

Climate change, as a global and local problem, and e-learning, as a prominent innovation area, are two intersected issues in this book. As a result, we can find an interdisciplinary mosaic in which the researchers' voices build scientific dialogs.

Regarding e-learning and Open Education, the book proposes one main idea: accountability of e-learning and Open Education in Climate Change Education.

E-learning allows add-on teaching and learning; it represents a different paradigm of teaching and learning. Therefore, the analysis of models and methodologies for sustainable e-learning is a fundamental basis to understand it as a powerful method for climate education.

Recent changes in social, scientific, and educational acceptance of e-learning and Open Education, with movements including MOOCs and OERs, put this educational perspective in a prominent place. However, multiple initiatives in this field must be accompanied by research and educational practices for new teaching and learning ecologies. Those ecologies encourage different ways of thinking, teaching, and learning; they are founded in constructs such as open and free education, cultural and social media, ubiquitous learning, m-learning, e-communities, personal learning environments (PLEs), e-participation, or e-citizenship that are challenging the ways teaching innovate on teaching and students innovate on learning.

Through the book chapters, several authors contribute to minimize the gap between practice and research in the development of sustainable e-learning in climate change education. This is also a way of innovating.

Twenty-two double-blind peer-reviewed chapters from Europe (Denmark, England, Germany, France, Latvia, Italy, Spain, and Portugal), Asia (India), Australia, Africa (Burkina Faso, Democratic Republic of the Congo, Malawi, and South Africa), South America (Brazil), and North America (Mexico and USA) cover different subjects related to the theme of this book. Together with massive open online courses (MOOCs), open educational resources (OER), and communications technology (ICT), this book contributes to the discussion about e-learning and Open Education in Small Island States, Climate Refugees, Climate Smart Agriculture in developing countries (the Global South), Climate Literacy, Health

curricula and Teaching, participation and governance systems, interdisciplinarity, and interculturality.

"Human resources resemble a crucial bottleneck in certain parts of the world, as a lack of qualified human resources can hinder the introduction of renewable and energy efficient technologies, as well as the wider application of appropriate technology and, even more importantly, maintenance of those technologies. Concerning capacity building, for example in the field of sustainable energy, recommendations include the use of lifelong learning measures such as dedicated capacity building and continuous professional development programmes, or the extension of curricula to better prepare learners for employment in green economic sectors. These short and longer-term measures should focus on building interdisciplinary, multidisciplinary skills and knowledge as required in sustainability related jobs." Franziska Wolf, Franziska Curran, Ellen Pflaum, and Hannah Ramic in Chapter "Education for Sustainability: Integrating Climate Change and Energy into Lifelong Learning Initiatives for Small Island Developing States" address the challenges and opportunities which open online interventions, such as massive open online courses (MOOCs), combined with open educational resources (OER), can offer to provide wider and free access to interdisciplinary high-quality knowledge provision. An area for which this is in high demand is energy access, energy security, and energy efficiency (EASE) and its relation to climate change, for which there is a growing demand across professions and age levels, and a deficit especially in lifelong learning in the developing world. This will be illustrated through the key online component of a dedicated lifelong learning model developed by the European funded EDULINK project L3EAP (short for "for Energy Access, Security and Efficiency in African and Pacific Small Island Developing States"). It is argued that approaches like the L3EAP mentored MOOC have the potential to play an important role in building and strengthening human capacities in less-developed regions of the world, where awareness of and knowledge about sustainable energy technologies and climate change can be lacking. The authors conclude that embracing ICT solutions can be a valuable cross-cutting measure to address the lack of human capacity in distant, less-developed, and remote locations, such as Small Island Developing States (SIDS), which may constrain a quicker uptake of sustainable energy technologies.

In Chapter "Distance Learning Will Enable Climate Refugees to Avoid Falling into the Social Risk Trap", María-del-Pilar-Quicios-García, Ana-Huesca-González, and Mª-Ángeles-Pascual-Sevillano describe how distance learning can help climate refugees protect themselves against the social risk that results from restrictions on their right to education. This documentary analysis is predominantly theoretical, and its general aim is to present a documentary corpus to facilitate classification of climate refugees in terms of their ICT competence. The specific aim is to provide keys for the design of educational programs that can closely match the competences of the individual refugee. This is the novelty and originality of this chapter. The refugee has traditionally been treated as an element within a group to which common educational methodologies are applied. This chapter treats each refugee as

an individual according to their ICT skills, so each one will require a specific type of education.

"Poverty and climate change vulnerability is increasing in Sub-Saharan Africa (SSA) because the region lacks education and skills development facilities and sustainable governance systems. Arguably, mainstreaming climate literacy in secondary schools through Information and Communications Technology (ICT) modalities can promote sustainable development and climate change resilience by providing early opportunities for the youth to gain knowledge and awareness of the behavioral and cultural changes that may foster improved climate change resilience." Dumisani Chirambo in Chapter "Leaving No-One Behind: Improving Climate Change and Entrepreneurship Education in Sub-Saharan Africa Through E-Learning and Innovative Governance Systems" through an inductive analysis based on research articles, case studies, policy briefs, and academic literature reviews, sought to highlight emerging ICT learning contexts in SSA as a means to determine the extent to which ICT may be used to promote climate change and sustainable development education in secondary schools. The paper showed that climate literacy at secondary schools was being constrained by a lack of climate change education material and content on existing ICT learning platforms and a lack of innovative governance systems to support governments in delivering climate literacy content to secondary schools and the youth. Consequently, to "leave no-one behind" requires non-state actors to develop and utilize innovative governance systems and digital climate literacy material that can complement government efforts to mainstream climate literacy at secondary schools.

"Hunger is still a major issue in the developing world. Education and sustainable agriculture can be seen as key links in overcoming hunger. Both can be combined in e-learning technologies; a popular method in developing countries and the Implementation of e-learning could provide a great leverage in improving education for sustainable agriculture in developing countries. E-learning has conditions which contribute to the implementation and success of e-learning." Aafke Schaap, in Chapter "E-learning as Tool to Feed the World", aims to assess if the Food and Agriculture Organization of the United Nations (FAO) addresses e-learning conditions according to scientific findings in their "E-agriculture Strategy Guide - Piloted in Asia Pacific Countries". This research answers the following question: Does the FAO address e-learning conditions per scientific findings in their "E-agriculture Strategy Guide"? If so, which conditions are addressed? This assessment is based on a literature review which provides a theoretical framework. With this framework, the selected FAO document is reviewed. The results present that the FAO takes all conditions, except two into account. The focus of the FAO in their "E-agriculture Strategy Guide" relies on course content, system (and internet) quality, and equality in education. Interpretation of the results shows that the FAO focusses on e-learning conditions of a technical nature or is close to other goals of the United Nations, such as equality. This research provides preparatory research for evaluation of e-learning strategies implemented by the FAO.

Maria Nuutinen and Walter Leal Filho in Chapter "Online Communities of Practice Empowering Members to Realize Climate-Smart Agriculture in

Developing Countries" introduce the readers to "Communities of practice that are networks where individuals share the same interest and the will to learn together on the same domain through regular communication". The Food and Agriculture Organization of the United Nations (FAO) has facilitated and provided online learning opportunities to 12 climate-related communities since 2012. Their objective is to speed up knowledge-sharing, innovation, and the uptake of sustainable, climate-smart agricultural practices. Based on members' feedback and online monitoring results, the structured learning events, and messages in the communities' online fora (email-based discussion fora, webinar platform, and a group on social media), some 12 500 members have helped the members and their colleagues and organizations to solve problems related to climate and food security. In this chapter, an analysis of the bottlenecks and possibilities of how online communities could benefit a larger group of stakeholders is performed, and the capacity development methods improved for stronger impact are outlined. This chapter also introduces the challenges seen in implementing the concept of online communities of practice, as well as related capacity development methods, outlining technical and nontechnical components.

Eva A. McNamara, Melaine Kermarc, Joseph Zambo Mandea, and Glenn Bush, in Chapter "Tertiary Education Knowledge and Standards in Sustainable Development: A Crisis for the Democratic Republic of the Congo", present a case study to stimulate debate and action to avert a crisis in capacity to plan and manage development sustainably in the Équateur province of the Democratic Republic of the Congo (DRC). The case study examines environmental literacy of higher education students enrolled in programs focused on rural sustainable development in the context of human resource needs to effectively implement complex sustainable development programs financed through international climate change initiatives. Written surveys of students and teachers and semi-structured interviews with key informants in a higher institute of education's administration revealed low comprehension of key environmental issues in the region (climate change, deforestation impacts), low French literacy, and limited access to teaching and learning materials as well as the Internet. Overall, this case study illustrates those immediate interventions which are needed to avert a current crisis in the ability of the DRC to scale-up planned sustainable development programs. Curriculum revisions and improved access to current information and training methods are especially needed to create a foundation for sustainable development within the country.

"The global food system makes a significant contribution to climate change, affecting greenhouse gas emissions and other major environmental impacts along the entire food chain. Individual food consumption is an important part of the production-consumption chain, because consumers make the final choice of the goods and services they consume, and their lifestyles determine how they influence sustainability practices. Simultaneously, there is an increasing concern for the environment issues and an increasing demand for naturalistic icons or organic production, free-range farming and unadulterated processing." Ana Pinto de Moura and Luísa Aires in Chapter "Food and Sustainability: An Emerging Subject in

Sustainable Environmental Sciences Education Applying to the e-Learning Environment" address the imperative to address sustainability in food consumer sciences education, due to the multidisciplinary nature of consumer food studies, by applying online education programs. The rational for e-learning approach is the fact that advances in information and communication technologies have had a tremendous impact on the format and approaches to teaching and learning.

"Climate literacy is a key impetus for triggering individual behavioral and societal change. Massive Open Online Courses (MOOCs), at first glance, entail a multiplier effect for climate literacy as they are recognized for offering non-formal learning opportunities to a wider audience. However, throughout the recent years MOOCs have been under manifold criticism from various corners challenging their educational value. A remedy for shedding light on the question whether MOOCs are a powerful tool for climate education is to bring in the students' perspectives on and experiences with MOOCs. These findings disclose the recipients' perceptions and give empirical evidence to assess the incorporation of non-formal learning into the students' learning context." In Chapter "MOOCs—A Powerful Tool for Imparting Climate Literacy?" insights from discussions with students, Daniel Otto presents an empirical study based on 35 interviews conducted with students who participated in an English-speaking MOOC about interdisciplinary perspectives on climate change. The interviewed students represent a variety of different nationalities and academic backgrounds. During the semi-structured interviews, the students revealed diverse reasons for their participation in the MOOC, multiple learning outcomes, and manifold opinions regarding the use of the MOOC in their personal learning context. This concludes that while MOOCs are a promising tool for climate change education, they require a deeper understanding by incorporating the students' perspective.

In Chapter "E-collaborating for Environmentally Sustainable Health Curricula", Peter Musaeus, Caroline Wellbery, Sarah Walpole, Hanna-Andrea Rother, Aditya Vyas, and Kathleen Leedham-Green aimed to demonstrate how medical educators can use e-collaborative tools for collaborating internationally and cross-institutionally toward designing environmental sustainability and health (ESH) education. The main focus of the chapter is on sustainable medical curricula. The chapter uses a case study approach to bridge these broader e-collaborative principles with the specifics of implementation driven and supported by e-collaboration. The case study describes the evolution of the Sustainable Healthcare Education (SHE) network into a network collaborative. Finally, the chapter discusses e-collaboration for education development through an illustrative case. The case concerns a UK-Greek University e-collaboration aimed at combating obesity and promoting climate literacy. E-collaboration is central at all levels of the ESH curriculum design process from forming a network collaborative around the curriculum process, alignment of assessment, and learning activities with objectives, discussing and agreeing on a vision to the actual implementation plan. E-collaboration aids the curriculum design process such that people feel that their participation and interests are valued, as well as providing resources and input to resource-stressed academics and institutions. E-collaboration is not an end in itself,

but a means of enabling a global network collaborative to address an issue that suits this type of collaboration toward sustainable healthcare education. This chapter is original in showing how a component of a sustainable medical curriculum is the promotion of climate literacy and how this is linked with e-collaborative tools. The chapter shows how health education should educate climate literate health professionals who can address and reduce public health impacts of climate change.

"Massive open online courses (MOOCs) give the opportunity to engage and teach a global audience in the rationale and arguments of climate change and its impact on health." In Chapter "Massive Open Online Courses (MOOCs) on Climate Change and Health: Teaching a Global Audience", Sandra Barteit, Anneliese Depoux, Ali Sié, Maurice Yé, and Rainer Sauerborn describe the possibilities of MOOCs for climate change education based on the example of three MOOCs on climate change and health that were offered on the online learning platform university and FUN-MOOC. One MOOC was designed for a broader audience without prior requirements in the area of climate system and climate change. The learning target was health impacts worldwide, best practices in adaptation and mitigation strategies, as well as the promotion of health co-benefits. This MOOC was subtitled in ten different languages. An executive MOOC was targeted at policy-makers as part of their conference briefing for the climate conference COP21 in Paris in 2015. The key arguments of the MOOC included the development of climate policies and their share of the burden and benefits, as well as scientific evidence behind the four key arguments based on human health for climate policy (Sauerborn 2016a, b). The third MOOC focused again on a broader audience on climate change and health within an African context for a francophone audience. In the following, authors introduce MOOCs for teaching climate change education to a global audience, also with a focus on developing countries, followed by a description of the three MOOCs on the topic of climate change and health in more detail with regards to their contents, participant demographics, retention rate, and encountered challenges. The authors discuss findings with regards to all three MOOCs and give insights into practices for employing MOOCs in climate change education, for developed and developing countries.

As emphasized in the Paris Agreement, effective capacity building is vital to enable developing countries to take strong climate action. However, such capacity-building systems cannot rely solely on our age-old systems of individualized instructions and certification through educational institutions. The target groups to be capacitated have strong livelihood concerns and possess tacit knowledge to address their issues. This rich pool of tacit knowledge needs to be blended with structured knowledge of the Educational Institutions and should be aimed at finding solutions in real-life settings. Paradigmatically, new approaches for adaptation and mitigation activities would go a long way in realizing these development goals. Distance education as a philosophy and as a methodology is favorably positioned to respond to the climate change impact by creating systems which are outward-looking, reason-driven, and involving multi-stakeholder's environment. Umesh Chandra Pandey and Chhabi Kumar in Chapter "Emerging Paradigms of Capacity Building in the Context of Climate Change" suggest a step

further in this direction to create paradigmatically new capacity-building systems for climate change. The idea is to have a paradigm shift in the university education from being structured with a predetermined curriculum and one which is based on individual certification to a contextualized learning based on practical knowledge, real-life experiences for exploring solutions in consultation with the community. The chapter would focus on how distance learning would create such opportunities and at the same time provide for capacity-building programs for climate change impact and its aftermath.

Luis Velazquez, Krystal Perkins, Nora Munguia, and David Zepeda in Chapter "A Coil-Enhanced Course on International Perspectives of Climate Change" considered the potential and significance of embedding intercultural experiences and globally networked learning into courses on climate change and sustainability. In particular, the State University of New York's (SUNY) Center for Collaborative Online International Learning (COIL) has developed a pedagogical approach aimed at fostering multicultural learning across various areas of study. Drawing from our experiences participating in the COIL Center's professional development programs and through the implementation of a COIL-enhanced course, several suggestions for infusing COIL-like models into courses on climate change and sustainability are offered. To begin, a brief review of the existing literature on distance education is provided. Then, a brief background of the SUNY COIL System is presented. This is followed by a case study analysis of the COIL-enhanced course, International Perspectives on Climate Change. Finally, some reflections about the COIL experience at the University of Sonora are offered, including successes, challenges, and suggestions for fostering climate change literacy and sustainable learning.

"Climate change is a key issue on today's scientific, social and political agenda. The United Nations Sustainable Development Goals reinforce its current priorities in this regard (e.g. SDG 13 Take urgent action to combat climate change and its impacts) and is one of the five priority areas of the Strategy 2020 of the European Commission." Fátima Alves and Ulisses Miranda Azeiteiro, in Chapter "Climate Change and e-Learning: Interdisciplinarity and Interculturality Challenges", discuss the specificities of climate change online learning in respect to syllabus contents and highlights its multidisciplinary and multicultural components. One of the characteristics of online learning is its capacity to reach an extensive number of people, scattered around the world and with diversified cultural backgrounds. This opens an extremely valuable path to research and societal responsibility, filled with potentialities and challenges. Student's cultural diversity and geographical belonging must be reflected in the syllabus contents, as well as in the objectives of the courses and in the competencies that should be promoted. Furthermore, in the design of the courses, it is increasingly relevant to reflect and value an interdisciplinary approach to teaching and learning, because it is a key factor in Climate Change Education and Awareness. In this interdisciplinary and multidisciplinary dialog, it is crucial to evidence the cultural and contextual validity of knowledge and the impact of socioenvironmental dimensions in the configuration of climate change challenges. For the purpose of this study, we took as an example two course proposals: "Environment, Health and Wellbeing" for social sciences undergraduate

students and "Governance of Climate Change Adaptation" for postgraduate students, presenting teaching contents, teaching and learning methodologies, effectiveness through e-learning in higher education institutions (HEIs), and the potential for increase in public climate science literacy.

"Spain and Brazil have played two significant roles in the field of higher education through inter-university cooperation; on the one hand, highly updated contents relating to sustainability and, on the other hand, an innovative system for the evaluation of education through competencies." Maria Julia Rubio Roldán, Glauco Gomes de Menezes, and João Carlos Cunha in Chapter "Innovations in Climate Change and Sustainable Management in Higher Education. Training and Evaluation" present an analysis of the model of integral sustainable administration. This model combines social, economic, and environmental factors based on the most outstanding contributions in this topic, and coins the concept of "socioecosustainability" as a necessary model for the twenty-first century. Furthermore, an educational process based on the model of climate change is evaluated. Conclusions provide useful recommendations to improve higher education around sustainability from the point of view of acquiring fundamental competencies for the development of professionals in truly sustainably organizations.

"Although distance learning and e-learning are currently acknowledged as important training tools for higher education institutions, they are seldom used as a way of disseminating environmental sustainability, climate change and its implications." Fernando J. P. Caetano, Carla M. B. P. Oliveira, Magnólia F. F. Araújo, and Maria C. F. D. Rego in Chapter "Towards Climate Change Awareness Through Distance Learning—Are Young Portuguese and Brazilian University Students Vigilant?" present the result of a teamwork between two universities, one from Brazil and the other from Portugal, which joined efforts to promote an interdisciplinary massive open online course associated with the environmental sustainability. We have interviewed university students from these two countries in order to understand their main conceptions and ideas about the climate changes as well as proposals they have for its mitigation. From these dialogs, we observed that, irrespective of the geographical distance/location, those students share similar concerns, conceptions, and proposals but it is noticeably lacking scientific knowledge when discussing these topics. This is an important starting point for the creation of a set of learning resources accessible to different audiences and with different and diverse backgrounds that can stimulate the interest of scientific knowledge. In this context, it is our belief that e-learning and distance education supported by the information technologies can efficiently and effectively contribute to a well-supported knowledge on environmental sustainability, namely climate changes and its causes and effects.

"As this is stressed in the international legislation and research, climate change is a serious global problem that has a negative impact on the quality of life which needs solutions at both global and local levels." Dzintra Iliško and Oļegs Dedels, in Chapter "Dealing with Climate Change as a Wicked Issue via Innovative Approaches", reflect on good practice of integrating innovative pedagogical

approaches dealing with climate change as a complex and wicked issue in a blended university study course: "Educating for sustainable social and cultural changes" at the Master's program level. The course is carried out at a regional University and highlights a promising practice of engaging students as transformative actors in their local contexts for initiating sustainable changes. It was concluded that the climate change issue needs to be dealt with as a wicked problem within a sustainability framework, and it needs to become an integral part of learning for a sustainable development. By learning about climate change, students not only acquired knowledge but also developed competencies to adopt sustainable lifestyles leading to a climate-resilient and sustainable behavior. The authors believe that a sustainable development requires changes in the way people think and act, and they see education playing a critical role in teaching-relevant skills for the application of change in this issue.

Paulo Dias, Luísa Aires, and Darlinda Moreira, in Chapter "e-Learning Diversification in Higher Education: Conceptions of Participation", reflect on the conceptions and different forms of participation in e-learning contexts in higher education and its influences in climate change literacy. Although the literature review highlights intense research on the value of participation in informal contexts, we argue that the construction of a pedagogical discourse on e-learning cannot be sustained without the pedagogy of participation. Such participation also acquires new meanings when analyzed using socio-constructivist and cultural approaches. In this study, the analysis of participation in e-learning contexts is based on categories such as leadership, sharing, and cohesion. The empirical data presented are the result of more wide-ranging research carried out at the Observatório da Qualidade da Educação a Distância e e-learning (Distance Education and e-learning Observatory) at the Universidade Aberta, Portugal. Data were collected from the online questionnaire given to a sample of 26 e-learning course leaders and pedagogical coordinators in face-to-face higher education institutions. The conclusions of the study highlight the different conceptions about the nature of e-learning processes and practices in higher education, which we believe highlight the need to promote a participation-oriented pedagogy as a fundamental aspect of both climate change literacy/education and online education and based on the construction of both pedagogical innovation and teachers' education to teach in virtual environments.

"The environmental crisis, caused by unsustainable development and an unjust model, requires a global change in a political, social and environmental context". To promote this change we need to redirect Higher Education to train citizens to be able to make responsible decisions and act in a sustainable way. This requires educational initiatives promoted by universities to redirect teacher training towards sustainability. With this objective, Mercedes Varela-Losada, Azucena Arias-Correa, and Pedro Vega-Marcote in Chapter "Training Teachers Committed to Climate Change Mitigation" present and focus a teacher training proposal based on treating the problems of climate change, the climate education, and the development of teaching skills. Its purpose is to enable students of the Faculty of Education Sciences, future teaching staff, to participate, individually and collectively, in

improving this socioenvironmental problem of a local and global nature, which also has a multiplier effect for society in their later professional development. The proposal is based on a holistic and participatory methodology, promoting the development of sustainable skills, participation, information processing, critical thinking, and autonomous and informed decision-making using ICTs and a platform providing distance learning. The experience can be the foundation for future proposals in different contexts and professional profiles.

Diogo Casanova, Linda Price, and Barry Avery, in Chapter "Supporting Sustainable Policy and Practices for Online Learning Education", describes an approach to the adoption of online learning in higher education. It is particularly relevant for readers interested in Online and Distance Learning initiatives that enact an agenda of climate change education through being sustainable and future proof. Authors present a pathway for ensuring sustainable educational initiatives, drawing from research that identifies crucial factors in this endeavor. In particular, it addresses how the adoption of Online and Distance Learning can be used as a catalyst for changing the pedagogical paradigm of universities and how this change may impact on the development of new policies and guidelines. In this chapter, we report on how policy, guidelines, and professional development can be designed for sustainable and consistent learning design and teaching practices.

In Chapter "Sustainable Mobility in Higher Education Through Virtual Attendance", Esteban Vázquez Cano and M.ª Luisa Sevillano García present various proposals for improving student mobility on their journeys to and from university. Specifically, we describe a student service delivered by the virtual attendance system implemented by the National Distance-Learning University (UNED) which is not only a reference in terms of support for the teaching-learning process but also enables the reduction of student journeys to UNED-associated centers and university campuses, thus reducing both the air and noise pollution caused using motorized vehicles. Furthermore, we analyze from the perspective of social networking analysis (SNA), the network of interactions obtained in online discussion forums about the benefits of using virtual attendance at University. The results show that students' perceptions about this system enables the reduction of private motor vehicles, contributes to the elimination of mobility wastes, and fosters academic networking and collaborative work at university.

"E-learning has increasingly been acknowledged as a legitimate option which contributes to the democratization of higher education. One of its advantages is the possibility of reaching non-conventional publics for higher education, including workers, adults, and people who live outside the main city centers. This is also an important aspect about sustainability education, particularly when addressing climate change education, as these publics may be less easily reached by conventional educational settings." Filipa Seabra, Susana Henriques, Teresa Cardoso, Daniela Barros, and Maria de Fátima Goulão in Chapter "E-Learning in Higher Education: Academic Factors for Student Permanence" discuss "permanence as a key issue and a significant obstacle to the success of any e-learning based initiative—for the educational goals to be met, one must ensure, in the first place, that students who enroll in a program are able to persevere, successfully learn, and reach graduation.

This chapter presents a framework of the concept of permanence in higher education, particularly in e-learning contexts and concerning adult populations."

"The dramatist and the scientist have similar goals as they both attempt to 'create unique, engaging and insightful texts about the human condition' (Saldina, J. (1999, p. 60). As the risks of devastating climate change becomes more and more apparent there is a growing understanding of the role the creative arts can play in making sense of the ecological challenges we encounter. Drama processes and performance can widely engage with sustainability issues across several Year levels and it's behavioral activism appeals to its audiences to think for themselves and 'act'. Dramatic form is premised on critical and creative thinking. As an art form, it is only a complete learning activity when it engages the learner to experience the drama and 'do' or 'act'." Linda Hassall, in Chapter "Climate Literacy and Collaborative On-Line Landscapes: Engaging the Climate Conversation Through Drama Facilitation in Distance and e-Learning Environments", discusses the potential to introduce climate literacies into online learning platforms through drama curriculum processes and practices. While utilizing drama in online learning landscapes is still largely a theoretical proposition, this paper suggests that the dramatic form could provide a unique means of fostering climate literacies with distance learners. A focus on environmental and ecological issues in the curriculum through drama collaborative processes and practices can potentially increase the possibilities for global climate change education and promote the importance of sustainability for future generations. This paper therefore proposes that dramatic investigations of scientific discourse may provide unique ways of developing climate literacy through alternative understandings, through adopting scientists' amassed knowledge and transforming it into something that can be experienced and explored kinesthetically in the representational worlds of the drama.

Given the variety of research, this book offers a diverse thematic/disciplinary and geographic overview of some current research and projects/action projects in Climate Literacy and Innovations in Climate Change Education—Distance Learning for Sustainable Education. In addition, the chapters address some important challenges and future developments, also giving insights to the discussion around consequences at multiple spatial, temporal, education, and socio-political scales and the multiple dimensions of Climate Literacy and Innovations in Climate Change Education.

We would like to take this opportunity to thank all authors who submitted their manuscripts for consideration of inclusion in this book. As the peer review was a double-blind process, we also thank the reviewers who have taken time to provide timely feedback to the authors, thereby helping the authors to improve their manuscripts, and ultimately the quality of this book.

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Contents

Education for Sustainability: Integrating Climate Change and Energy into Lifelong Learning Initiatives for Small Island Developing States

Franziska Wolf, Franziska Curran, Ellen Pflaum and Hannah Ramic

Abstract Human resources resemble a crucial bottleneck in certain parts of the world, as a lack of qualified human resources can hinder the introduction of renewable and energy efficient technologies, as well as the wider application of appropriate technology and, even more importantly, maintenance of those technologies. Concerning capacity building, for example in the field of sustainable energy, recommendations include the use of lifelong learning measures such as dedicated capacity building and continuous professional development programmes, or the extension of curricula to better prepare learners for employment in green economic sectors. These short and longer-term measures should focus on building interdisciplinary, multidisciplinary skills and knowledge as required in sustainability related jobs. This chapter addresses the challenges and opportunities which open online interventions, such as massive open online courses (MOOCs), combined with open educational resources (OER), can offer to provide wider and free access to interdisciplinary high quality knowledge provision. An area for which this is in high demand is energy access, energy security and energy efficiency (EASE) and its relation to climate change, for which there is a growing demand across professions and age levels, and a deficit especially in the developing world. This will be illustrated through the key online component of a dedicated lifelong learning model developed by the European funded EDULINK project L3EAP (short for

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"Lifelong Learning for Energy Access, Security and Efficiency in African and Pacific Small island Developing States"). It is argued that approaches like the L3EAP mentored MOOC have the potential to play an important role in building and strengthening human capacities in less developed regions of the world, where awareness of and knowledge about sustainable energy technologies and climate change can be lacking. The authors conclude that embracing ICT solutions can be a valuable cross-cutting measure to address the lack of human capacity in distant, less developed and remote locations, such as Small Island Developing States (SIDS), which may constrain a quicker uptake of sustainable energy technologies.

Keywords Mentored MOOC · Sustainable energy · Open educational resources Small island states

Introduction

Human resources resemble a crucial bottleneck, preventing parts of the world from entering more sustainable development pathways. A lack of qualified human resources still constrains the introduction of renewable and energy efficient technologies as well as the wider application of appropriate technology in Small Island Developing States (Innis 2012). The lack of qualified local personnel for maintenance of those technologies may further threaten progress in achieving the Sustainable Development Goal #7 which aims to ensure access to affordable, reliable, modern and sustainable energy for all. This is even more crucial for developing nations. Small Island Developing States (SIDS), for example, are constrained by some inherent characteristics, e.g. remoteness, small population, size of land, institutional infrastructure e.g. higher education institutions (HEI), and access to finance. At the same time, however, SIDS are highly susceptible to impacts of climate change as they are often located in regions where sea-level rise and extreme events such as cyclones, flooding and droughts already severely impact national development today (UNEP 2014). Many SIDS are heavily dependent on oil to fuel their economies and, correspondingly, national development. As such, exploitation of renewable energies such as solar, wind, geothermal and other types for production, combined with increasing energy efficiency in production and consumption, promises a significant opportunity to reduce the economic burden and dependence on fossil fuels, increasing sustainable development while contributing to the provision of cleaner energy supplies.

For SIDS, the qualification of its island workforce, such as through formal education, can be costly both on institutional as well as on individual levels. Informal educational measures, openly accessible knowledge and free educational offers become more and more important, not only for younger generations who grew up with internet technology but, in fact, all age groups. The buzzword 'lifelong learning' refers to the range of educational formats—in classroom settings, outside the classroom or online—, comprising general education, vocational

education, vocational training, non-formal education as well as informal learning undertaken throughout life which ideally leads to new knowledge, improved skills and strengthened competencies.

First and foremost, online learning activities are often regarded as one possible way to reduce costs of instruction. Referring to higher education institutions (HEI), Yuan and Powell (2013:17) claim that "higher education is already experiencing a period of unprecedented change worldwide", and the cost of funding was a major driver of this change which appears to be valid for both the developed as well as developing world. Moreover, online learning activities may serve to attract new sources of funding, reach out to new and external learners and even improve the quality of teaching and learning through embedding innovative formats and types of media that address learner behavior and labor market needs. Wolf et al. (2018:1) add that "embracing ICT solutions, in the area of energy, can be a valuable crosscutting measure to promote education for sustainability and address the chronic human capacity problem that constrains the quicker uptake of sustainable energy technologies in SIDS". How HEI may support such development will be briefly elaborated in the following chapters.

Chances and Drivers of ICT-Based Capacity-Building for Higher Education

When assessing the potential for ICT to be used in capacity-building, it needs to be considered that such mediated online learning arrangements fundamentally differ from on-site trainings (Siemens et al. 2015; Muilenburg and Berge 2005). Those who are working in the dynamic fields of renewable energies (RE), be it practitioners implementing RE technologies or educators at HEI who are teaching tomorrow's RE professionals, face the need to continuously update their knowledge and skills to meet the demands of working and academic environments (Wolf et al. 2018). This underscores the relevance and growing demand for lifelong learning opportunities that enable individuals to continuously update their knowledge levels and skills throughout their working lives, i.e. build new and strengthen existing capacities.

Regarding formal and non-formal education, and fueled by the inception of the Internet, digital technology has, by now, been adopted by higher education institutions (HEI) and beyond, for teaching and learning on and off campus all over the world (Kirkwood and Price 2016:1). Digital media can be utilized for classroom teaching, in blended learning contexts where learners participate in both classroom and digital sessions, as well as fully online, such as in virtual classroom settings, which might have online lectures or modular courses. These are, increasingly, developed in the form of massive open online courses (MOOCs), and offered both by providers of formal education, i.e. HEI, as well as private actors. There are three main drivers especially for HEI to develop such openly accessible online courses:

They expand access to higher education to a broad(er) audience, they allow HEI to create a space for experimentation with online teaching and learning, and they serve to extend the HEI's brand, helping them to gain international reputation. Generally, private companies reach out to learner groups that may not resemble the 'core' target groups of universities, for example learners who lack resources, time or entry qualifications for formal education offers yet strive to strengthen existing or build new capacities, or improve existing skills and competencies (Yuan and Powell 2013:8).

From a learner's point of view, openly accessible online learning can resemble a cost-efficient, convenient measure to foster lifelong learning, and more and more HEI have started to embrace such online approaches for a number of reasons. Firstly, there has been an increase in the availability of appropriate technological infrastructure as well as in the acceptance of online learning. This is reflected in increased digital literacy of learners, who nowadays have fewer barriers to be able to master digital technologies and their related hardware, and in the growing number of educational offers of various kinds (DiMaggio and Hargittai 2001; Wolf et al. 2018). Online learning offers a range of degree courses, from fully free and open to paid. For example, the Massachusetts Institute of Technology (MIT) started offering open online courses already in 2002 (Yuan and Powell 2013), whereas the major universities in SIDS regions, for example, the University of the West Indies (UWI) in the Caribbean, offers over forty paid full-time online degree programmes in various disciplines, indicating popularity and acceptance of online learning in SIDS (http://open.uwi.edu/programmes). Relating to HEI and their online learning offers, Yuan and Powell (2013:17) suggest a "significant momentum behind the concept of free and open access to high quality university learning, and it is likely that content and courses will continue to be promoted resulting in more MOOCs and other types of open education approaches emerging."

Openness is another driver of educational innovation and is expected to lead to further transformation of higher education. According to Yuan and Powell (2013:6), the concept of openness in education- relating to the free sharing of knowledge through which demographic, economic, and geographical barriers to learning may be overcome—had already evolved in the early 20th century. Referring to small island populations, the growing openness in online learning can thus provide great opportunities to access the latest know-how and expertise, to support lifelong learning. OER are characterized as openly accessible resources, i.e. downloadable via the internet, for which the creator explicitly permits their use by third parties for teaching and learning as well as non-commercial or commercial usages. Creative Commons licenses are the means to clearly define the type of use, i.e. if the OER may only be used or if it could even be changed and used in further settings by others (Mruck et al. 2013). By now, there is an established open educational resources (OER) movement comprising a wide range of organisations, governments, institutions, educators and learners from all over the world who fund, support, develop and use OER (Yuan and Powell 2013:18). Also city governments have become interested in seizing opportunities of OER to increase the leverage of academic knowhow. One example of this is how the Hamburg Open Online

University (HOOU) bundles all OER material developed by the higher educational and research institutions of The Free and Hanseatic City of Hamburg in Germany, on an openly accessible platform for its citizens (see: www.hoou.de).

While academics, like in the case of the HOOU, explore and experiment with the development of OER material, such as small content used for teaching and learning, the literature suggests that open courses such as MOOCs have the power to influence existing teaching processes, It is argued that educators can take part in, and share their knowledge in, open courses facilitated by others, and through this, learn and explore the pros and cons of various online learning approaches in different learning contexts (Yuan and Powell 2013:18).

A number of motivations exist for the development and use of MOOCs, as well as the participation in MOOCs. For universities and educational institutes, this could include to increase reach and flexibility of offered coursework, as well as for cost drivers as technology assisted learning can do (Kirkwood and Price 2016) or to strengthen, support or supplement parts of curriculum of a program. Zheng et al. (2015) examined the motivations for learners to do MOOCS and found that they cover reasons such as complementing their studies or work, to assist in improving their employability, and for curiosity, amongst other things.

Complementing this, a study conducted by the Duke university singled out four categories of learner motivations: (i) Tapping into new areas of knowledge; (ii) Personal challenge combined with social network aspect; (iii) Simplicity and convenience; and (iv) Curiousness to explore online education (Belanger et al. 2013).

Opportunities and Challenges of Massive Open Online Courses

Technological advances have facilitated the development of online learning environments, which can enable learning across distances. Online resources can be used to support traditional learning methods to improve learning outcomes and can be utilized in a fully online or blended online and classroom manner (Nguyen 2015), in groups or by individuals (Keegan 1998). A study by Nguyen (2015) surprisingly revealed null findings for the difference of online learning to traditional face to face learning.

Massive Open Online Courses (MOOCs)

While MOOCs are a form of online learning, there are some significant differences between virtual learning environments and MOOCs. This can include things such as the accessibility and openness that MOOCs can have, which can differ from

virtual learning environments, as well as the scales generally operated on, for example (Zheng et al. 2015).

MOOCs, as their name may suggest, are courses that are massive in scale, open and online, however there is still some contention around having a clear definition (Kay et al. 2013). Massive in scale refers to the number of participants (Waks 2016) (Hood and Littlejohn 2016), and there can be significant variation in these such numbers while still having the course fall under the MOOC banner. The 'openness' of a course, according to Hood and Littlejohn (2016) can have a number of meanings such as such as access, cost, that the knowledge is open or that it is open to be reused and developed further and as can the 'online' nature of MOOCs, which could be fully online or blended. As such and in general, a MOOC is an online course that is theoretically accessible to large groups of people.

Classification Schemes

The two main ways that MOOCs have been traditionally characterised as are either 'xMOOCs' or 'cMOOCs'. xMOOCs typically have a more traditional course and lecture format, but are extended and online; these have been known as the most commonly represented, and the most common types of MOOCs (Kay et al. 2013). cMOOCs, also known as connectivist MOOCs are ones which rely upon the generation of knowledge through participation of learners, and creation of course content through interaction and communication with each other (Kaplan and Haenlein 2016). As such cMOOCs might rely upon use of social media, and discussion forums as a central part. Although this classification system as xMOOCs or cMOOCs has been commonly used and referred to, some sources suggest that this system is insufficient to capture the diverse natures of these types of courses and their unique attributes (Conole 2014), and there are other ways that they have been described.

There are diverse characteristics and attributes that MOOCs can have, which can be used to classify them in different ways. Considering time, courses can be synchronous or asynchronous, meaning that learners are carried through the course at the same time, or can access it in their own time, respectively. As such these courses have sometimes be labelled as SMOCs, synchronous massive online courses or SSOCs synchronous small online courses (Kaplan and Haenlein 2016). The degree of 'openness' of a course can give rise to variation of MOOC look-alikes, such as SPOCs, small private online courses (Hood and Littlejohn 2016; Hashmi 2013).

Some MOOCs are labelled based on their purpose, such as the use of MOOCs4D, MOOCs for development (Castillo et al. 2015), which can serve to increase reach and information flows and build capacity for sustainable development outcomes, for example. Clarke (2013) proposed a list of 8 different types of MOOCs that take into account some of the main characteristics, such as origin, time and size. These

included: transferMOOCs, madeMOOCs, synchMOOCs, asynchMOOCs, adaptiveMOOCs, groupMOOCs, connectivistMOOCs and miniMOOCs.

Finally, Conole (2014) proposed 12 dimensions that could be used to classify MOOCs which were: the degree of openness, the scale of participation, the amount of use of multimedia, the amount of communication, the extent to which collaboration is included, the type of learner pathway, the level of quality assurance, the extent to which reflection is encouraged, the level of assessment, how informal or formal it is, autonomy, and diversity. These dimensions and different named classifications confirms that there is huge diversity in types and broadness in the definition of what a MOOC is.

Challenges and Opportunities

One of the major challenges facing MOOCs is that there is no agreed upon and robust way, or set of metrics, to measure quality and impact of MOOCs and to compare between different MOOCs (Hood and Littlejohn 2016; Onah et al. 2014). A very common metric used is drop-out rates, which can be contributed to by factors such as; student intent to complete or not, lack of time, difficulty and lack of support, amongst other things (Onah et al. 2014). Measurement of MOOC quality by drop-out rates alone has been heavily criticised, and it is recommended that contributing factors need to be taken such as participant motivations (Daradoumis et al. 2013). A metric related to drop-out, but looked at across the duration of the MOOC is persistence, as explored by Breslow et al. (2013). This can capture how far through a course students move before dropping out, and might imply how much benefit a student received from the course prior to dropping out. In general it is recommended that caution is applied to understand any metrics used (Hood and Littlejohn 2016) when evaluating the quality of a MOOC or comparing between them. Context specific metrics that reflect the unique nature of participants and their motivations, as well as course outcomes might appropriate for assessing the quality and success of MOOCs.

Aided by their ‘open’ nature, the ability to attract diverse participants from around the world and with varying levels of education is a strength of MOOCs, however this is not always fully realised (Hood and Littlejohn 2016; de Waard et al. 2014). It has been noted that ‘access’ for people in developing countries can be quite complex with a number of barriers including infrastructure access, digital literacy and language barriers (Liyanagunawardena et al. 2013). In general, MOOCs have potential to be open and accessible, but on a case-by-case basis the limitations need to be understood, especially in the context of developing countries, and where the content is designed to help sustainable development.

An additional challenge relates to online learning characteristics: As this kind of learning takes place virtually, i.e. not in a physical classroom, and without direct face-to-face interaction with fellow learners, online learners need high self-discipline, intrinsic motivation, and personal commitment, aspects which are

required for reflection and self-organization of one's own learning process (Zawacki-Richter et al. 2009; Anderson 2008).

Comprehensive e-tutoring and a learning community have been identified as key ingredients that will enable learners to successfully work in a self-determined, self-paced manner that is a typical feature of open online arrangements—the literature suggest that less than 10% of online learners are able to do without such facilitation and motivating learning community (LI 2017).

A significant opportunity within MOOCs is their ability to be tailor made to different contexts and suit different specific needs, and this is aided by their open access and online nature. A clear example is the use of MOOCs for capacity building and specific local needs of developing contexts, and specific purposes and demographics (Castillo et al. 2015). In terms of their structure, it has also been suggested by Zheng et al. (2015) that MOOCs can be tailored to meet motivations of participants including a "learning-driven" or a "certificate-driven" approach. If such courses are then designed in a modular way, and if learners are awarded by ideally bankable credits, this can increase learners' motivations (Yuan and Powell 2013). The collection of large amounts of data also presents an opportunity to learn (Breslow et al. 2013) and even to tailor make and improve courses. Other opportunities include the use of automated tools to streamline MOOC processes (Daradoumis et al. 2013), and creativity in the interactivity to increase engagement (Gené et al. 2014).

A significant strength of MOOCs also include their ability to facilitate social interaction and engagement between participants, both formally and informally, internally and external to the course (Zheng et al. 2015). This can lead to increased networks extending beyond the course and for continued collaboration supporting further learning.

Finally, through their flexibility and openness, MOOCs can support lifelong learning by principle as they "may also contribute to balancing work, family and social life (…) encourage more mature students to participate in higher education and gain qualifications to further their careers (Yuan and Powell 2013:18)." An example of an open online course that addressed the various opportunities and constraints by means of a unique mentored approach will be presented in the following chapter.

The L3EAP Online Learning Course "Sustainable Energy for SIDS"

In the frame of the Europe Aid project L3EAP (www.project-l3eap.eu), a mentored modular open online course has been developed, targeting distinctive audiences located on Small Island Developing States and which takes a constructivist approach to teaching, i.e. providing learners with hand-on knowledge and actionable outcomes.

Based on a survey of training needs that explored the learning preferences and characteristics of energy practitioners and academics in Fiji, Mauritius and Germany, a lack of formal educational programmes and non-formal training schemes focusing on EASE topics was identified (L3EAP 2017). In their analysis of the online course, Wolf et al. (2018) describe three crucial requirements for the design of such programmes that would need to be considered to meet the distinctive learning needs of practitioners and academics:

- Convenience—modular segments of short duration, ideally with close tutorial facilitation;
- 24/7, on demand availability—allowing to match individual work schedules and different times zones in which learning would take place; and
- High level of interaction with fellow SIDS learners and SIDS experts—fostering the transfer of contextualized knowledge, appropriate technologies and applicable skills.

This resulted in a two-stream lifelong learning model applied by the EU project, with one stream offering specific training courses on EASE topics to build local capacity in SIDS and the other stream resembling a generic online course on EASE (L3EAP 2017). How this second stream integrates the aforementioned considerations is further elaborated on below.

Profile

In 2016, the L3EAP partner consortium, in close collaboration with the Hamburg Open Online University, developed and implemented a six week long open online course on "Sustainable Energy for SIDS" with more than 1000 learners, hereof 54% from SIDS and 46% from the rest of the world, with a completion rate of about 13%. The e-course aimed at introducing an international community of heterogeneous learners to theoretical concepts, methods and distinctive real-life cases from two SIDS regions, the Pacific and the Indian Ocean. The pilot course comprised a range of learning material (videos, training booklets, quizzes, assignments, case studies). An iteration of the course with a slightly adapted, improved design took place in early 2017, reaching out to 750 learners this time.

With this concept, the L3EAP partners intended to provide an open learning opportunity that met distinctive needs of SIDS regarding sustainability topics, included transnational knowledge transfer, was grounded in real-life cases, and allowed for international networking. The design as a fully virtual course enabled implementation and facilitation without geographical or time zone related restrictions. Due to open access, a heterogenous learner group of university students, academics, members of public authorities and practitioners of various ages and from 29 out of 38 small island states (plus further countries) took part.

In anticipation of reaching out to a heterogenous learner group located on islands all over the world, Wolf et al. (2018) stated that the course was developed as a

MOOC from the very beginning. The course designers considered a set of specific conditions for course development:

- Access to state-of-the-art knowledge, expertise and a high diversity learning community;
- Collaborative learning arrangement driven by topical interest that supports peer-to-peer interaction;
- Use of open educational resources to support the dissemination of rights-free learning material to stakeholders outside the course, e.g. other universities; and
- Consideration of future iterations after pilot course evaluation and closing of the EU project.

The didactic design of the online course can be labelled as learner-centric and competencies-based. As Bretschneider and Pflaum (2016:112) found little scientific grounding or even an agreed upon definition of learner-centrism in the German-speaking literature, they suggested that learner-centric design resembles a fusion of two different perspectives, one being the learner-oriented approach known from education, the other being learner-centrism applied in user-centred software development (Pflaum and Wolf 2018).

Methodologically, the online course developers determined their key target groups according to a user-centered design approach which focuses on the development of computer-based products for and with the potential users (Abras et al. 2004). This approach puts the potential users, their existing knowledge and skills, their motivation and capacities, or learning requirements, at the heart of interactive systems development.

Over six weeks, the online course followed a certain modular structure that allowed learners each new week to access new content. The concluding week seven comprised of reflection, the evaluation of the final assessment and the official farewell. The final assessments served as means to evaluate if the overall learning objectives had been achieved, i.e. gaining new knowledge and skills. Consequently, the content, methods and tasks were designed in a way that learners were enabled to write an empirically grounded energy project proposal. Every week, the complexity and/or difficulty of tasks increased, guiding the learners successively towards the knowledge and skill level they needed to complete the final assignment. The following table illustrates the course weeks and the respective subtopics as well as the related tasks and learning goals (Table 1).

The overall structure, broken down into weekly modules, implied already a certain pathway to interact with the learning content. Every week, the complexity and difficulty of tasks increased, guiding the learners successively towards the knowledge and skill level they needed to complete the final assignment.

However, learners could pursue a range of learning paths, depending on their motivation as well as on their own capacities in terms of learning time. In practice, this meant that some learners chose the path that led to the certificate of completion in the end whereas others only picked what they needed, or what they were

Table 1 Overall structure of online course "Sustainable Energy for SIDS"

Week	Topic	Assignment/*Learning goals*
1	Overview	Analyzing energy in SIDS with an interdisciplinary framework *Sketch key issues, disciplinary aspects of the overall topic*
2	Challenges	Sustainable energy production in SIDS *Explain why sustainable energy essential for SIDS,* *Describe concrete examples from concrete SIDS settings*
3	Development	Energy access and energy security *Analyze theoretical foundations, concepts;* *Critically examine concrete examples from SIDS settings*
4	Strategies	Energy efficiency and energy management in SIDS *Explore theoretical foundations, concepts;* *Critically examine concrete examples from SIDS settings*
5	Technologies	Sustainable solutions for SIDS: the promise of renewable energies (RE) *Analyze theoretical foundations, concepts and RE technologies;* *critically examine concrete examples from SIDS settings*
6	Regimes	Policies, initiatives, programs *Identify suitable political frameworks for proposal* *Critically examine concrete examples from SIDS settings*
7	Reflection	Evaluation of project proposals and feedback to learners *Critical reflection of learning outcomes*
Learning goal at course completion: Create an evidence-based proposal for an energy project in a specific SIDS context		

Source L3EAP (2017)

Table 2 Learners personal learning goals (L3EAP online course survey)

Learner's personal goals for the course	%
To keep up to date with all course content, and complete all submission items on time (quizzes, case studies, assignments)	65.08
To watch/read most of the course content, and complete most of the submission items on time	20.63
To look at content in my own time, and maybe not complete the assessment items	5.56
I am teaching this subject and interested in the OER course material	4.76
To look through some of the course content, and complete some submission items	2.38
I'm just having a look around at this stage	0.79
No answer given	0.79
Total	100.00

Source L3EAP (2017)

interested in, without completing mandatory tasks that would have resulted in a certificate at the end (see Table 2).

Comprehensive e-facilitation resembled a key to motivate and inspire learners: A set of experienced e-facilitators and e-tutors guided, motivated and challenged the

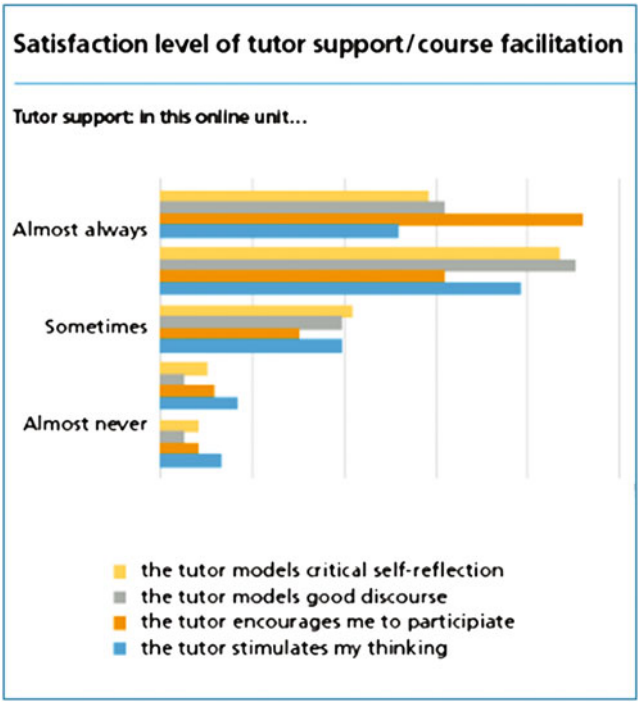

Fig. 1 Outcome of learning survey/pilot run of online course. *Source* L3EAP (2017)

learners sparking interaction and collaboration among the learners as well as between learners and e-tutors who were also experts in the topics of the course. During the online phase, these online facilitators and online tutors played important roles and positively influenced the learning experience in the virtual settings to a large extent through the overall coordination of and motivation of learners (see Fig. 1).

As this 'mentored' approach may be unusual for learners, especially those who possess less experiences with online learning, it should be duly communicated upfront to raise the motivation of learners to successfully work themselves through the online phase (e-Trainer 2017).

E-Tools

In line with the user-centred approach, learning objectives for two distinctive use cases (energy practitioners, master students) have been developed in a first step. Even though the learning objectives differed to some extent they were by no means contradictory to each other. These learning objectives then guided the

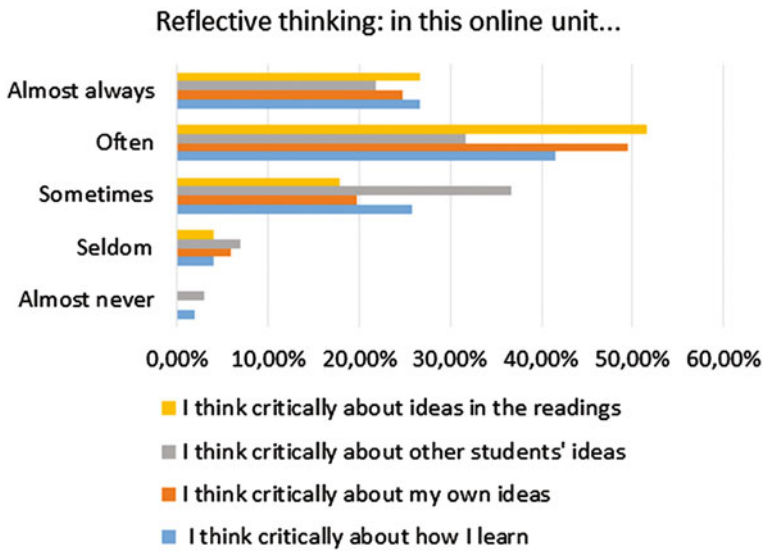

Fig. 2 Learners' perceptions/reflective thinking. *Source* L3EAP (2017)

development course content, and appropriate e-tools were chosen to suit these different user needs, their distinctive learning characteristics and the determined learning objectives (see Fig. 2). In the frame of the online course "Sustainable Energy for SIDS", learners were provided with a range of e-tools which are briefly described in the following:

Videos: Short videos (no longer than 5 min each) present technologies, policies and socio-economic aspects in SIDS, illustrated by real-life examples. Corresponding audio files and transcription were also provided to learners;

Slides: For those learners who needed more background information, training booklets were provided in which learners could read up on theoretical concepts and further background information related to the weekly topic. This content could also be downloaded by the learners;

Further resources: Comprehensive material for further reading, enabling learners to explore original energy policies and frameworks, national energy statistics, scientific papers and relevant best practice reports;

Interactive quizzes: Quizzes are included as a fun means to self-test learning progress. For this, the built-in feature of Moodle was used, where learners receive instant feedback on their answers;

Case studies/discussions: Case studies were introduced as a means of reflection, interaction and joint discussion which were facilitated by the online moderators and e-tutors. For this, distinctive weekly discussion forums were opened up and facilitated.

Deliverables: Weekly assignments which were shared within the learning community served to spread learnings and best practices throughout the community, enabling them to learn from each other.

All in all, the learning environment preferably applied asynchronous e-tools to communicate with and guide the learners along their individual learning paths. Especially the last two interactive e-tools (case studies/facilitated discussions, deliverables including peer review) are valuable tools to create learning occasions and opportunities for learners to discuss and engage with the topic, two important indicators of learner-centrism as suggested by Pflaum and Wolf (2018).

Lessons Learned

The L3EAP online course has achieved its course objectives (see objectives Table 3). The positioning and framing matched reality in that the course reached the envisaged learner groups, and it attracted an even higher number of participants than envisaged. Concerning the audience, the first run saw more SIDS participants than the second run in which 2/3 came from 'rest of world' countries. However, this may be due to the different timing—the first course was conducted in late summer, the second course in early spring—and due to recommendations.

The course appeared to be valuable to learners' professional and academic practice, and participants trained to critically assess island energy regimes, sustainable technologies and identify appropriate solutions. The course designers supported the online learning motivation of the learning community through using a broad range of e-tools, with particular attention paid to those that support

Table 3 Course objectives, key indicators and performance measures, L3EAP online course

Positioning	Interdisciplinary adult education course making current research accessible for students in higher ed, practitioners in the field of energy, to broaden awareness of the topic's complexity and provide a research-driven intervention in development discourses
Framing	Non-curricular, stand-alone course format for heterogeneous audience of adult-learners with proficiency in English
Audience	At least 500 course participants in pilot phase – 60% of which based in SIDS or SIDS ex-pat community – 40% rest-of-world Main target groups: – Political stakeholders/decision-makers/NGO in SIDS energy sector – Higher-Ed students in technical or development studies programs – Researchers interested in interdisciplinary perspectives on energy topic – Private and public donors/investors in sustainable energy management
Evaluation	Active participation, completion rate, recommendations rate
Indicators	Overall demand and feedback as an indicator for future course iterations

Source L3EAP (2017)

interaction and collaboration. Due to an on-going demand, the course has been repeated again, and it is planned to reiterate the course a third time in fall 2017.

Through the comprehensive mentoring by the course facilitators in the frame of the weekly online discussions, interaction with learners through peer-review activities and interactive discussions alike reflective thinking was encouraged (see Fig. 2). The facilitation, guidance and constructive feedback provided by the online moderators was also well received by the learners (L3EAP 2017). The high level of interaction also supported learning from peers and reflecting on own learning styles. Participant feedback also suggests that the learners have practical use for the knowledge and skills they gained (see Fig. 3). This may be especially related to the training of proposal writing skills which directly meets the existing need of small island energy practitioners and academics.

Finally, the development of the online module required a substantial amount of resources in the design phase, the development phase, the production phase (content and especially the professional video production), as well as the implementation and evaluation phase. The additional support of the Hamburg Open Online University beyond the resources the EU project could provide was thus key for the timely and professional development and delivery of the online course. As such, the L3EAP approach reflects lessons learned from early online learning initiatives who were not as successful as thought: "Lessons learnt from failing early online learning initiatives in the UK: the fact that the approach took a supply-driven rather than demand-led approach. (…) UK Open University experiences indicate that a much greater up-front investment of resources, time and careful planning is needed when designing distance-learning courses" (Casey 2012 in Yuan and Powell 2013:14).

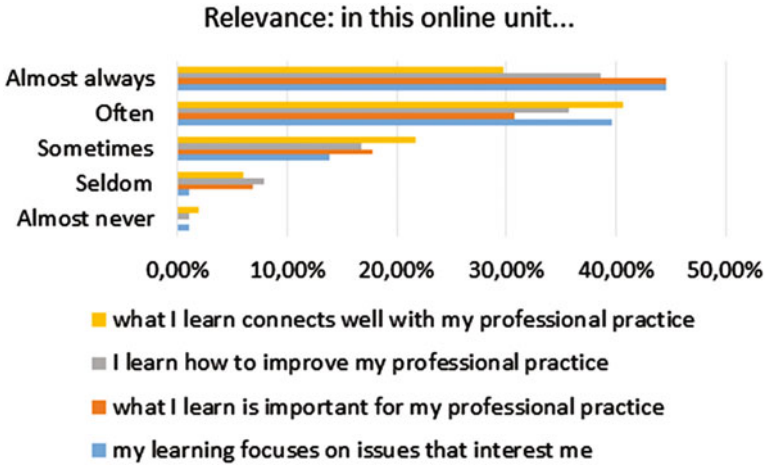

Fig. 3 Learners' perceptions/relevance of online course. *Source* L3EAP (2017)

Conclusions and Recommendations

From the experiences gained from the online course "Sustainable Energy for SIDS" it may be concluded that well designed open online courses can greatly assist in building and strengthening local capacities, especially in distant, remote islands. Online interventions such as the L3EAP online course can also be used for complementing existing capacity-building activities on the ground, and/or for increasing the outreach to further stakeholders. The creation of learning communities and enabling learning from peers are some other important factors that such online courses can support, and their relevance for lifelong learning opportunities should not be underestimated.

The L3EAP online course structure, its OER components and stand-alone course design allow easy replication and integration by others who want to extend their curricula with transdisciplinary topics, given that respective capacities and expertise for set-up of the platform, promotion and online facilitation exist.

Through its learner-centered design, the L3EAP course thus appears to have created an attractive learning experience that has been inspiring, motivating, and fun for learners worldwide. As these type of constructivist online learning approaches and related research is still rare in many parts of the world, educational actors are encouraged to experiment with developing and testing such formats to create a solid evidence base for online learning.

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Distance Learning Will Enable Climate Refugees to Avoid Falling into the Social Risk Trap

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Abstract This chapter describes how distance learning can help climate refugees protect themselves against the social risk that results from restrictions on their right to education. This documentary analysis is predominantly theoretical, and its general aim it to present a documentary corpus to facilitate classification of climate refugees in terms of their ICT competence. The specific aim is to provide keys for the design of educational programs that can closely match the competences of the individual refugee. This is the novelty and originality of this chapter. The refugee has traditionally been treated as an element within a group to which common educational methodologies are applied. This chapter treats each refugee as an individual according to their ICT skills, so each one will require a specific type of education.

Keywords Distance learning · Manifestations of social risk · Climate refugees E-book · Streaming · Moocs

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Introduction

The *climate refugee* does not legally exist (Fernández 2015). This assertion is based on the 1951 Convention Relating to the Status of Refugees, a document that provides the basis for the legal action applicable to refugees but which does not include climate change as possible cause for bestowing refugee status.

Setting aside the limitations of international law, practitioners in sociology, social pedagogy, social education and collective ethics consider these environmental migrants to be a population at social risk, for two reasons: first, these persons do not have their basic needs covered in their country of origin; second, they cannot exercise their social rights (to employment, social protection, housing, education, health and a healthy environment and adequate nutrition…) in the country they abandon as a consequence of climate change (Lebrero Baena and Quicios García 2010).

In Europe, Sweden and Finland in particular have aided refugees but without conferring refugee status (Sola Pardell 2012; Sweden's Immigration Law 2005). Both countries have endeavoured to cover *climate refugees'* basic needs.

Once basic needs are satisfied, the climate refugee can only abandon a state of social risk by being able to exercise the social rights mentioned earlier. Access to education is one of those rights; and if it were not for distance education, the climate refugee would have to give up this right on abandoning the country of origin.

Distance education is a teaching methodology characterized by the mediated didactic dialogue between teachers at one institution and students situated in a different space, enabling the latter to learn independently or in groups (García Aretio 2014). In the 21st century, this mediated dialogue now knows no frontiers as it can be developed through any kind of electronic device connected to a data network, thus facilitating ubiquitous and on-the-move learning (Vázquez-Cano and Sevillano 2015).

The climate refugee can take advantage of the potential of u-learning to continue with the study plan he/she was following in the country of origin even though they are now situated in another country. They only need a smartphone; all the rest can be provided by distance learning institutions (Pascual 2013).

It makes it much easier for the climate refugee who has/her basic needs accounted for, and who can access education, to integrate in the society of the country of origin; they can maintain their network of close contacts from their native country, continue with their study plan from the country of origin, follow the study plan drawn up in the country that has accepted them, develop the habit of continuous and permanent education and cease to be a member of a collective at risk or fall into the social risk trap (Quicios García 2013; Lebrero Baena and Quicios García 2011).

Manifestations of Social Risk Among Climate Refugees

Incessant deterioration of the environment in the country they inhabit, or an imminent climate catastrophe are usually the causes that lead environmental refugees to lose contact with the reference coordinates of their lives.

These situations place the climate refugee under enormous stress, and leave them vulnerable to emotional problems (Navarro-Lashayas 2014), or to the worsening of a psychosocial disturbance particular to the migrant population, known as the Ulysses Syndrome (Achotegui 2012a; Ayala García 2014; Young 2014); stress also arises from culture shock (Oberg 1960), and there is also the phenomenon of acculturation stress (Sánchez and Jaramillo 2014).

All these pathologies have their roots in shattered hopes and an imbalance between expectation and reality. These conditions manifest themselves in organic symptoms that are somatic and range from depression and confusion to anxiety (Achotegui 2012b). All these symptoms can be treated with medication, but these ailments do not improve because they are not illnesses, rather they are symptoms of illnesses. The climate refugee is manifesting in organic symptoms the consequences of conditions of extreme pressure under which they had to leave their places of origin (Sola Pardell 2012).

International law could revise the 1951 Convention Relating to the Status of Refugees. By adding climate change as a cause that impels a migrant to abandon a territory, the displaced migrant who is forced to leave his/her country because of a natural disaster resulting from climate change could then acquire the status of refugee and thus reduce his/her exposure to social risk. If this were to happen, the climate refugee would suffer less from stress by being able to reconnect with their close social contacts through services on digital mobile, or fixed, devices (chats, Skype, WhatsApp, online leisure websites…) (Aparici 2011).

The Relation Between Climate Refugees and ICT

Climate refugees have one characteristic in common. They have all been forced to abandon their countries of origin due to a natural disaster caused by climate change. This collective is formed of people of all ages, social classes, levels of education and technological competence. This heterogeneity thus obliges distance education institutions to accommodate their strategies to the characteristics presented by each individual climate refugee seeking to resume education in their new country of residence.

Climate refugees include students considered to be *pseudo-analogical*, who use ICT following the logic, structure and utility of the educational resources in place before the digitalization of content. Such students are able to design their own study model and professional development model largely ignoring the influence of new

media tools. They are mere consumers of online knowledge (Sevillano García et al. 2016; Aguaded and Sánchez 2013; Villalustre 2013; Khan 2012).

Climate refugees also include digital migrants and students who are network visitors. These are groups of passive users who do not participate in media; they are *old learners*, people who taught themselves from non-digital sources because they have not been able to achieve a sufficient level of multimodal or multimedia literacy (Avello Martínez et al. 2017; González García 2013).

These two collectives are joined by climate refugees who are *new learners*, new millennials, students of the "instant message generation" and the "Net generation", digital natives, digital and technological literates, resident students and media prosumers (García-Ruiz et al. 2014; Ferrés et al. 2012).

These new learners are characterized by being highly adept at multitasking; they do not think in a linear way and their styles of learning are many and varied (OECD 2008). They form part of a generation that thinks and learns interactively (Ramos et al. 2010). They can generate content as individuals, and show greater control and creative capacity than the *old learners.* The *new learners* have a stronger sense of identity and their own attributes (Siemens 2006). They are autonomous and independent in their learning styles, combing through sources and resources in order to find new content that they can mix and match.

The *new learners* design their learning strategies not by searching out specific blocks of data (McLester 2007) but by exploring, consulting and synthesizing knowledge rather than assimilating content from one single source of validated knowledge as represented by a book or a professor expounding at a conference (Dede 2005). Evidently, each type of learner is going to request a different type of e-learning generation, which distance education has to acknowledge and maintain synchronically active. We now analyse each of these types (Cabero 2013).

The Different e-Learning Generations

The first generation of e-learning constitutes adapting printed material to the web format. This is done on Web 1.0, a static, one-direction network managed and maintained by programmers remote from the teacher and student who uses it. Web 1.0 is a network of knowledge and information, a network of documents that is very useful for presenting in a theoretical way the conceptual bases of any discipline. It is also very useful for analogical students, the old learners, climate refugees who use technologies exclusively for e-learning, or for those who only want to learn on their first-generation speed digital mobile devices.

On Web 1.0, students learn from an expositional teaching methodology, in which master classes are given along with material provided by technological companies. The professor continues to be the specialist who transmits the knowledge to the students. This is not attendance-based but mediated, and this web format is ideal for climate refugees regardless of their technological skills. They can keep in contact with people from their own country, acquire essential knowledge about

their host country and can continue learning from the study plan developed in the country they have had to abandon (Huesca González and Agudo 2013).

The second e-learning generation is about finding the best virtual campus (platforms and managers) for learning, while the third generation follows a model supported on collaboration and flexibility. This third generation of e-learning is the one used by climate refugees who are empowered as prosumers, and the aim is for the students to generate knowledge in conjunction with others and access material from different devices. The second and third e-learning generations use Web 2.0, Web 3.0 and even Web 4.0.

Web 2.0 is a learning and communication platform that acts as a meeting place for teachers and students, and for students to communicate among themselves. Its features are collaboration and collective knowledge. Web 2.0 synthesizes the three levels required for knowledge generation: open access to data, the interactive transformation of data into information and creative knowledge collaboration. It includes blogs, RSS, wikis, mashups, tagging, folksonomy and tag clouds.

In Web 2.0, the teacher is the guide who facilitates learning by helping students to discover knowledge. He/she is the person who redirects the learning if the student is unable to obtain that knowledge alone. The teacher does not just transmit knowledge but conducts the generation of the knowledge made by the user on the web.

Web 3.0, or the semantic web, aims to link, integrate and analyse various data sets in order to obtain a new flow of information. On Web 3.0, the teacher is just one more piece in the collaboratively constituted learning jigsaw puzzle. The teacher orients the construction of knowledge, accompanies the student in the production of knowledge and provides the resources needed for its construction. This is the most complex of the webs in use but also the most versatile. Web 3.0 has improved accessibility, mobility, and the potential for simulation, creativity and innovation. This is the web that is responsible for powering globalization (De Castro 2012).

Web 4.0, or the symbiotic web, views the future of the Net as a symbiotic interaction between humans and machines to produce more potent interfaces, such as mind-controlled interfaces. Web 4.0 will be open, intelligent and adaptive in terms of reading digital content. The role of the teacher in Web 4.0 is not yet clearly defined. Web 3.0, the semantic web, and Web 4.0, the symbiotic and ubiquitous web, are interrelated (Pascual 2013).

Climate refugees can include people who have been taught via traditional analogical teaching or e-learning (using technology for learning), m-learning (access to learning services via mobile devices), t-learning (learning interactively via television), or u-learning (learning anywhere and at any time via any type of digital device). U-learning, as a ubiquitous setting, integrates both e-learning and m-learning as the user can access traditional content and more up-to-date content formats via digital mobile devices (Rodrigo and Castro 2013).

U-learning will adapt the materials to the ICT skills of the least competent climate refugees, in other words, to the pseudo-analogical students. This is a basic measure to ensure that no climate refugee is denied the opportunity of receiving an

education via the distance learning methodology. The more competent climate refugees can enrich the material provided by acting as prosumers, or media prosumers, offering the work they have produced to less-skilled students. This action helps fulfil several objectives:

- To consolidate the learning of the material provided
- To learn to transmit the knowledge acquired
- To form a sense of comradeship
- To establish a support network among environmental refugees
- To maintain contact with the territory they were forced to abandon
- To preserve the language, customs and traditions of the country of origin

In short, the objective of distance learning is to prevent the emergence of digital divides among the climate refugees who study using this educational methodology, as well as to establish resilient relationships among them. These two strong points can prevent other social risk situations from arising.

Didactic Material for the Different e-Learning Generations

The e-Book

Distance education classifies the book in print version as auxiliary material, a physical support condemned to extinction since 1971, when Michael Hart conceived of the e-book, the electronic book, the digital book or cyberbook (Vassiliou and Rowley 2008). Since the birth of the e-book, distance education has gradually adapted its information hardware but its didactic strategy determining how information is transmitted is largely unchanged, in other words the e-book is only the electronic version of the printed version. The e-book is the digitalized version of a book that enables it to be viewed on a specific electronic device or in a specific digital format (García Orosa and López García 2016).

The electronic devices used to read e-books are many and various, ranging from table-top computers to the e-reader or e-book reader, as well as the tablet, smartphone, laptop or netbook. All such hardware needs software apps like MOBI, DjVu and others in order for e-book content. The use of this hardware and software have advantages and disadvantages for this type of learning format, the advantages being:

They enable the location of specific data in the texts via the *search* command. This tool optimizes reading time and allows for a selective search for information in the text.

- It enables the reader to make notes and underline text without damaging the document
- It is space-saving
- It saves on paper and ink

- It provides access to other e-books via Internet
- E-books can be acquired by online purchase
- It is less wearing on the eyesight

Disadvantages include potential copyright infringement. It can lead to a new type of digital divide by obliging users to have specific hardware and software to access e-books. There is the initial outlay to purchase the hardware device and the software apps needed for e-reading. Another possible drawback is the damage to the environment caused by the generation of electronic junk in the renewal of devices.

Setting aside the pros and cons of the e-book, in their most basic formats these devices are suitable for those refugees who are pseudo-analogical because as students they only consume knowledge from the Net via first-generation speed digital mobile devices with access to Web 1.0, which is a static, instructional and one-directional web.

In distance education accessed by Web 2.0 and later versions, other types of devices are available, such as the smart book, or digital book. These enable the user to access digital libraries and empower the reader to construct knowledge via the data found in the documents the student can access via the smart book. In other words, the smart book is a door through which the reader can pass in order to access other books to which they are redirected. Using the smart book means the student can create knowledge autonomously, and this type of material is of particular interest to new learners, to prosumers and media prosumers as well as to Web 2.0, 3.0 and 4.0 users.

Those climate refugees with greater ICT competence will be able to generate e-books in their own native languages. Such materials are an important contribution and by this action, distance learning can boost students' capabilities in their native languages. It also enables their culture to be extended to all ICT users, and helps maintain emotional stability and reciprocal affective relationships among persons forced to become environmental refugees due to climate change.

Streaming

Some climate refugees have acquired higher levels of technological expertise and need more enriched material. These refugees can teach themselves by ubiquitous learning and can create knowledge collaboratively. Streaming, or online reading, might be the ideal tool for such people as it means users can profit from the huge quantity of information available to anyone, anywhere and at any time (García-Peñalvo and Seoane Pardo 2015).

Streaming combines the features of ubiquitous learning with the advantages of e-books, and enables the user to produce and disseminate information in such a way that learning becomes permanent and in space and time. Until streaming becomes the predominant learning format, new students can access education via MOOCs (massive open online course).

MOOCs

New learners surf the Net in search of content with an attitude that is collaborative, connective and heterarchical. They search for and then post learning material that is free, in large quantity and totally accessible. MOOCs are the teaching material that fits well with these conditions. According to Vázquez-Cano (2013:48):

> *Current learning scenarios in higher education are oriented towards a new format that combines three basic principles: cost-free, large-scale and ubiquitous. These three principles are evident in MOOCs, and the development of such courses opens up a new concept of education and training. This type of new learning macro-scenarios has its roots in the philosophy of the "open learning movement" based on four fundamental ideas: redistribute, remake, review and reuse.*

MOOCs are courses that offer (Osuna Acedo 2014; Vázquez et al. 2013a, 2013b):

- Massive online access, free for all those interested in a subject that does not require class attendance or official certification for having completed the course.
- Open and free access. To do a MOOC, the student does not need to have prior qualifications certifying a certain level of knowledge of the subject.
- Learning that takes place entirely online. This channel of communication crosses all barriers of space and time.
- Synchronous and asynchronous interaction between teachers and students or among the students themselves via chats, forums, videoconferences…
- No certificate for having done the course, neither does it charge fees. The learning action is assessed and accredited as knowledge acquired.
- Designed with an emphasis on the audiovisual. Written texts are only used as support material.
- Activities which are programmed, planned, documented, sequenced, tutor-assessed and certified.
- A variety of methodologies such as autonomous, collaborative and participative learning.
- Material that is free and which can be openly accessed.
- Minimal teacher intervention.

The teacher develops a different task for each MOOC modality and for each of its phases. At one point, the teacher could adopt the role of leader, or connector, depending on the type of student he/she is dealing with. So, the role of the teacher determines whether the MOOC is classified as xMOOC or cMOOC (Cabero Almenara et al. 2014).

The MOOCs in which teachers take on a leadership role are xMOOCs, and are focused mainly on pseudo-analogical students and old learners. Here the teacher continues to transmit knowledge in a one-directional way. These xMOOCs pursue the philosophy of Web 1.0 and the first-generation e-books. The logic behind xMOOC teaching is that the student carries out activities proposed by the teacher in virtual scenarios. Nothing more. The student does not produce knowledge in collaboration with other students (Moya López 2014).

The xMOOCs respond to a schematic that is "one to many", or at most "one to one". They offer content via platforms on which students can view videos and post exercises they have completed. These are then assessed by course colleagues, and correction is sometimes but not always overseen by the teacher. In xMOOCs, if exams are set, they are in multiple-choice format, with the items chosen according to the content of the course videos and the practical work carried out by the students in the e-exercises proposed by the teacher (Zapata-Ros 2015).

The advantages of xMOOCs are that they try to provide a personalized form of learning by allowing each student to progress at his/her own pace. They generate learning groups in which each colleague learns from another, and they correct each other's work under teacher supervision. These courses develop technological or mediated competences (Bartolomé-Pina and Steffens 2015).

On the other hand, cMOOCs, which are connectivist in nature, are more oriented to new learners, prosumers and media prosumers. Here, all students produce knowledge in a horizontal way under the schematic of "many to many" and "many to one". In other words, this type of MOOC is similar to the way learning takes place on the social networks and in personal learning settings. They develop a type of collaborative learning based on contact and the interaction of all the course participants. The role of the teacher is to construct the learning community and to be just one more piece in the collaborative jigsaw who participates in the co-creation of learning that is collegiate in style. MOOCs are basic for the social construction of learning acquired in virtual settings (Chiappe-Laverde et al. 2015).

Not all MOOCs fit into these two rigid categories, and there are those that overlap both. For example tMOOCs, or eclectic MOOCs, are a version of MOOCs that specialize in the resolution of different types of tasks and activities that increase in complexity and which allow the student to advance on the course, or not, depending on the progress achieved (Drake et al. 2015).

Other types of MOOC cover up to eight different modalities (Torres and Gago 2014):

- TransferMOOCs. These courses previously existed in different MOOC formats.
- MadeMOOCs are more innovative than xMOOCs and cMOOCs. MadeMOOCs make effective use of video and interactive material, which are well produced and of a superior quality to that available on older MOOCs.
- SynchMOOCs are courses with fixed start and end dates, which would seem to contradict the early philosophy of this learning modality.
- AdaptativeMOOCs. These courses provide personalized learning experiences based on dynamic assessment and the use of huge quantities of data gathered on the courses. They represent the MOOCs' learning analytics version.
- GroupMOOCs are courses that focus on the collaboration that takes place between small groups.
- ConnectivistMOOCs are courses that emphasise the connection that can be established within a network of participants.
- MiniMOOCs. These courses are much more limited in scope than traditional MOOC courses.

Conole (2013) started with 12 dimensions to classify MOOCs into an indeterminate number of categories depending on the dimensions considered. These 12 dimensions are: entry level requirement, scale of participation (massification), use of multimedia, use of communication, extent of collaboration with other participants, type of learning (centred on the needs of the student or, teacher-focused and more structured), level of the quality guarantee, promotion of auto-reflexive processes, level of assessment, formal/informal nature, autonomy and diversity.

Regardless of the categories into which they fall, MOOCs are endowed with both strengths and weaknesses. MOOCs' educational strengths are: the adaptability of methodologies to the characteristics of the online society, the redefinition of roles, the use of assessment strategies that confer an active role on students, flexibility and adaptability of the academic courses on offer, cooperation between teachers and students on the MOOC, open access to a wide range of learning that is international in scope and the development of technological tools to support the teaching-learning process (Valverde Berrocoso 2014).

The educational weaknesses evident in MOOCs are (Valverde Berrocoso 2014): the preponderance of teaching methodologies based on outmoded educational theories; the presentation of "educational innovations" that are nothing of the kind; the standardization of knowledge, that is, applying the same content and activities to all students; the lack of a universal design for learning, in other words, the absence of differentiated educational attention; a lack of knowledge of the development and evolution of e-learning; the devaluation of the teaching function in the teaching-learning processes, namely in assessment and tutoring; the partial and self-interested perspective of the "open education" concept; the predominance of economic considerations over pedagogical experimentation and research in education; the requirement that students have a certain level of digital competence and they are, to a greater extent, independent learners.

As with all the educational instruments that endure over time, it is evident that the advantages outweigh the weaknesses, which enables them to remain relevant and in active progression.

MOOCs are the most versatile distance-learning tool for climate refugees, and this is evident in the number of MOOCs built for refugees. The Kiron University, a German online non-profit university, invites refugees to access their online courses from anywhere in the world free of charge. It does not require refugees to present proof of academic qualifications, as it is well aware of the problems refugees have in getting hold of such documentation.

> "Kiron University, or "the international university for refugees", has some of the most internationally eminent professors on its roster, thanks to its MOOCs. Refugee students can start university courses even before they obtain legal status in Germany. The reality of the new technologies and the emergence of the collaborative consumer in the world of education put them within reach of a whole series of master classes from universities such as Harvard, Stanford or Yale.
>
> …/…In their first year, the students can try out material to see which course they want to study. In the second year, they must choose between one of the five degree courses on offer,

> and in the third and final year the students attend classes at one of the 15 partner universities (in Germany and abroad) in order to complete their degrees.
>
> …/…The founders' long-term aim is to enable refugees to have access to university degree courses. It is estimated that there are around eight million young refugees worldwide". (El País 2015).

A second example of MOOCs aimed specifically at refugees can be found in work carried out by psychologist Barbara Moser-Mercer, of the University of Geneva. This professor has used MOOCs to educate refugees residing in camps in Kenya and Somalia, and successfully adapted the MOOC format to conditions on the ground. With Internet access almost impossible, she took with her course material, videos and exams downloaded onto pen drives in order to be able to replicate courses on the few computers available at United Nations departments in the camps (Moreno 2014).

Another use of MOOCs for refugees can be seen on virtual platforms such as Coursera, edX and Kiron, which offer MOOCs on Setting Up a Business, Programing and Commercial Activity, through "MOOC Camps" aimed at 60 countries worldwide such as the Democratic Republic of the Congo, Kenya, Lebanon and Jordan, countries that host large numbers of refugees (Martínez 2016).

As can be seen, MOOCs are the most versatile distance-learning tool for protecting climate refugees from the social risk inherent in not being able to exercise their right to education. MOOCs can provide education to anyone with a mobile device anywhere in the world.

Conclusion

Distance education is the ideal methodology for enabling climate refugees to avoid slipping into the social risk trap, as they will be able to exercise their right to access education and no longer have their educational needs unmet. The great advantage of distance education is, first, its capacity to adapt its learning materials to the technological competences of each student; second, it allows students to learn at their own pace and to follow their own learning styles; third, it opens up a range of educational possibilities that match the aspirations of each and every user and their motivation to educate themselves through u-learning.

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Leaving No-One Behind: Improving Climate Change and Entrepreneurship Education in Sub-Saharan Africa Through E-Learning and Innovative Governance Systems

Dumisani Chirambo

Abstract Poverty and climate change vulnerability is increasing in Sub-Saharan Africa (SSA) because the region lacks education and skills development facilities, and sustainable governance systems. Arguably, mainstreaming climate literacy in secondary schools through Information and Communications Technology (ICT) modalities can promote sustainable development and climate change resilience by providing early opportunities for the youth to gain knowledge and awareness of the behavioral and cultural changes that may foster improved climate change resilience. Through an inductive analysis based on research articles, case studies, policy briefs, and academic literature reviews, this chapter sought to highlight emerging ICT learning contexts in SSA as a means to determine the extent to which ICT may be used to promote climate change and sustainable development education in secondary schools. The chapter showed that climate literacy at secondary schools was being constrained by a lack of climate change education material and content on existing ICT learning platforms; and a lack of innovative governance systems to support governments in delivering climate literacy content to secondary schools and the youth. Consequently, to "leave no-one behind" requires non-state actors to develop and utilise innovative governance systems and digital climate literacy material that can complement government efforts to mainstream climate literacy at secondary schools.

Keywords Climate change education · Leave no-one behind · Massive open online courses (MOOC) · Microfinance · Sustainable development goals (SDGs)

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Introduction

Despite the existence of many programmes and frameworks to improve climate change education, capacity building, adaptation and mitigation such as the United Nations Framework Convention on Climate Change (UNFCCC), climate change vulnerability in Africa is arguably increasing. For example, the Intergovernmental Panel on Climate Change (IPCC) highlighted that even though African countries have initiated comprehensive planning processes for climate change, the implementation of these plans is lagging; and the integration of climate change programmes with national economic and development planning is limited (Niang et al. 2014). To add to this, many climate change resilience-building interventions in the region do not include measures to improve access to secondary/tertiary education even though improved access to secondary/tertiary education is an aspect that many communities and beneficiaries consider imperative for local climate change resilience-building (GOM 2013a; UNDP 2014). To make matters worse, Africa is in dire need of (i) education and skills development facilities, (ii) sustainable governance systems, and (iii) hard infrastructure (WEF 2014) in order to overcome its development challenges and have a good chance to address its problems related to climate change, poverty and inequality. Consequently, Africa's education and skills development inadequacies are projected to make Africa to eventually become home to 50% of the world's illiterate population (WEF 2014).

Many universities in Sub-Saharan Africa (SSA) have various environmental programmes related to climate change capacity building. However, some commentators have pointed out that focusing on the provision of climate change education at university and targeting climate change education towards university scholars with an interest in climate change might not be the best solution for improving climate change knowledge and resilience (Mutasa 2016). Arguably, SSA needs to drastically reform the current education curriculums so that climate change studies and entrepreneurship should be taught to learners at all levels including secondary schools (Mutasa, 2016; Ajufo 2013; Baah-Boateng 2013; Musarurwa 2012; UNESCO 2010; Amanchukwu et al. 2015). However, whilst reforming education curriculums to incorporate climate change studies at secondary schools may have the potential to reduce climate change vulnerability in SSA, challenges still exist in developing and implementing pertinent curriculums and education policies since many SSA governments have problems in sufficiently funding and investing in education and skills improvement systems (WEF 2014; Mambo et al. 2016). Additionally, donor support to African education systems and climate change programmes has been inadequate and unreliable (e.g. Official Development Assistance (ODA) to Africa declined 0.5% in real terms between 2013 and 2014 although in nominal terms it was virtually unchanged—$135.2 billion in 2013 as against $135.1 billion in 2014; and ODA to least developed countries, landlocked developing countries, and small island developing States declined 16% in real terms compared to 2013) (UNECA 2015).

Distance education and distance education institutions were hyped as a solution to reach out to the isolated, marginalised, challenged and minority groups (Prinsloo 2016). Unfortunately, distance education never fully realised this promise due to regulatory constraints, institutional inefficiencies and structural inequalities affecting access to education (Prinsloo 2016). However, with the advent of the internet and mobile phones there is now potential to finally reach out and educate societies' marginalised and isolated communities through various Information and Communications Technology (ICT) education platforms. In Africa, 14.7 out of 100 inhabitants use the internet, which is much lower than the World average of 43.7 (UNECA 2015). However, Africa's average annual growth rate of internet users per 100 inhabitants is growing faster than the World average growth rate (i.e. 21.7% for Africa against a World average of 10.2%), hence if the current growth rates are maintained over the coming years, Africa may match or exceed the World average internet usage rate (UNECA 2015). Arguably, such remarkable growth in Africa's internet usage rates may therefore be embraced by development practitioners and education policy specialists as an opportunity to promote the use of ICT based education platforms either as compliments or replacements of distance education and distance education institutions.

ICT is considered as a catalyst that can facilitate life-long learning, climate change education (Alexandru et al. 2013), inclusive human development (Asongu and Le Roux 2017) and entrepreneurship (Fatoki 2016). The Sustainable Development Goals (SDGs) are calling for the youth to have access to learning opportunities that can help them to acquire the knowledge and skills needed to exploit opportunities and to participate fully in society (UN, 2015). Therefore, arguably, ICT may be harnessed to mainstream climate change education programmes in secondary schools and support the implementation of the SDGs. This may be important in the context of SSA as SSA is experiencing high rates of population growth to the extent that it is the only region where the rural population is continuing to grow in absolute terms (Moore 2015), hence enhancing the knowledge, awareness and participation of the youth and women on climate change issues can promote sustainable development by significantly helping in the effective implementation of climate change programmes at community level (GOM 2013b).

Previous studies on climate change education, entrepreneurship and sustainable development include Gupta et al. (2015) who analysed innovation for social enterprises in Africa and concluded that in the absence of a favourable environment for innovation, the impact of social entrepreneurship and social enterprises in Africa was constrained by existing institutional voids and market inefficiencies. Timothy et al. (2016) looked at e-learning (electronic learning) experiences from Nigeria, South Africa and the United States of America, and concluded that a combination of technology and learner's attitudes towards e-learning material and activities were aspects that determined the success of online courses. Tenzer and Pudelko (2015) discussed how the private sector through African–European partnerships between entrepreneurs could facilitate the attainment of the SGDs in SSA. Asongu and Nwachukwu (2017) assessed some factors that could facilitate inclusive human development in SSA and concluded that educational quality, innovation and

internet penetration influenced knowledge diffusion hence mobile phones were an integral component in facilitating knowledge diffusion for inclusive development and sustainable development. However, there are knowledge gaps regarding the innovations that could be implemented is SSA to promote ICT based learning for climate change education and facilitating sustainable development at secondary schools. This chapter therefore sought to address these knowledge gaps by highlighting emerging ICT learning contexts in SSA so as to determine the extent to which ICT may be used to promote climate change education and diffuse knowledge about sustainable development in SSA's secondary schools. To achieve the goals of the chapter, an inductive analysis using secondary data consisting of various research articles, case studies, policy briefs, and academic literature reviews focusing on the challenges and opportunities for climate change capacity building and ICT based education was undertaken.

The chapter is structured as follows: Section "E-Learning and M-Learning Strategies for SSA" provides a brief background on some e-learning and m-learning (mobile learning) platforms that have been developed to support primary and secondary education in SSA. In Section "A Case for Integrating Climate Change Education with Entrepreneurship Education", the chapter provides an argument on how a combination of climate change education and entrepreneurship can increase the agency of the youth towards climate change action. In Section "Discussion", the chapter provides a discussion focusing on how climate change education can facilitate the attainment of the "Leave No-One Behind" principle of the Sustainable Development Goals (SDGs). The discussion also shows how non-state actors such as microfinance institutions can implement polycentric governance approaches in order to support national governments in promoting climate change education at secondary schools. The chapter ends with a conclusion in Section "Conclusion" which emphasises the need to mainstream climate literacy at secondary schools through ICT in order to foster behavioral and cultural changes in the youth that can promote sustainable development.

E-Learning and M-Learning Strategies for SSA

ICT education platforms, more especially, e-learning and m-learning modalities can be utilised to promote access to education in various contexts. E-learning is defined as knowledge delivered by online services as education and training. E-learning is therefore a technique to enhance learning and teaching experiences and is used to educate students with or without their instructors through any type of digital media (Alexandru et al. 2013). M-learning is an extension or subset of e-learning which encompasses the use of wireless and mobile technologies (e.g. smartphones and tablets) to wirelessly transmit learning modules and administrative data, and to enable learners to communicate with lecturers and peers (Brown 2003). Developing and developed countries have various challenges in relation to improving the deployment of ICT for life-long learning, climate change education, poverty

reduction and entrepreneurship hence innovations that are effective in developed countries might not necessarily be effective in developing countries. For example, the main e-learning challenge in developed countries is how education enterprises can attract learners to their e-learning services and platforms due to an influx of Massive Open Online Courses (MOOC) (free internet based courses and programmes run by universities and development organisations) (Timothy et al. 2016; Liao and Lu 2008). In contrast, the main e-learning challenges in the developing world include a lack of relevant infrastructure (e.g. accessible and affordable broadband coverage to rural regions), and a lack of relevant learning environments (Brown 2003; Timothy et al. 2016; Asongu and Le Roux 2017). Since the constraints for enhancing the use of ICT for education vary between developing and developed countries it can be argued that developing and developed countries require different policies, strategies and actors in order to improve climate change education through ICT.

Table 1 shows some of the challenges, threats and opportunities in the climate literacy ICT domain particularly in relation to the development and use of e-learning and m-learning platforms. Notwithstanding the issues contained in Table 1, various local e-learning and m-learning platforms have been developed in SSA. Such platforms have arguably been developed as business opportunities or as social enterprises noting that the education systems in many SSA countries are characterised by poorly funded government schools, low quality education standards, overcrowding in classrooms and expensive private education (UNECA 2015; Mambo et al. 2016).

Below are examples of four e-learning and m-learning platforms that are trying to make primary and secondary school education more inclusive and affordable in the context of SSA. The examples provided below were identified through purposive sampling hence are not intended to provide a representative sample of the e-learning and m-learning platforms available in SSA but rather to provide an indication of the different implementation modalities and the nature of various non-state actors that are providing ICT solutions for secondary school education.

Eneza Education

Eneza Education is a virtual tutor that allows students to learn through their mobile phones. Eneza Education is available through text messaging and an Application/App for smartphones. This enables the service to be accessible to people in both rural and urban areas as it can work in areas with limited or no internet access and is compatible with normal phones and smartphones. The Eneza platform provides tutorials, tips, and assessments that are aligned to local primary and secondary school curriculums through virtual tutors and teacher's assistants. The platform also has a Teacher Development Course to help teachers in developing good skills in class, staff and finance management; and a Business Course to help small business owners to develop appropriate skills in banking, financial management and

Table 1 ICT challenges, threats and opportunities for creating learning and innovative education in climate change

Challenges	Threats	Opportunities
Bridging the digital divide and bringing Informatics systems for climate change education to groups that have the greatest need	Inadequate information on the best use of ICT and on how to incorporate climate change issues in education	The emergence of identifying and delivering different types of information needed for effective adaptation to climate change
Directing users to high quality information and to teach them how to assess the quality of information	Climate change information on the internet is of variable quality, overwhelming and often difficult to interpret	Institutional and individual capacity to deploy training programmes using e-learning methods
Guiding teachers and students to use specific information in educationally appropriate ways	Low ICT literacy—a potential difficulty for users to understand specific information, better manage their own way of living, and make informed decisions about personal choices	Guaranteed validity and consistency of the available information provided by the information systems for climate change education
Developing strategies to ensure high quality standards in the publication of web based information	The lack of adequate infrastructure in certain regions	Raising awareness on the fact that ICT can decrease vulnerability both to natural climate instability and human-induced climate change
Generating new web applications able to anticipate the long-term unexpected impacts of the climate change	The use of the Information systems for climate change education will work differently in different contexts, both geographically and over time	A strengthening of the teacher-student relationship in which information flows in both directions

Source Alexandru et al. (2013)

investments. More important are the assertions that up to 30% of the platform's users are not the school going segment that the platform was intended for but either drop-outs or older learners that do not go to school (Eneza Education 2017). This arguably demonstrates the zeal that people have for learning in non-traditional/non-classroom learning environments and that when there is relevant material available that is affordable and easy to access, even the non-traditional learners will try to access it to improve their understanding of things.

Ruzivo Digital Learning

Ruzivo Digital Learning is an online interactive digital learning platform targeted at primary and secondary school students in Zimbabwe. The platform is a product and

business entity of Econet Wireless (Zimbabwe), Zimbabwe's largest provider of telecommunications services (i.e. mobile and fixed wireless telephony, etc.). The Ruzivo Digital Learning platform allows students and teachers to subscribe and access digitalised academic content, including interactive lessons, exercises and tests. The platform also records the exercises and tests that a learner/subscriber undertakes and generates detailed performance reports hence his/her progress or lack thereof can easily be ascertained by the student, guardian, parent and teachers (RDL 2017). The platform therefore enables students and school authorities to easily gauge their performance and standards against national benchmarks and other schools.

Shasha

Shasha is an online repository of notes, exam questions and preparation materials for secondary school students. The platform also promotes peer-to-peer learning through online discussion forums. The platform does not charge access/user/subscription fees as it collects revenues for its sustainability through online advertising revenues (Shasha Network 2017). The platform therefore partly reduces the financial constraints to accessing education material that poor households have.

Padziwe Digital Library (PDL)

Padziwe Digital Library (PDL) is a secondary school focused learning software that can be used online and offline. The software package also has study guides and past exam papers which guide students on the topics for them to cover in preparation for certain exams; notes capability so that users can write and store their own notes in a database; and study tips providing helpful tips on how students can study and handle exams effectively (PDL 2017). The content on this platform is delivered through a variety of media types (animations, videos, audios, slideshows, graphics, and plain texts) hence the interactivity and visual presentations engage the students in a variety of ways and makes the learning process to be less monotonous.

Various businesses, entrepreneurs and philanthropists have risen up to the challenge and tried to address the capacity gaps in SSA's educational systems by enhancing student and teacher education and training through e-learning and m-learning modalities. The case studies demonstrate various transformative ways to provide accessible and affordable educational material and support services to primary and secondary school children from diverse backgrounds and in various contexts. The case studies also highlight an urgent need for climate change education to be included in primary school and secondary school curriculums. This follows that the focus of many platforms is to prepare students for national exams as per their national curriculums hence their content was based on the subjects in the

national curriculums (e.g. Agriculture, Mathematics, Geography, etc.). Since climate change education is not in most curriculums, most platforms therefore do not consider climate change material as being worthy of teaching or hosting. Climate change is not an environmental issue, but a phenomenon that fundamentally affects how societies develop; hence effective mitigation and adaptation does not only encompass measures to increase awareness but requires measures to facilitate various behavioral and cultural changes (GoM 2013a; IPCC 2014; Wibeck 2014). The omission of climate change education in curriculums and the lack of climate change education material on most ICT platforms therefore thwart efforts to promote sustainable development and youth empowerment since the opportunity to foster behavioral and cultural changes in society early on is missed.

A Case for Integrating Climate Change Education with Entrepreneurship Education

Abandoning the traditional framing of climate change as an environmental problem and reframing climate change issues has the potential to encourage more people to take actions to enhance climate change mitigation and adaptation. For example, climate change can be reframed as a security issue, emphasising risks to personal security posed by drastic climate change; or as an economic issue, linking climate change impacts with national economic performance (Wibeck 2014). Africa's poverty and climate change vulnerabilities are characterised by a predominance of rural poverty whereby poverty is noted to be at least three times higher in rural areas than in urban areas because of poor rural infrastructure, youth unemployment and limited access to quality education (UNECA 2014). Arguably, framing climate change in the context of an opportunity to eradicate poverty (and its contributing factors), create jobs, promote entrepreneurship and promote equality may therefore encourage the youth to develop an interest in climate change issues and incentivise businesses, entrepreneurs and philanthropists to develop climate change education ICT content for various market segments.

In addition to framing climate change as a socio-economic opportunity to foster sustainable development, there is also a need to put more effort into developing climate change education content that is engaging and salient to SSA secondary school students so that SSA's youth should feel that they have the agency to mitigate and adapt to climate change. Wibeck (2014), considers that agency is a key factor in determining whether people will engage in pro-environmental behaviour or not. Therefore, unless people believe that they can do something about the problem, and that it is worth doing something, it will be difficult to encourage engagement (Wibeck 2014). Consequently, the failure of some climate change programmes and strategies could be attributed to their climate change communications which contained alarmist messages and visualisations that increased public awareness of the severe impacts of climate change but also engendered feelings of

hopelessness and apathy in the audience (Wibeck 2014). Arguably, by integrating climate change education with entrepreneurship education it might be possible to improve the interest of secondary school students (the youth) in climate literacy and empower them with the knowledge to enable them to understand the aspects that they can do in order to reduce their climate change vulnerabilities. Entrepreneurship education can enhance the creative abilities of people and their values thereby enabling them to establish more efficient and effective processes and products, shape new norms and beliefs and enable them to take action in the midst of uncertainty (Iyigün 2015; Gutiérrez and Baquero 2017). More importantly, teaching entrepreneurship can reduce youth unemployment in SSA and hence promote sustainable development by reducing inequality and the marginalisation of the youth in accessing jobs (Ajufo 2013; Efe 2014). Due to the flexibility of e-learning and m-learning modalities, there is therefore a significant scope that ICT education platforms can therefore enhance secondary school learning environments in SSA by providing mechanisms to promote the integration of entrepreneurship and climate change education so that African youth can develop a sense of climate change agency and to enable secondary school learners to develop new practices and strategies for managing their climate change risks.

Discussion

The SDGs stipulate that by 2030, all learners should acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles (i.e. SDG 4.7); and that various stakeholders should improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning (i.e. SDG 13.3) (UN 2015). In order for this to happen, the utilisation of ICT for climate change education particularly to secondary school students and the youth will be imperative since ICT modalities provide the means to which secondary school students can access external materials and support related to climate change education; and secondary schools can provide climate change education and sustainable development knowledge even where the schools do not have a curriculum and teachers for such subjects.

Since some of the Millennium Development Goals (MDGs) were not achieved in many countries, global leaders, through the SDGs have made a pledge to "Leave No-One Behind." Through this pledge, non-income-based inequalities (such as access to education) will be tackled and governments will attempt to ensure that marginalised groups make progress on human development indices more quickly (UN 2015; Stuart and Woodroffe 2016). Arguably, these aspects mean that development practitioners and policymakers have to deploy new innovative strategies and engage various stakeholders into the education, climate change and poverty reduction fora to enhance knowledge and implementation of the SDGs and climate change mitigation and adaptation programmes. Consequently, there is an

urgent need to improve access to climate change education through different media and approaches especially to the youth and non-environment specialists (i.e. enhance climate change awareness raising and integration into school curriculums; enhance the sharing of climate change traditional and local knowledge; enhance participatory action research and social learning; and enhance knowledge-sharing and learning platforms) (IPCC 2014). A failure to improve access to climate change education at various levels may therefore exacerbate climate change vulnerability and cause many poor and marginalised communities to be left further behind.

The case studies provided demonstrate that SSA already has some established private sector led online, offline and text message based secondary school curriculum based ICT platforms that are aimed at improving the accessibility and affordability of secondary school education material and content. However, many SSA governments/countries have under-resourced educational systems (Hendrix 2017; Mambo et al. 2016), hence they are unlikely to be able to comprehensively institute the political and institutional transformations and implement policies that are required in order to mainstream climate change education into secondary schools. This means that secondary school climate change education is not only constrained by the lack of climate change education material and content but also by a lack of new innovative modalities that can support national governments to develop and deliver pertinent climate change education material and content to secondary schools and the youth.

Arguably, the issue of developing and delivering climate change education to secondary schools can be addressed by stakeholders utilising innovative governance systems such as polycentric climate change governance systems, as a means to improve access to ICT education platforms for climate change education. This can therefore enable non-state actors to take an active role in supporting national governments in developing and delivering ICT based climate change education to secondary schools. This follows that measures for coping with climate change may be enhanced by taking a polycentric approach at multiple local, regional and national levels involving different stakeholders rather than focusing on single top-down policies (Scrieciu et al. 2015). Ostrom (2008, 2009, 2010), stated that polycentric governance is characterised by an organisational structure where multiple independent actors mutually order their relationships with one another under a general system of rules. Polycentric systems can function independently or form an interdependent system of relations in order to address collective action problems, free-rider problems and social dilemmas such as climate change education, capacity building, mitigation and adaptation (Ostrom 2008, 2009, 2010). Arguably, with various improvements in the ICT sector such as cheaper mobile phones and increased internet penetration there are now great opportunities to utilise polycentric governance approaches to promote climate change education and entrepreneurship education in different learning environments at optimal cost. To expound on this further, some non-state actors are innovating new ways to which polycentric governance systems can be utilised to promote climate change education and sustainable development. For example, the Beneficiary-Led Climate Change

Resilience Building Programme (BLCCRBP) in Malawi demonstrates how polycentric governance approaches may be used to facilitate climate change and entrepreneurship education in secondary schools (SOO 2017).

Microfinance is regarded as a development tool that provides financial services (i.e. credit, savings and insurance) and other complementary services such as skills education and training, youth empowerment, disaster risk management, renewable energy deployment and advice on agricultural practices to marginalised and rural populations (Ksoll et al. 2016; Moore 2015; Hogarth 2012; Agrawala and Carraro 2010). In the BLCCRBP, a microfinance institution has adapted its business model to include providing climate change education and entrepreneurship specifically to secondary schools to respond to the shortfall in strategies and programmes for empowering secondary school students on climate change issues.

Using a polycentric governance approach, the BLCCRBP aims to mainstream entrepreneurship and climate change studies into secondary schools and tertiary education institutions by creating and mentoring 300 "Climate Change and Entrepreneurship Clubs" at secondary schools and tertiary education institutions, and providing them with a Climate Change and Entrepreneurship Education Course for them to pursue through e-learning and m-learning modalities (Chirambo 2017). The BLCCRBP's polycentric approach focuses on empowering each climate change and entrepreneurship club to be able to identify the factors that increase climate change vulnerability in their communities and enable them to develop appropriate responses. It can therefore be anticipated that all the participants of the climate change and entrepreneurship clubs will be in a better position to develop business plans, use various financial services, and create social enterprises that can improve climate change agency and reduce their communities' climate change vulnerabilities.

Figure 1 provides a schematic diagram of a polycentric climate change and entrepreneurship education framework on which the BLCCRBP is based on. The diagram illustrates how a Project Implementer/non-state actor can get technical support, grants and social/impact investments from external sources in order to develop, teach and distribute climate change education content and material. On the other hand, participating secondary schools form climate change clubs in order to enable constructive dialogue and tutoring between the students, teachers and Project Implementers. The Project Implementers can use their own climate change education content and material, and also direct the students to appropriate content and material that is available from other online, offline and text message based e-learning and m-learning platforms.

Whilst the implementation of the BLCCRBP is still in its infancy hence its impacts cannot yet be evaluated, the programme is still useful in demonstrating how non-state actors such as microfinance institutions can adapt their business models in order to promote climate change education and training. An area for further research may be to evaluate the BLCCRBP to determine its ability to empower students in terms of climate literacy.

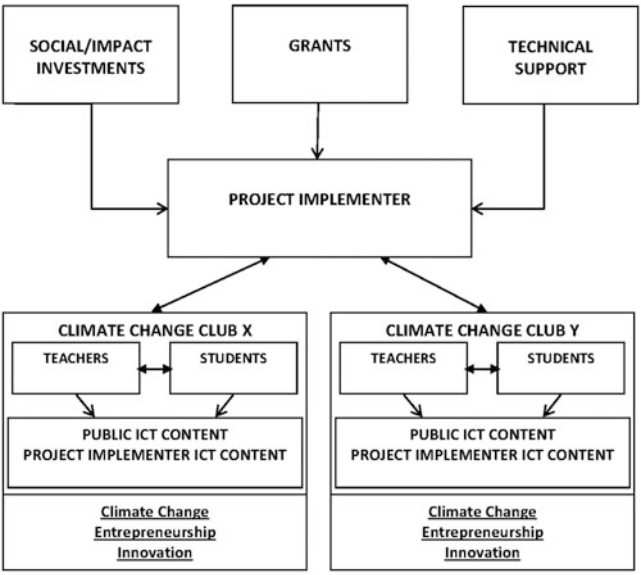

Fig. 1 Polycentric climate change and entrepreneurship education framework *Source* Author

Conclusion

The challenges for enhancing climate change education in developed countries and developing countries differ. In developed countries, there is a proliferation of various kinds of climate change information available online through learning platforms and other structures. The material is also readily accessible as the countries have good ICT infrastructure. In the developing world, there is low content on pertinent climate change information available through ICT platforms, and the situation is made even more challenging due to the poor ICT infrastructure prevalent in most developing countries. However, various stakeholders have made various initiatives to complement government investments in the education sector by implementing and developing various e-learning and m-learning platforms that improve the availability and accessibility of course material and exam material for secondary school students and secondary school curriculums. Unfortunately, most of these platforms do not contain specific climate change education content and material since climate change education is not included in many school curriculums.

Improving climate literacy systems and socio-economic institutions in SSA faces many challenges, hence there could be merits in integrating climate change education with other subjects that promote innovation and agency such as entrepreneurship. Moreover, promoting climate change education and entrepreneurship education at secondary schools to empower the youth on climate change issues through various e-learning and m-learning platforms can ensure that

"no-one is left behind" since this strategy will not only improve education on climate change but can also enable climate change challenges to be turned into opportunities for creating jobs and reducing marginalisation in pursuit of the SDGs. This can be attributed to the notion that improving knowledge on climate change can enable the youth to be more knowledgeable about society and human development processes, as well as enable them to take pro-active roles in developing strategies and social enterprises that can facilitate the development of appropriate anticipatory adaptation and mitigation options to avert the adverse impacts of climate change.

Many governments might delay in introducing climate change education in secondary schools and government investments in educational systems might be inadequate to ensure the attainment of the SDGs by 2030. Consequently, what is currently important is for various non-state actors to step up their efforts to popularise the use of ICT modalities as a means to address the gaps in the availability of climate change education material and content, and lack of implementation modalities or governance systems that can complement government efforts to develop and deliver pertinent climate change education material and content to secondary schools and the youth. Once this is achieved, SSA will be on a good trajectory to have the youth and secondary school students as agents that can facilitate sustainable development as they will, from an early stage, be equipped with the knowledge and awareness of the behavioral and cultural changes that they need to make in order to enhance climate change resilience.

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E-Learning as Tool to Feed the World

Aafke Schaap

Abstract Malnutrition is still a major issue in the developing world. Education and sustainable agriculture can be seen as key links in overcoming malnutrition. Both can be combined in e-learning technologies, a popular method in developing countries. Implementation of e-learning could provide great contribution in improving education for sustainable agriculture in developing countries. E-learning has conditions that contribute to the implementation and success of e-learning. The aim of this chapter is to assess if the Food and Agriculture Organization of the United Nations (FAO) addresses e-learning conditions adhering to scientific findings in their 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries'. This research tries to answer the following question: *Does the FAO address e-learning conditions according to scientific findings in their 'E-agriculture Strategy Guide'? If so, which conditions are addressed*? This will be assessed by a literature review which provides a theoretical framework. Within this framework, the selected FAO document is reviewed. The results demonstrate that the FAO takes all conditions into account, except two. The focus of the FAO in their 'E-agriculture Strategy Guide' is course content, system (and internet) quality and equality in education. Interpretation of the results show that the FAO focusses on e-learning conditions of a technical nature, or those that are close to other goals of the United Nations. This research provides a preparatory analysis for evaluation of e-learning strategies implemented by the FAO.

Keywords Distance learning · Climate literacy · E-learning conditions
Strategy assessment · Food and Agriculture Organization (FAO)
Sustainable agriculture · Developing countries

Assessment of e-learning conditions addressed in the 'E-agriculture Strategy Guide' of the FAO for distance learning in sustainable agricultural development in developing countries.

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Introduction

Global action is needed to combat hunger and malnutrition; the number one cause for health issues worldwide (World Food Program 2017). Especially in developing countries this "continues to be a major health burden" (Müller and Krawinkel 2005, p. 1). "Although undernourishment has been on the decline in both relative and absolute terms, nearly 800 million people are still affected by chronic hunger today" (Van Der Meijl et al. 2017, p. 7). This chapter focusses on distance learning in order to contribute to fight against hunger and malnutrition. Distance learning includes e-learning technologies. Sustainable development could provide a contribution in combatting hunger by improving sustainable agriculture. The conditions of e-learning implementation are discussed, which are critical for successful implementation. The discussed statement for this chapter is whether the 'E-agriculture Strategy Guide' of the Food and Agriculture Organization (FAO) addresses necessary e-learning conditions found and proved in scientific literature. More specifically, this chapter attempts to answer the stated question: *Does the FAO address e-learning conditions according to scientific findings in their 'E-agriculture Strategy Guide'? If so, which conditions are addressed*?

The stated research question combines two key links in fighting hunger and improving sustainable development: sustainable agriculture (Farming First 2009) and education (Gartner 2010). Agriculture should be sustainably practised in the next decade "to sustainably produce more food from less land through more efficient use of natural resources and with minimal impact on the environment in order to meet growing population demands" (Hobbs et al. 2008, p. 1). Education (for adults) contributes to technological and social development and empowers the poor, which makes investments in education indispensable for developing regions (Duveskog 2013).

These two key links, sustainable agriculture and education, can be combined in e-learning technologies. E-learning is a solution for filling the knowledge gap between theory and practice by establishing a connection between these (Cooper and Spencer-Dawe 2006). This education method is suitable for the development of sustainable agriculture as "it has the capacity to enhance learning and expand access to education and training in agriculture and natural resource management at the global, regional and local levels" (Atkinson and Rao 2006, p. 155). Promising results of e-learning can already be seen in healthcare education (Cooper and Spencer-Dawe 2006) and in developing countries (Sife et al. 2007). E-learning has multiple advantages: great information access and communication via ICT, increasing teamwork and partnership, and great cost-benefit by teaching large numbers of students. E-learning can also easily incorporate pedagogical improvements, using graphic design, simulations and virtual experiences (Sife et al. 2007; Welsh et al. 2003).

Although e-learning is a widely accepted method, it still faces some challenges. Examples of these challenges are lack of technical support, lack of interaction and lacking ICT skills (Sife et al. 2007). To tackle these challenges it is necessary to clarify the conditions for e-learning implementation.

E-learning education for sustainable (agricultural) development is implemented by The Food and Agriculture Organization (FAO). "The Food and Agriculture Organization of the United Nations (FAO) (2000) asserts that "information and knowledge play a key role in ensuring food security and sustainable development"" (Munyua et al. 2009, p. 4.). The FAO has their own e-learning platform and e-learning policy, which focusses on managing and supporting sustainable use of natural resources (FAO and International Telecommunication Union 2016).

'The E-agriculture Community of Expertise' is a part of the e-learning platform (Food and Agriculture Organization of the United Nations, E-learning centre 2017a). This is a "global initiative to enhance sustainable agricultural development and food security by improving the use of information, communication, and associated technologies in the sector" (Mangstl and Division 2008, p. 5). The term e-agriculture is globally understood as the interaction between ICT and agriculture.

The 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries' of the FAO and International Telecommunication Union (2016) is selected for assessment done in this research. This document is suited for this assessment because it is an important document for e-agriculture development: it leads in the development of new ICTs in agriculture and it is one of the newest guides provided by the FAO and International Telecommunication Union (2016).

The short term impact of this research is that it clarifies which conditions and to what extend the FAO addresses scientifically proved e-learning conditions in their 'E-agriculture Strategy Guide'. This research is important because previous research has shown that the lack of appropriate ICT policies hinders further development of ICTs in agriculture (Munyua et al. 2009). This research tries to clarify what conditions are necessary for appropriate e-learning implementation and their related policies. Follow up research could provide an overview of to what extend the FAO has an effective 'E-agriculture Strategy Guide'. On the long term, the impact of this research should be that e-agriculture development brings us a step closer to the development of sustainable agriculture and thereby closer to the eradication of malnutrition.

This chapter is structured as follows; the used definitions will be discussed, followed by the methodology and theoretical framework. After the theoretical framework, the results will be presented, followed by the discussion and conclusion.

Defining Concepts

The following paragraphs will describe some of the common definitions with regards to the subject of this chapter.

Conditions
In this research conditions are seen as the circumstances or factors which affect e-learning. This influence can be either negative or positive. The conditions are built up from associated factors. A factor is the concept, which is given direction by the condition. Conditions can contribute to successful e-learning, which can be seen as the development of an interactive education system, which serves its goal (Zhang et al. 2004; Andersson and Grönlund 2009).

E-learning
Welsh et al. (2003) describe e-learning as follows: "E-learning can be defined as the use of computer network technology, primarily over an intranet or through the internet, to deliver information and instruction to individuals" (Welsh et al. 2003, p. 246). Where Pagram and Pagram (2006) state:

> "E-learning is a much used and misused term. Kurtus (2004) states that e-learning is a catch —all term that covers a wide range of instructional material that can be delivered on a CD-ROM, over the Local Area Network (LAN), or on the Internet. It includes Computer-Based Training (CBT), Web-Based Training (WBT), Electronic Performance Support Systems (EPSS), distance or online learning and online tutorials." (p. 2.)

All these methods will be taken into account in this research since it is not clear which e-learning method is most commonly used by the FAO in developing countries or in (sustainable) agriculture.

Methodology

This research is carried out by a literature review followed by an assessment of the 'E-agriculture Strategy Guide' of the FAO. A literature review will be used to design a theoretical framework which can be applied on the selected FAO document. This review provides a clear overview of the scientific findings and ideas of e-learning conditions. The assessment will answer the stated research question. This method is due to time and financial constraints the most achievable method. Used methodologies in previous and similar research are mainly based on literature reviews (Atkinson and Rao 2006; Munyua et al. 2009; Raab et al. 2002; Sife et al. 2007), some in combination with quantitative analyses. Other authors based their research on participatory methods, interviews or reviews in combination with desk reviews (Behrman et al. 2004; Mangstl and Division 2008; Pretty 1995; Zhang et al. 2004) and the Delphi Method (Bhuasiri et al. 2012). E-learning conditions are rarely researched, this makes a literature review a suitable method to use.

Firstly, the general ideas about e-learning will be collected. These will be shortly described in the introduction and background section. Subsequently the specific ideas about e-learning conditions will be collected. This shall be done by literature research. The articles used in this research were found using Scopus and Google Scholar. Fourteen articles have been selected; all are peer-reviewed articles. These articles have been reviewed. They researched and described factors and conditions regarding e-learning technologies and implementations for e-learning conditions. For the theoretical framework nine articles were selected. This selection is based on the interface with e-learning conditions, not the adaptation process to e-learning. Selection criteria that were taken into account are based on e-learning in combination with one of the following concepts: conditions, factors, education, ICTs, criteria and success. Therefore it was important to take the definition of e-learning conditions, as described in the section 'defining concepts', into account. Originating from these selection criteria nine articles have been selected and reviewed for the theoretical framework.

The selected articles did not provide theories, however they did provide multiple frameworks with conditions, factors or criteria which data is collected by several methods, as described above. Conditions, factors and criteria are used, because they can be brought back to e-learning conditions.

The created theoretical framework in this research is based on the factors and conditions mentioned by Bhuasiri et al. (2012). This article was chosen as basis for the framework because this overview was the most extended and general overview of conditions found in the literature. Furthermore it is the most referenced article found in the used compass.

The other selected articles have been reviewed and the factors, conditions or criteria are compared to the conditions mentioned by Bhuasiri et al. (2012). Matching conditions are added to the framework and categorized under the corresponding conditions of Bhuasiri et al. (2012). Only the conditions which are supported by Bhuasiri et al. (2012) and one or more articles are used in the final framework to improve the reliability of the framework.

To answer the research question a policy or strategy assessment is needed. The assessment will be based on the created theoretical framework. The FAO 'E-agriculture Strategy Guide' will be analysed by the appearance of conditions formulated in the theoretical framework. The results section will describe which conditions met the conditions formulated in the theoretical framework and how these are formulated in the FAO document. This research translates scientifically proven e-learning conditions and how they are addressed in practice in a strategy guide. These results will answer the formulated research question.

Theoretical Framework

The theoretical frame based on the findings of Bhuasiri et al. (2012), identifies the success factors of e-learning in developing countries "that influence the success of e-learning systems" (Bhuasiri et al. 2012, p. 843). These factors are retrieved "from

the literature and compares the relative importance among two stakeholder groups in developing countries, ICT experts and faculty" (Bhuasiri et al. 2012, p. 834). These elements are divided into six dimensions and the related factors. The most important dimension is seen as *learners' characteristics* for ICT developers, where *infrastructure and system quality* were the most important from a faculty perspective (Bhuasiri et al. 2012). The implementation of these success factors should lead to a better learning system in developing countries. The findings of Bhuasiri et al. (2012) are presented in Table 1. Notable is that Bhuasiri et al. (2012) give a broad variety of clear defined factors. It seems a sufficient overview of success factors in developing countries in e-learning implementation. Both technical, motivational, pedagogical as quality aspects are taken into account.

The other selected articles, which are used in the theoretical framework, are shortly summarized before using their findings: Firstly, Sun et al. (2008) investigate the critical factors of e-learning: "results revealed that learner computer anxiety, instructor attitude toward e-learning, e-learning course flexibility, e-learning course quality, perceived usefulness, perceived ease of use, and diversity in assessments are the critical factors affecting learners' perceived satisfaction" (p. 1183). Secondly, Johnson et al. (2008) show that factors related to course performance, course satisfaction and course instrumentality are useful for the creation of successful e-learning environments. Thirdly, Zhang et al. (2010) shows that: "some factors of perceived innovative attributes, such as cost, quality, agility, schedule control, certification of degree, personal demands and so on" (p. 1428), have an influence on the e-learning conditions. Fourthly, Rajesh (2003) finds that ICTs related problems are focussed around: socio-political factors, human and administrative factors, economic factors and technical factors. Furthermore, the paper of Sife et al. (2007) "discusses new learning and training technologies considering their pedagogical, cost and technical implication" (p. 57). Also, Valsamidis et al. (2011) designed a framework with conditions "for applying e-learning to agriculture. It may be applied to three different stages of educational process: (i) platform development, (ii) courses development and delivery, (iii) platform and courses evaluation" (p. 373). Followed by Blass and Davis (2003), they propose a set of criteria to consider when designing an e-learning environment. These criteria focus of whether and how the implementation of e-learning should take place. Finally, Lim et al. (2007) researched both the determinant of effective online training and the variables affect learning performance and transfer performance.

Table 1 shows which authors' criteria, factors and conditions found agree with the stated dimensions and factors of Bhuasiri et al. (2012).

All factors (and thereby the related conditions) are supported by a wide range of authors. For this reason all conditions determined by Bhuasiri et al. (2012) are used in the final theoretical framework. Table 2 shows the related condition of each factor. The conditions defined in table 2 are inspired by the conditions of Bhuasiri et al. (2012).

Table 1 Represented factors and conditions found in the literature, summarized on the basis of Bhuasiri et al. (2012)

Dimensions [by Bhuasiri et al. (2012)]	Factor [by Bhuasiri et al. (2012)]	Reviewed literature
Learners' characteristics	Computer self-efficacy	Blass and Davis (2003), Lim et al. (2007), Sife et al. (2007), Valsamidis et al. (2011)
	Internet self-efficacy	Blass and Davis (2003), Sife et al. (2007), Valsamidis et al. (2011)
	Attitude toward e-learning	Blass and Davis (2003), Lim et al. (2007), Sife et al. (2007), Sun et al. (2008), Valsamidis et al. (2011)
Instructors' characteristics	Timely response	Blass and David (2003), Valsamidis et al. (2011)
	Self-efficacy	Blass and Davis (2003), Sife et al. (2007), Valsamidis et al. (2011)
	Technology control	Blass and Davis (2003), Lim et al. (2007), Sife et al. (2007) Sun et al. (2008), Valsamidis et al. (2011)
	Focus on interaction	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	Attitude toward student	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	Interaction fairness	Blass and Davis (2003), Rajesh (2003), Valsamidis et al. (2011)
Institution and service quality	Computer training	Blass and Davis (2003), Rajesh (2003), Sife et al. (2007)
	Program flexibility	Blass and Davis (2003), Rajesh (2003), Zhang et al. (2010)
Infrastructure and system quality	Internet quality	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Sife et al. (2007)
	Reliability	Blass and Davis (2003), Rajesh (2003), Sife et al. (2007)
	Ease of use	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Sun et al. (2008), Valsamidis et al. (2011), Zhang et al. (2010)
	System functionality	Blass and Davis (2003), Johnson et al. (2008), Lim et al. (2007), Rajesh (2003), Sife et al. (2007), Valsamidis et al. (2011), Zhang et al. (2010)
	System interactivity	Blass and Davis (2003), Johnson et al. (2008), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	System response	Blass and Davis (2003), Sife et al. (2007)

(continued)

Table 1 (continued)

Dimensions [by Bhuasiri et al. (2012)]	Factor [by Bhuasiri et al. (2012)]	Reviewed literature
Course and information quality	Course quality	Blass and Davis (2003), Johnson et al. (2008), Lim et al. (2007), Sun et al. (2008), Valsamidis et al. (2011), Zhang et al. (2010)
	Relevant content	Blass and Davis (2003), Johnson et al. (2008), Lim et al. (2007), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	Course flexibility	Johnson et al. (2008), Sun et al. (2008), Zhang et al. (2010)
Extrinsic motivation	Perceived usefulness	Johnson et al. (2008), Sife et al. (2007), Sun et al. (2008), Valsamidis et al. (2011), Zhang et al. (2010)
	Clear direction	Johnson et al. (2008), Sife et al. (2007), Valsamidis et al. (2011), Zhang et al. (2010)

Table 2 Theoretical framework of e-learning conditions derived from the literature, dimensions and factors by Bhuasiri et al. (2012). Formulated conditions are inspired by Bhuasiri et al. (2012) and multiple other authors used in the framework

Dimension [by Bhuasiri et al. (2012)]	No.	Factor [by Bhuasiri et al. (2012)]	Condition [inspired by Bhuasiri et al. (2012)]
Learners' characteristics	1.	Computer self-efficacy	Learner is able to use the computer to complete certain task
	2.	Internet self-efficacy	Learner is able to use internet to complete certain task
	3.	Attitude toward e-learning	Learner has a positive impression of e-learning
Instructors' characteristics	4.	Timely response	Instructor responds in a certain time span to question of learner
	5.	Self-efficacy	Instructor is able to successfully perform certain tasks
	6.	Technology control	Instructor can control instructional presentation
	7.	Focus on interaction	There is exchange (educational and social) between instructors and learners and among learners
	8.	Attitude toward student	Instructors provide various forms and methods to contact the students
	9.	Interaction fairness	Learner is feeling equally treated throughout the online learning environment

(continued)

Table 2 (continued)

Dimension [by Bhuasiri et al. (2012)]	No.	Factor [by Bhuasiri et al. (2012)]	Condition [inspired by Bhuasiri et al. (2012)]
Institution and service quality	10.	Computer training	Occurrence of specialized instruction and practice for computer skills
	11.	Program flexibility	E-learning course is flexible to serve learners' needs
Infrastructure and system quality	12.	Internet quality	There is access to internet and the quality is sufficient
	13.	Reliability	Information is accurate, dependent and consistent
	14.	Ease of use	The system is usable without need too much effort
	15.	System functionality	The e-learning system is functional for the purpose of instructions and assessments
	16.	System interactivity	The system is interactive
	17.	System response	The system responds in certain time between user action and feedback received from system
Course and information quality	18.	Course quality	The quality of writing, images, video or flash meets accepted standards
	19.	Relevant content	The provided material (information, course, content and services) meets certain standards
	20.	Course flexibility	The course is flexible to adapt in working, learning and commuting hours
Extrinsic motivation	21.	Perceived usefulness	The e-learning course is enhancing learners learning performance
	22.	Clear direction	E-learning system is free of confusion of ambiguity

Results

The results are derived from the theoretical framework applied on the 'E-agriculture Strategy Guide'. The 'E-agriculture Strategy Guide' is assessed according to the conditions described in the theoretical framework.

As stated in the introduction the assessed report is the 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries' of the Food and Agriculture Organization. This report gives a broad overview of the implementation of e-learning strategies in developing countries. It describes in detail the implementation phases of ICTs in agriculture and gives a starting point for implementation. Therefore this document is perfectly suited for this line of research, because conditions can be derived from the detailed information given about the implementation phase of e-agriculture. Only two parts of this documents describe the

implementation phase of e-agriculture 'Part 1: Establishing a National E-agriculture Vision' and 'Part 2: Developing a National E-agriculture Action Plan' (FAO and International Telecommunication Union 2016). Part 3 of the strategy guide describes monitoring and evaluation, which is not relevant for this research.

The 'E-agriculture Strategy Guide' notes that in general economic growth is important for reducing malnutrition as long as it is inclusive. Investing in agriculture is a great opportunity for farmers and: "In fact, agriculture is around four times more effective at raising incomes among the poor than other sectors" (FAO and International Telecommunication Union 2016, p. 4).

The results derived from the FAO document will be presented in accordance with the conditions presented in the theoretical framework. Tables 3, 4, 5, 6, 7 and 8 shows the conditions and the related findings, followed by the corresponding page number in the 'E-agriculture Strategy Guide'.

The conditions found in the 'E-agriculture Strategy Guide' are presented and described in tables 3, 4, 5, 6, 7 and 8. Goals and challenges have been added to the results presented in the table, because goals and challenges may be related to the associated condition. As can be derived from tables 3, 4, 5, 6, 7 and 8, most conditions are supported in the 'E-agriculture Strategy Guide'. Although, not all conditions are clarified or represented that often. Only the factors 'attitude towards student' (Table 4, 8.) and 'clear direction' (Table 7, 22.) and their related conditions are not represented in the 'E-agriculture Strategy Guide'.

Interpretation of the results shows that the 'E-agriculture Strategy Guide' focusses mainly on: well-designed e-learning course, access and capability of the course and equity in the extension of the e-agriculture courses. These conditions are addressed most specifically (see mainly tables 6 and 7). It cannot be said that some conditions are marked as more important than others by the FAO; the number of support in the FAO document of a certain condition cannot be seen as weight. The only conclusion which can be drawn is that the FAO mentions some conditions more often than others. This suggests that these conditions are taken more often into account. A possible explanation of f.i. the related condition of the factor 'equity' is mentioned more often, could be other goals of the FAO; such as empowering women (Food and Agriculture Organization of the United Nations, Millennium Development Goal 3: Promote gender equality and empower women 2017b).

Another explanation for the FAO's focus and the found conditions (well-designed e-learning course, access and capability of the course) can be that the FAO focusses mainly on infrastructural conditions. Without taking these conditions in account, the whole e-agriculture project would not exist. Follow-up research or an evaluation of the e-agriculture project, could possibly give more insights about the social/pedagogical conditions addressed by the FAO.

A possible explanation for the missing conditions is that:

> "components are not required to be defined in detail at this stage. It may also unnecessarily constrain the way in which these components can be realized physically. The implementation plan will determine the detailed requirements and design of these components. Other e-agriculture components will likely be identified during this step, for example components such as policy, standards and information protection. They should be noted as they are

Table 3 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Learners' characteristics'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Learners' characteristics	1.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Digital literacy and capability of farmers to harness ICTs (53); – Digital literacy and human capacity development (71); – Enable farmers to electronically access appropriate agricultural services directly without the need for an extension agent (83); – Smartphone and desktop applications (6); – E-agriculture skills and competencies that agricultural—workers require (91); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	2.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Digital literacy and capability of farmers to harness ICTs (53); – Equity and accessibility of information services (53); – Digital literacy and human capacity development (71); – Enable farmers to electronically access appropriate agricultural services directly without the need for an extension agent (83); – E-agriculture skills and competencies that agricultural workers require (91); – taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	3.	– Mass media outlets may be the only means by which the general public is informed and influenced about it, so these outlets are particularly important if a high public profile is sought (37); – Communications with other key groups should be designed according to their level of interest, expertise and support (37).

identified, and considered when analysing that specific component" (FAO and International Telecommunication Union 2016, p. 85).

Bhuasiri et al. (2012) describe two dimensions as the most important: learners' characteristics (Table 3) and infrastructure and system quality (Table 6). This includes the following factors and related conditions: computer self-efficacy, internet self-efficacy, attitude towards e-learning, internet quality, reliability, ease of use, system functionality, system interactivity and system response. As can be seen in Tables 3, 4, 5, 6, 7 and 8. The results in this research correspond with Bhuasiri

Table 4 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Instructors' characteristics'.

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Instructors' characteristics	4.	– Timeliness of services (76).
	5.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37).
	6.	– Digital literacy and human capacity development (71); – Smartphone and desktop applications (85); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	7.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Interaction with experts (76).
	8.	x
	9.	– Awareness of gender aspects and the changing role of women and youth in ensuring food security and using ICTs (29); – Women and young farmers to ensure representation of women and youth (32); – Equity and accessibility of information services (53); – Marginalization of women with respect to ICT use in agriculture (106).

et al. (2012) findings. An explanation can be that in e-agriculture application, both faculty and ICT developers are concerned.

The e-agriculture strategy document mainly discusses the phases of managing teams and stakeholder engagement, and infrastructural issues. The found conditions cannot be seen as practically feasible and are mainly a recommendation for further practice and the decision making process.

Discussion

The results of this research has some weaknesses. The first weakness is the high level of interpretation in the way in which results are obtained. Everybody could possibly connect the conditions of the theoretical framework and the results of the 'E-agriculture Strategy Guide' assessment differently. This level of interpretation would be less if the results were derived from a statistical method. This research in combination with a survey among e-agriculture users would provide less interpretable results. Although this seems a better method, the aim of this research is to

Table 5 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union, 2016) for the associated conditions of the dimension 'Institution and Service quality'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Institution and service quality	10.	– Group forums and workshops wherever practical to facilitate participation by a larger group of stakeholders (42); – Digital literacy and capability of farmers to harness ICTs (53); – Digital literacy and human capacity development (71); – Enable farmers to electronically access appropriate agricultural services directly without the need for an extension agent (83); – E-agriculture skills and competencies that agricultural workers require (91); – Education and training (development, integration or changes to existing curricula) required to develop an e-agriculture-ready workforce (91); – Education and training (literacy and digital literacy) (91); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	11.	– Mass media outlets may be the only means by which the general public is informed and influenced about it, so these outlets are particularly important if a high public profile is sought (37); – with other key groups should be designed according to their level of interest, expertise and support (37); – Access to agricultural information (75); – Accessibility to information and services (76); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106); – Content that is no longer required is maintained rather than deleted, and referred to as potential future directions for e-agriculture (115).

map the conditions mentioned by the FAO, taking a survey into account would give an evaluation of the project.

Furthermore the aim of the 'E-agriculture Strategy Guide' is broader than the conditions derived from the theoretical framework. The FAO focuses on control of e-agriculture development and the best methods to implemented several phases of the process. The conditions presented in the theoretical framework are focused on a more practical and pedagogical implementation of e-learning.

The theoretical framework sums up scientifically proven conditions of e-learning. Although they are proven, it may be that some conditions are different in other situations. Whether content is relevant or not depends on the case.

Table 6 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Infrastructure and System Quality'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Infrastructure and system quality	12.	– Current ICTs and e-agriculture environment (26); – Mobile network operators (MNOs)/telecommunication service providers (TSPs) with e-agriculture services (32); – Mobile network operators/TSPs (33); – Equity and accessibility of information services (53); – Improve the profitability of agricultural products and services through efficient logistics, universal and connected ICT infrastructure, better market access (55); – Availability, incident, access and service-level management (81); – Mobile, fixed and satellite networks (84); – Internet (84); – Inadequate penetration of ICT network (e.g. broadband, sensing networks, IT solutions) (106); – Poor ICT and e-agriculture infrastructure (106).
	13.	– Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55); – Security standards, network and Interoperability standards, and cloud security standards. For example, ITU-T X Series and Y Series recommendations (87); – All e-agriculture services providing agronomic information services are being information to farmers adhere to the AGROVOC provided by several actors (including the standard (88); – Weather station information, production information and demand, historical data about land quality, land ownership, and content relating to agricultural practices (89).
	14.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106).
	15.	– Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106); – Equity and accessibility of information services (53); – Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55).
	16.	– Interaction with experts (76); – Interactive voice response systems (IVRS) (84); – Platform-level interconnectivity, and Inter-Cloud interoperability. Financial services interoperability. For example, ITU-T X Series and Y Series recommendations (87); – Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106).
	17.	– Timeliness of services (76); – Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106);

Table 7 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Course and Information Quality'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Course and Information quality	18.	– Academia (agricultural universities) (32); – Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55); – Capture and sharing of agricultural information among agricultural services' providers (71); – Facilitate free and open sharing of information and knowledge generated by public institutions (72); – Applications platforms e.g., Content Management Systems (85); – Although not a government standard, GSMA' mAgri's Guidelines for creating agricultural VAS content56 are a relevant example; and Direct2Farm content management guidelines (87).
	19.	– Academia (agricultural universities) (32); – Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55); – FAO's Agricultural Information Management Standards (AIMS) (55); – Clearly defines the content sources and standards (70); – Capture and sharing of agricultural information among agricultural services' providers (71); – Facilitate free and open sharing of information and knowledge generated by public institutions (72); – Applications platforms e.g., Content Management Systems (85); – Open access to data and big data analysis (85); – Agricultural knowledge resources (85); – There are also challenges of data collection through sensors and integration of this information into existing databases and application platforms (85); – Supports standards, technology and good practices for open access and open data in the agricultural domain, geospatial and sensor data, metadata standards, such as Meaningful Bibliographic Metadata (M2B), data set compatibility for cross-platform sharing, and open access date (87); – Weather station information, production information and demand, historical data about land quality, landownership, and content relating to agricultural practices (89).
	20.	– Facilitate free and open sharing of information and knowledge generated by public institutions (72); – Applications platforms e.g., Content Management Systems (85); – Content that is no longer required is maintained rather than deleted, and referred to as potential future directions for e-agriculture (115).

Table 8. Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Extrinsic Motivation'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Extrinsic motivation	21.	– Weather alerts, good agricultural practices, and market price information personalized alerts and suggested actions based on weather, timing, crop and land quality. M-learning platforms; SMS, MMS, mobile applications (apps); Voice messages, video messages, and disaster warning systems agriculture portal (89).
	22.	x

The result of this research cannot be compared with results of other studies, because the subject is focussed specifically on the assessment of the FAO report. Although, the results of this report focus on infrastructural/technical conditions, where most research concerning e-learning conditions is focussed on social/pedagogical conditions. This makes it hard to place this research in a broader context. Research focussing on the implementation of e-learning and the related conditions should provide a more inclusive framework for as well technical and pedagogical conditions.

Even though this study shows some weaknesses, it gives a sufficient overview of important e-learning conditions addressed by the FAO.

Conclusion

This research used a theoretical framework of e-learning conditions to distinguish the addressed conditions in the FAO's 'E-agriculture Strategy Guide'. The results can be a contribution to further development and evaluation of e-learning technologies. The stated research question: '*Does the FAO address e-learning conditions according to scientific findings in their* '*E-agriculture Strategy Guide*'*? If so, which conditions are addressed*?' is answered by an assessment of the 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries'. The analysis shows that all found conditions (computer self-efficacy, internet self-efficacy, attitude toward e-learning, timely response, self-efficacy, technology control, focus on interaction, interaction fairness, computer training, program flexibility, internet quality, reliability, ease of use, system functionality, system interactivity, and system response) are addressed in the 'E-agriculture Strategy Guide', except two conditions (attitude towards students, and clear direction). This means that the FAO addresses conditions according to scientific findings. The focus of this document is on the conditions: quality of the course, internet access and capabilities of the system, and the equality of interaction (empowering women and the rural poor). An explanation for the focus of the FAO on certain conditions could be other goals of

the FAO and the importance of infrastructure for setting up an e-learning system. Although the FAO focusses mainly on more technical conditions, scientific literature discusses many pedagogical and social conditions for e-learning. The main arguable comment on this assessment is the high level of interpretation. This research gives only a direction for further conclusions towards e-agriculture implementation and the conditions the FAO should focus on. This study shows that the FAO takes scientifically proved e-learning conditions into account in the 'E-Agriculture Strategy Guide' in regard with developing sustainable agriculture education in developing countries.

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Online Communities of Practice Empowering Members to Realize Climate-Smart Agriculture in Developing Countries

Maria Nuutinen and Walter Leal Filho

Abstract Communities of practice are networks where individuals share the same interest and the will to learn together on the same domain through regular communication. The Food and Agriculture Organization of the United Nations (FAO) has facilitated and provided online learning opportunities to 12 climate-related communities since 2012. Their objective is to speed up knowledge-sharing, innovation and the uptake of sustainable, climate-smart agricultural practices. Based on members' feedback and online monitoring results, the structured learning events and messages in the communities' online fora (email-based discussion fora, webinar platform and a group on social media) between 12,500 members have helped the members and their colleagues and organizations to solve problems related to climate and food security. To allow development organizations to reply to the needs of practitioners and the challenges that climate change poses to food security and rural development in a timely manner, stakeholder involvement and the "crowd-sourcing" of information is vital. The use of various online fora and platforms, as well as different methods for facilitating communities' exchanges, has revealed several points that educator designing and conducting e-learning could benefit from, allowing for more efficient learning opportunities as a contribution to sustainable transformation of societies. In this chapter, an analysis of the bottlenecks and possibilities of how online communities could benefit a larger group of stakeholders is performed, and the capacity development methods improved for stronger impact are outlined. This chapter also introduces the challenges seen in implementing the concept of online communities of practice, as well as related capacity development methods, outlining technical

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and non-technical components. Finally, the elements that should be considered, for successfully using online fora for more efficient social learning, are listed.

Keywords Online community of practice · Capacity development
Climate-smart agriculture · Facilitation · Development · ICT food security
Rural communities

Introduction

Online communities of practice have been expected to contribute to solving challenges related to climate change and the learning challenges that development practitioners, smallholder farmers, herders, fishers and foresters are facing around the globe. The challenge for developing capacity includes not only the need to adapt to the new kinds of changes in the long-term weather patterns, but also the need to reduce greenhouse gas emissions, following the international commitments many countries have signed, to limit climate change.

Communities of Practice (CoPs) have been defined as: "groups of people sharing a concern or a passion for something they do and learn to do it better as they interact regularly" (Wenger 1998). To be able to function, according to Wenger, a community of practice needs: the domain, the members and the practice. In recent years, new concepts, such as 'networks of practice' (Teigland 2003), or 'electronic' or 'virtual network of practice' (see e.g. Wasko et al. 2004) have been proposed, to capture the new forms of communities exchanging on an ever-expanding variety of platforms on the internet. As the term 'network' indicates, these groups can be more "informal, naturally occurring" (Teigland 2003), as well as "geographically separate, but still share work-related practices" (Vaast 2004 in Hildreth and Kimble 2004). As the term 'communities of practice' is still the most used, and as the studied online communities facilitated by the Food and Agriculture Organization of the United Nations (FAO) use this term, the writers use it also in this study.

The number of organizations and individuals willing to start new communities for specific challenges is expanding rapidly (based on a personal observation in e.g. agencies within United Nations, and popular social media fora, such as Facebook, LinkedIn group as well as exchanges with colleagues working on knowledge management) as the benefits of social learning is proved by several organizations, especially in the private sector (Wenger and Snyder 2000; see also: Cambridge et al. 2005). The domains are often complex or require innovation, therefore benefitting from knowledge of different types of experts and combining information from different levels (e.g. field, regions, national, international). As an exchange network of practitioners, communities of practice have potential to speed up access to relevant guidance and information, shared learning, innovation and knowledge exchange on climate-related matters, increase longer-term networking, and improve access to interdisciplinary, collegial support and stronger collaboration for more efficient actions, and finally, sharing best practice across geographical distances

effortlessly. In addition, communities of practice have already played a role in raising creative problem solving and effectiveness of different kind of organizations (see e.g. the examples in Wenger and Snyder 2000). In the FAO communities, the social learning process has shown to enhance understanding and shared definition of key concepts that can support climate change action in different sectors.

However, the activity of many online communities of practice has declined: many have been struggling to function effectively, and to achieve their goals (that in most cases the communities define themselves) for multiple reasons. Several of FAO's 12 online communities of practice created to support practitioners working on different aspects of agriculture sectors (crop, livestock, forestry, fisheries and aquaculture) and climate change have been active and growing ever since the launch of the first one in 2012 and carry on with innovative content sharing and learning (Swennhuis and McCaffrey 2016). Starting with 40 members and one single community, the communities now reach over 12,500 members from over 144 countries (not all members indicate their country); including from a wide range of key organizations in the agriculture, climate and development sector functioning in local, national, regional and global levels as well as main stakeholder groups. The studied communities use three different online platforms: one for emails, second for social media and a third one for webinars and are made visible on FAO web pages as well as partners' sites.

As examples of learning activities, between March 2012 and May 2017 the membership of these communities have benefitted from 17 online learning events, including email-based and structured discussions and over 70 expert presentations on topics ranging from gender and climate-smart agriculture to lifecycle analysis of livestock sector's environmental impact. These presentations have been moderated by FAO's organizing team, and specifically prepared for the learning events. The presentations have been prepared by experts in each topic, both from various development organizations (approximately 40% of them working at FAO), private sector actors, researchers, and some members of the community of practice. Many expert presenters have also became and remained members of the communities after the events. Feedback from members has been very positive and, as a proof of communities' utility, the amount of members leaving communities remains very low (less than 40 persons per year). Based on membership monitoring data, members also keep on participating in learning events and join other sub-communities, indicating also this way their satisfaction with the way the communities function.

The communities' membership grows especially prior, during and after learning events. Also, new members seem to find the community both through FAO's online dissemination and by invitations from other members.

Study Design

The study has been conducted through participatory action research, learning by doing, combining qualitative and quantitative analysis of survey results with the members as well as online learning event discussions. The research data of this study consist of exchanges with 12,500 members within 12 different communities, as well as coaching and training sessions with colleagues wishing to set up communities and/or organize online seminars (or 'webinars'). The data has been gathered through webinars (polls, chats), online surveys and questionnaires, social media, web sites and email (monitoring data e.g. on number of clicks to links), coaching sessions (e.g. through instant messaging applications, such as Skype discussions) and interviews with fellow facilitators and moderators between March 2012 and July 2017. The article is partly based on analysis conducted for a publication *Guidebook for online facilitators. Sharing experiences from climate change and agriculture communities of practice* (FAO 2016), and developed further in this text to cover the distance learning aspects with new data based on new learning events and larger group of community members.

Components of Online Community Learning

The learning process of online communities of practice can be analysed through three main components:

1. Capacity development through online communities
2. Facilitation components
3. Technical components

To conclude, writers would like to suggest some elements for further development in order to reinforce the learning results and the overall impact of online communities of practice.

Capacity Development Through Online Communities

Figure 1 shows the factual process how a member of the FAO-facilitated climate communities can take part in a learning event, if he/she chooses to do so. The actual event usually lasts a bit over two weeks, and consists of one to two webinars and facilitated email-discussion with structuring questions. The objective of the questions is to drive the email-based discussion toward conclusions and entice members to take practical action in their day-to-day work. Figure 2 showcases feedback collected from members in regards their preferred means of exchanging prior to a specific learning event. Rather surprisingly, email-based exchanges are preferred by almost 2/3 of the respondents, whereas only 45% prefers attending the webinars.

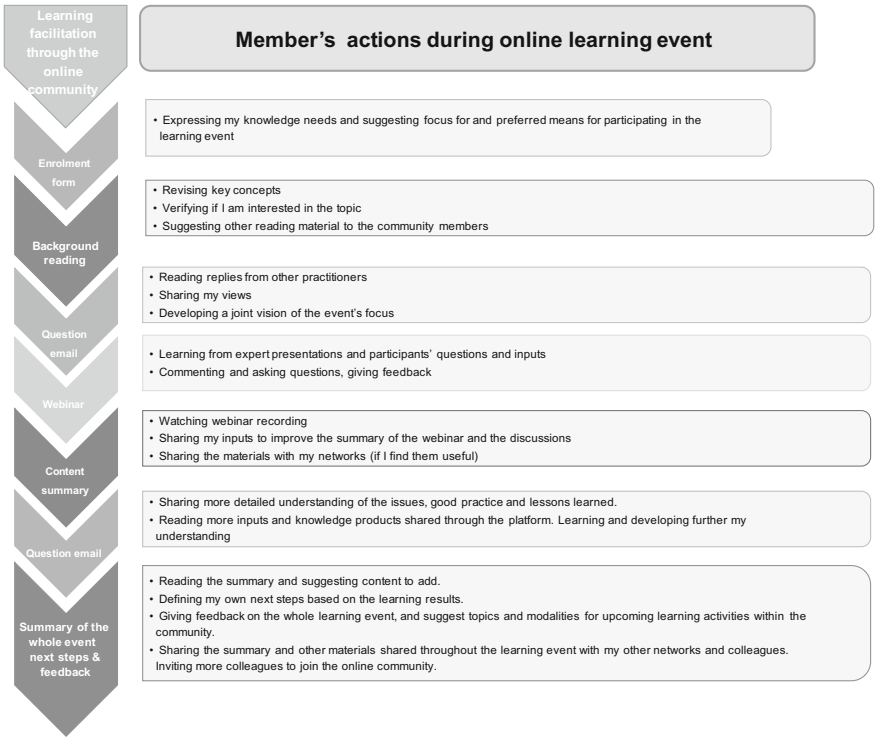


Fig. 1 Example of an online learning event's learning path from a members' perspective—an ideal case. *Source* Maria Nuutinen, FAO (2017)

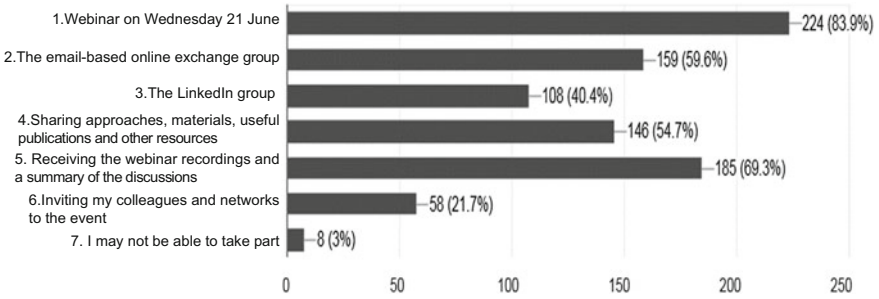


Fig. 2 Responses of community members regarding their preferred means of participation in an online learning event of the community of practice. Please note that the enrolled participants could pick several options. N = 267. *Data* Maria Nuutinen, FAO, collected through a Google form

Lack of time available is the most common limiting factor that the participants report through the feedback forms as reasons why they have not taken part in the event. Also, if the member feels that the content is not appropriate for his/her level

of expertise, the member will most likely stop following the exchanges related to the event. In some cases, very motivated members contribute in shifting the event's focus toward a topic that interests them more and suggest a new angle or more complex problematic to other participants. As an example, in the latest learning event on irrigation and climate-smart agriculture, most exchanges were sparked by member's question of potential maladaptation caused by irrigation.

Capacity Development

Capacity development can be defined in very many ways but has been mainstreamed in the international development agencies' work in the past decennia. Within FAO, the definition used is as "in international development, capacity is seen as "the ability of people, organizations and society as a whole to manage their affairs successfully" (FAO 2010: Corporate strategy on capacity development). For FAO's work as a United Nations organization, this capacity should help countries in achieving their development objectives, such as the Sustainable Development Goals as well as the national development plans. The Corporate strategy further defines:

> 'Capacity development' is the "process whereby people, organizations and society as a whole unleash, strengthen, create, adapt and maintain capacity over time". (…) It is a complex, non-linear and long-term change process in which no single factor (e.g. information, education and training, technical assistance, policy advice etc.) can by itself be an explanation for the development of capacity.
>
> FAO 2010

This definition matches well how the social learning through CoPs work with their focus on learning over a longer period of time, forming a part of the development of their environments, organizations and their individual skills, knowledge and ways of working.

Dimensions of Capacity Development

For learning and developing capacity, online communities are a tool with great potential to achieve benefits within the three dimensions of capacity development: the enabling environment, within organizations and individuals (FAO 2015). In terms of enabling environment, online communities can help in creating an enabling environment through engagement of large group of stakeholders who are working on similar subjects, for example agriculture sectors and climate change, and help in creating a beneficial environment for these capacities to develop, such as "capacities to formulate and implement policies and lead policy reform", as well as governance, and incentives (FAO 2010). At the organizational level, the CoPs can structure information, and function as part of the institutional memory, making key content accessible to new staff e.g. through the email-based fora's library

function. The individual level, all members can use the knowledge and information shared via the CoP to develop their understanding and capacity.

Means of Online Learning

Within the studied CoPs in FAO, online learning consists of:

1. email-based forum called "Dgroups" of the online communities of practice where any member can post questions, suggest discussion topics and other concerns (moderated) (Dgroups Foundation 2017);
2. webinar space (Adobe Connect) with expert presentations, polls, questions and answers sessions and collection of take-home messages and feedback;
3. Social media group on LinkedIn (see through: http://bit.ly/micca_linkedin)
4. facilitated and structured discussions through online fora (Dgroups and LinkedIn or partner's forum); and
5. sharing and receiving key knowledge materials in a variety of formats, such as e-learning courses, training guides or videos through online fora (ibid.).

Box: About Dgroups communities

Each community on the Dgroups platform (www.dgroups.org) is accessible with a password to people who have filled in the membership request form, and who have been approved. All messages sent to a community-specific email address are accessible to all members, after they have been moderated, like in any email-list. The messages sent to the Dgroup community, can also be delivered to members' mailboxes, at the frequency they wish to receive them. In addition to the message function, a Dgroups community shows in the same way as most online fora the list of members, discussion threats, a library, a calendar, and allows the moderators to use some community monitoring tools. The Dgroups platform itself is managed by an independent foundation through its steering committee.

For more information: www.dgroups.info/about-dgroups

All the online fora (1–5 listed above) are moderated and facilitated by FAO's facilitating team with occasional external professionals. As can be seen in the Fig. 2 from the enrolments of a learning event called "Irrigation in climate-smart agriculture—challenges and responses", which took place in June 2017, the biggest share of enrolled participants are especially interested in joining the webinars, receiving webinar summaries and recordings and participating in the e-mail-based facilitated discussions on the Dgroup forum.

The content of the tens of webinar sessions can be accessed through the FAO web site (See e.g. FAO 2012–2017 www.fao.org/in-action/micca/resources/learning) as well as the corporate YouTube channel.

FAO has used this method of combining various online for a and sources of information mainly for adult capacity development purposes in the agriculture, land use and forestry sectors in the developing countries. Making content available on

several ways allows accessing the information also with low-bandwidth internet connection and choosing between different ways of engagement. Students form a large share of the members, and frequently request support from other members for definition of their study topics, for collection of data or recommended literature. Given the age (over 5 years) of the communities of practice, some of the early members who joined the first community focusing on climate change mitigation in agriculture, might have followed the exchanges throughout their studies, and be now in the beginning of their professional career.

Senior-level members form an important part of the communities (based on the results of enrolment forms, and the LinkedIn group's monitoring data). They tend to share results of projects and advise less experienced members. Policy-makers and higher-level public officers tend to send thank you emails to the facilitators noting that the materials shared have been useful for them, but they do not necessarily email the communities directly. As the communities host also high number of people from different academia and research organizations, the members often benefit from messages about most recent study results. Altogether, this interconnectedness of different stakeholder groups has the potential to increase the quality of content, as well as the trust and appreciation between different groups. Based on exchanges with national focal points of a UNDP–FAO project focusing on integrating agriculture sectors into National Adaptation Plans (NAPs), difficulties in collaboration and coordination between different ministries, sectors as well as local, sub-national and national levels is often an important barrier to efficient climate change adaptation planning and budgeting (private exchanges during project's workshop, April 2016, FAO headquarters, Rome, Italy). Therefore, in the long-run, similar online communities that can allow for good exchanges and coordination, have the potential to improve the results of members' work at different levels.

Challenges of Online Communities

Using online communities of practice for transforming agriculture (or other sectors) in the changing climate is a rewarding but also a challenging task (see e.g. for: Tarzimi et al. 2006). Based on the FAO team's experience, there are three main challenges that communities face:

1. challenges of online environment for pedagogy and attention;
2. competing for members' time;
3. creating a shared understanding of complex concepts in a wide range of contexts; and
4. technical difficulties related to ease usability of online fora. (FAO 2016).

While the second and the third challenge impact the possibilities how the community's members can engage in learning activities, the challenge of creating a shared understanding of key concepts requires often more time and effort both from the participants as well as the facilitating team.

Challenge for Pedagogy and Attention

Webinars can be good means of conveying new information that does not necessarily require a lot of training to be integrated in the learners' day-to-day work. Participants can attend webinars from any device with a fairly good internet connection (512 Kbps for webinar attendees, wired connection is recommended in most cases, mobile data being too weak, see for: Adobe 2017), and organizers do not need to cover travel expenses. Compared to e-learning courses or Massive Open Online Courses (MOOC), webinars are a more agile tool: they can be prepared quicker, and they provide opportunities for synchronized exchanges between participants, therefore adding to the 'official' content shared by the organizers. In addition, content can be easily adapted to the rapidly evolving climate knowledge.

The FAO facilitating team records the webinars, and shares recordings e.g. via social media video sites, and communities, extending the amount of users that can benefit of their content. It is possible to monitor to some extend the participation to the webinar and participants' learning results, but in the end, it is up to the participant how much attention he/she is willing or able to give to the session.

As participants often attend webinars from their offices, or at least from their computers, it can be often observed that their attention drifts easily to emails or other tasks awaiting. As nor the speakers nor listeners are visible to others in most FAO webinars (in order to reduce the bandwidth required, that increases with video broadcast), there is less social pressure to attentively listen to the presenters compared to traditional seminars. In the analysed communities, learning through webinars is voluntary and no certificates are given to participants. The FAO team has experimented with various approaches detailed below possibilities to increase the attention given by the participants for improving learning results.

The FAO facilitating team has developed a participatory approach of organizing the learning events. It starts with the enrolment phase and its survey, allows collecting data on participants' capacity development and learning needs, wishes and questions, and combining them to the expert steering group's recommendations and vision, in order to cater focused, inspiring and useful content. To maintain attention, email messages as well as webinar presentations and speeches are kept to the point, short and engaging. The webinar sessions often include various polls and questions and answer sessions, as well as an opportunity to give feedback. These participatory sections have a true purpose (e.g. of collecting information on field experience, understanding members' views or recommendations, and combining the summaries of the event) and they rhythm the events and sessions on different fora.

Since 2015, the webinar organizers have also sought to further develop the learning path to improve the capacity development results. This has meant closer integration of email-based exchanges and webinars, as well as more structured webinars with interactive parts in webinars. The webinar facilitators have also asked participants to define their own learning objectives and requested at the end of the session and each learning event the participants to evaluate if they have reached their own objectives. Through these approaches the facilitators have noticed that the

amount of participants remaining in the webinars until their end and participating in the final polls has increased.

For assessing systematically learning results, the next step would be to test participants' knowledge in a more systematic manner, adding to the result of self-assessments.

Joint Definition of Concepts for Climate Literacy

Climate change impacts sectors directly depending on weather conditions and related natural resources. To be able to interpret climatic impacts and prepare for them, climate literacy should be urgently increased especially within actors in the agriculture sectors.

Communities of practice aim at supporting their members in developing climate literacy as part of its capacity development. Joining to the FAO-facilitated communities is free of charge. New members find the communities mostly through colleagues, social media and newsletters, that keep the flow of joining members constant. Online learning events increase the membership significantly. Moderators scan through the reasons the new members indicate for joining the email-based network or the community on social media. Most new members indicate that they are working or studying something related to the community's domain and wish to learn more. The members are not required to work or certificates of studies on climate change or agriculture, but because of the character of exchanges, people who are not engaged in this domain, will not remain in the fora for long.

Prior to start of learning events, the facilitators aim at sharing background information sources via email. These background materials, articles, videos, publications, often offer basic definitions of key terminology to be used and are chosen to cater relevant information to members with different levels of experience on the topic. In addition, the facilitators regularly forward to the list information of opportunities for strengthening understanding of the basis of climate or food security literacy, for example courses from World Bank's Open Learning Campus, or other MOOCs. The FAO facilitation team monitors frequently the activity of the communities, including expressed views and opinions in the emails, surveys and during webinars. The monitoring allows having a basic understanding of how members define and comprehend climate change as a phenomena, and what are the main challenges as well as the solutions they have identified to effectively adapt to and mitigate climate change.

As an example of joined concept definition within a community, during several events in 2014 and 2015, a large share of participating members wanted to spend considerable time to define the concept 'climate-smart agriculture'. During an event focusing on the implementation of the climate-smart approach at the field level, the facilitators suggested this definition to the concept, trying to summarize different aspects that members suggested, e.g. clearly articulating how agroecology and climate-smart agriculture are related to each other. The facilitators then drafted a

definition proposal that formed the basis for the following exchanges. In addition to offering additional information sources, the FAO-facilitators summarise regularly the discussions and main content of the learning events building the institutional memory and making the core knowledge exchanged and generated more easily available. Referring back to previous learning event recordings and summaries accessible through the various fora (Dgroups library and dissemination emails, web sites, social media) allows also new members to benefit of the previous events' results.

> I've been able to see the arguments of people coming from various perspectives and this has helped me to frame my perspectives which I have in turn used to influence my organisation at several levels.
>
> – Member of a FAO-facilitated community of practice to the project evaluators.
>
> (Swennhuis and McCaffrey 2016.)

In terms of climate literacy, the 17 online learning events and webinars have increased the practical understanding of the members, based on the received feedback, and what can be observed during the evolvement of exchanges. This understanding is not only about concrete ways how the climate change impacts their work and environment, but also their understanding of what and how they can adapt better to the changes and mitigate climate change.

In addition, based on members' feedback, peer support has empowered them. This strengthening of community members' agency is one of the main outcomes of the CoPs.

Skills Developed

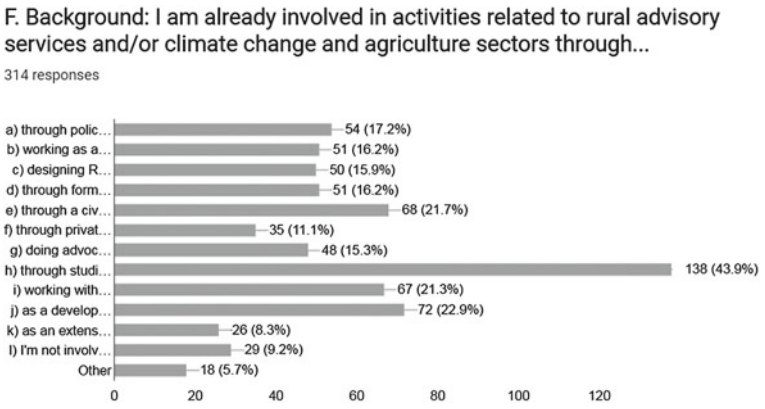
Developing skills forms part of capacity development. In addition to technical skills and knowledge related to climate change and agriculture sectors, such as irrigation, conservation agriculture or agroforestry, the exchanges through the online community platforms develop other, more functional capacities, sometimes defined as 'soft skills', often vital for getting things done in the climate field. These skills and capacities can include: networking and partnering skills; helping groups to achieve their results, or 'facilitation' skills; ability to raise interest of other stakeholders on a particular issue; write engaging and concise text; train language skills (most of the exchanges in FAO-facilitated communities are held in English, Spanish or French); and create understanding of related fields. In the final evaluation of the MICCA project, members expressed their views on the main benefit and value of the community/communities of practice to them to the independent evaluators:

> I have benefited more from the links shared by colleagues than the discussions. Some of the links shared have been wonderful and have provided fresh insights for my work. I look forward to applying these in my work.
>
> MICCA is an ideal platform to share news, post, helps that are based on the common subject thematic.

> Even I am not able to actively participate as much as I would like to, I enjoy reading the many relevant and inspiring comments. I find this approach more efficient, to get a little portion every day… I really enjoy being part of this community!
>
> – Three members of FAO-facilitated communities of practice.
>
> (Swennhuis and McCaffrey 2016.)

Regarding the learning processes, the evaluators concluded that: "for many, the primary value of the CoP discussions are in the information shared." (Swennhuis and McCaffrey 2016).

As an example of learning on subjects outside the previous area of expertise, for the community of practice on Agriculture sectors and climate change, consisting of over 3700 practitioners, students, members of academia, policy makers and private sector (data from August 2017), the learning events focusing on policies have often been most challenging, as only a minority of the members work with policy processes (as can be seen in the Fig. 3). Still, the members of the community of practice have underlined that it is useful for them to get to know the policy area that influences their work often in a very direct manner.



Legend:
a) through policy processes, e.g. planning and budgeting for Rural Advisory Services (RAS)
b) working as a civil servant
c) designing RAS and training extension agents
d) through formulation of national climate plans and actions (e.g. National Adaptation Plans, NAPs, or Nationally Appropriate Mitigation Actions, NAMAs)
e) through a civil society organization
f) through private sector activities, e.g. providing RAS services
g) doing advocacy or communications
h) through studies or research activities
i) working with an intergovernmental organization
j) as a development practitioner working on RAS and/or climate change
k) as an extension service agent
l) I'm not involved yet

Fig. 3 Only 17% of 314 enrolled participants to the webinar enabling advisory services for climate-smart agriculture were working on policies. N = 314. *Note* Participants could choose several options. *Source* Enrolment form: webinar "Enabling advisory services for climate-smart agriculture" FAO (2017). *Data* Maria Nuutinen, FAO, collected using Google Forms

Facilitation Components

The importance of organic, fostering and sensitive facilitation is often highlighted over technological concerns (see e.g. Hearn and White 2009). Facilitator and moderator have complementary roles in helping the members of the community of practice in reaching their goals. Figure 4 describes the differences as identified by the FAO team working with the communities, and lists common tasks performed by the two. Sometimes one person can play the two roles.

Facilitator's questions can help participants and the community as a whole to reach their learning objectives. These facilitating questions (see for more, e.g. in FAO 2016, pp. 21–30) do in best cases take the participant through a learning path, and at the end, he/she has defined how to use the lessons learned in practical action.

Technical Components

In the agriculture sectors especially, the challenge of providing easily accessible and relevant climate-related information tailored for different stakeholders is staggering. In addition to the fact that farmers, herders, foresters and fishers, and people working on the value chains, are so geographically dispersed compared to practitioners in cites makes the task even more challenging. Yet, they are the ones needing the climate-related information the most. The main target audience of the studied communities are the people planning development work, and working with thein the development context to support them with this task of addressing climate change and food security together.

MODERATOR	FACILITATOR
Guides and helps members in the usage of the forum/ fora, the netiquette and with the rules of engagement	Provides equal opportunities for members to share their different viewpoints to be shared
Manages the membership	Observes the content, style and rhythm of the interactions
Manages the settings of the forum as needed	Must be familiar with the topic (knowledgeable with current issues, interventions and research) and the types of actors engaged
Maintains a rhythm of activities: e.g. approves messages to the email list 2–3 times a day on working days	Takes a proactive role in taking the discussion forward
Monitors and reports on the development of membership and activities	Continually assesses: what is needed now? What is the atmosphere in the community?
	Thinks: what question would spur ideas sharing? Is there a member whose involvement would be especially useful at this point?
	Contacts members and request inputs or consultations

Fig. 4 Differences between moderator's and facilitator's tasks in FAO online communities of practice. *Source* In FAO (2016), Maria Nuutinen

There are specific benefits and challenges in the use of Information and Communication Technologies (ICT)—especially when considering how to reach different geographically dispersed groups. To those who can connect to internet, social media channels, a webinar or an email list, the online channels can deliver relevant knowledge faster than a publication. Still, online exchanges have their limitations, and means to structure visually the exchanges in a comprehensible manner should be developed further, especially to allow all stakeholder groups' engagement. Making online fora more user-friendly, through allowing for the visual structuring of exchanges (e.g. through tagging with key words, and powerful search engines within the fora, would be essential for helping CoP members to find the relevant information.

Though internet connection issues have hugely improved, with the 67% of the youth (15–24) is using internet in developing countries and 30% in least developed countries (see for: ITU 2017; in comparison to: World Economic Forum 2015; UN News Centre 2015), since the start of the work in 2012 still approximately 2% of participants e.g. to webinar sessions report that they either can assist fully in the session. In the developing country context, the email-based exchanges of the communities that can be accessed also through simple cell phones with mobile data connection, can help in reaching and engaging some of the less connected regions—and potentially more climate-vulnerable benefiters. ITU reports (2017) that the mobile-broadband subscriptions have increased in least-developed countries by over 50% between 2012 and 2017, though still only a bit more than 20% of inhabitants have a mobile-broadband subscription. In all developing countries combined, approximately 50 out of 100 inhabitants have a mobile-broadband subscription in 2017 (estimates, ITU 2017). An important digital gender gap exists globally (ITU 2017), and is also reflected in the FAO-facilitated communities participation rates: in general terms, female participants form approximately 40% of the participants.

Technical content of the FAO online learning events depends on the involvement of experts. In best cases, the experts have engaged in three ways: first, advising in the focus of the whole learning event, secondly in giving webinar presentations and finally in replying other members' questions both during the webinars and through the email-based discussions. The facilitator of the event needs to keep in mind the different levels of knowledge and experience that the members have, and keep the exchanges both comprehensible and interesting to most members.

Monitoring and Improving

Social media and online learning platforms, such as Moodle, give efficient tools to structure the learning path and monitor learners' activities and contributions. For documenting and showcasing communities' impact and efficiency, our team has used monitoring tools both for the accessing online documents, sites and fora. Additionally, the focus and the quantity of the participants' inputs can be monitored through platforms' key word search, and seeing which discussion topics and questions have sparked most replies with more content suggestions and advise. One challenge is to decide which things to monitor, how often, and what not, as the

activity of the communities is sometimes intense, and monitoring should not be the main focus of the moderator. The FAO guidebook gives suggestions on where to focus in the chapter Monitoring, evaluation and reporting on communities of practice (FAO 2016).

Elements for Further Development

Integration of Existing Communities and Online Courses

To FAO team's experience during e-learning courses and MOOCs, the social aspect that makes people engage in processes more fully, are often very limited. Platform developers have made attempts to bring in more social engagement features, such as group discussion or tasks, but at the same time it cannot be expected that participants would develop strong social relations with people they engage with for some weeks only (see for sites of MOOC providers, such as edX; Coursera, World Bank). Given that learning is in most cases a social process (for more on social systems on learning: Wenger 2012), it could be beneficial to test further integration of existing communities of practice and more structured learning courses. For organizers of these learning opportunities, the curricula design might require more flexibility and collaboration with facilitators together with pedagogues.

Development of Online Platforms and Structuring Information

The content shared on online communities is often hard to search. Summaries of discussions, learning events and webinars are an important step in making the main content easily available, but often the exchanges still reflect the real-life communications in its fragmented nature. Online platforms have possibilities to develop further to better highlight the main content exchanged in different groups.

Results and Conclusions

According to the experiences gathered as part of the project, the main elements to achieve good learning results that satisfy members of the online communities and address challenges are:

1. dedication of sufficient human and financial resources allocated to support the facilitation and moderation of the communities and the organization of learning events;

2. clearly defining the key concepts at hand, the focus and domain of the community with its members;
3. choosing easy-to-use online forum (that the members and target audience for new members is using already or can learn to use) or fora
4. taking into consideration the objectives and the needs of the target audience; and
5. engaging topical experts (e.g. leading professionals in partner organizations, researchers willing to share their results) to actively contribute to the community's exchanges.

These element cater for developing capacity at different levels, ensuring that the maintenance and facilitation as well as technical content and ICT solutions are accessible.

To conclude, there is a growing interest towards using online communities of practice for finding solutions to climate-related challenges, and this should be encouraged. The facilitator has a fundamental role in balancing between participatory approach and actions, which focus exchanges toward topics that really matter.

To develop further the online communities as social learning systems, it would be recommended to find ways to integrate e-learning opportunities, such as MOOCs and online communities of practice. As a second, additional way ahead, interlinking the ecosystems of different online communities more effectively would be beneficial in solving multidisciplinary issues, such as climate change. In addition, online platform developers should aim at more developed ways to showcase better the main content developed and shared within online communities in a structured and concise manner. The improved social learning systems could help ensuring that information and knowledge were increasingly benefitting not only the community members, but through their work, societies and the global community as a whole.

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Tertiary Education Knowledge and Standards in Sustainable Development: A Crisis for the Democratic Republic of the Congo

Eva A. McNamara, Melaine Kermarc, Joseph Zambo Mandea and Glenn Bush

Abstract This paper presents a case study to stimulate debate and action concerning the lack of capacity to plan and manage development sustainably in the Équateur province of the Democratic Republic of the Congo (DRC). The case study examines environmental literacy of higher education students enrolled in programs focused on rural sustainable development in the context of human resource needs to effectively implement complex sustainable development programs financed through international climate change initiatives. Written surveys of students and teachers and semi structured interviews with key informants in a higher institute of education's administration revealed low comprehension of key environmental issues in the region (climate change, deforestation impacts), low French literacy, and limited access to teaching and learning materials as well as the Internet. Overall, this case study illustrates those immediate interventions which are needed to avert a current crisis in the ability of the DRC to scale up planned sustainable development programs. Curriculum revisions and improved access to current information and training methods are especially needed in order to create a foundation for sustainable development within the country.

Keywords Democratic Republic of Congo · Sustainable development Higher education · Tertiary education · Environmental literacy Institutional capacity building · REDD+ · Deforestation · Decentralization Climate change · Knowledge transfer · Internet access

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Introduction

> Development does not start with goods; it starts with people and their education, organization, and discipline. Without these three, all resources remain latent, untapped, potential.
>
> Schumacher (1973, p. 117)

This case study focuses on students in the province of Équateur in the Democratic Republic of the Congo (DRC) enrolled in tertiary education programs focused on sustainable development and the environment.

The quality of their work supporting rural development projects while maintaining natural resource stocks, and especially forests, is inextricably linked to national and international sustainable development initiatives, as well as large investment programs such as REDD+ (Reduction of Emissions from Deforestation and Forest Degradation in developing countries plus the sustainable management of forests, conservation of forest carbon stocks and enhancement of forest carbon stocks). This program aims to compensate actors providing a conservation service of forest resources, whether they be state actors, civil society or private entities. This compensation can be in the form of direct financial payment or in the form of sustainable development activities such as agricultural extension or social infrastructures. Regardless of the benefit-sharing program put in place in the context of REDD+, development practitioners implementing these projects are required to master both best practices in the development realm as well as have a comprehensive understanding of natural resource management. There is currently no academic literature exploring the environmental literacy of these students, the quality and subject matter of the national environmental and sustainable development tertiary programs within the DRC, the institutional capacity of tertiary institutes in Équateur, their ability to access information, or their ability to stay up to date with new and important research happening at institutes and universities around the world.

In order to inform projects and programs looking to build capacity and increase environmental literacy as it pertains to sustainable development and climate change mitigation and adaptation, this study was undertaken to better understand (1) If higher education students in the sustainable development field are equipped with the basic knowledge of fundamental environmental concepts that will allow them to contribute to environmental programs like REDD+ and sustainability-based development initiatives and (2) What are the barriers to obtaining a relevant and current education in this field, and how can these barriers best be alleviated?

While this case study is small, the results of the survey were used by a pilot REDD+ project to design sustainable development activities that would best suit the needs of the staff and students at the surveyed university. The discussion includes information about how this was done, and highlights the complexity of facilitating information transfer in the context of the DRC. We focus our conclusions on the importance of these programs being improved in a participatory manner and how capacity building and knowledge transfer for sustainable development can only be supported and sustained if projects and programs set up to improve sustainable

development education are flexible enough to adapt to provide individualized and targeted resources when needed.

Literature Review

Tertiary Education (TE) and Sustainable Development

There is no, "one size fits all" when it comes to how a community can achieve sustainable development (Khelghat-Doost et al. 2011). However, universities can play an important role in building human capital by helping develop capable community leaders, managers, and educators (Ketlhoilwe and Maila 2008; Khelghat-Doost et al. 2011). Since the early 1990s several international agreements have been put in place, which

> *…acknowledge that the role of [*Institutes of Higher Education*] can be categorized into three groups. The first is that higher education has a role to play in helping students gain awareness of the world in which they live. The second, an understanding of the way in which multifaceted economic, social and environmental processes interact with each other (including the contribution individuals make to these processes) and lastly, familiarity with the perspectives of other societies and cultures on these issues.*
>
> Khelghat-Doost et al. (2011, p. 111)

Higher education institutions have been identified as necessary leaders in the sustainable development movement. Knowledgeable experts, research facilities, modern infrastructure, and students from diverse populations with diverse interests make universities a unique place for sustainable development initiatives to grow and flourish (Khelghat-Doost et al. 2011). Additionally, "Institutes of Higher Education appear to be appropriate candidates for assuming the sustainable development leadership and becoming center points of coordination between different actors and members of society (NGOs, individuals, private sector, etc.) in achieving sustainable development goals," (Khelghat-Doost et al. 2011, p. 115). This does not come as a surprise, as a 1994 report form the World Bank noted:

> Higher education is of paramount importance for social and economic development. Institutions of higher education have the main responsibility for equipping individuals with advanced knowledge and skills required for positions of responsibility… estimated social rates of return of ten percent or more in many developing countries also indicates that investments in higher education contributed to increase in labor productivity and to higher long term economic growth essential for poverty alleviation.
>
> World Bank (1994, p. 1)

However, while sentiments about the value of tertiary education seem not to have shifted dramatically since the 1990s, funding from the Inter-American Development Bank and African Development bank dropped from 129.7 million and 520.8 million respectively between 1990 and 1999 to 8.8 million and 52.5 million USDs between

2000 and 2005. And this decrease in funding has not gone unnoticed. In the World Bank Group Education Strategy 2020 it is acknowledged that since 2000 "the share of education funding for tertiary education and vocational education has declined, while the share of "general education" funding—which benefits several education levels—increased" (World Bank 2011, p. 48). This decrease in funding for TE is presented as a positive, and it is clear from the rhetoric of the report that basic education (pre-primary, primary, and low secondary levels) is considered to be a more valuable societal investment than tertiary education.

This situation is paradoxical, as it is estimated that, "if Africa could increase the tertiary education stock of its population by one additional year (averaged over the whole population) the GDP per capita growth rate in Africa would rise by 0.24 percentage points in the first year" (Bloom et al. 2006, p. 7). Coupled with the fact that increased rates of tertiary education promote a faster adoption of modern technologies, "this higher rate of technological growth […] may boost incomes by roughly 3 percent after five years and by 12 percent eventually" (Bloom et al. 2006; p.7).

In addition to these cuts, conflicting interests abound regarding how these funds are distributed—much development aid money earmarked for TE is actually channeled through universities in developed countries, as "technical assistance" has historically been more valued than in-country capacity building at the tertiary level. This is illustrated not only by the substantial aid funding many American universities receive to train developing country nationals but also by the Department of International Development's (DFID) funding of research for developing countries in UK universities (Kapur and Crowley 2008), as well as their scholarship offerings to developing country nationals. However, 2003 study showed that only about 40% African nationals who went to the USA to pursue PhDs returned to their country of origin (Gupta et al. 2015), suggesting that encouraging studying abroad may not greatly contribute to capacity deficits within developing countries.

Donors are not unaware of the benefits of TE—a rigorous literature review funded by DFID in 2014 concluded that although more studies about TE's impacts on development are needed, there is

> …evidence to suggest that TE may provide greater impact on economic growth than lower levels of education…TE provides a range of broader, measurable benefits to graduates, relating to health, gender equality and democracy, among other areas. In addition, it contributes to the strengthening of institutions, and the forming of professionals in key areas, such as education and healthcare. The diverse functions of the university, in addition to its direct impact on economic growth, should be acknowledged and supported.
>
> Oketch et al. (2014)

Contrarily to this report, DFID's research and development website advertises their current research (being done within UK universities) which focuses on reducing corruption and improving governance (DFID 2015)—which could possibly be improved by funding higher education facilities abroad and not at home. According to Bloom et al. (2007) there are significant positive correlations between corruption, rule of law, and quality of bureaucratic institutions (general governance indicators) and a country's higher education enrolment rates. Despite this, facilities

in developing countries, especially in Sub-Saharan Africa, remain largely neglected (Kapur and Crowley 2008), while governance focused programs carried out by development organizations abound.

Despite the ever-growing span of research initiatives being undertaken in higher education facilities around the world, much needed research that is specific to the needs of developing countries is not being sufficiently undertaken. Agricultural research, for example, is often more helpful for industrial farmers, and not particularly advantageous for small-scale farmers living in poverty. Even in the cases where research is specific, the transfer and application of this knowledge is often done poorly, inappropriately, or not at all. The most practical remedy to this situation is the investment in higher education facilities within developing countries in order to build capacity to not only help students develop hard skills, but also to provide an environment where innovative research is encouraged, supported, and highly applied (Kapur and Crowley 2008).

Tertiary Education as a Vector for Sustainable Development in DRC

In the DRC there is a great need for workers who are highly and specially trained, as well as critical and creative in their approaches to problem solving, as sustainable development needs to be highly contextualized and specific depending on resources, population and needs. The university has often championed as a promoter of middle class growth, which has been seen to have a positive impact on the organization of institutions (Kapur and Crowley 2008). Income inequality is high in the DRC, and the development of a middle class, perhaps aided by better access to quality degrees, could be a catalyst for sustainable development.

In the most recent Growth and Poverty Reduction Strategy Paper (GPRSP) for the DRC, Pillar 1 of the report, entitled 'Strengthening Governance and Peace', it is emphasized that there is a great need for capacity building among leaders in order to address poor governance issues and corruption (IMF 2013). Tertiary education does just this—it educates future leaders about the needs of their countries and gives them the skills to tackle these problems.

While there is no available data available about the returns of higher education in the DRC, a recent study done in the neighboring Republic of Congo found convex returns to education, highlighting significantly higher returns in income levels from tertiary and secondary education than primary education (Kuepié and Nordman 2015). In the DRC, a context of "extremely limited capacity" (Aquino and Guay 2013, p. 74) of the government to implement projects and programs at national and local levels, capable professionals are in high demand. However, in 2012 it was estimated that out of the 9000 young people who exit Congolese universities each year, less than 100 find a job for which they are not overqualified. This is most likely due to the inconsistent quality of educational facilities in the country, and the fact that foreign qualifications are more highly considered by employers (OECD et al. 2012).

Currently in the agricultural sector, which in Équateur will need to be involved in sustainable development initiatives as agriculture is both a cause of deforestation in the province but also a high potential economic sector given its perfect climate for crops like palm oil (Woods Hole Research Center 2007), qualifications are generally low and most junior staff hold only bachelor degrees or lower while senior staff approaches retirement age (Ragasa et al. 2014).

Tertiary Education in Equateur

Équateur is the poorest province in the DRC and suffers from high political instability (IMF 2013). Équateur's graduates will be vital to the future of a province whose economy is, and most likely will continue to be, based heavily on the exploitation of its natural resources. Therefore, it is pertinent that graduates have adequate levels of environmental literacy (EL)—specifically an understanding of environmental degradation and sustainable resource management in order to foster an economic development that is environmentally sustainable for future generations.

While research has exposed the necessary corruption of teachers within the DRC education system (Brandt 2014), there is no literature about the actual content of the national curriculums nor about the TE sector in Équateur. While universities in more developed cities such as Kinshasa and Kisangani are able to benefit from partnerships with international universities and NGOs, more remote provincial universities in the DRC have been largely ignored.

Additionally, travelling to the provincial capital of Mbandaka is arduous and expensive, making Équateur province generally an undesirable place to be, as many goods and services as well as basic utilities such as electricity and running water are not widely available. While there is no available literature on the TE sector in the province, the findings of a study from Brandt (2014) on primary education can be extrapolated to the university level to highlight the unwillingness of teachers to travel to remote provinces and the difficulties that institutions have in finding qualified staff.

Study Context

The DRC, Equateur Province, and Its Forest

The DRC covers over 2.4 million square kilometers of land of which about 63% is forested (FAO.org 2017). Conflict and political mismanagement over the past decades have severely hindered development, and the DRC currently ranks 186 out of 187 on the human development index (UNDP 2015). Located in the northwest of the DRC and with a population of roughly 9 million, Équateur is the poorest

province in the country, and about 93.6% of the population is estimated to be living in extreme poverty (UNDP 2009). It is important to note that this paper refers to the statistics available for the old province of Équateur, however it has been divided into five smaller provinces as of 2015. The province sits in the heart of the Congo Basin, and contains about 25% of the country's forested land. Several years of relative stability and a booming population are beginning to put more pressure on these forests, and low access to electricity (estimated around 1%) (UNDP 2009) and limited economic opportunities—the informal economy accounts for about 95% of family incomes within the province (UNDP 2009)—mean that the growing population, especially in rural, isolated areas, must increasingly turn to the forest for their livelihoods (Milburn 2014). Already in Équateur an estimated 90% of the population depends directly on the forest and its resources for food, fuel and medicinal plants, and often sell excess or high value goods to garner a monetary income (CPP-CAD 2009). It is estimated that between 2001 and 2013, 1.2 million hectares of land were deforested in the province alone (Walker 2015).[1]

Équateur province has a young population, with over 57% of its inhabitants below the age of 20 and an average age of 21 (UNDP 2009). While population growth has slowed in the DRC in recent years, it is still comparably high even for sub-Saharan Africa, averaging about 3.1% growth in 2015 (World Bank 2016). Deforestation in the DRC is caused primarily by shifting agricultural practices (Russell et al. 2011; Potapov et al. 2012; Woods Hole Research Center 2007), as well as by charcoal production driven by the needs of growing urban populations (Potapov et al. 2012). Deforestation alone is estimated to cause a rise in temperature of around 0.7 °C, with some spots reaching 1.258 °C warming by the middle of the century (Akkermans et al. 2014). Additional warming caused by other factors, coupled with an average rainfall decrease of 5–10% (Akkermans et al. 2014) will further challenge the livelihoods of the people of Équateur.

The DRC government has adopted an integrated REDD+ program framework that acknowledges that the protection and conservation of forest resources is a complex issue that needs multi-sectorial and ministerial communication, participation, and collaboration to be successful and sustainable. These integrated programs will be based in areas identified as "high risk" areas for REDD+, such as Équateur, and the framework recognizes that REDD+ must include efforts to support and stimulate sustainable development as well as address direct and indirect drivers of deforestation (Fond National REDD+ 2015). In 2006, the DRC government adopted the idea of decentralization in their national constitution to help the country develop by allowing more localized governance structures to focus on regional needs and potential, and giving them "administrative freedom and managerial autonomy with regard to their economic, human, financial and technical resources" (Cabinet of the President of the Democratic Republic of Congo 2006). A similar route has been taken with the development of the national REDD+ framework policy—although the general

[1]This estimation is based on data extracted from Baccini et al. (2012)'s global carbon data set in order to look more closely at deforestation rates within the province

framework and investment plan has been developed at a national level, REDD+ provinces will be required to develop their own strategies depending on contextual issues, institutions and available resources, as illustrated by the Mai Ndombe Emission Reduction Program (Ministry of Environment, Conservation of Nature and Tourism 2014). Équateur's vast forest resources, hotspots of deforestation, and high poverty rates mean that the national REDD framework considers it a "high risk" area for increased deforestation. Both the country's GPRSP for 2011–2015 and the province's own most recent development plan from 2010–2015 cite REDD+ as a key monetary investment in their hopes of achieving a sustainable development as well as conserving their forest resources (CCP-CAD 2009; IMF 2013).

For Équateur, given its year-round growing season and a large potential local and regional market, this process could focus on rehabilitating degraded lands to be used for agriculture, as well as encouraging REDD+ friendly practices like crop rotation and agroforestry. However, the success of REDD+ projects depends on more than developing a logical framework. The DRC REDD+ Investment Plan for 2015–2020 has identified that their first window of funding must address the need for capacity building, as capacity deficits are a risk to a decentralized REDD+ structure. The plan notes that "capacity building of local and national institutions to better manage space and natural resources" are a key to laying "the foundations for a harmonious and sustainable development of the country" (Fond National REDD+ 2015).

While there are a number of capacity building initiatives going on within the DRC, there are few that are directly involved with agricultural training institutes and/or tertiary education institutions (Ragasa et al. 2014). The DRC's tertiary education framework has not seen thorough reform since 1971, although several reports have been produced identifying problems as wells as possible interventions (Table Ronde de l'Education en République Démocratique du Congo «Vers une stratégie pour une Education de qualité pour Tous»—Rapport General 2004; Cellule Technique pour les Statistique de l'Education (CTSE) 2009). New programs addressing environmental issues and sustainable development have been put in place in the last decade, however there is little information available that explores what exactly students in these programs are learning about the environmental state of their country, the threats and causes of climate change, and sustainable development theory. Given that institutional capacity building has been recognized as essential to the success of REDD+ within the country, it is important that the role of the university in building human capacity, producing relevant and sound research, and training citizens be considered as a valuable investment in encouraging sustainable development in the DRC.

Study Site: L'Institut Supérieur de Développement Rurale Mbandaka (ISDR-MDK)

L'Institut Supérieur de Développement Rurale Mbandaka (ISDR-MBK), or the Higher Institute of Rural Development in Mbandaka, is a higher education institute located in Mbandaka, the capital of Équateur province. The institute offers both *graduat* and *licence* courses (modeled after the old Belgian system), of three and two years respectively. The first year of *graduat* is a general year, after which students can choose their course of study from five options; social organization (OS), rural enterprise development and management (GDER), rural planning (PR), rural administration (AR), and Environment and Sustainable Development (EDD).

At the time of the study, ISDR-MBK had a total of 30 educators, 2 of whom were professors. The remaining 28 make up the 'scientific body'—some of who are assistant teachers and others who are 'chefs de travaux', teachers who supervise practical work. The professors are mainly responsible for teaching the *licence* students while the remaining teachers teach the *graduat* level courses.

In the 2014–2015 school year, ISDR-MDK had a total of 1,253 students, 1,074 *graduat* and 179 *licence*. While female students account for about 40% of *graduat* students (higher than both the national and provincial averages), they only make up about 28% of the *licence* course. As of 2014, according to their own records, ISDR-MDK had awarded degrees to 2781 students. Numbers of students receiving diplomas decreased severely during the period between 1993 and 2007, with the number of graduates falling to a low of 7 in 2001, most likely due to conflict within the country.

The ISDR-MDK campus is made up of several buildings; offices for administration, living quarters for students, and classrooms containing only desks and chalkboards. During an interview with the Director General of the institute he noted that theft is rampant, and the few valuable teaching resources (including computers) they receive are usually stolen, as security resources are insufficient. The library is a single room and contains primarily theses written by previous students. Most of the few books date back to the Belgian colonial era, including agricultural volumes written in the 1950s. During an informal conversation the librarian remarked that until the conflict in 2000 many students did come to use the library, but after that interest and quality of the work declined. The campus does not have Internet access.

ISDR-MDK's main missions, according to the 'Guide to Discovering ISDR Mbandaka' (Institut Supérieur de Développement Rural de Mbandaka 2015), are:

1. To provide formative training to create professionals able to work in the most diverse areas of national life. As such, ISDR-MDK provides teaching for those enrolled in its programs designed to foster the emergence of new ideas and skills development.
2. To organize basic scientific research oriented towards the specific problems of the Democratic Republic of Congo, taking into account new techniques and technology in the world.

In order to achieve these two objectives, they must:

- Train Rural Development Technicians (TDR), specifically men and women capable of arousing, accompanying, planning, supporting and encouraging human, economic, and social development of rural communities;
- Collaborate in the study of human, economic and social-organization faced in rural areas;
- Establish a varied and complete documentation about all aspects of rural life.

Additionally, the guide goes on to note that all students will graduate well versed in five topics: agriculture, fisheries management, agro-pastoralism, biotechnology/appropriate technology, and environmental/biodiversity ecosystems. All students are to attend weekly field trips to organizations and businesses during their first year, cultivate their own small agricultural plot each year, spend at least ten days working and observing life in rural villages during their second year, and do a two or three-month internship with a local public or private non-governmental organization (NGO) during their final year to gain work experience.

While there were several higher education institutes in Mbandaka very willing to participate in this research, the decision was made to work with ISDR-MBK exclusively due to time and cost constraints. Only two institutions in the city offer environmental courses (ISDR-MBK and the University of Mbandaka). ISDR has the best reputation locally in terms of academics, is the older of the two, and is primarily focused on training rural development technicians.

Method

Evaluating Environmental Literacy

In order to evaluate the student's current environmental literacy (EL) levels, the EL Evaluation Instrument (ELEI), designed to help higher education institutes to "better understand [their] current impact before investing heavily in change" (Shephard et al. 2013, p. 477) in terms of education for sustainability was used as a model for the written survey done at ISDR. The ELEI was designed to help "academic departments to better understand the degree to which they are fostering this attribute in their undergraduate teaching and the degree to which our undergraduate cohorts possess it" (Shephard et al. 2013, p. 478).

Given that the students at ISDR are being trained in rural development issues, which in the case of Équateur overlap significantly with environmental issues, an environmental literacy survey was a logical starting point for understanding larger capacity deficits within the institution. The example ELEI developed by Shephard et al. (2013) was used as a basis for the EL survey, but multiple-choice questions that more specifically addressed environmental problems in Équateur were also

added. Shephard's ELEI was designed in collaboration with the North American Association for Environmental Education (NAAEE), a recognized institution that has been working over many years to design instruments to assess the level of student's EL. It is important to note here that their ELEI was designed to be efficient to distribute, meaning that tests were graded by machine and students were asked to respond to the multiple-choice questions and also give their 'confidence level'. This was impossible to replicate in Mbandaka—there are no grading machines available. Additionally, based on the tryout of the survey the format was also considered foreign to students, so additional questions about confidence in their answers were deemed unsuitable for the context and may have hindered response rates. All surveys were filled out anonymously.

Nine multiple-choice (MC) questions were included on the student surveys. Two questions were included as "test" questions, which focused on very recent government information and research addressing local deforestation and agricultural issues. The purpose of including these questions was to see whether or not this relatively new data, which is of direct concern to sustainable development actors in the region, was being effectively communicated to these university students within the environmental and development sector. The performance on these questions was hypothesized to be low in comparison to the more general knowledge questions. The general knowledge questions included several taken from Shephard's ELEI, however given that those questions were designed for university students in New Zealand and Australian in 2012, it was necessary that additional questions be developed that would be more appropriate in a rural, rainforest context (i.e. replacing questions about fracking with questions about forest resources).

All questions were developed, selected, and/or modified in partnership with the National REDD Coordination's Provincial Focal Point for Équateur, as well as the Project Manager of Projet Équateur, a pilot REDD+ project based in Mbandaka, in order to ensure that questions and vocabulary were appropriate for students, as well as correctly reflected environmental knowledge relevant to the sustainable development of the province. Administration officials at ISDR were also given the questions in advance for review, and offered advice for modifications and the mode of distribution to ensure that the structure of the survey would not hinder the students' ability to perform in a way that accurately reflected their level of knowledge. A pre-test was also run with local environment and sustainable development professionals to ensure the difficulty level reflected professional standards. According to the ISDR brochure, graduating students should not only understand basic ecological systems, but also be able to bridge gaps between social and environmental issues. Thus, the survey, although not considered to have a high level of difficulty, touched on a number of basic ideas and concepts related to these issues within the province and country.

Data Collection

Students surveyed in July of 2015 were in their final years of their course at ISDR-MBK, hereafter referred to as L2 (*Licence* year 2) and G3 (*Graduat* year 3). A disproportionate stratified random sampling method was used to select 40 students from official class lists. The G3 students were chosen exclusively from the EDD option, and the L2 students, as there were only 13 students enrolled in the EDD option total, chosen from all five course options. A total of 32 surveys were collected from 12 female and 20 male students (a response rate of 80%) over a period of two days.[2] All 20 teachers and professors at ISDR-MDK were invited to fill out the survey. A total of 12 surveys were completed, 11 by teachers and 1 by a professor, for a response rate of 60%. All surveys were completed anonymously.

Student surveys included demographic questions, the modified ELEI, as well as questions about future goals, their opinions of the quality of their education, Internet use, and changes they might like to see at ISDR. Educator surveys included background questions, questions about internet use and teaching materials as well as the portion of the ELEI used to measure environmental sentiments, not knowledge (including the environmental knowledge component could have been potentially insulting to the educators). Semi-structured interviews were also carried out with administration. ISDR-MBK shared their official course lists as determined by the Ministry of Education Superieur et Universite (MESU) as well as their enrollment and graduation statistics and information brochure. Government documents from the MESU website and partner NGOs concerning tertiary institutions were also consulted, however reports were not current and the website has since gone offline.

Surveys and interviews were conducted in French, as French is the national teaching language in DRC. ISDR-MBK is a public institution and classes, administrative information, and library materials are in French although regional dialects are widely spoken throughout the country.

Results

Descriptive Results

In order to gain a more general demographic understanding about those surveyed, student participants were asked to answer questions about their age, gender, and grade level. These results are displayed in Table 1. Educators surveyed were asked

[2]While the survey was initially to be given on one day, an additional day was added as many selected students, especially females in the *licence* course were unable to attend (they normally attended evening classes at the institute as they worked during the day). Other students selected could not attend as they had already finished their classes and coursework and had returned home to other cities.

Table 1 Descriptive results for students surveyed

Total surveys collected	Age range (years)	# of male students	# of female students	Number of L2 students	Number of G3 students	L2 average age	G3 average age
32	22–58	20	12	13	19	28	27

Source Own data

Table 2 Descriptive results for educators surveyed

# of educators surveyed	Age range (years)	Average age	Number of years teaching (range)	Average number of years teaching	Male	Female	Teachers	Professors
12	43–60	53	4–32	15	12	0	11	1

Source Own data

similar questions, as well as how long they had been teaching and if they were considered teachers or professors. These results are illustrated in Table 2.

Test Item Analysis

Before looking into scores further, all numerically scored questions were looked at through quantitative analysis in order to determine if any of the questions were inappropriate for the audience. Results of this analysis are shown in Table 3. For this analysis Difficulty Index (Df) and Discrimination Index (Dc) were used. The Df reports the difficulty of a question on a scale of 0.0-1.0, and the ideal item difficulty for a four alternative multiple choice test is considered by Thompson and Levitov (1985) to be halfway between a pure guess (0.25) and all answering correctly (1.0), or 0.625. The Dc is a measure of a question's ability to differentiate between students who average higher scores overall and students who average lower scores (Colbert 2001). It is measured on a scale of −1.0 to 1.0. Negative scores indicate that more students who scored lower overall answered the question correctly, while scores above 0 indicate that more students who scored higher overall answered the question correctly. Negative scores would indicate that higher scoring students struggled with a question, signifying that its wording or format may be flawed.

Difficulty Levels

Difficulty level was appropriate (<0.7 and >0.3) for all questions except MC1(0.72), MC3(0.84), MC4(0.03) and MC5(0.25).

Table 3 Test item analysis

Question	Ns or Σc	Df	Dc
Multiple choice 1 (MC1)	**23**	**0.72**	**0.33**
Multiple choice 2 (MC2)	17	0.53	0.44
Multiple choice 3 (MC3)	27	0.84	0.33
Multiple choice 4 (MC4)	1	0.03	0.11
Multiple choice 5 (MC5)	**8**	**0.25**	**0.22**
Multiple choice 6 (MC6)	**13**	**0.41**	**0.67**
Multiple choice 7 (MC7)	**13**	**0.41**	**0.56**
Multiple choice 8 (MC8)	18	0.56	0.44
Multiple choice 9 (MC9)	15	0.47	0.11

Source Own data
N_s = Number of successful students
Σ_c = Sum of total credits
D_f = Difficulty Index
D_c = Discrimination Index

Discrimination Index

All questions scored positively on the discrimination index, indicating that students in the top 27% of overall scores did answer more questions correctly than those students who scored in the bottom 27%, signifying that questions were appropriately structured and used accessible language.

Multiple Choice Environmental Literacy Questions

The average score on this section of the test was 47%, including all nine questions. Without the two "test" questions, the average score overall rose slightly to 53%. All score frequencies are illustrated in Fig. 1.

When not including the "test questions", which most students performed poorly on, significant differences were seen between average multiple-choice questions section response rates of those of different genders as well as students in different grade levels. Score frequencies by gender and grade level are illustrated in Fig. 2. Two-sample t-test revealed that *graduat* students (median score 41.1%) scored significantly lower than higher level *licence* students (median score 66%); ($t = -3.21$, $df = 22$, $p < 0.01$). Another two-sample t-test also showed that male students (median score 59%) scored significantly higher than female students (median score 42%); ($t = 2.51$, $df = 30$, $p < 0.05$).

A one-way anova analysis of variance showed that age range had no significant impact on overall multiple-choice scores ($F(2, 27) = 0.84$, $p > 0.05$).

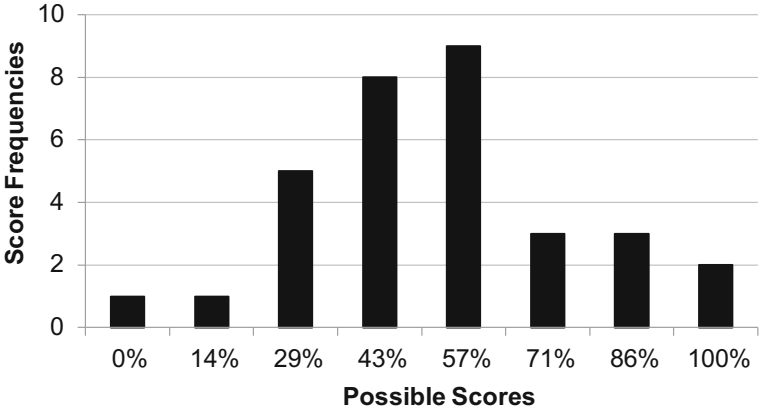

Fig. 1 Score frequencies (not including "test" questions) for student multiple choice section

Opinion and Behavioral Questions

Out of all the students, most expressed satisfaction with the quality of their education. When asked if they thought ISDR-MDK was preparing them successfully for a career as a rural development worker only two students responded no, while 28 (88%) responded yes (2 did not respond).

However, when asked if there were classes not offered at ISDR-MDK that they would like to take, 22 students (69%) responded yes. Of the responses, the following classes were most mentioned.

1. Ecology (6 mentions)
2. Sociology (3 mentions)
3. Project Management (3 mentions)
4. English (3 mentions)

Students were also asked if they used the Internet, and 23 students (72%) reported that they did, most commonly from their smartphones or at the cyber café. Several students indicated that Internet credit was expensive.

All students except one reported having heard about climate change somewhere, most commonly in class at ISDR (15 mentions), at the conference hosted on World Environment Day at ISDR hosted by the provincial REDD+ focal point and Projet Équateur (11 mentions), on the radio (11 mentions), on television (6 mentions), or on the internet (5 mentions).

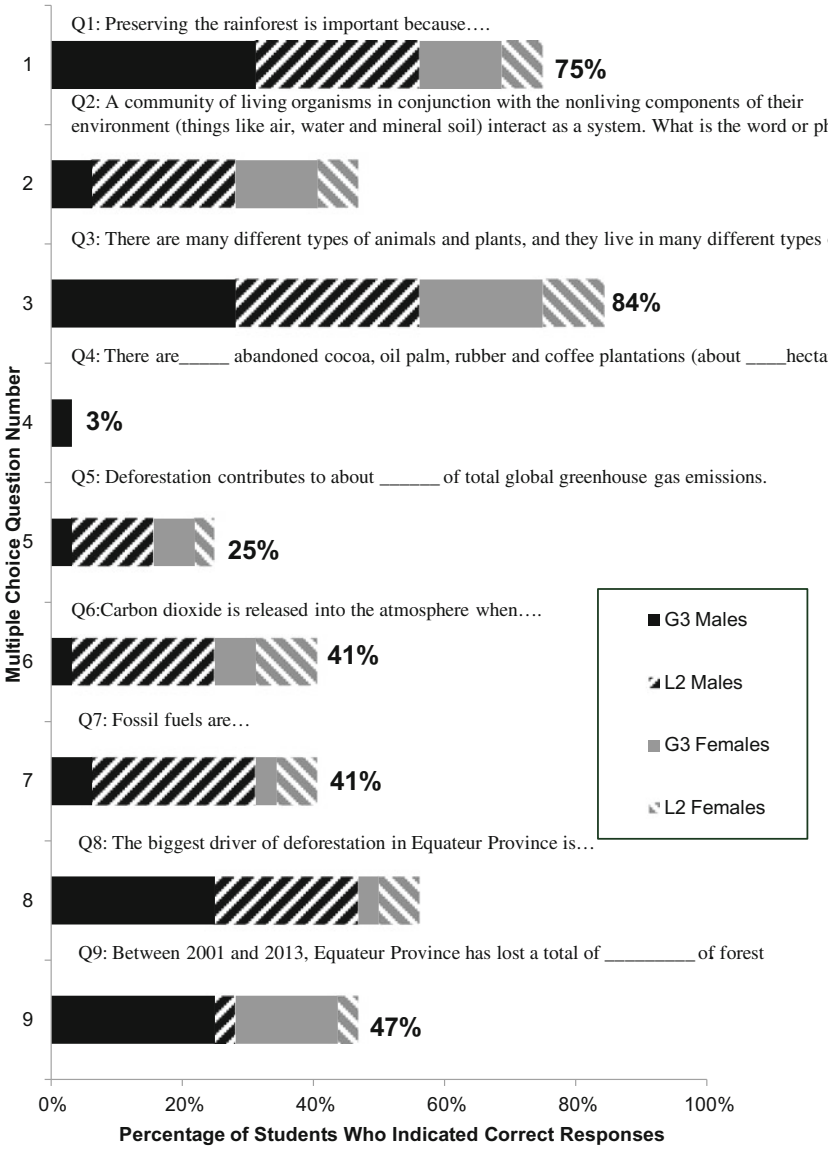

Fig. 2 Correct answers rates to "environmental knowledge" multiple choice question based on grade level and gender

Open Response Educator Surveys

Educators were asked a number of questions about their experiences at ISDR-MDK, their own education, and their views on the development of the province. When asked what they thought the biggest challenges to sustainable development in Équateur were, the overwhelming response was that poor management of natural resources and environmentally degrading practices would be the hardest to overcome. Also mentioned were poor governance, the mentalities of the population, and poverty.

The educators responded that they viewed ISDR-MDK as an institution for training development technicians to be able to work doing outreach and capacity building in the DRC. The majority of educators indicated that their students were being trained so that they would be able to help educate rural populations about environmental issues, as well as help them develop and learn alternative, less ecologically harmful practices, especially in regards to agriculture.

Educators surveyed taught between 1 and 5 courses. While most of the courses they listed were in the official curriculum, several were not. These classes included one on HIV/AIDS (currently being taught by two of the educators), a class called "Sanitation, Hygiene and Environment" and a final entitled "Appropriate Technologies".

When asked how they develop the lessons for their classes, most educators simply listed the challenges they face when doing so. These challenges were

1. Lack of Library/Teaching Resources (6 mentions)
2. Low salary (3 mentions)
3. Limited Teaching Hours (these are determined by the state and inflexible) (3 mentions)
4. Lack of Further Training (2 mentions)

When asked where they get material for teaching, the most common responses were:

1. Library (both personal and otherwise) (8 mentions)
2. Internet (5 mentions)

Educators were also asked to list any challenges that they have when teaching their students, these challenges were:

1. Ability to do practical/field work with students (limiting factors included lack of transport and funds) (5 mentions)
2. Students unable to communicate adequately in French (4 mentions)
3. Inadequate teaching materials/internet access (4 mentions)
4. Low level of students due to poor primary and secondary schooling (3 mentions)

Many of these complaints were echoed throughout answers to other questions, and when asked how they evaluated their students, three educators indicated that because the level of their students is so low, and because students have little or no

access to reading materials, exams and assignments are "modified" so that they can be "achievable". Two educators also indicated that corruption at the primary and secondary levels leads to students receiving passing marks despite not having the necessary skills and knowledge to do so.

Although several educators responded that their access was limited due to high costs, 8 educators reported using the Internet two or more times per week, with the remaining 4 indicating that they did not or rarely used the Internet.

All but one educator reported speaking about climate change in their courses.

Discussion

Environmental Knowledge

Based on results from open-response and multiple-choice questions, it is clear from response rates that most students surveyed have generally low levels of environmental literacy, but a few have managed to master basic environmental concepts despite limited access to resources.

The differences in score between grade levels could be due to work experience, as administration noted that *licence* students are required to have several years of experience in the development and/or agricultural sector before they are admitted to the program. Regardless, it is concerning that there is such a difference in knowledge between the two classes concerning basic concepts, especially as *graduat* students were in their final year and about to start their working careers.

Gender inequality is a much-discussed issue in the DRC, however the significant differences in score between females and males attending the same courses suggest that even when women are given access to higher education, they are not receiving the same benefits. This could be due to a number of factors, including more time spent taking care of household necessities (childcare, cooking, cleaning, etc.) instead of focusing on schoolwork, or perhaps may have something to do with the fact that ISDR's teaching staff is all male. Further research is needed to understand this issue, however interventions at the university level must be aware of educational issues surrounding gender even within educational institutions.

Educational Barriers

Overall the survey offered much insight into the workings of ISDR and the challenges that educators, students, and administrators face. Poor language skills and low general knowledge levels seem to hinder students in their performance as well as pose a great challenge to educators. Administrative financial barriers as well as state-designed courses and curriculums mean that educators are limited in how

much time and funds they can invest into their teaching, as well as how much practical training they can provide to students. When asked for a list of the courses offered, ISDR-MDK provided the national curriculum, a list of classes that should be taught every year by each rural development institute (there are currently four other ISDRs in Goma, Bukavu, Mbeo Bandundu, and Uvira, in addition to Mbandaka). It also includes the hours that should be allocated to theoretical and practical teaching. Classes that students had expressed a desire to take (specifically English and project management) were listed in the national curriculum, which reflects that ISDR-MDK does not have the means and/or educators necessary to uphold national curriculum standards. Staff ranged in age from 43 to 60, and had been teaching from 4 to 32 years. Several teachers noted that they have not had access to continued training, which means that their teaching materials and personal knowledge of environmental issues may not be current. Incidentally, the Director General also acknowledged that they have had a difficult time recruiting educators because they cannot guarantee that their salaries will be paid.

While there is little literature on the subject, recent research done in the DRC suggests that educators who do not receive adequate pay often depend on "motivation fees" from students. Although a teacher may not formally ask students for money, students will often give money to their teachers and expect rewards (i.e. higher/passing grades) in return (Brandt 2014). This would account for some students at ISDR-MBK being unable to read, write and speak fluently in French despite having received marks high enough to be accepted into the institute.

Putting Information Transfer into Context

While the results of this survey highlight important gaps in information access, addressing these issues on the ground is still a challenge, despite the large amount of open access information and courses available on the Internet. This survey was given in July of 2015, and the following summer a digital library, complete with Internet access and a large database of open access information, was installed on ISDR's campus. While this may address some of the lack of available resources, it does little to address French literacy levels, and there were many other challenges that came to light during the installation. Most notably:

1. **How to Acquire, Use, and Service Computers and the Internet**

Given the isolated nature of ISDR, all Congolese contractors capable of installing a solar system at the university were not locally based. This led to delays in installation and servicing. Lack of local technicians and the complexity of procurement procedures from international donors are a hindrance to projects like these, especially if the project intends on hiring and engaging local businesses.

2. **Securing Expensive Equipment**

During the first month of the library's installation there were two attempted break-ins reported by ISDR staff. ISDR does not have the monetary means to hire security guards, and so the building had to be reinforced to ensure the materials could be stored safely.

3. **Computer Literacy of Staff and Students**

This survey highlighted that most of the staff and students access the Internet from their mobile phones. When the library staff was introduced to the laptop database of learning materials, many of them struggled to use the computers. Training can address these issues, but most preferred to use the tablets.

4. **Unreliable Internet Connections and Limited Bandwidth**

ISDR now has access to the Internet via a satellite system, but Internet is often unreliable due to overhead clouds. The decision was made to also provide an offline database of materials that could provide some information even without Internet access. Additionally, a limited number of providers means that bandwidth is costly and limited, so sites that use video or similar interactive features may not work in this context. While there are many sites that provide free interactive courses, they do not work well in this environment. To address bandwidth limitations, ISDR staff and students are not supposed to download items without permission from the head librarian, as downloads slow Internet access for the whole library.

5. **Internet Literacy and Trusted Information**

While not solely an issue in this context, the ability to scrutinize information on the Internet is a valuable life skill that is not often attained without training. Additionally, advertisements based on IP addresses near ISDR often contain viruses and malware, or are adult themed in nature. Therefore, aside from restricting access to inappropriate and unsafe content, it is paramount to train students and staff to identify secure and reliable online content.

Conclusion

Present approaches to vocationally orientated capacity building through programs such as REDD+ focus on offering key workers limited "on the job training" to develop novel skills and experiences, such as participatory forest management, land use planning, and carbon monitoring training. Wide-scale sustainable development practices will not become best practice unless there is a serious overhaul of the broader tertiary education system. This is in terms of both theory, e.g. curriculum

design, and practice, e.g. tertiary education management, access to information resources and networks. Tertiary and technical schools are responsible for training future leaders and workers in all sectors, and graduates are essential to the success of decentralized REDD+ programs and other sustainable development initiatives, especially in remote and highly impoverished provinces like Équateur. The university structure offers an excellent opportunity for formal capacity building through already existing institutions managed and attended by DRC citizens, but the specific challenges of students and staff will need to be carefully considered and addressed.

This study utilizes a case study of a single tertiary education establishment in an inaccessible province, perhaps the poorest and least developed of all regions in the DRC. As such, the conditions experienced perhaps represent a worst-case scenario. As noted earlier, in universities in Kinshasa and Kisangani there have been some efforts to support improvement in teaching and training. However, the range of issues described in this case study are relevant in a general sense to the DRC and there remains a systematic underinvestment in training and education in all sectors in the DRC.

The survey results show clearly that at present ISDR is not preparing students to be effective rural development practitioners. Teaching staff face numerous challenges in rectifying knowledge gaps and capacity deficits, including their own, due to lack of financial, material, and information resources. Sustainable development at scale in Équateur will not be possible without serious and sustained financial and technical support to reform and recapitalize the national tertiary education infrastructure. Based on the size of Équateur province alone (which has an estimated population of about 9 million people), hundreds, if not thousands, of environmental and development professionals will be needed to scale up sustainable development programs at the provincal level, let alone nationally. This represents an immediate crisis in terms of realizing ambitious policy objectives such as the national REDD+ investment program. The levels of funding for rural development that are presently being committed are laudable, however there are presently insufficient adequately trained individuals to manage those funds productively. In the DRC, zero net deforestation by 2030 will not be attainable without systematically and rapidly addressing the educational needs and capacity deficits of tertiary institutions and their sustainable development and environmental experts in training.

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Food and Sustainability: An Emerging Subject in Sustainable Environmental Sciences Education Applying to the e-Learning Environment

Ana Pinto de Moura and Luísa Aires

Abstract The global food system makes a significant contribution to climate change, affecting greenhouse gas emissions and other major environmental impacts, along the entire food chain. Individual food consumption is an important part of the production-consumption chain, because consumers make the final choice of the goods and services they consume, and their lifestyles determine how they influence sustainability practices. Simultaneously, there is an increasing concern for the environment issues and an increasing demand for naturalistic icons or organic production, free-range farming and unadulterated processing. This work addresses the imperative to address sustainability in food consumer sciences education, due to the multidisciplinary nature of consumer food studies, by applying online education programmes. The rational for e-learning approach is the fact that, advances in information and communication technologies have had a tremendous impact on the format and on the approaches to teaching and learning.

Keywords Activity theory · Diet · Environmental impact · Food safety, food security · Public health

The Relevance of "Food Dimension" for Sustainable Consumption

Food, health and environment are dimensions that are interchangeable (Loo et al. 2017). The Food and Agriculture Organization of the United Nations (FAO 2012a, p. 7) considers health aspects to be linked with sustainability in the context of food

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and defines sustainable diets as: "diets with low environmental impacts which contribute to food and nutrition security and to a healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources".

In fact, during the last two decades, there has been a widespread of consumer concern and distrust over food products and production methods in the agriculture and in the food industry. These attitudes tend to be reinforced by the absence of face-to-face contact between buyers and sellers during the process of food selection, leaving the burden of assessing product quality entirely in the consumers' hands. Shopping under these circumstances is a stressful activity, while the lack of trust in agricultural and industrial methods of production and food quality gives rise to feelings of uncertainty and insecurity (Cunha and Moura 2004). In this context, there has been an interest in the "return to nature", remerging new food production/consumption patterns, following a sustainable consumption approach based on the environmental, nutritional and/or health qualities and ethical concerns (Murdoch and Miele 1999), such as: (i) food preferences (meat consumption), (ii) organic foods, (iii) local foods, and (iv) food waste concern.

The purpose of this paper is to describe the most important food consumption patterns that downside the globalization process, evaluate the main challenges related to them and discuss their impact on sustainable consumption. This analysis may contribute to the development of sustainable environmental sciences courses by incorporating the sustainable food consumption perspective in their curricula. The emergency of applying e-learning is considered, taking into account that e-learning is becoming widely accepted in formal and non-formal education proving to have the potential to be effective in expanding education for sustainability (Azeiteiro et al. 2015).

New Trends in the Food Consumption

Food Preferences: Meat Consumption

Over the past decades, rapid changes in diets and lifestyles have occurred with industrialisation, urbanisation, economic development and market globalisation. All these drivers promote the process of diet Westernization among other cultures/countries, namely towards upper-to middle-income developing economies (Drewnowski and Popkin 1997), and even in populations having rich and deeply rooted culinary traditions, such as Japan (Morinaka et al. 2013) or Southern Europeans countries (Varela-Moreiras et al. 2010). This dietary pattern, belonging to the common eating habits in developed countries of Western Europe and the United States of America of America, is characterized by a high consumption of red

meat, refined grains, processed meat, dairy products, processed and artificially sweetened foods, and salt, with minimal intake of fruits, vegetables, fish, legumes, and whole grains (Cordain et al. 2005).

In fact, the available food consumption of meat is increasing, with the biggest increases couriers in developing countries. Developing countries between 1969/1971 and 2005/2007 have accounted for a large share of this increase in food consumption per capita (kcal/person/day) from 11 to 28, contrasting with the 63 to 80 increase for industrial countries over this period (FAO 2006). In addition, the most developing countries especially in China and Brazil have largely completed the transition to animal products: meat and livestock products (eggs and dairy foods). On other hand, in both developing and industrial countries (including again China) the consumption of pulses, roots and tubers between declined between 1963 and 2003 (Kearney 2010). There is also a great consensus in the scientific community about changing the Western diet to have a positive outcome for both people's health and environment (Friel et al. 2009).

Diets that increase the risk of many chronic non communicable diseases (NCDs), which mainly comprise cardiovascular diseases, diabetes, cancers, chronic respiratory diseases, obesity, and osteoporosis, are relatively high in total fat, saturated fats, sugar, salt, alcohol, refined grains and foods of animal origin, whereas diets that protect against chronic diseases are relatively high in minimally processed grains, legumes, fibre, vegetables, fruits and foods of plant origin (Popkin and Du 2003). Reducing intake of meat (particularly red meat), dairy products and eggs in high income countries will promote significant health benefits, as diets rich in saturated fats (primarily from higher meat and milk consumption) are associated with an increased risk of cardiovascular diseases and stroke, colorectal cancer and diabetes (Pan et al. 2012).

On the other hand, meat tend to have higher environments impact due to greenhouse gas (GHG) emissions and their inefficiency of production. According to FAO, the livestock production is estimated to be responsible for 18% of the global emission of GHG (a higher share than transport sector), promoting global warming temperatures, with the main contributor being CH_4 from enteric fermentation, N_2O from manure and fertilizer, and CO_2 from land use change and agriculture energy use (Steinfeld et al. 2006). Raising and feeding livestock introduces an additional trophic level in the food chain, and each trophic level leads to losses of energy and nutrients, reducing the efficiency of the production (Nemecek et al. 2016). In this context, ruminants (cattle, sheep and goats) account for a large share of total livestock emissions, because they are less efficient in converting feed into useful products than monogastrics, like pigs and poultry. Moreover, livestock is by far the single largest land use sector in our planet, as it accounts for 70% of global agriculture land, and 30% of the global land surface, contributing as a key factor in deforestation and land degradation, particularly in Latin American (Steinfeld et al. 2006). As livestock production intensifies, it depends less on locally available feed resources (e.g. unconsumed portions of household food, crop residues) but increasingly on feed concentrates (cereals, oil seeds), that are traded domestically and internationally, leading to an intensification of the existing cropped area

(Thornton 2010). Moreover, livestock production is a key player in increasing water use, accounting for over 8% of global human water use, mostly for the irrigation of feed crops. It is also considered the largest agricultural source of water pollution, mostly from animal waste, antibiotics and hormones and fertilizers and pesticides used for feed crops. All these factors contribute to the livestock sector being the leading player in the reduction of biodiversity.

Different studies suggested that respecting the dietary recommendations for a healthy diet would reduce the overall environmental impacts in developed countries particularly in terms of GHG emission and land use. The change would imply a reduction of meat consumption and would lead towards a plant-based diet (Davis et al. 2010; Westhoek et al. 2014). Nevertheless, the environmental impacts of plant-based food items may vary according to growing practices and climatic conditions.

Organic Foods

Organic agriculture is a production management system that uses methods safeguarding the environment from some production stages trough handling and processing. It favours renewable resources, recycling and returning nutrients to the soil found in waste products. With regard to livestock, organic agriculture places particular emphasis on animal welfare and the use of natural foodstuffs. Under the organic system, the focus is on maintaining and improving the overall health of individual farms' soil-microbe-plant-animal system (following a holistic approach), which affects present and future yields (IFOAM 2008). As result, the emphasis in this process is on using the environment's own systems for controlling pests and diseases in growing crops and rearing livestock thus avoiding the use of synthetic pesticides, herbicides, synthetic fertilisers, growth promoters and gene manipulation, as well as the prophylactic use of antibiotics and the zootechnical use of hormones. That is, the resource "nature" is manipulated to encourage processes, which help raise and maintain farm productivity. Concisely, what differentiates organic agriculture from other non-organic agricultural production methods is the focus on management. In organic agriculture, management is directed towards preventing problems, while stimulating processes, which assist in nutrition and pest management (FAO 1998). This means that organic agriculture has generically beneficial impacts on the environment and animal welfare compared to conventional agriculture. It demands lower energy requirements and gives a clear benefit for biodiversity on agricultural land (Tuomisto et al. 2012). The main challenge in organic agriculture is to increase yields without causing harm to the environment. Since its yields tend to be lower, it means that more land is needed to produce the same amount of food. The main reason for low yields in organic farms are soil nutrient deficiencies and problems with pests, diseases and weeds (Tuomisto et al. 2012).

Focusing our analysis on the European continent, organic food and farming has continued to grow across Europe. Since 1985, in Europe, the total area of land under organic production increased from 0.1 million to 12.7 million hectares by 2015 (which is 25% of the world's organic agriculture land), and in the EU-28 it increased to 11.2 million hectares, an increase of 7.8% over 2014. Within the EU, organic farming is regulated by the European Council Regulation No 834/2007 (EC 2007), which sets the basis for national standards in the EU. All organic producers are inspected by organic inspection bodies, which may be private or managed by government. Retail sales of organic products totalled around 29.8 billion euros in 2015, an increase of 13% over 2014. Within the EU-28, retail sales of organic products totalled approximately 27.1 billion euros, an increase of 12.6% over 2014. The highest per capita consumption in the world with more than 170 euros is found in Switzerland, Denmark, Luxembourg and Sweden (Willer and Lernourd 2017).

Burning in mind these data, a question is imposed: what are the main drivers that motivate Western consumers, particularly Western European consumers for organic food consumption? It is generally accepted that the market of organic products is driven by three primary consumer concerns: (i) concern for personal health (the way that food is related to health), (ii) consumer fears regarding conventional food safety (linked to the health concern), and (iii) concern for the environmental and animal welfare (Cunha and Moura 2004). Even though some studies point out that there is significant motivation to buy organic food on environmental or ethical grounds, most researchers indicates that the consumption of organic foods is related to a decreasing confidence in the quality of conventional foods, perceived by consumers as "unnatural", and the increasing concern for health (Magnusson et al. 2003).

The health public concern is part of a widespread anxiety among consumers about the quality of food one eats. Even through there is food safety control, systems and legislation have been put in place throughout the EU to minimize the risk to consumers' health (Mil-Homens et al. 2016). Since the middle 1980 s, most Western European countries have faced various food safety incidents that have led to increasing public unease about health and safety of modern methods of production (Cunha et al. 2010). Food hazards amplified by the media (Kasperson et al. 2003) could be directly related with food crisis (e.g. BSE in cows, avian flu) or lifestyle hazards, such as eating disorders (Moura and Cunha 2009). European consumers may perceive a reduction in pesticide residue risk associated with substituting conventionally grown products by organically grown ones, reflecting an increased health benefit (Saba and Messina 2003).

Local Foods

The term "local food", "local food system" or "short food supply chain" compasses different dimensions. It is a geographical distance between food producers and consumers. It is also a political-social concept, in the sense that it represents a

counter movement to the dominant trend toward larger scale, industrial-like farm operations, considering the modern food system (Peters et al. 2008). According to this argument, local food systems are also related to small farms that are linked to the community through social and economic relationships, in the sense to bring farmers and consumers together (Hughes et al. 2007). This enables consumers to connect with the place of production, people involved and methods of production used, providing increasing public awareness, knowledge and understanding of issues related to how foods are produced and signals related to the origin of the food product (Lapping 2004). The link between the food product and a geographic area or region of origin has been an increased interest in Europe essentially by the increasing policy support, particularly within the EU, and the fact that European consumers look for products that are authentic (Ribeiro et al. 2016).

Consumers buy local food products at farmers' markets or places that are physically proximate to the farmer, as they are perceived to have a higher quality (because they are fresher) and less processed, to be more healthy and nutritious (because of shorter travel distances), to have a better taste (reinforcing their perceived natural content and authenticity), to support the vitality of rural areas by providing an ever-growing multiplier effect within the local economy; and to have an environmental friendly production process (Lee and Kader 2005; Selfa and Qazi 2005; Zepeda and Le 2006).

In fact, one of the potential social benefits of local food systems arises from transportation cost savings. Local food can serve as a substitute for food shipped from often distant countries or regions, therefore reducing "food miles". The reduction of food travel distance allows the reduction of fossil fuel energy use, accompanied with declines in greenhouse emissions such as CO_2, and environmental pollution (Pirog and Rasmussen 2008). Nevertheless, other factors affect the impact of transportation on greenhouse emissions, rather than transport distance, such as the mode of transport or the type of transport (cooled or uncooled). For example, CO_2 emissions are slightly higher for fruits and vegetables transported using air freight, whereas fruits and vegetables traveled by sea have a lower emissions ratios, even for long-distance travel, because this is a highly energy-efficient method of moving goods (Saunders and Hayes 2007). Moreover, other contributions to energy use and emissions, other than transportation, may be important to assess the overall impact of local food systems (farm inputs, farm production, processing, distribution, consumption and disposal). In this context, provenance and the mode of agriculture production assumes particular relevance. When using the total life cycle of GHG emissions for different vegetable supply chains, higher emissions in food transport (long-distance travel) coupled with low emissions in food production (open field) may in some cases net lower GHG mission when compared to lower emissions in food transport (locally grown) coupled with higher emissions in production, due to temperature-controlled greenhouse using fossil fuels, particularly for cold countries, as greenhouses in colder climates need to be heated (Chen et al. 2016).

Food Waste Concern

According to the FAO, one-third of all edible food produced for human consumption is wasted or otherwise lost from the food chain per year, or about 1.3 billion tonnes (Gustavsson et al. 2011). The food wastage is particularly severe in industrialized countries: following the FAO's food balance sheet for 2007, food waste in North America and Europe is about 95–115 kg/capita/year, whereas in South/Southeast Asia and Sub-Saharan Africa it is 6–11 kg/capita/year (Gustavsson et al. 2011).

Furthermore, rising population levels combined with shifting dietary patterns in emerging economies will put increasing pressure on the global food supply, as more food is necessary to feed more people. The United Nations predicts that the world population will reach 9.6 billion by 2050 (UN 2012) and this growth will require at least a 70% increase in food production, excluding crops used for biofuels (FAO 2009) or a more efficient use of natural resources and food production (EC 2014). In this context, food waste generation is particularly an ethical issue. Wasting food means missing opportunities to feed the growing world population (FAO 2012a), and the consumption of scarce resources (like land, water and energy) used in the production, processing, distribution and the consumption of food (Bräutigam et al. 2014). In turn, this, leads to diminished natural ecosystems and the services that they provide (Hall et al. 2009).

Although food waste occurs along a food supply chain in both developed and developing countries (Parfitt et al. 2010), different strategies are needed to tackle food waste in these countries (Gustavsson et al. 2011). In developing countries, food waste arose mostly during the early and middle stages of the food chain (production, harvest, processing, storage and transportation stages), due to lack of infrastructure within the food chain, and lack of knowledge or investment in technologies (FAO 2012b). By contrast, in developed countries, food is to a significant extent wasted in both retail and consumption stages, both in households and food services (Monier et al. 2010). For example, considering the whole food supply chain, with the exception of agricultural production, the generation of food waste across the EU-27, based on the EUROSTAT database, in 2006, accounted for 89 million tonnes, corresponding to 181 kg/capita (Monier et al. 2010). The consumption stages (household activities and food and beverage service sector) generated 56% of all the food waste produced by food value-adding chain, with a higher proportion of avoidable food waste. This approach is particularly important when taking into account the increasing consumption of food away from home in the last decades in Western countries, due to modern lifestyles and time (Moura and Cunha 2005). Different factors may explain the avoidable food waste (edible food by the majority of people). At home, with too much food being cooked, prepared, served or damaged during this processing, and the expiration date label (Quested and Johnson 2009). In food services, consumers' distaste for given menu items, and overproduction due to inaccurate forecasting of consumers demand (Oliveira et al. 2016).

The significant quantity of food waste generates substantial amounts of GHG emissions, promoting climate change. Methane (CH_4) is produced when food waste decomposes under anaerobic conditions in food waste landfills (Buzby and Hyman 2012). Even though, there are clear indications of a shift away from landfilling towards preferred waste management approaches in the EU, 50% of biodegradable waste or bio-waste generated in the EU-27 in 2010, was still landfilled (EEA 2013). Food waste generated within the EU-27 during 2006, generated GHG emissions equivalent to 170 million tonnes of CO_2, considering the full life cycle of food, from the agricultural sector to the final consumer. Due to increasing quantities of food waste, emissions estimates for 2020 rise to about 240 million tonnes of CO_2 equivalent gases being released (Monier et al. 2010). That baseline value represents approximately 3% of total EU-27 emissions in 2008 and is close to the total GHG emissions of Romania or of the Netherlands in 2008.

Food, Sustainability and Education: The e-Learning Food Consumption and Environment Module Approach

Food consumption is one of the private consumption areas that has the largest impact on the environment, as one third of households' total environmental impact, including energy and land use, water and soil pollution and GHG emissions, is related to food and drink consumption (EEA 2005).

In this context, education for sustainability plays a particular role in achieving more sustainable food consumption patterns as students acquire these skills and apply to their daily lives (Luppi 2011).

With many advances in information and communication technologies there have been tremendous impacts on the format and on the approach to teaching and learning, most notably in terms of online education programs (Hay et al. 2004). Online education provides students an alternative method of study facing individuals' busy lifestyle, allowing students to be able to proceed at their own pace and identify their own personal course timeline (Shanley et al. 2004). E-learning offers a great number of opportunities of interaction and decision-making, based on flexibility of format and easy access to knowledge, as well as engagement within the learning process (Aires et al. 2014).

For the academic year of 2010/2011, the Food Consumption and Environment module took place in the context of e-learning as in M.Sc. in Participation and Environmental Citizenship course offered by Universidade Aberta (UAb), the only public distance learning higher education institution in Portugal in the area of online and advanced e-learning (Azeiteiro et al. 2015). It was a formal course, organized according to the European Credit Transfer and Accumulation System (ECTS), and with the virtual pedagogical model of UAb (Pereira et al. 2007). In this context, the forum was used to allow for asynchronous exchanges: teacher guidelines, questions

posed by students and discussion. The open source Moodle (http://elearning.uab.pt/) was the course platform solution used in all UAb's courses.

The module was taught completely in e-learning mode and was organised in a set of topics, each of them developed in a two to four week period. Generally, each topic was associated to one learning task. The teaching and learning method used engages the student in active learning of concrete and critical problems that are real. This is achieved through the inclusion of a number of activities with accompanying teacher such as: surveys, quizzes, assignments compulsory discussion groups and searching on the internet to access online databases (Moura et al. 2010). Support materials included the teacher's slide presentations and original documents, scientific papers, research papers and internet websites. The continuous assessment component (obtained through the e-activities) is weighted at a minimum of 60% of the entire module evaluation.

The Food Consumption and Environment programme intents to cover the environment "hot spots", according to the academic literature review presented previously, covering the following topics:

- *The complexity of* "*global food system*". Its approach was to emphasise the diversity of actors and their interactions along the food chain and the markets where the product is exchanged.
- *The perception of food safety*. In this case, fears about a given food create adversely short-effects on preferences and consumption of that particular food.
- *The individual food choice criteria*. The main food choice determinants were identified which range in scope from sensory and psychological preferences to practical reasons (convenience, price, variety) and personal concerns (wellbeing, self-expression, sustainability) (Moura and Cunha 2005).
- *Sustainable food consumption*: *drivers and barriers*. The major environmental impacts of food consumption were considered: waste generation, recycling, personal transport, residential energy use for preserving and preparing food, and food preferences.
- *The new food choice and consumer paradigms*. Students were asked to contrast one sustainable food product (organic foods and traditional food products) and one unsustainable food product perceived by consumers (genetic modified foods). This was a work team activity.

Activity Theory: A Framework for Online Learning

The aim of this study was to explore how well students responded to the task proposed by the teacher to achieve its outcome, which resulted from students dynamics of online communication during the group work forum. For this, the *subject* (the students) was motivated by the need to transform an *object* (a problem

or idea) into its desired *outcome* (a reflection report about a real food safety incident from a press release), by carrying out a series of actions that are mediated by *tools.* This approach has a framework called the activity theory (AT). The application of the AT for better understanding the social structure of online environments follows Engeström (1999) and Baran and Cagiltay (2010) approach. Within AT, the student is not analysed separately but rather in a social context while interacting with other students and the teacher. AT was initially developed by Leontiev. Its original framework it was founded in the Vygotkian concept of mediation, mainly in the triangle: subject, object and tool (Fig. 1). Engeström (1999) later advocates new AT generations. In the second AT generation the author argues that the focus of mediation is the relationship of the expanded basic Vygotsky triangle and the relationships of other components of the activity system - communities, rules, and division of labour, a model to represent the human system activity (Fig. 1). Later Engeström (1999) expands the third AT generation with dialogue.

The different items of the triangular model applied to the topic "perception of food safety" are presented subsequently in order to better understand the relationships between each item to mediate the interactions (Fig. 1).

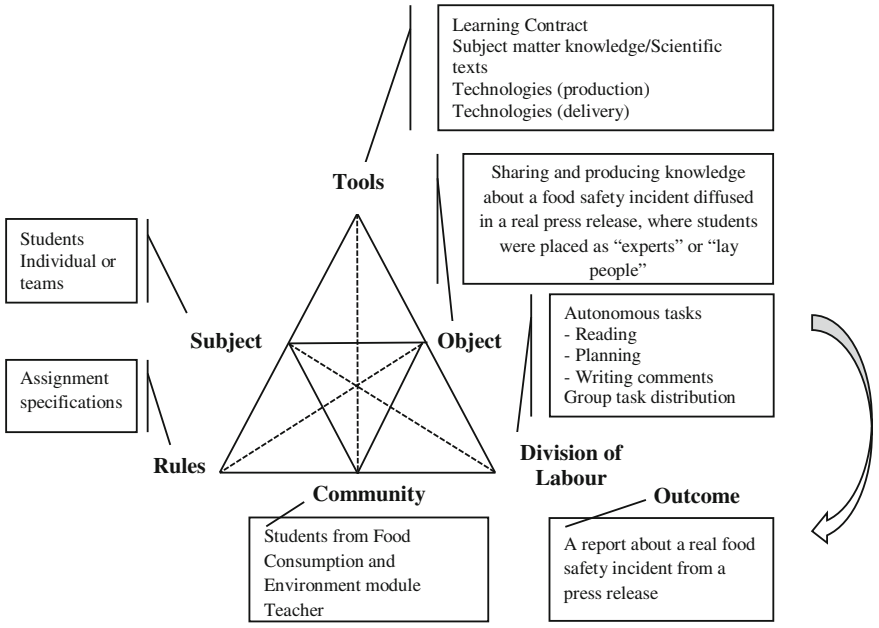

Fig. 1 Designing a topic of e-learning activity system. *Source* Adapted from Baran and Cagiltay (2010), Blin and Munro (2008)

Items of the Triangular Model

Subject

In 2010/2011, a student group of 12 students (58% men), average age of 47.7 ± 8.5 years, from Portugal and from Portuguese-speaking African countries (Mozambique and Cape Verde) were enrolled in this module with a diverse academic background, coming from disciplines such as engineering, environmental sciences, humanities (geography), life sciences (nursing) or social sciences (Table 1).

Object

The purpose of this task was to develop and assess students' perceptions of food safety incidents, considering the role of different agents of the food chain: the food company, the Portuguese food regulator and the consumer. In this case, fears about a given food create adversely short-effects on preferences and consumption of that particular food, and it would be interesting to confirm if there is some similitude of individual students' behaviour regarding a proxy food crisis situation.

The task proposed to students was from a real press release developed in July 2007. The news article communicated that some lots of a dairy product from a leader brand, target to children, were removed from the market because there was a probability that one of his additive (the guar gum) could be contaminated with two substances: dioxins and pentachlorophenol. It also communicated on the news article that the national regulatory authority did not assign an imminent risk to the consumers' health, since the amount of additive present in the food in question was

Table 1 Characteristics of the students

Student code	Gender	Age (years)	Academic degrees (Higher Diploma)	Residential area
P1	Male	47	Sociology	Cape Verde
P2	Female	39	Environmental Health	Central region of Portugal
P3	Male	43	Safety Engineering	Central region of Portugal
P4	Female	55	Physics and Chemistry	Central region of Portugal
P5	Male	51	Nursing	Central region of Portugal
P6	Female	33	Public Relations	Azores (Island, Portugal)
P7	Female	53	Geography	Central region of Portugal
P8	Male	42	Social Sciences	Mozambique
P9	Male	42	Social Sciences	Central region of Portugal
P10	Female	43	International Relations	Central region of Portugal
P11	Female	37	Biochemistry	Azores (Island, Portugal)
P12	Female	63	Physics and Chemistry	Southern region of Portugal

low (residual presence). This task comprised two parts. Firstly, students worked in a team for a period of eight days, when they were asked to evaluate the press release placing as "experts" or as "lay people", according to the position given by the teacher. At the end, each group submitted their work in the platform.

Tools

Support materials included teacher's slide presentations and original teacher's documents, scientific publications (papers, research papers), website links, and digital video created by the teacher and produced by the UAb digital services related specifically to perception of food risk. The technologies available to produce materials included computers, generic applications such as MS Word, and the technologies to deliver them included forum posts, Moodle technologies and functionalities.

Rules and division of labour

In accordance with the virtual pedagogical model of UAb for the MSc courses, the Food Consumption and Environment module is a structuring element, the Learning Contract that acts as a mediator between the academic requirements and the students' needs and interests (Pereira et al. 2007). This document, presented to students since the beginning of the module, is structured into module objectives, topics/tasks to be developed (that are chronologically presented), competences to be acquired or developed, list of support learning materials and module assessment. In this context, the Learning Contract acts as a pedagogical tool that incorporates the *object*, *rules* and *tools*.

Additionally, students should considered at least three main rules defined by the teacher: (i) to interact with the other group members for the report construction; (ii) to deliver the report on time; (iii) to accomplish the number of pages imposed by the teacher.

Moreover, the team work forums were separated forums composed by two to four members and supported work in smaller groups, where members discussed the subject in private in order to elaborate their work. Students worked through notes and/or power point presentations prepared by their teacher, commented information transmitted by their colleagues via the group work forum, and understood the subject matter by helping to produce the report group.

Community

This community consist of the 12 students who participated in the Food Consumption and Environment module. They were from different academic backgrounds and place of residence.

Sub-activity System Analysis

The activity system was broken down into the following four sub-activity trials: (i) subject-tools-object; (ii) subject-division of labour-object; (iii) subject-community-object; and (iv) subject-rules-object. For this, we analyzed parts of the discussion posts exchanged by students during the group work, presenting for each sub-activity trial only one discussion from either of the four groups. The quotes used in this text were translated into English, where the brand in question was referred to as "brand XX" and the company as "food company YY". The students will be identified with a code.

Subject-Tools-Object

During the knowledge creation process, students looked at the same problem from different points of view, as students of this module came from a wide range of backgrounds, nationalities and cultures (Table 1).

The news article to be analyzed, the scientific publications, the digital video and the documents made by the teacher allowed students to better understand the subject. Moreover, the task proposed and the fact that students evaluated the press release placing as "experts" or as "lay people", brings the subject to life and provides them with opportunities to link theory to practice in order to better acquire the perception of food safety and its consequences to the food chain.

> **Group work 3**
>
> **by P10—Tuesday, 2nd November 2010, 23:58**
>
> Dear colleagues,
>
> Given that we have to write a report in the point of view of a "specialist", I have done a brief research about the matter that I have referred and I would like to share the collection of information with you.
>
> Maybe some of this information can be put into our document.
>
> I confess, that with everything I have read and heard, it is increasingly difficult to choose what to eat and what I give to eat, especially to my children.
>
> It is difficult to run away from this involuntary ingestion of toxic materials, as we don't even have the notion of what happens in the production circuit until it reaches us consumers… I think that all of this is scary and you just need to see the kind of diseases that grow from what we eat.
>
> But as "specialists" we have the duty to alert, don't we?

by P6—Thursday, 4th November 2010, 13:50

Hi P10,

I've already read the teacher's documents and the notes that you left of your research.

When I read the news article for the 1st time, what I immediately considered as fundamental was to understand what really is the guar gum and the pentachlorophenol in a way to figure out the dimension of the eventual problem.

Like that, during the course of today, I will research on the mutter.

Additionally, the group work forum served as an essential tool. The asynchronous exchange of knowledge across students, reinforcing a holistic approach to education where analytic skills, cross-referencing and critical thinking facilitated a critical conversation (Altomonte et al. 2016). The discussion supported dialogue between students, so that comments, information, data and links were shared. A total of 91 posts were sent to the discussion during the group work forum (Table 2).

Subject-Rules-Object

The rules announced previously were accepted and adopted by students, as they defined the process of reaching their objectives. Moreover, students were aware that the teacher could access the group work forum and follow the discussion. This may condition their participation, as their performance affects their grades. Additionally, for Master's degree students, the virtual pedagogical model of UAb achieves to promote a strong interaction and collaboration between students and teachers and recognises students as active builders of this interaction (Pereira et al. 2007).

Group work 2

by P5—Wednesday, 3rd November 2010, 22:21

Hi colleagues,

It is the first time that we will all work together. I don't know how you are, but I have been absent for a couple of days and I'm now seeing that I have a lot of work to do.

Table 2 Characteristics of the group work forum

Characteristics	Group 1	Group 2	Group 3	Group 4
Number of members	3	4	2	3
Members (code)	P1, P4, P11	P5, P7, P8, P12	P6, P10	P2, P3, P9
Number of posts exchanged	8	21	29	33

I don't know your opinion, but we could schedule some deadlines for the completion of the work.

For example, we could schedule for until the 6th to read the texts and place our analysis of those texts by the 7th or 8th. In that way, we would have the 9th and 10th to elaborate our reports.

What is your opinion?

Good work.

by P5—Wednesday, 10th November 2010, 12:45

Hello P12,

I think that for a "start" it will be good. However, it has been asked of us that we produce a work between 4 and 6 A4 pages.

I have already placed a proposal to be discussed and so has Manuel. I would like if you gave your opinion (and the other colleagues too) to see if we can put the work together with all contributions.

Subject-Division of Labour-Object

Generally, for the four groups, two moments were identified when students analysed the real article that considered dairy products targeted to children that were potentially contaminated with two substances. In the first moment, students intended to identify the structure of the report, by highlighting the main topics to consider in the report. Once this step was stabilized, an attempt of division of labour emerged as there was a schedule to accomplish.

Group work 4

by P3—Monday, 8th November 2010, 21:15

I have read the manual and taken some conclusions. How are we going to elaborate the work? Do we shoe all of our conclusions and someone compiles then or do we do it in parts? We have to put in our report until the 10th.

by P9—Tuesday, 9th November 2010, 09:15

I think that the nest way would be to place our conclusions and notes on the forum and then someone "compiles" them.

by P2—Tuesday, 9th November 2010, 16:54

P9, the document that you annexed could serve as an introduction, but the references are missing… could you place in the sources?

So the work will have an introduction, after that we will have to do the analysis of the news article, from the consumer point if view… what type of consumer should we be?
And should we talk in a more technical or simple manner?

Subsequently, students discussed and shared materials in order to produce and improve their group work, joining their own experience with these comments as process of a combination and socialisation. They commented on topics, criticised others' comments and sent their contributions, making their knowledge more explicit.

Group work 4 (cont.)

by P2—Sunday, 7th November 2010, 00:20

A news article of this sort can have, in y opinion, three answers from the consumers:
– trust in the brand: "so if they identity the problem and take the affected batches, it is because they possess a quality control. Maybe other brands have identical levels and they don't know (or don't say it)".
– skepticism of the product/brand: "if products for children have these contaminants, I can only imagine the rest of the products".
– neutrality: the point of view of someone that thinks that nowadays, everything is wrong (or on the contrary, that in the past there weren't so many precautions as today, and children would grow well). To this consumer, there might be a reduction in the purchase of the product, but something very slight and temporary (after all, the son actually likes so much these yogurts).
I don't know if we should explore all the possible consumer vies points in our work, or if we should choose the must consensual and approach the theme of that point of view…

by P9—Tuesday, 9th November 2010, 22:25

I don't think that the consumer was at all weakened by the matter of the "brand XX", once it was the "food company YY", that informed the authorities and removed the product from the market.

by P3—Wednesday, 10th November 2010, 18:48

If I were in the shoes of the consumer, I would be in doubt about the news article and would probably stop consuming the product and try to find alternatives from other brands that inspire confidence. Here we can see the situation of the power of "decision" that is very important, but I understand and agree with P9's conclusion. Therefore, there are different possible reactions from the consumer.

by P9—Wednesday, 10th November 2010, 18:55

I disagree with the choice of the two options, of considering the studies that were done but also consider that there wasn't a decrease in "food company YY" sales and the consumer will continue to buy the "brand XX" (I say this because I buy it!!)

by P2—Wednesday, 10th November 2010, 22:21th

P9, I don't know if at the time that decrease in sales wouldn't have existed… even if temporary…I personally don't buy, it is a very synthetic food filled with food colourings and sugars (but if you offer my daughter one I will let her have it, I'm not that fundamentalist!)

Analysing the dynamics of the division of labour for the four groups, all members contributed for the report construction. Additionally, we identify for some groups, a salient tension during de report construction as different approaches were considered when students analysed the consumer perception regarding the food crisis announced in the news article. Nevertheless, these dualities allowed for a learning progress considering that different perspectives were put in question (Barab et al. 2002). For example, considering the group 4's progress, the report submitted contemplated two hypotheses accommodating the different students' perspectives (P2 and P3 "against" P9): (i) consumers care about the food safety incidence and they lack confidence regarding the brand in question; (ii) consumers trust the institutions and the brand, as regulatory authorities did not take unplanned actions in response to the alert received.

Subject-Community-Object

Community members were students and the teacher from the Food Consumption and Environment module. Even if these students did not search social relations, patterns of interaction or an alternative source of knowledge, at the end they may participated in the task because they wanted to complete the module and obtain a Master degree. In this sense, students within the group work forum defined together the work plan and divided consensually the tasks in order to accomplish the report, however, a sense of community among them never completed formed.

Group work 1

by P4—Tuesday, 9th November 2010, 13:11

I don't think that we are working well as a group. The deadline for the work is tomorrow and there haven't been any exchange of ideas.
I am creating a summary of the concepts that in the meantime I will place on the forum, but I would like to know what the group intends to do and in which way should the report be done.
I await for your exchange of ideas.

by P11—Tuesday, 9th November 2010, 13:24

Hello P4,
I have just placed some concepts and regulations that I think could be useful for our work, I don't know if you have already seen them?

In my opinion, referring to the way in which we should create the report, we could do it in the following way:

Introduction
– food safety and its evolution in its last few years.
– the different concerns of consumers and specialists.
– talk about the new article itself.

Middle
– describe the dangers of the substances to consumers.
I cannot remind myself of anything more for the moment, I don't know, what do you think?

by P4—Wednesday, 10th November 2010, 14:25

I hope that the work stands up to the challenge that has been proposed to us. Can you P11 place the work on the forum?

by P11—Wednesday, 10th November 2010, 15:11

Yes, I agree with you, I'm going them to place our work on the forum with our student number.
I also hope that it meets the demands of the proposal.
See you soon.

Discussion

The relevance of the "food dimension" for sustainability policies is now widely accepted. As a result, consumers have a major role in making food chains more sustainable, by the choices they make when buying food. Consumers can reward more sustainable food production and punish less sustainable alternatives (Grunert 2011).

The Food Consumption and Environment module, delivered entirely online, may offer an opportunity to a better understanding of the major perceived influences on individual food choice and their impact on the environment, as it covers the contemporary environmental problems related to food. The Activity Theory (AT) fostered the design of an analysis model in this topic, as it describes complex interactions and learning relations. Therefore, AT appears as a relevant framework to analyse the online learning process. For this, instead of simply transmitting factual information about sustainability concepts and processes, the module's approach was twofold: to use experiential and interactive learning processes (a learner-centred approach), and to encourage the adoption of sustainability principles, ethics and values (a transformative approach), supporting the critical reflection of them (Barth and Burandt 2013). In this context, the asynchronous discussion forums, namely the group work forums, supported this learning process offering the

opportunity to deeply reflect on the topic of food consumption sustainability and gather relevant information before contributing to the discussion on the subject. Although this tool allows for sociability among the students community across long distances, a robust relationship was not formed as these members were together only to accomplish specific objectives (Baran and Cagiltay 2010). To overcome this situation, Blin and Munro (2008) proposed the use of other communication tools that demand collaboration or reflection, such as glossaries, journals, and wikis. Nevertheless, the tasks and the module were limited on time and this short time period restricted pedagogic relationships that would sustain additional live and class experience. Other informal settings, namely social networking websites (e.g. Facebook) are more oriented to increase social presence of individual members of a community (Aires et al. 2014).

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MOOCs—A Powerful Tool for Imparting Climate Literacy? Insights from Parleys with Students

Daniel Otto

Abstract Climate literacy is a key impetus for triggering individual behavioural and societal change. Massive Open Online Courses (MOOCs), at first glance, entail a multiplier effect for climate literacy as they are recognized for offering non-formal learning opportunities to a wider audience. However, throughout the recent years MOOCs have been under manifold criticism from various corners challenging their educational value. A remedy for shedding light on the question whether MOOCs are a powerful tool for climate education is to bring in the students' perspectives on and experiences with MOOCs. These findings disclose the recipients' perceptions and give empirical evidence to assess the incorporation of non-formal learning into the students' learning context. Empirically, the chapter is based on 35 interviews conducted with students who participated in an English-speaking MOOC about interdisciplinary perspectives on climate change. The interviewed students represent a variety of different nationalities and academic backgrounds. During the semi-structured interviews, the students revealed diverse reasons for their participation in the MOOC, multiple learning outcomes and manifold opinions regarding the use of the MOOC in their personal learning context. This allows concluding that, albeit MOOCs are a promising tool for climate change education, they require a deeper understanding by incorporating the students' perspective.

Keywords Climate literacy · MOOCs · Climate change · Distance learning Interdisciplinarity · Students · Climate education

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Introduction

If remaining scepticism about climate change needed to be eradicated, the latest IPCC reports wiped it away and pointed to its devastating effects (IPCC 2014). In addition, the amplified accuracy of the IPPC's models allows impact prognoses regarding the local short and middle range consequences for different countries and regions. Although this modelling process is still in an early phase, it can facilitate policy decisions on mitigation and adaptation strategies (Piontek et al. 2014).

Hence, while climate impact research delivers valuable data to formulate strong responses in terms of mitigation and especially adaptation, it falls short in generating a fundamental change of consciousness that needs to be triggered in societies all over the globe. This is the case for countries in the global South as well as in the global North. Utilizing and disseminating the idea of climate literacy in formal and non-formal education is a key impetus for a change in individual and societal behaviour towards climate change. Despite the fact that the classical educational system is the first important lever for climate literacy, Massive Open Online Courses (MOOCs) have turned out as an intriguing new and innovative tool to open up education (Bell et al. 2017; Diver and Martinez 2015; Jona and Naidu 2014; Liyanagunawardena et al. 2013). MOOCs can be either understood as complementary to or reaching beyond the educational system. One reason for the latter is that MOOCs are attributed to support informal learning (Fidalgo-blanco et al. 2014; Sangrà and Wheeler 2013). For some scholars informal learning is even perceived to be more pervasive than formal learning as it surpasses formative organized and controlled learning (Bates 2014). Especially the integration of social media in MOOCs has opened the door for informal learning, albeit hitherto the learning impact assessment lacks solid empirical findings. Notwithstanding this debate, MOOCs are predominantly described as instruments for non-formal learning (Bates 2014; Fidalgo-Blanco et al. 2016).

MOOCs are an important instrument to improve the openness and inclusiveness of education (Boyatt et al. 2014; Rodriguez 2013). Everyone in possession of a mobile device and an internet connection becomes the potential target group of a MOOC, in particular if the topic of the MOOC is of relevance or triggers curiosity. Using MOOCs to spread the idea of the urgency to tackle climate change and appropriate solutions thus make them prima facie a promising tool for climate literacy. However, a glance at the published literature demonstrates that the students' motivation to learn about new topics in MOOCs as well as to complete them are manifold and thus require further empirical review (Hew and Cheung 2014; Wang and Baker 2015).

In a nutshell, the current appraisal of MOOCs, generally speaking, is hitherto ambivalent (de Langen and van den Bosch 2013; Ebben and Murphy 2014). While some hype them as a disruptive technology that changes educational access and costs, others utter disbelief that MOOCs serve as an innovative model for education (Baggaley 2013, 2014; Bell et al. 2017; Fischer 2014).

The objective of this chapter therefore is twofold in critically assessing and discussing the added value of MOOCs and to evaluate its potential for fostering climate literacy. The latter is pivotal as climate literacy's "acceptance into mainstream discourse is relatively recent" and exploiting adequate educational approaches is a compelling necessity (Arndt and LaDue 2008). Furthermore, albeit extensive literature on MOOCs exists, only few contributions deal with interdisciplinarity and the quality of learning about climate change as a matter of priority (Burch and Harris 2014; Otto et al. 2016).

Core argument of this chapter is that hitherto no in-depth understanding exists of how students benefit from their participation in MOOCs. Learning motivation and learning experience of students need an enriched understanding. One cause of this criticism is rooted in the paucity of adequate qualitative data to excavate the educational use of MOOCs (Otto et al. 2016). Predominantly, quantitative data is presented to assess the success of MOOCs. Only gradually the benefits of qualitative analysis of MOOCs is becoming manifest (Abeer and Miri 2014; Liu et al. 2015). As Fischer argues, one reason could be rooted in the fact that MOOC providers do not necessarily collect the data deemed the most relevant by educators, "as with many data collection efforts, the data collected are those that are the easiest to collect, not necessarily the most relevant ones" (Fischer 2014, p. 150). Similar Veletsianos and George in their systematic analysis of MOOC literature find that "very few studies were informed by methods traditionally associated with qualitative research approaches (e.g., interviews, observations, and focus groups)" and that the current state of knowledge is based on an overwhelming dependence on particular data collection and analysis methods (Veletsianos and Shepherdson 2016). As a consequence, they urgently demand an expansion of the methodological approaches used for MOOC research.

For the case of climate literacy, qualitative data permits to unveil the mundane utilization of MOOCs by the students. For instance, how do students make use of MOOCs in their informal and personal learning environment? Is there a perceived benefit in taking MOOCs about climate change for their formal education? Empirically, the chapter builds on data derived from a MOOC about "Climate change—a question of justice". In addition to a quantitative evaluation, 35 interviews with students were conducted and evaluated to divulge their experiences. Qualitative content analysis was used to cluster the semi-structured interviews and carve out general trends.

For the structure of the chapter, in the first section MOOCs and their relevance for climate literacy are discussed. Criticisms as well as aptitudes are balanced against each other. In the second section, the content and scope of the MOOC is offered. The methodological approach is outlined to render how the data was obtained and evaluated. In the third section, the findings are presented and discussed. Finally, conclusions for further development of MOOCs are drawn against the background of these findings.

MOOCs as a Tool for Improving Climate Literacy

Intuitively supposing that climate literacy is a recent phenomenon devoted to the mounting importance of climate change is a misconception. Early efforts to promote climate literacy can be dated back to the International Geophysical Year (IGY) of 1957–1958, when the U.S. National Academy of Sciences published a science education publication. The brochure emphasised that the alternation of the natural greenhouse effect can have dramatic impacts on the Earth's climate.[1] In accordance with the scientific evolvement, climate literacy has advanced to make a significant contribution to the public understanding of the human impact on the climate.

The National Oceanic and Atmospheric Administration (NOAA) in 2009 published a book formulating the claim that a climate-literate person (GCRP 2009)

- understands the essential principles of Earth's climate system,
- knows how to assess scientifically credible information about climate,
- communicates about climate and climate change in a meaningful way, and
- is able to make informed and responsible decisions with regard to personal actions that may affect climate.

Based on these principles, a diversity of Non-Governmental Organisations (NGOs) and research as well as educational institutions on all levels have spurred the idea that students, teachers and lifelong learners become climate literate citizens. For instance, the Earth Day Network (EDN) is launching a campaign for global environmental and climate literacy for the Earth Day in 2020.[2]

Albeit the idea of climate literacy is spreading, it still faces important hurdles and limitations. One problem is the common misconception of the scientific background of climate change (Harrington 2008). Another problem is the stagnant public confusion about the degree of scientific consensus around the human impacts on the climate system, especially in the US (McCaffrey and Buhr 2008).

However, leaving aside the misunderstandings and misconceptions about the contents of climate literacy, the manner of how to convey knowledge to the target audience is likewise a pivotal question. In a globalized world, characterized by a turn towards a technical and knowledge society, new ways of learning emerge as compelling (Stromquist and Monkman 2014). The digital evolution has triggered a disruptive change in education. Widespread and fast internet services have produced various new digital learning opportunities like virtual learning environments and communication tools. Physical presence in educational institutions can thereby be reduced or even replaced by blended learning or virtual seminars. Virtual mobility is a recent trend permitting the students to take a course abroad without leaving their home university (Becker and Otto 2016; Salgado et al. 2012). Students nowadays are capable to create their own personal learning environment and by this means tailor what and how they want to learn. This has likewise elicited new

[1] http://cpo.noaa.gov/OutreachandEducation/ClimateLiteracy.aspx.

[2] http://www.earthday.org/campaigns/education/global-environmental-climate-literacy-campaign/.

educational innovation in climate change education like the use of digital storytelling or simulation and serious games (Otto 2014, 2017; Powers and Kirkpatrick 2012; Tobias and Fletcher 2012).

MOOCs have evolved to be a major contributor to the educational debate in the recent years (Diver and Martinez 2015; Fischer 2014). At the time when Dave Cormier from the University of Prince Edward Island first coined the term MOOC in 2008, describing a course about Connectivism and Connective Knowledge (CCK08), not many people might have been attentive to the educational implications (Liyanagunawardena et al. 2013). A fundamental notion is that MOOCs provide online courses open for everyone to join. The only precondition is to possess a computer or mobile device. Whereas a MOOC course, with varying duration between 4 and 12 weeks,[3] is free of charge, certification is usually fee-based. In the last years, the number of MOOC providers has incrementally increased using hosting platforms like Coursera, Udacity, or edX (Jansen and Schuwer 2015). Topics for MOOCs are manifold ranging from Biomimicry to Spanish for Beginners.

Hitherto, almost 10 years of intensive debate, inside and outside the scientific community, have not led to a final conclusion on whether MOOCs are rather a "disruptive innovation or a disturbing invention" (de Langen and van den Bosch 2013). Whereas a peak of the euphoria was reached when the New York Times called 2012 the "year of the MOOC", at the end of 2013 the Washington Post already declared the hype as exaggerated (Pappano 2012). However, the appearance of MOOCs in open and distance education has radically changed the way opening up education and distance education is discussed.

A more sober-minded look at MOOCs suggests that the reality lies somewhere in-between the range of euphoria and disillusionment. Overtly, there still is no clear agreement on a core definition of MOOCs. What can be classified as a MOOC is imprecise, for example the threshold of when a course can be characterized as 'massive'. Massiveness in MOOCs is often equivalent to far more than 10,000 inscribers. This simultaneously yields the consequence of high attrition rates among the participants. Taking into account the different methodologies, the percentage of MOOCs completion rates is around 7 and, in some cases, as low as 0.8 (Jordan 2015). Almost no big MOOC provider displays completion rates over 10% (Khalil and Ebner 2014). Articles addressing the challenge of high attrition have presented various strategies to cope with the problem, some of the most favouring methods suggested are accommodating students on different time tables, encouraging student completion and to enhance the interaction among the students and the interaction of students with their instructor (Khalil and Ebner 2014). However, furnishing proof of fruitful ways to lower attrition is enduring. This may be rooted in the fact that MOOC enrolment is easy while unsubscribing is not deemed necessary. Furthermore, various reasons for enrolment may exist which may not be congruent

[3]For example: http://www.uab.cat/web/study-abroad/mooc/plan-and-design-a-mooc/plan-the-course-1345668290863.html or https://uqx.uq.edu.au/content/educators.

with the providers' expectations, for instance certification. DeBoer et al. (2014) emphasize that "the massive open nature of MOOCs may be so different from traditional educational environments that terms like enrolment or dropout may need to be reconceptualised."

Openness of MOOCs is correspondingly an important term that needs elucidation (Boyatt et al. 2014). While openness is acknowledged to be a central characteristic of MOOCs, the debate on to what extend the different educational formats of MOOCs enable openness is ongoing (Alraimi et al. 2015; Mackness et al. 2010). Didactically, this has manifested in a dualism between cMOOCs and xMOOCs (Margaryan et al. 2015). While the dominant pedagogical model, called xMOOCs, is echoing classical teacher-oriented university courses, cMOOCs differ as they follow a connectivist learning approach intended to encourage interaction between the students. No clear answer has been given about a consistent pedagogical model for MOOCs (Baggaley 2013, 2014). This dualism is accompanied by the attribution of MOOCs as non-formal or informal learning. MOOCs are predominantly characterized as instruments for non-formal learning (Bates 2014), on the other hand cMOOCs endeavour to blur the barriers between the learning activities of students in MOOCs and their daily activities, for instance the use of social media (García-Peñalvo et al. 2015).

In a nutshell, notwithstanding many key issues in the debate remain open; MOOCs nevertheless perpetuate their role as a focal point for future learning: "Even the loudest critics of MOOCs do not expect them to fade away" (Fischer 2014).

This chapter is therefore intended to provide a deeper look at the target group of MOOCs: the students. Despite the fact that vital discussions about the future pedagogical model of MOOCs are important, the debate about what students really pursue with MOOCs is often neglected. What is the learning motivation and how do students assess their learning outcomes and the further use of their MOOC participation. In the case of climate change, disclosing the students' experiences with MOOCs can lead to a more differentiated picture and be valuable to determine the use of MOOCs to improve climate literacy.

A Brief Note on Methods

Whereas a variety of studies about MOOCs occur using quantitative data analysis (Liyanagunawardena et al. 2013), there is a dearth of qualitative analyses about the students' learning experiences with MOOCs (Abeer and Miri 2014; Otto et al. 2016; Zheng et al. 2015). This is particularly true for the case of climate change.

The findings presented in this chapter are based on 35 interviews with students who participated in the MOOC "climate change—a question of justice" that was conducted in 2015. Overall, 2908 students participated in the MOOC, 302 of them earning a certificate at the end of the course. This leads to a completion rate of around 11% which is in the range of completion rates of MOOCs that can be found

in the literature (Jordan 2015). The students represented 78 countries ranging from Albania to Zambia.

The MOOC aimed to provide the students the competences to be critical observers of the 21st Conference of the Parties (COP) held under the United Nations Framework Convention on Climate Change (UNFCCC) in Paris in December 2015.

The MOOC was offered by the FernUniversität in Hagen in cooperation with the Lund University in Sweden. Using the dominant pedagogical model, the course was designed as an xMOOC (using an instructional design), and ran eight weeks in anticipation of the start of the COP in Paris. The MOOC entailed eight units with four video lectures, each being approximately ten minutes long. Virtual forums were provided to spur the discussions between the students all supervised by a tutor. Supplementary material like access to scientific articles was offered and a weekly consultation hour took place with the lecturers. For the validation of their knowledge and to obtain a certificate multiple-choice quizzes were provided for each of the units. To obtain a certificate for the MOOC, the students had to watch at least 80% of the lectures and successfully complete the multiple-choice questions for each unit with a success rate of at least 80%. Afterwards, the certificate could be downloaded by the students free of charge.

An interdisciplinary course approach was selected to provide the students a comprehensive understanding of climate change. A key objective was to impart the students the competences to be a critical observer of the upcoming climate change conference in Paris where 196 parties bargained for a binding agreement to keep the earth warming below 2 °C (Otto 2016). Having established a common knowledge foundation in the first lectures, students were supposed to learn about different facets of climate justice for example land-grabbing, climate security, the changing of lifestyles and the question of degrowth or green growth.

At the end of the course, the most active students were asked whether they would be willing to conduct a personal interview to share their learning experiences. Over 70 students signalled their willingness for bilateral parleys via Skype. Due to limited internal capacities, only 35 students could be selected for the interviews. The criteria for the selection were an even distribution of key variables such as age, country of birth and academic background. The interviews were audio-recorded and afterwards transcribed on an anonymous basis. 35 interviews, each lasting approximately 15 minutes, were conducted. In order to facilitate comparability as well as flexibility, semi-structured interviews were used (Louise Barriball and While 1994) (Table 1).

The interviews were coded and clustered using Mayring's structured qualitative content analysis to map out trends and tendencies (Mayring 2000) and to render the students underlying motivations and individual learning experiences. The focus of the interviews was therefore person-centred instead of variable-centred (Wiebe et al. 2015). Learning is a non-linear process which has to commensurate with the personal objectives and distinctive learning goals (Table 2).

Table 1 Interview guide

Interview guide
1. Have you been dealing with the topic of climate change politics before? If yes, in which way?
2. Why did you participate in the MOOC?
3. Which contents of the MOOC interested you the most?
4. Which personal learning outcomes did you gain from the MOOC?
5. What motivated you to complete the course?
6. Do you expect to benefit in the future from completing the course? And if yes, in which way?
7. Is the certificate useful for you? In which way?

Table 2 Gender, nationality and education

Number	Gender	Nationality	Current educational program or employer
1	W	Netherlands	Ph.D. candidate with climate related topic
2	M	Zambia	Master in Climate Change Science Working in the Ministry of Agriculture
3	M	Montenegro	Master in Political Science
4	W	Germany	Journalist
5	M	Mauritius	Working in Climate Change Adaptation
6	W	Columbia	Degree in Sustainability Science
7	M	France	Ph.D. candidate in Climate Change Politics
8	W	Romania	Master unrelated to Climate Change
9	M	South Africa	Policy government adviser in climate change
10	W	Ecuador	Ph.D. candidate in Climate Change
11	W	Germany	Ph.D. candidate in Climate Change (energy storage)
12	W	Germany	Master in Sustainability Economic
13	W	Germany	Working as youth consoler in the division for Energy Literacy
14	W	Germany	Degree Program in Philosophy
15	M	Jordan	Master Degree in Environmental Management Ph.D. candidate in Climate Change
16	W	Switzerland	Degree Program in Environmental Engineering
17	W	Madagascar	Working for German Society for International Cooperation (GIZ)
18	M	Germany	Master in Earth Science
19	W	South Africa	Masters in Climate Change and Development
20	M	Germany	Policy Adviser
21	M	Germany	Degree Program in Computer Science
22	W	Spain	Master in International Economics
23	M	Nigeria	Ph.D. candidate in environmental conflicts
24	W	Australia	Degree Program related to Climate Change

(continued)

Table 2 (continued)

Number	Gender	Nationality	Current educational program or employer
25	M	Portugal	Journalist
26	W	Germany	Bachelor in Policy Management
27	M	Australia	Working for the government in Australia Ph.D. candidate in Climate Change
28	M	Germany	Federal Foundation for the Environment
29	W	Germany	German Federal Environment Foundation
30	W	Turkey	University teacher for environmental topics
31	M	France	Master in Environmental Economics
32	W	USA	Applying for a fellowship in Climate Protection
33	W	Germany	Working for World Vision Germany
34	M	Nigeria	Working for the Nature Cares Resource Centre Preparing a Ph.D. proposal in climate change
35	W	Norway	Master in Globalization

Findings

A central objective was to examine whether MOOCs are a promising educational tool for climate literacy. After critically scrutinizing the interviews, five broader categories were formed to elucidate the students learning motivation and learning experience: (1) *Prior experience with the topic*. (2) *Motivation for participation*. (3) *Most interesting aspects of the MOOC*. (4) *Personal learning outcomes*. (5) *Benefits*.

Prior Experience with the Topic

A first noteworthy observation is that merely four of the students interviewed had no prior experience with the topic of climate change. Most of the students stated that their current educational program is related to climate change, for example a Bachelor, Master, or Ph.D. (Table 3).

Table 3 Prior experience

Name	Frequency	Percentage	Percentage (valid)
Education	24	68.57	68.57
Career	13	37.14	37.14
None	4	11.43	11.43
Overall (valid)	35	100.00	100.00
Missing	0	0.00	–
Overall (valid)	35	100.00	–

Thus the rationale of the majority was to obtain thorough knowledge in a topic they are presently studying. Student 7 for example said that he is researching a climate related topic in his Ph.D.: "*Right now I am a Ph.D. student between a university in France and one in Germany. And one of the topics that I am dealing with, with my Ph.D. project is REDD, REDD+ [Reducing Emission from Deforestation and Degradation]*."

Interestingly, 13 students have working experience or are at present working in a field related to climate change. Student number 27 is a typical example: "*I am working in the climate change policy sector for the government of Australia. Specifically on climate change for 12 months but I have also been dealing with climate change through other policy areas for four years*."

Motivation for Participation

The category *motivation for participation* was intended to offer more detailed information about the students' rationale to join the MOOC. Knowledge acquisition through participation in the MOOC was most frequently named as a motivation (21 times) (Table 4).

This suggests that the students' main motivation is not necessarily bounded to a formal learning context. Especially the key topic of the MOOC "climate justice" raised discernible interest. Like student 32 said: "*I am involved with climate change issues with different organisation, like grass-root organisations but sometimes, that issue of climate justice gets lost and I wanted to have better understanding of what were the main issues and how you could understand climate justice from a global perspective*."

Another important motivation was to support the personal educational circumstances or career paths through participating in the MOOC. This does not essentially encompass formal learning contexts. The students were confident that the MOOC can help them accomplish certain personal goals; to develop a research proposal for a Ph.D., apply for a fellowship, or prepare a course for learners.

Table 4 Motivation

Name	Frequency	Percentage	Percentage (valid)
Knowledge acquisition	21	60.00	61.76
Education	19	54.29	55.88
Career	11	31.43	32.35
Take part in a MOOC	2	5.71	5.88
Access to structured knowledge	1	2.86	2.94
Overall (valid)	34	97.14	100.00
Missing	1	2.86	–
Overall	35	100.00	–

Student 3 expresses the need to learn the basics of climate change: "*I think it is an important topic and because, as a post graduate student of political science, I thought I should know at least the basics of climate change*."

In the working context, job search, developing new perspectives and networking was mentioned, for example by student 34: "*For me it was an opportunity to [get into contact with] big networks and actually it worked out with one or two networks during the course*."

Interestingly, student 32 in particular mentioned the additional materials which were offered in the platform: "*So I think it's very helpful for me to have those extra materials because I am going to finish reading through them and that will help me to get new ideas on how I approach my proposal [for fellowship]*."

Most Interesting Aspects of the MOOC

Climate change is a rather fuzzy topic and can best be understood using an interdisciplinary approach (Hulme 2009). Albeit the main focus was on climate justice, the MOOC covered all relevant scientific disciplines (natural science, political science, economics, etc.). This broader perspective is echoed in the students answers as there occurs no dominant category to be the most interesting. However, possible solutions to solve climate change were indicated to be an especially exciting aspect, closely followed by the international governance system, the North-South relations, and eco-colonialism regarding justice (Table 5).

The interviews moreover revealed that the students have a strong interest to discover concrete opportunities for personal action, a focus not necessarily found in university curricula (McKernan 1996). (Too) often curricula focus on the

Table 5 Most interesting aspects

Name	Frequency	Percentage	Percentage (Valid)
Solutions	14	40.00	41.18
International climate governance	13	37.14	38.24
North-South relations and eco-colonialism regarding justice	12	34.29	35.29
Carbon markets	8	22.86	23.53
Multidimensionality of cc	7	20.00	20.59
Climate refugees, migration, climate wars	7	20.00	20.59
Physical science basis	7	20.00	20.59
Transnational climate governance	6	17.14	17.65
Overall (valid)	34	97.14	100.00
Missing	1	2.86	–
Overall	35	100.00	–

communication of theories and methods neglecting to promote the practical implication for instance through incorporating the teachers' practical knowledge (Van Driel et al. 2001). Student 17 said: "*And the other thing is the example from the Philippines presented by the lecturer. It gave to me something more concrete, more real, how to adapt and how to make it appropriate for the beneficiaries*." Beyond, many students expressed willingness for local engagement. Students 32 mentioned: "*I think the last chapters made a little bit of possible solutions, like what people could to. Like people that were taking the MOOC, like what we could do in our local environment, in a local context, the ways for us to get involved and do more about it*." This shows that students, beside profound knowledge, are also looking for areas of activity in their personal environment.

Since the MOOC was intended to prepare for the climate change conference in Paris, the governance system was another field of interest. Student 31 said: "*I also found interesting the whole dynamics that make the negotiations. And the analysis of different groups, interest groups, that was made*."

Another area that found high approval is the North-South-relations and eco-colonialism as a matter of climate justice. There was, in particular, interest to discern the different dimensions of climate justice and how it manifests in the international discourse as stated by student 31: "*But the dimension of the North-South relationship, the intergenerational dimension but also the chain of discourse was some of the justice dimension that was particularly interesting*."

Remarkably, the physical science basis was not perceived as one intriguing aspect. When the students were asked about less interesting lectures, the scientific underpinning of climate change was named. That may be rooted in the complex nature of climate sciences and the scientific consensus on climate change which cannot be easily understood without prior knowledge. This underscores that understanding the scientific consensus is difficult, not only for layer people.

Learning Outcomes

A major objective was to determine whether the students perceived to have achieved learning success after the MOOC and how they define it. Through coding of the interviews, two main categories in terms of learning outcomes were identified: learning about the content and developing specific competences to cope with the challenge of climate change (Table 6).

Nearly 86% of the student mentioned content related learning. Clustered according to the different topics of the MOOC, climate politics and the multidimensionality of climate change were most frequently named (Table 7).

That is of little astonishment as conveying a basic political understanding to the students was a core aim of the MOOC. Student 34, for example, mentioned the comprehensive view he obtained: "*Having the broad view of what is the political interest of the groups, understanding of the politic interest of the global South and global North in terms of decision-making. It gives me a good understanding of*

Table 6 Learning outcomes

Name	Frequency	Percentage	Percentage (valid)
Content	30	85.71	88.24
Competence	18	51.43	52.94
Overall (valid)	34	97.14	100.00
Missing	1	2.86	–
Overall	35	100.00	–

Table 7 Learning outcomes about topics

Name	Frequency	Percentage	Percentage (valid)
Multidimensionality of climate change	14	40.00	46.67
Climate politics	14	40.00	46.67
Overall understanding of the topic	10	28.57	33.33
Climate justice	4	11.43	13.33
Climate science	3	8.57	10.00
Solutions	2	5.71	6.67
Economics of climate change	1	2.86	3.33
Eco-colonialism	1	2.86	3.33
Climate refugees	1	2.86	3.33
Carbon market	1	2.86	3.33
Overall (valid)	30	85.71	100.00
Missing	5	14.29	–
Overall	35	100.00	–

challenges of climate change policies and implementation in different countries." On the other hand, the students enhanced their understanding about the multidimensionality of climate change and similarly their overall understanding of the topic. This perception might be due to the interdisciplinary approach of the MOOC. Student 35 expressed: "*I think I have more, like diversified knowledge, like I can see more aspects of climate change now than I did before. Also I learned about new kind of problems and situations which is really good*."

In terms of competences, clustering disclosed a more manifold picture than with regards to the content. The students mentioned a broad spectrum of different trajectories ranging from analysing the political process to reflecting one's own lifestyle (Table 8).

There is also indication that the new-found competences were used to convey the importance of climate change to colleagues or friends. Student 17 said: "*So I used what I learned from the MOOC to explain to my colleagues in the area where I work and as well for the colleagues I have in the whole Madagascar. To explain, where it comes from and why do we act do to this, to implement this sustainable handprint, so the principles behind the decision or the methodology of the company*

Table 8 Competences

Name	Frequency	Percentage	Percentage (valid)
Follow, analyse, evaluate climate politics	5	14.29	27.78
Argumentation, advocating, follow/participate in discussions	5	14.29	27.78
Understand and critically assess the media	4	11.43	22.22
Transfer/apply knowledge in research/proposal/job	3	8.57	16.67
Explain climate change/politics to others	2	5.71	11.11
Increased interest	2	5.71	11.11
Reflect own lifestyle	1	2.86	5.56
Overall (valid)	18	51.43	100.00
Missing	17	48.57	–
Overall	35	100.00	–

to implement it." Likewise advocating for climate change in discussions is a competence many students obtained. Student 9, who is working as a policy adviser, said he is "*(…) more involved in suggesting really big chances and then showing people that inequality, if you really see where it comes from and manifest, you can use that as an argument on which you based big change recommendations*." The MOOC also managed to enable the students to scrutinize the dominant public information about climate change for example the political process. Student 30 stated: "*I was having difficulties to understand the negotiations part, but this course provided me with some tools to understand and evaluate the information about climate change*."

Benefits from MOOC

All the students interviewed successfully passed the course and received a certificate. One pivotal question was therefore how the students, beyond certification, expect to benefit from their MOOC participation (Table 9).

Clustering disclosed that the students perceive the benefits to be predominantly helpful for their future career. In terms of career chances, the students primarily want to improve their current job position or apply for new jobs. Student 2 for example said that "*(…) currently I am working in the Ministry of Agriculture. So I do a lot work in terms of adaptation of small-scale farmers to climate change. I would like to move on to policy issues and I feel some of the knowledge I've gained I use it in engaging in policy matters*."

Analogous expectations can be observed for the issue of education. Participation in the MOOC can help to prepare for a fellowship, as students 23 explains.

Table 9 Benefits from MOOC

Name	Frequency	Percentage	Percentage (valid)
Career	19	54.29	55.88
Knowledge acquisition	17	48.57	50.00
Education	16	45.71	47.06
Access to structured knowledge	10	28.57	29.41
Overall (valid)	34	97.14	100.00
Missing	1	2.86	–
Overall	35	100.00	–

"*I gained a lot. Currently I am putting up a proposal for (…) a climate protection fellowship*." Primarily, the students' perceived an added value for their current or future educational program. This comprises Bachelor, Master or Ph.D. programs. The opportunity to learn in this non-formal context for instance was useful for student 1 in formal matters: "*We have a science researcher school. It consists of seven different universities here in the Netherlands. So, I sent them an email to get credit out of that and I got 2.3 credits out of this course*." Participating in a MOOC can likewise be a precondition for participating in a formal learning context like for student 3: "*Because of the course, I was now able to enrol in a simulation game on climate change here in my university*."

Conclusion

This chapter pursues to provide a profound analysis of the pertinence of MOOCs for climate literacy. Based on the findings presented, there is no easy answer. The interviews illustrate a kaleidoscope of rationales why and how students use MOOCs as a tool for their informal and formal learning context.

Notwithstanding this, some corollaries can be derived from the findings which might contribute to the further understanding of MOOCs and for climate literacy.

MOOCs educate the educated

The idea that MOOCs are a tool to educate the uneducated about climate change has to be rejected. This finding is not exclusively valid for the case of climate change, but is reinforced by other studies (Emanuel 2013). Based on the findings presented, only four students had no prior contact (working or degree) with the topic and all interviewed students had a higher educational background. This impression is complemented by the quantitative analysis that was conducted for the MOOC. In this respect, MOOCs cannot be considered as helpful to empower a multitude of climate literates. With regard to the starting assumption MOOCs cannot be perceived as a tool to elevate climate change in the consciousness of people.

MOOC (elements) as a customized personal setting

The interviews refute the myth that MOOCs are studied the same ways as classical university courses. University courses are predominantly studied target-oriented and in a linear fashion over a fixed period of time. Contrarily, the interviews illustrate a vivid picture. Parleying with students disclosed a variety of utilizations for the personal learning context. Supporting the individual educational path or job situation was one of the main motivations for the students to enrol. Non-formal learning in MOOCs is therefore integrated into the formal learning context. On the other hand, this does not necessarily mean that students want accreditation for their participation in a MOOC. They reconcile MOOC resources with their individual formal and informal demands. This can also be observed when the students uttered statements about their favourite course content. However, the students interviewed were goal-oriented and aware what they wanted to obtain through the MOOC. But these goals cannot be captured by applying classical motivational categories, for instance guidance for local engagement.

Learning what and how

Indication could be identified that learning occurs through MOOC participation. This encompasses content as well as competences. Although this conclusion is based on the students' self-perception, the author is inclined to believe a knowledge growth arose. In particular, a noteworthy merger occurred that blurred the distinction between learning and action. The interviews provided intimations that students are looking for tangible opportunities of how to cope with climate change in the personal life situation. Reconciling the input of researchers and practitioners is therefore an auspicious approach. Again, these positive impressions are limited to those who were by this time sensitized about the topic.

Outlook

The urgency of climate change is hasting and climate literacy therefore is a key impetus to capture the problem of climate change. The findings presented suggest that MOOCs are not the persuasive answer to foster climate literacy, but constitute an auspicious tool to cross the boundary between formal education and lifelong learning. Hitherto, this ascription is limited to people inside the educational system. However, there is indication that MOOCs can broaden the (disciplinary) perspective of students towards the problem and point to essential topics like climate justice or possible solutions. In the best case, practical implications possibly will follow.

In terms of MOOCs, there is obviously a need to broaden the scope of analysis and to go beyond classical measurement. Albeit the depicted picture then becomes vivid, this does not mean that compelling results become disguised. On the contrary, the findings represent the whole bandwidth that exists when students

participate in a MOOC. This fuzzy picture should be kept in mind when it is suggested that MOOCs have certain generalized characteristics and in particular when opportunities are discussed of how to advance them.

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E-collaborating for Environmentally Sustainable Health Curricula

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Abstract

Purpose This chapter aims to demonstrate how medical educators can use e-collaborative tools to collaborating internationally and cross-institutionally towards designing environmental sustainability and health (ESH) education. The main focus of the chapter is on sustainable medical curricula.

Methodology The chapter uses a case-study approach to bridge these broader e-collaborative principles with the specifics of implementation driven and supported by e-collaboration.

Findings The case study describes the evolution of the Sustainable Healthcare Education (SHE)-network into a network collaborative. Finally, the chapter discusses e-collaboration for education development through an illustrative case. The case concerns an UK-Greek University e-collaboration aimed at combating obesity and promoting climate literacy.

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Research implications E-collaboration is central at all levels of the ESH curriculum design process from forming a network collaborative around the curriculum process, alignment of assessment and learning activities with objectives, discussing and agreeing on a vision to the actual implementation plan.
Practical implications E-collaboration aids the curriculum design process such that people feel that their participation and interests are valued, as well as providing resources and input to resource stressed academics and institutions. E-collaboration is not an end in itself, but a means of enabling a global network collaborative to address an issue that suits this type of collaboration towards sustainable healthcare education.
Originality This chapter is inventive in showing how the promotion of climate literacy can be a component of a sustainable medical curriculum and how this process is facilitated with e-collaborative tools. The chapter demonstrates how health education should educate climate literate health professionals who are able to address and reduce public health impacts of climate change.

Keywords Medical curriculum · Environmental sustainability · Network collaboration · Climate literacy · Case study

Introduction

E-collaboration has the potential to enable educators, policy-makers and researchers around the world to contribute towards designing an environmental sustainability and health curriculum, including a focus on climate literacy and health. In particular, e-collaboration provides a way to bring collocated participants from different disciplinary backgrounds, organizations and different regions and countries to contribute together towards an educational project.

E-collaboration in designing health care education is challenging. First, e-collaboration needs to take heed of considerable differences in national standards and provisions of healthcare (Starfield and Shi 2002; Ozcan and Khushalani 2016) and health education (Harden 2006). Second, e-collaboration needs to consider different stakeholders' opinions. The stakeholders include health agencies, clinicians, educators, students, and patients. These stakeholders might hold different opinions about the health curriculum and about use of hospital and educational resources including how to deal with waste and energy consumption; it is fair to assume that different stakeholders represent different positions or interests, which makes e-collaboration all the more necessary to understand different positions and mediate between them. Third, health education is highly interdisciplinary; conceptual and empirical challenges abound in synthesising and working between different traditions of research. In medicine for instance, subjects range from the traditional biosciences of anatomy, biochemistry and physiology to the clinical medical sciences such as oncology and haematology to humanities such as communication and ethics, and social sciences such as psychology and sociology (Kapucu 2006). While cross-disciplinary work provides an expanded perspective

on today's complex health issues, historically entrenched disciplinary boundaries and a tendency toward specialization have created the need to develop new strategies for e-collaboration. In summary, there is lack of trialled approaches towards sustainable medical curricula facilitated by e-collaboration

While e-collaboration can help any curriculum network build, our focus in this chapter has a double focus specifically on both health professional education (e.g., climate literate health professionals) as well as sustainability. Research on how to use e-collaboration to design ESH curricula is both relatively new and highly relevant for patients, institutions (medical schools), societies, and indeed the planet. There is a need to integrate environmental sustainability and health (ESH) in the required and elective health sciences curricula. For example, providing health professionals with the ability to identify climate related health impacts (e.g., aggravation of pre-existing conditions, heat-stress, vector-borne diseases, mental health effects, and respiratory problems). In a few countries, health faculties or medical schools have made solid progress toward incorporating ESH education into the curriculum. Unfortunately, in most countries, such teaching is lagging or altogether absent. This chapter, therefore, advocates for continued innovation in supporting the curriculum collaborative, whose purpose is to design, share, and evaluate different environmental sustainability and health (ESH) education modalities focusing on the environment as a key determinant of health.

In this chapter, we examine our experiences as medical educators collaborating internationally and cross-institutionally towards designing ESH education with a focus on the sustainable medical curriculum that includes educating climate literate health professionals. Network members used electronic technologies because they were geographically dispersed and hence needed to work both synchronously and asynchronously. Our overarching aim in the chapter is to formulate guiding thoughts around general organizational processes that can inform engaging and fruitful sharing of educational curricula, materials and goals.

We provide an illustrative case to bridge these broader e-collaborative principles with the specifics of implementation driven and supported by e-collaboration. The approach to e-collaboration that we propose aims to achieve three objectives. First, the discussion of e-collaboration should provide insights that are relevant to all aspects of curriculum design. Second, cognisant of the global nature of many current challenges for environmental health and medical education, the practices that we propose can facilitate collaboration across borders and can be adapted and applied internationally. Third, we aim for an approach that enables collaboration between diverse stakeholders and involves low financial and environmental costs.

Sustainability in the Curriculum

Fundamental determinants of health such as air quality, water safety, climate, biodiversity and natural resources are global; they cut across national and political borders (Costello et al. 2009). E-collaboration is ideally suited to this kind of global

concern. In one direction, it facilitates design and subsequent dissemination of centrally agreed targets, strategies and policies such as the Sustainable Development Goals and ESD approaches. In the other direction, it allows the dissemination of examples of good practice and supports the development of locally relevant learning opportunities, informed by centrally derived goals and guidelines.

Lack of sustainability is a threat to human health worldwide, yet it has not received the attention it deserves in health education worldwide (Thompson et al. 2014). Learning objectives concerning core sustainability have been developed in the UK (Costello et al. 2009), adopted in the UK national medical curriculum (GMC Outcomes for Doctors 2015), and the validation is ongoing in the USA (Teherani et al. forthcoming) and expanded through international collaboration (Walpole et al. 2017). However, they are, to our knowledge, yet to be incorporated into learning and assessment on a national basis in any country. For example, specific training on the impact of climate change on health is limited, if not completely lacking. Generally, local medical educators' enthusiasm has tended to precede top-down institutional policy and support, driving the sustainability agenda into core teaching. E-collaboration could help to build national and international networks of educators pioneering new ESH teaching, thus bringing momentum to the process of formulating high academic standards and policies to implement ESH.

Organization and Terminology of the Chapter

In Box 1, we present the terminology pertaining to the topic. Subsequently, we describe the evolution of the Sustainable Healthcare Education (SHE)-network into a network collaborative. We then support our discussion of e-collaboration for education development through an illustrative case. The case concerns an e-collaboration between King's College London and Aristotle University, Greece, which aimed to combat paediatric obesity in Greece. By addressing network development as well as an on-the-ground case-based application of e-collaborative principles, we explore the theory and practice of e-collaborating while sharing lessons learned.

Box 1: Terminology

Climate literacy and health relate to how well students and professionals analyse principles of the Earth's climate system and effects on health as well as make judicial decisions in regards to healthcare actions that might affect both health and climate.

Collaborative or **network collaborative** refers to an organisation within a network in which members contribute towards a specific project.

Curriculum can on the one hand refer to the organised content and objectives of education as produced by an educational institution such as a medical school. This includes both formal and informal teaching and assessment methods. On the other hand, it can refer to students' experiences

with such content and objectives as they translate it into concrete learning activities.

Curriculum network or **curriculum collaborative** refers in this chapter to a group of medical educators who might be co-located and distributed across the world, yet communicate and e-collaborate on a regular basis and work together to address medical curriculum concerns.

Environmental sustainability and health (ESH) education has an overall mission to educate students with knowledge, skills, and attitudes that can contribute to environmentally sustainable high quality health-care. Sustainable here might refer to activities for building viable ecological, socio-economic conditions for sustainable healthcare. ESH curricula are health educational curricula that integrate learning about the relationship between ecosystems and human health, approaches to providing sustainable healthcare and an environmental sustainability perspective in public health and professionalism.

Medical educators are teachers, administrators, researchers, faculty developers, curriculum designers, and students who are involved in planning, conducting, evaluating, and researching learning and teaching at medical schools.

Collaborative Integration: The SHE-Network

In the following, we explore how the SHE-network has developed from its institutional origins to a global endeavour. Members of the networks involved in promoting ESH education share a desire to ensure that medical students are prepared to address the challenges and opportunities that the relationship between humans and ecosystems brings to healthcare. One example of this is to investigate the impacts on health from changes in the climate. Here we explore how this led into the SHE network's formation and growth. Our discussion touches on the network's aims, its successes to date, and challenges that remain.

Fostering a Collaborative Network

E-collaboration can help to spark and maintain a curriculum collaborative network. The SHE-network was launched in 2009 to foster cooperation around ESH education. Key milestones in the development of the network are shown in Fig. 1.

Members of the SHE-network predominantly used the network as an e-collaborative support structure, sharing their practice, and seeking common solutions. However, until recently, most members acted autonomously within their own institutions to develop teaching for their students. The SHE-network was

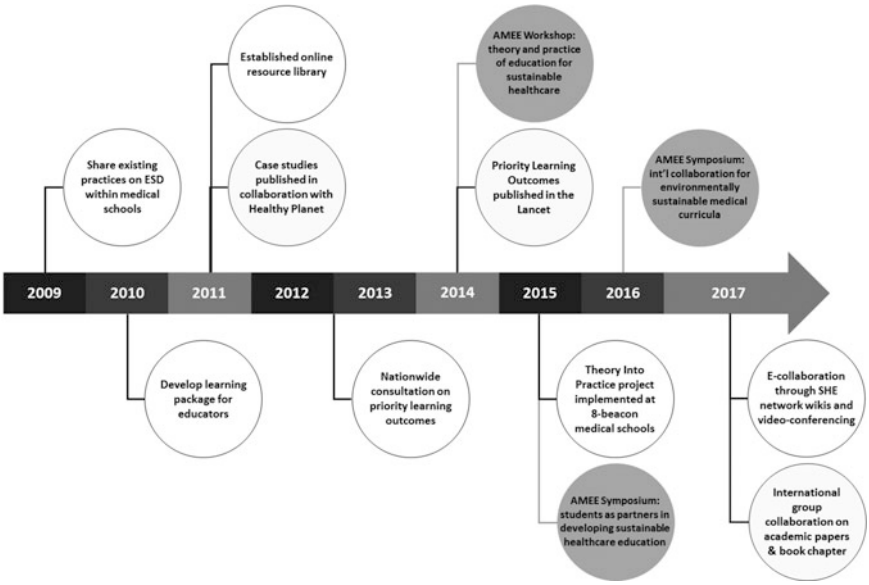

Fig. 1 The key achievements of the Sustainable Healthcare Education network over the past decade

therefore a loose or informal work organisation among educators. The leadership of this group passed, over time, from its creators (one academic and one clinician) to a leader with more ample time and resources (a senior academic medical registrar doctor). With an increasing membership, the SHE-network naturally evolved from loose cooperation with irregular contacts from members, towards a stronger collaboration where active participants maintained regular engagement including updates to all members. The SHE-network is an example of a collaborative that supports consensus building, and provides social capital (Briggs 2007) in what is currently a 'bottom-up' movement, that is beginning at a local level and at low levels in the organisational hierarchy before moving to influence change at an aggregate level (Walpole et al. 2017).

Once the network was well established, the time had come to work towards the global mandate of integrating sustainable practices into medical education and addressing the health impacts of climate change. This came about through a highly interactive symposium (with both face-to-face and video-linked interaction between participants) that also served as a network node. A core group from the SHE network sought a forum for this endeavour and identified the 2016 AMEE (Association for Medical Education in Europe) conference (the world's largest conference for international medical educators, held annually) (Walpole et al. 2017). The group ran a symposium exploring environmental sustainability curriculum development building on previous years' experience at AMEE conferences. After the workshop, conference participants self-selected to join a SHE-based core

group de-briefing and exchanged contact information. When participants returned to their home institutions, several responded to the workshop leaders' invitation to participate in a publication summarizing the workshop structure and outcomes. In the following six months, several related projects were developed.

SHE-network accomplishments

As initially outlined, the aims of the SHE-network's e-collaborative activities target-specific outcomes. Currently completed and on-going projects include network expansion, development of an on-line presence through an established web-based platform, publications and presentations in a range of formats and settings, the development of open-access case studies, curriculum materials and online network discussion.

Network expansion

After the AMEE meeting, the SHE-network expanded its reach through representatives across continents. These included not only individual participants, but affiliated educational networks with the potential to expand SHE's reach. Network strengthening, expansion and creation of nodal centres within or between organizations such as universities or medical schools offer opportunities to support the long-term goal of educating healthcare professionals to think and act for a sustainable agenda. Expanded networks can use e-collaboration to move from a narrowly defined towards a well-defined goal without losing sight of the broader understanding of ESH. For instance, e-collaboration allows for discussion of whether the top priority should be to lower carbon-emission in hospital or primary care or to tackle the mutual effects between health and climate change, or migration patterns in the future.

At the same time, network expansion requires e-collaboration to facilitate inclusivity, and its correlate: resisting fragmentation. To keep all e-collaborators engaged and goal-focused, small breakout groups were formed through e-communication and these groups addressed specifically assigned tasks. Sub-groups have had the opportunity to reconvene online and report to the broader network on the subtasks and larger enterprise.

Platform development

An e-repository of resources and materials is an important focal point for sharing materials. The SHE-network collaborative uses the Centre for Sustainable Healthcare's subsection on SHE to post resources and materials for curricular development. Access to a repository of free educational materials is essential to assist users internationally in adapting their curricula to specific settings and various levels of resource allocations.

Based on experience of the SHE network, an ideal repository amenable to e-collaboration should have the following characteristics. First, a list of resources, particularly open-access on-line courses focusing on ESH, but also agencies and organizations that provide education and advocacy tools. Second, the repository should assemble syllabi that users can adapt in developing learning objectives and

structuring courses at their own institutions. Third, full course content modules should allow easy adaptation in resource-limited areas, where lack of time and funding may interfere with curriculum development. Fourth, a materials repository must provide a forum for feedback because of varying local concerns in face of globally applicable conditions. In summary, a materials repository must provide a forum for feedback. The SHE-network's comment function allows e-collaborators to add to and comment on postings, which in turn facilitate discussion of the latest pedagogical thinking.

Scholarship

In the wake of the SHE-network's presence at AMEE, one of the group's goals was to enlist collaboration on scholarly activities, including publications and presentations. Thus, network members could enlist collaboration on projects that would build on previous accomplishments and enhance the network's visibility and credibility.

In writing up research papers and preparing conference submissions, members as e-collaborators of the SHE-network experimented with different communication intensities, that is, coming together face-to-face at widely spaced intervals, communicating as a plenary through video or audio modalities or on a variety of e-platforms, and breaking out into small groups communicating electronically to accomplish specific tasks. But in general, the e-collaboration tools available to the SHE-network serve exactly the same purpose as for any other collaboration and include any combination of the following: synchronous web-based chat tools, asynchronous conferencing tools, e-mail, internet-based list-servers, Web 2.0 with social network tools, collaborative writing tools and collaborative decision support systems (Rosalind 2014).

E-collaboration with videoconferencing is useful in planning conference workshops, conducting research and writing journal articles. Shared successes in these areas have spurred the network on, over time, towards increasingly complex goals. As Schauer and Zeiller (2011) point out, to promote e-collaboration success, successful synchronous cooperation is key. In our experience, none of the communication venues or platforms mentioned above replace or compensate for tacit elements that are crucial to the group's success. These include a sense of diligence and responsibility, passion for the project, and openness and respect towards colleagues.

E-collaboration needs to resolve issues around authorship in a collaborative network. Our experience was that e-collaboration adapted to fluid leadership where different contributors were encouraged to step up at different times depending on the network members' evolving priorities. We found that the more motivated the group, the less leadership is necessary and the more coordination functions take precedent. The assignation of followership, authorship and sense of agency may for that reason not be as problematic for a passionate issue-driven volunteer group as it is for traditional collaborations.

Curriculum development

Network participants have contributed various specific curricular examples via the SHE-network. These range from course syllabi to detailed descriptions of workshops and modules incorporated into pre-clinical and clinical courses to on-line case studies. Although data are lacking on the extent to which these curricular cross-network postings have been adapted thus far across institutions, sharing of curricular material is most feasible under specific conditions.

First, curriculum development must involve committed faculty as e-collaborators who already have experience with curriculum implementation and can inform best practices, that is, share their successes for how to export a curriculum to other medical schools within their own or other countries. There is also a need for relevant faculty in this collaboration e.g. educators who are knowledgeable and experienced in environmental health, sustainability, climate literacy.

Next, faculty will be best motivated to use e-collaborative technologies if they are aligned with the technologies as a social practice of medicine. It is important to recognize that the collaborative tools used for purposes of medical research, medicine as science, medical education and the medical profession follow and an intricate but meaningful social practice (Crawford 2006). Medicine for instance centres on standard diagnostic and treatment modalities across institutions. E-collaboration allows participants to query the network members about differences in the social practices in which they participate. This might give us worked examples as to how health is affected by climate change and its ramifications in different settings.

Finally, to further the network's goal of developing curricular material, network members gather information on and develop responses to the challenges network e-collaborators might have encountered in adapting different components of web-based resources in a range of settings. While this web-based approach to shared curricular materials will likely mean focusing at first on homogeneous end-users, e.g. learners from developed countries where fossil fuel consumption is not only high but also taken for granted in everyday life, we hope to use all the strands of our connective capacities to involve e-collaborators from low- and middle-income countries (LMIC). To this end, it is important to engage students and, elicit their input to make the cases and simulations relevant to their local circumstances to eventually achieve global portability.

Case Example: UK-Greek University Collaboration

In the previous section, we described the development and expansion of an international medical educational network and its potential to enhance communication, scholarly collaboration, and curricular integration of ESH across institutions on a global scale. What might such collaboration look like in the setting of a concrete project that addresses specific institutional and culturally mediated needs? We

present an example of e-collaboration that moved towards designing e-learning tools (see Box 2). The project was specifically geared towards creating a more sustainable healthcare system with few resources. While the example of the SHE network demonstrates how a network can develop and produce wide-ranging outputs, this case demonstrates how a partnership e-collaboration for a more focused project can be effectively engage stakeholders, develop messages and outputs that have value in different contexts and encourage participation and interaction between educators and students. Although the example focuses on addressing obesity, this lessons learned are applicable to promoting climate literate health professionals.

Box 2: Case study: E-collaboration between two institutions

Who? Representatives of the Aristotle University of Thessaloniki, Greece (AUTH) invited representatives of King's College London, UK (KCL).

Why? The overall purpose was to present and cope with an obesity epidemic in Greek society. KCL was invited to support AUTH in introducing a behaviour change intervention to address obesity. By way of background, Greece is burdened with the highest rate of paediatric obesity in the world. Obesity is precursor of inactivity, arthritis, cardiovascular disease, hypertension, diabetes and stroke, as well as social and psychological distress. The impacts of this obesity epidemic are unsustainable, with increasing morbidity driving up the social, financial and environmental costs of healthcare provision. In addition, the Greek healthcare system and indeed higher education system is constrained by financial austerity following the recent collapse of its financial system.

The project was low budget, which was the initial driver for adopting an e-collaborative approach. The project needed lecture materials, handouts, scenarios to support peer-to-peer role-play, teacher training, monitoring of assessments, and careful ongoing evaluation as an established educational programme from the UK was effectively being transplanted into the Greek context.

What? There were three curricula collaborative elements. First, the intervention involved a lecture and role-play on broaching obesity and applying behaviour change theory and motivational interviewing techniques to support patients in both setting and achieving a personal goal. Students were provided with tailored information on evidenced strategies to improve diet, lose weight and/or increase physical activity levels. Second, students were distributed to a large network of general practices across the region and required to complete a behaviour change intervention with patients. Third, students were required to submit a reflection on their experiences as a compulsory but formative assessment.

How? The process involved regular video conferencing meetings using a free online platform were set up with the course organiser at AUTH to individualise the collaborative process. Materials were shared via email and

translated locally. An interactive webinar was set up to support teacher development that included skills training in motivational interviewing and practical applications of behaviour change theory. Students were sent to over 130 primary care locations in three termly blocks and completed behaviour change consultations that included setting patient-led goals and action plans with over 3000 patients in a single academic year. Students were required to submit their reflective essays and a summary of each consultation via a free cloud-based document-sharing site. These were accessed and translated into English using free online translation software and used, with ethical approval, to evaluate the programme, looking at the experiences of students through their reflective essays and the experiences of patients through the consultation summaries.

Evaluation—how? The efficiency of this e-collaborative approach was evident to all involved. KCL's initial input was a single afternoon webinar, where existing teaching materials were recycled. AUTH gained access to the KCL programme that had been honed across three years of action research. Students across a multi-site network were able to articulate and reflect on their learning as part of their assessment, which was then submitted via cloud-based file sharing, and used to quality control and improve their experience. The research interests of the team at KCL were used to support the evaluation needs at AUTH. This synergy was created by breaking down the barriers to international collaboration, where physical distance, language barriers and resource disparities become less significant through technology. The impacts in terms of environmental sustainability will depend on the students' success in changing behaviour. Adopting a 'back of the envelope' method of estimating these savings, if 1 in 10 patients achieved their goal and that goal resulted in a 33% reduction in health care needs over the life of that patient, then the healthcare-related carbon footprint of those 3000 patients would be reduced by approximately 3%.

Integrating a Range of Stakeholders

The first lesson of the case of UK-Greek University collaboration is that e-collaboration can integrate a range of stakeholders. Keeping external stakeholders or key players involved is important in the curriculum design process because they have the resources to improve but also greatly hinder any new initiative. This is particularly relevant when external stakeholders such as health politicians and physician postgraduate representatives at hospitals or in the national physician association are invited to participate in the network collaborative. In short, e-collaboration must keep external stakeholders or key players content that progress

is achieved by frequently communicating (synchronously and asynchronously) with external stakeholders and giving them options about how they transmit their feedback and opinions to the whole network.

The second lesson is that e-collaboration can be used for purposes of knowledge sharing between external and internal stakeholders. Sharing of new curricula, learning-centred teaching, new technologies etc. need to be continuous. This is relevant because a curriculum is a process involving continuous program design and renewal (Briggs 2007). The continuous process derives from the fact that a curriculum has its own lifecycle according to the academic year and stakeholders need to be kept updated about current activities. Furthermore, curriculum renewal or reform might come about following international research trends, faculty and student desires to change (or keep) the curriculum as well as political pressure from external stakeholders. Regardless of the pace of curriculum renewal, e-collaboration is a way of keeping stakeholders at two institutions (e.g. medical schools as in above case: KCL and AUTH) each with external and internal stakeholders on the same page.

A third lesson is that e-collaboration is helpful in uniting stakeholders in the process of formulating a vision. Agreement on standards and course-validation is one aspect of this. Another is to share and discuss benchmarks or visions from professional bodies that the ESH curriculum needs to fulfil. E-collaboration might help participants agree on common standards and the structure of the curriculum such as how many hours and which type of assessment. This should then contribute to building a vision and a shared narrative about the value of ESH for the involved stakeholders of the institutions. In summary, external and internal stakeholder e-collaboration, agreeing on the novelty and visionary status of sustainability (e.g., climate literacy) might help stakeholders to build an ethos as change agents and involved medical schools to build an image as sustainable medical schools (i.e., schools producing climate literate medical professionals).

Addressing National and Local Health and Political Contexts

The above case is an example of how e-collaboration provides an opportunity for one medical school (KCL) to not only export the message of sustainability, but also develop it together with another medical school (AUTH). It is pertinent in the initial phase of e-collaboration to build awareness of national and local contextual differences. Once a consensus has arisen through collaboration, there needs to be a process of individuation to the local context.

The discipline of sustainable healthcare education often arises and becomes an internationally shared agenda within a national or local context. E-collaboration must address local and contextual factors and take account of national and cultural settings in which medical schools are situated. The point is that two different medical schools in different or even in the same countries might not serve the same patients (i.e., presenting with similar disease patterns), the same medical students or

share the same curriculum and educational objectives. Because these differences might sound obvious, or because we as educators get accustomed to our own curriculum and terminology etc., differences can easily be overlooked and tailored solutions might be missed. For instance, while the UN's Education for Sustainable Development (ESD) agenda provided a general context for change (UN 1987; UNESCO 2006), it did not address the specific institutional constraints in healthcare delivery that leaders would need to account for to implement ESD.

ESH education is influenced by numerous factors beyond the pedagogical reorientation urged by ESD. These factors include changes in social and political trends, healthcare practice, scientific advancements, health systems reorganisation, varying climatic conditions and national and international policy developments. For instance, in relation to the above-mentioned UK-Greece collaboration, change caused by external factors such as increased awareness of environmental determinants of health and introduction of carbon-emissions reporting in the UK (NHS 2012). It was also manifested through an increased focus on transparency and quality and a better understanding of the carbon footprint of healthcare, and the creation of new organisations such as Public Health England (Negev and Kovats 2016); and enshrining responsibility within the UK Climate Change Act 2008 (Costello et al. 2009). In summary, e-collaboration towards curriculum development is charged with political pressures for reform or renewal nationally and internationally.

The Role of Students: Enabling Broad, Equitable Participation

E-collaboration can enable broad, equitable participation. The perspective of students is crucial to ensure that the design, content and delivery of curricula meet the needs and expectations of learners. Traditionally curricula have had limited participation of lower 'status' stakeholders, for example students or patients having limited input compared to professors or consultants.

In the Greek/UK collaboration described above (Box 2), students were able to give their 'evaluation' of the course and their experiences with patients as part of their reflective essay submission, effectively creating a participatory action research project, where their experiences were fed forward into the next cycle of curriculum development. Challenges were anticipated in collaborating between differently resourced medical schools with disparate cultures and population profiles. Nonetheless, the depth of learning and reflection by students at AUTH and the reported engagement of their patients exceeded the levels reported at KCL. There was a high level of engagement by students in this progressive, e-collaborative project.

Our vision moving forward would be of an ongoing international collaboration, extending to students, blurring boundaries between educators and students, promoting scholarship, and involving and empowering students as active partners in the ongoing review and development of curricula (Fetterman 2001). The majority of today's students are active users of social media and online communications in a

variety of forms. Notably, In the UK, the medical student campaign 'Healthy Planet' (www.healthyplanet.org), which addresses environmental and health issues, mainly communicates through social media and cloud-based technologies. The International Federation of Medical Students' Associations brings together medical students from over 100 countries, involving a variety of e-collaboration tools. Students may be more *digitally native* and willing to be *digital immigrants* than educators (Prensky 2001) may and may be experienced at getting to know and use new online platforms.

In the case of SHE, students clearly provided leadership, for example, by creating and disseminating e-learning modules and webcasts. Although medical students have highly demanding course requirements to meet, many students have made significant contributions both during student-selected projects and outside of their formal medical training (Dyrbye et al. 2006). Students' idealism, energy and career motivations may be contributing factors. In summary, students are important partners in e-collaboration both because it is important to take into account their perspective on the priorities for medical education, and because they bring useful skills, energy, and experience.

Conclusion

In conclusion, e-collaboration is central at all levels of the ESH curriculum design process. This is particularly the case in forming a network collaborative around the curriculum process, to alignment of assessment and learning activities with objectives, to discussing and agreeing on vision, to the actual implementation. E-collaboration can aid the curriculum design process such that people feel that their participation and interests are valued, as well as providing resources and input to support stressed academics and institutions. E-collaboration is not an end in itself, but a means of enabling a global network to address an issue that suits this type of collaboration.

The projects discussed in this chapter highlight the need for five further lines of research. First, e-collaboration has implications not only for ESH curriculum design, but also for faculty capacity development. Thus, once the curriculum is in shape, we found that there arises a need for initiatives that enhance medical educators' teaching competences or capacities to teach about new and unfamiliar topics (e.g., climate literacy). Medical educators at all levels from tutors to seasoned professors might benefit from participating in the network for e-collaboration on teaching modalities (e.g. e-learning).

Second, future research must (or needs to) look more at ethics. As discussed above, e-collaboration can potentially widen accessibility of and participation in curriculum development, but it is also important to be cognisant of the potential inequality of participation, production and ownership within such a network. Research could investigate the complex issues about ownership of tools, e.g. copyright in relation to sustainability, as well as political and economic

embeddedness of a network aiming to be environmentally conscious. Thus, an issue for environmentally conscious networks is the stated environmental credentials (e.g. green accountability) of providers and platforms that the network engages with. If the provider of an e-collaboration tool does not have an adequate environmental policy, are medical educators wanting to implement a green curriculum ethically obliged to avoid using and recommending such a tool, even if it might technically be the best solution?

Third, future research should consider how the output of an e-collaboration could be formalised and made widely available through e-learning. Our examples demonstrate useful outputs of e-collaboration, and their applicability in different settings. With existing medical curricula often at capacity and little room for new fields to be introduced, e-learning provides an opportunity to provide learning episodes for large numbers of students in both LMIC and high-income countries (Frehywot et al. 2013).

Fourth, future research might look at ESH through the lens of higher education research. One question is whether ESH as a curriculum strategy and ideology impedes or furthers trans-border trade in higher education. On one hand, e-collaboration is arguably a powerful set of tools and strategies that are impervious or at least neutral to the rising demand for online higher education. On the other hand, e-collaboration is not just a neutral approach. It affects how health curricula are shared and developed towards or away from ESH curricula integrated or as stand-alone courses in the curriculum. It was our opinion as researchers and educators that ESH should be integrated into health education and not be a stand-alone course. However, further research is needed to substantiate this opinion and formulate guidelines for the design of ESH curricula.

Fifth, research is needed on higher education concerning the interplay between e-collaborative curriculum and higher education policies around blended learning. University education is going online at a rapid pace with open universities, MOOCs, e-universities etc. Research should assess what role e-collaboration can play in this development.

In conclusion, in our experience e-collaboration around curriculum design is about networking and organising work. E-collaboration might only improve workflows if the organisation, e.g. the ways the members of the subgroups are organised, is ready to embrace e-collaborative tools. E-collaboration emerges to address parochial limitations in institutional and national political agendas pertaining to medical schools' curricula. It underscores the need for global connectivity and continuous real-world practical engagement as well as more theoretical work and collaboration. E-collaboration might help in formulating new policies and initiatives between regions or even countries around student exchange agreements to address sustainability as a global concern by keeping members up-to-date on issues as well as promoting discussion, (e.g., around current thinking and research related to climate literacy for health professionals). The impact of e-collaboration on ESH curriculum and subsequent impact on a more sustainable global environment depend on both the actual tools and their application in collaborative networks.

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Resources

http://www.healtheweather.com/dailybreath.
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Massive Open Online Courses (MOOCs) on Climate Change and Health: Teaching a Global Audience

Sandra Barteit, Anneliese Depoux, Ali Sié, Maurice Yé and Rainer Sauerborn

Abstract Massive open online courses (MOOCs) give the opportunity to engage and teach a global audience into the rationale and arguments of climate change and its impact on health. We want to describe the possibilities of MOOCs for climate change education on the example of three MOOCs on climate change and health that were offered on the online learning platform iversity and FUN-MOOC: one MOOC was designed for a broader audience without prior requirements in the area of climate system and climate change. The learning target was health impacts worldwide, best practices in adaptation and mitigation strategies, as well as the promotion of health co-benefits. This MOOC was subtitled in ten different languages. An executive MOOC was targeted at policy makers as part of their conference briefing for the climate conference COP21 in Paris in 2015. The key arguments of the MOOC included the development of climate policies and their fair share of the burden and benefits, as well as scientific evidence behind the four key arguments based on human health for climate policy (Sauerborn 2016a, b). The third MOOC focused again on a broader audience on climate change and health within an African context for a francophone audience. In the following, we introduce MOOCs for teaching climate change education to a global audience, also with a focus on developing countries, followed by a description of the three MOOCs on the topic of climate change and health in more detail with regards to their contents,

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participant demographics, retention rate and encountered challenges. We discuss our findings with regards to all three MOOCs and will give insights into practices for employing MOOCs in climate change education, for developed and developing countries.

Keywords Climate change · Health · Climate change education
Massive open online courses · MOOC

Introduction

Climate change is in the news worldwide and captures global alertness: for the COP21, delegations from over 190 different countries met to consult on how to decrease greenhouse gas emissions to sustain global warming under 2 °C (Centre Virchow-Villermé 2016). The urgent call for climate change mitigation and the pursuit of a vision of low-carbon and climate-resilient economies and countries lead an increasing number of universities and institutions to develop courses to prepare students. Several studies identified the need for more training among health professionals, also with regards to communication and engagement towards health effects of climate change (Sayre et al. 2010; Barna et al. 2012; Nigatu et al. 2014; Wei et al. 2014; Adlong and Dietsch 2015a, b, Rudolph and Gould 2015). Especially in low- and middle-income countries (LMIC), there is an urgent need for trained healthcare workers as reported by the world health report 2013 (World Health Organization 2013) and a lack of education in the curriculum of health professionals regarding climate change (Majra and Acharya 2009; Nigatu et al. 2014). The recently growing numbers of massive open online courses (MOOCs) and their equivalent growing numbers of participants, offer possibilities to embrace climate change education (Escher et al. 2014; Chuang and Ho 2016). Already in the world health report of 2006, the WHO recommends employing regional resources and IT to moderate costs (World Health Organization 2006) of education and appeal to contribute to global health educational opportunities (Withers et al. 2016).

Health is a top priority worldwide and according to the Intergovernmental Panel on Climate change (IPCC; very high confidence), “health of human populations is sensitive to shifts in weather patterns and other aspects of climate change” (Woodward et al. 2014). Health is found to be a motivator of behavioural change of populations (Sauerborn 2016a, b) and can be the base to help raise awareness and stimulate action with regards to climate change, increasing the reach to a global level with support of technological developments in online education, such as MOOCs (Levy and Patz 2015). Thus MOOCs are possibly an enabling factor also to fulfil the Sustainable Development Goals (SDG), as outlined by the background report for the UNESCO (International Council of Open and Distance Education (ICDE) 2015).

What Are MOOCs?

MOOCs are targeted at masses (**m**assive), are open to anyone anywhere given an Internet connection (**o**pen), its coursework is delivered entirely over the Internet (**o**nline) and contents are offered in a course-like-style (**c**ourses) (Hoy 2014). The majority of MOOCs on the most prevalent learning platforms offer xMOOCs (Adams et al. 2014) that are mainly based on the principle of knowledge replication that is transferred with video lectures, literature resources and quizzes. The open access policy of MOOCs allows students worldwide to access educational resources that otherwise may not be available to them financially and geographically (Withers et al. 2016). As an example, a MOOC that was offered on the subject of Artificial Intelligence by Stanford University in the US attracted over 160,000 students and in the end the top Stanford student was outperformed by 411 online students (Brynjolfsson and McAfee 2014). MOOCs are free of charge, learning is possible at an individual pace, everyone can sign up without restrictions, learners can support each other and build an online community, and in our case subtitles in up to ten languages are offered to lower the language barrier. Also for climate change education, MOOCs offer possibilities to engage a broad audience in climate change policies and practices, as well as they encourage the advancement towards sustainable development and climate literacy linking the debate of climate change to health. Researchers, health practitioners and institutions need to support the process of developing policies and interventions to adapt to outcome related to climate change. MOOCs could be an instrument to open access on a global level to quality education on climate change and health (Levy and Patz 2015), providing another mean to spread knowledge about a more climate friendly and healthier planet (Sauerborn 2016a, b)—especially as the technology needed to access MOOCs becomes increasingly cheaper and widespread, also in resource-low countries (Alliance for Affordable Internet 2017).

The three MOOCs on climate change and health allow participants to connect climate change and health outcomes and to give insights into adverse health effects of climate change and health co-benefits resulting from climate policies (Levy and Patz 2015; Sauerborn 2016a, b). Furthermore, the MOOCs encourage people to engage with their local political representative and actively initiate change on a local, municipal level.

However, a necessity of MOOCs is online access. Internet access has increased and is increasing globally, especially with the growth of the mobile broadband market (Alliance for Affordable Internet 2017). In 2017, more than 50% of the world will be online. Yet, the costs to access the Internet still keep low-resource countries left behind, the so-called digital divide (Alliance for Affordable Internet 2017). According to the Affordability Report 2017, Zimbabwe as an African country currently has the cheapest cost of 1 GB mobile data with 6% of average monthly income, followed by Tanzania with 8.74% (Alliance for Affordable Internet 2017). Evaluations of MOOCs show that in general they attract educated, middle-aged participants from developed countries (Escher et al. 2014; Hansen and

Reich 2015). Climate change affects populations worldwide, and the health of the poorest is often the most vulnerable. Therefore, it is important to keep the discussion and effort ongoing to close the gap of the digital divide and make climate change education as accessible as possible for everyone worldwide, targeting two Sustainable Development Goals (SDGs)[1]: *goal 9*—Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation,[2] and *goal 13*—Take urgent action to combat climate change and its impacts.[3] Overall, the demand for higher education in Africa is growing and current numbers indicate that Africa may not be able to provide the necessary infrastructure for higher education (Escher et al. 2014). MOOCs can be envisioned to act as an enabling factor (Escher et al. 2014) and an opportunity for higher education (Warusavitarana et al. 2014), also in the area of climate change and health. Current approaches to make MOOCs accessible within resource-low environments are only minor—such as decreasing the data volume of the MOOC by making lectures accessible as text downloadable files, providing audio files separately to the MOOC videos, offer low resolution videos—as they decrease the overall learning experience and deprive participants of the multimedia element of the MOOC. In order to enable people, especially in low income countries, to access the Internet and access qualitative higher learning resources, Internet access needs to be affordable. The importance of Internet access is now reflected in goal 9 of the SDG: "Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020". The 2017 Affordability Report suggests that 1 GB of data should not cost more than 2% of the average income (Alliance for Affordable Internet 2017). To bridge low-bandwidth and high mobile data prices in low-resource countries, on campuses within certain areas MOOCs could be provided centrally on a local server within a local Wi-Fi network.

MOOCs on Climate Change and Health—Educating the World

The Heidelberg Institute of Public Health (HIPH) has developed and designed three MOOCs on the topic of climate change and health together with partners from the Centre Virchow-Villermé[4] (CVV) and Université Sorbonne Paris Cité (USPC) in Paris, France, and the Centre de Recherche en Santé de Nouna[5] (CRSN) in Nouna, Burkina Faso. These MOOCs are offered on two different learning platforms: one

[1] https://sustainabledevelopment.un.org/sdgs.

[2] https://sustainabledevelopment.un.org/sdg9.

[3] https://sustainabledevelopment.un.org/sdg13.

[4] http://virchowvillerme.eu.

[5] http://www.crsn-nouna.bf.

platform is the Germany-based, commercial learning platform iversity[6]—MOOCs are mainly in German and English—and on the francophone, non-commercial learning platform FUN-MOOC,[7] supported by the French government. The main objective of the MOOC is to familiarize a broad audience as well as the specific audience of policy-makers to the rationale of climate change and health of populations. Currently, health is not prominent in the debate on climate change. To increase the accessibility and the reach of the arguments on climate change and health, the medium of MOOC was chosen as it has shown to be promising, especially in reaching a broader audience and people burdened by financial, geographical or language restrictions (Brynjolfsson and McAfee 2014; Chuang and Ho 2016).

Development and Design of the MOOCs

All three MOOCs have been designed and produced with scientific experts of the field and the MOOC factory[8] of the CVV, who provided the technical team for the video production process.

The contents of the MOOC *Climate Change and Health (CC&H)* are based on a yearly, two-week presence short course at the HIPH that averagely had around 25 participants. The course materials were adapted and condensed to fit in video segments of 7 to a maximum of 14 min each (see Tables 2, 3 and 4). Four scientists, all authors of the health chapter in the IPCC fifth assessment report, designed and developed the MOOC *Climate Change and Health for Policy-Makers (CC&H PM)* focusing on policy-makers attending the COP21. The francophone MOOC *Changement climatique et santé dans le context Africain (CC&S)* has been collaboratively designed by experts from the HIPH and CRSN from the field of public health, climatology and meteorology who have taught the topics in presence courses, which served as a basis for the design and development of this MOOC. Multimedia such as graphs, video sequences and pictures were used to support the learning process within the MOOC segments. The English MOOCs were shot in a small video room of the CVV in Paris and on location in Burkina Faso. The video editing and course creation on the respective MOOC platforms was done by CVV. The promotion of the MOOC was through mailing lists, social media channels, word-of-mouth, conferences and through the online learning platforms.

[6]https://iversity.org.

[7]https://www.fun-mooc.fr.

[8]MOOC factory: http://virchowvillerme.eu/the-mooc-factory/.

MOOC Climate Change and Health (CC&H)

The MOOC *Climate Change and Health (CC&H)* offered on the learning platform iversity is targeted at a global audience and focuses on the latest evidence of the relation between climate change and health. The MOOC CC&H addresses a broad public audience, for example, health professionals, teachers, journalists, meteorologists, climate scientists and every global interested citizen without prior knowledge of climate system and climate change. In order to increase the global reach and to make the MOOC accessible to people whose first language is not English, the MOOC was subtitled in nine different languages: Arabic, Chinese (Mandarin), English, Hindi, Indonesian, French, Portuguese, Russian and Spanish. The objective of the MOOC CC&H is to familiarize students with the global effects and impacts on health, in particular for their respective home country. Throughout the course, students analysed their country as a case study, which then was published and discussed in an online forum with MOOC course participants from the same country to understand the limits and strengths of their respective home country's climate adaptation plan. Furthermore, the MOOC covers the topic of best practices for adaptation and mitigation strategies, as well as for health co-benefits. Discussion forums were setup with a focus on diseases and other target-group specific interest groups, such as climate change-related child malnutrition or health effects on the elderly. The objective was to engage students with their national and local policy makers to initiate a process to focus on health-related impacts of climate change in their respective home countries.

Overall, the MOOC CC&H contains 25 video lectures with an average length of 9.8 min per video lecture, arranged in the following six chapters: (1) What is climate change and how can it affect health? (2) What health effects do we expect? (3) Reducing emission—in health terms: Prevention, (4) The good news: doing something to reduce emissions is good for your health, (5) Adapting to the effects of already occurring climate change: "Therapy", (6) Outlook: A climate friendly world is healthier, more equitable, sustainable and fun.

Furthermore, the MOOC offered a journal to students for their exercises, which covered: (1) What is climate change to you? (2) In your opinion?—Climate change policy and (3) Health as a positive leverage for climate policy—Interview someone. All students are able to access each other's journals to foster discussions.

MOOC Climate Change and Health for Policy-Makers

The MOOC *Climate Change and Health for Policy-Makers (CC&H PM)* followed the format of policy briefs as it was designed for policy-makers and negotiators, involved in climate agreements, particularly as an input for the United Notions Framework Convention on climate change—the 21st Conference COP21 in Paris, in 2016. The objective of the MOOC CC&H PM was to teach the effect of health in

climate policy as a central theme and motivator (Sauerborn 2016a, b). Four renowned scientists authored this MOOC and also the health chapter in the recent fifth assessment report of the IPCC. This MOOC has a total runtime of 3 h stretched over one week, providing evidence of health as central for climate policy: Four key climate policy arguments based on human health are presented that are integral in all climate policy negotiations (Sauerborn 2016a, b):

1. Health is a positive motivator, a driving force for citizens.
2. The huge health co-benefits must enter the risk-benefit calculations.
3. There are health limits to adaptation.
4. Decreased work productivity in hot countries.

One key argument of the course is to reflect on health as a key indicator for sustainable development and for climate policy. The course is organized in four lectures each eight minutes long and each developing the four key health arguments, that are complementary following a common storyline. Seven optional quiz questions are available, as well as a discussion forum which was central to engage participants in exchanging views and initiating discussion on course topics. Course assistants and the course lecturer participated in the forums and provided weekly feedback with videos to individual questions and email comments, on top to personal email feedback during the course.

MOOC Changement Climatique et Santé En Contexte Africain

The francophone MOOC *Changement Climatique et Santé en Contexte Africain (CC&S)* was targeted at a francophone audience, in particular focusing on West Africa, including students and professionals in the field of public health and environmental sciences interested in the interdisciplinary issue of the health impacts of climate change. The MOOC CC&S defines climate change and its health impacts in Africa and provides an environment for reflection on how to best adapt and prevent risks for health and to work collaboratively on climate change and its health impacts. Experts in public health, climatology and meteorology from CRSN and HIPH were involved in the design and production of this MOOC to describe, explain and analyse climate change and introduce course participants to the concepts of prevention, mitigation and adaptation. The course was spanned over five weeks covering the topics of: (1) Basic physics of climate change, (2) links between climate change and human health, (3) responses to mitigation, surveillance and prevention, (4) responses to adaptation, (5) policy responses.

Looking Behind the Curtain

We have analysed all three MOOCs. Overall, the three MOOCs on Climate Change and Health (Climate Change and Health, Climate change and Health for Policy-Makers, Changement Climatique et Santé en Contexte Africain) attracted almost 7,000 participants globally. The retention rate—how many participants have earned certificates—varies for the three MOOCs between 1% for CC&H, 20% CC&H PM and 9% for CC&S. For the MOOCs on CC&H and CC&H PM most participants progressed less than 5% of the total course contents. The retention decreases for the course progress span of 5–20% (CC&H: 12%, CC&H PM: 15%) and 20–80% (CC&H: 5%, CC&H PM: 7%). However, for having progressed more than 80% of course contents, there is a slight increase in participant retention of the CC&H (6%) and a steeper increase of participant retention of the CC&H PM (19%) (see also Table 1).

People participated from all over the world in all three courses, most participants were from high income countries, especially from Germany (iversity) and France (FUN-MOOC). However, half of the participants are from lower middle-income countries, and for the MOOC CC&H PM there were even more people participating from lower middle-income countries than from high income countries (see Figs. 1 and 2).

The strongest represented age group in all three MOOCs is from 31 to 40 years, followed by the age group 26–30 years, and then 41 years of age and older.

The MOOCs CC&H and CC&H PM were translated into 9 (Arabic, Chinese—Mandarin, English, Hindi, Indonesian, French, Portuguese, Russian, Spanish) and 7 languages (Arabic, Chinese—Mandarin, Hindi, Indonesian, Portuguese, Russian, Spanish) via the open-source translation website Amara.[9] Native speakers of the HIPH—doctoral and Master course students—translated subtitles for the MOOC, who previously have attended the presence course in Climate Change and Health in Heidelberg and were familiar with the domain language of climate change and health (Fig. 3).

Discussion

The analysis of the demographic data of the three MOOCs confirmed the findings of other MOOCs: mostly students from high income countries between 25 and 40 years of age are making use of this educational resource. Depending on the origin of the learning platform, the nationality of the participants is reflected: On the German iversity platform predominantly participants from Germany registered, on the French FUN-MOOC platform mostly French participants registered. Both platforms are available in English and offer MOOCs in English, but also MOOCs in German (iversity) or French (FUN-MOOC). The French MOOC CC&S has

[9] http://amara.org/en/.

Table 1 MOOC participants and overview

	Climate change and health	Climate change and health for policy-makers	Changement climatique et santé en contexte Africain
Number of participants	2735	1782	2451
Total number of participants certified	24	349	213
% Participants certified	1%	20%	9%
Course progress			
<5% (total/%)	2111/77%	1167/65%	
5–20% (total/%)	335/12%	174/15%	
20–80% (total/%)	143/5%	126/7%	
>80% (total/%)	167/6%	342/19%	
Total min. runtime videos	244	41	198
Number of videos	25	4	23
Avg. min per video	9.8	10.25	8.6
MOOC runtime (weeks)	6	1	5
Subtitles	9 (Arabic, Chinese—Mandarin, English, Hindi, Indonesian, French, Portuguese, Russian and Spanish)	7 (Arabic, Chinese—Mandarin, Hindi, Indonesian, Portuguese, Russian and Spanish)	

attracted quite high numbers of participants from francophone, low income countries, which can be attributed to the MOOC being offered in French also attracting a francophone West-African audience. The MOOC CC&S focuses on climate change within an African context and was co-developed by experts from Burkina Faso. For the targeted audience of a MOOC, the respective learning platform has to be taken into account. As our analysis showed, the francophone MOOC had high participation from French-speaking countries, such as France and West-African countries. The reach of the francophone MOOC CC&S to a West-African audience on the French learning platform FUN-MOOC was much higher than that of the CC&H and CC&H PM MOOC on the German iversity learning platform. Figure 2 shows the country of origin per learning platform: German participants make up the majority on the MOOCs on the German-based iversity platform (15% CC&H and 12.3% CC&H PM) and on the FUN-MOOC platform French participants make up the majority with 33.2% of all participants of CC&S. Also, the country of origin differs vastly between the iversity MOOCs and the MOOC on FUN-MOOC: iversity attracts participants from countries with dominantly English-speaking communities (India, Pakistan, Philippines, Italy, UK, Nigeria, Canada, Bangladesh,

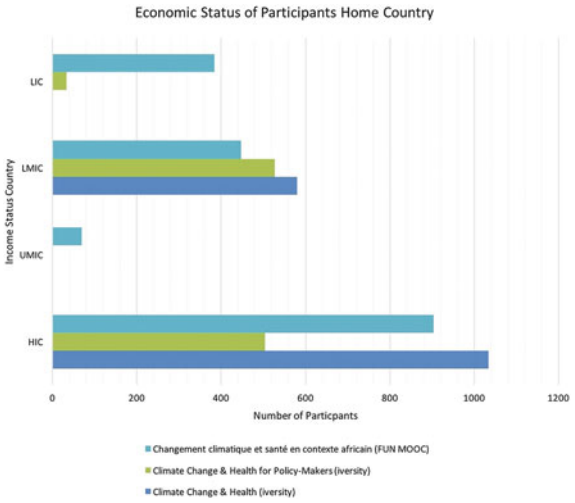

Fig. 1 Economic status of home country of MOOC participants (*LIC* low income country, *LMIC* lower middle income country, *UMIC* upper middle income country, *HIC* high income country as defined by Worldbank)

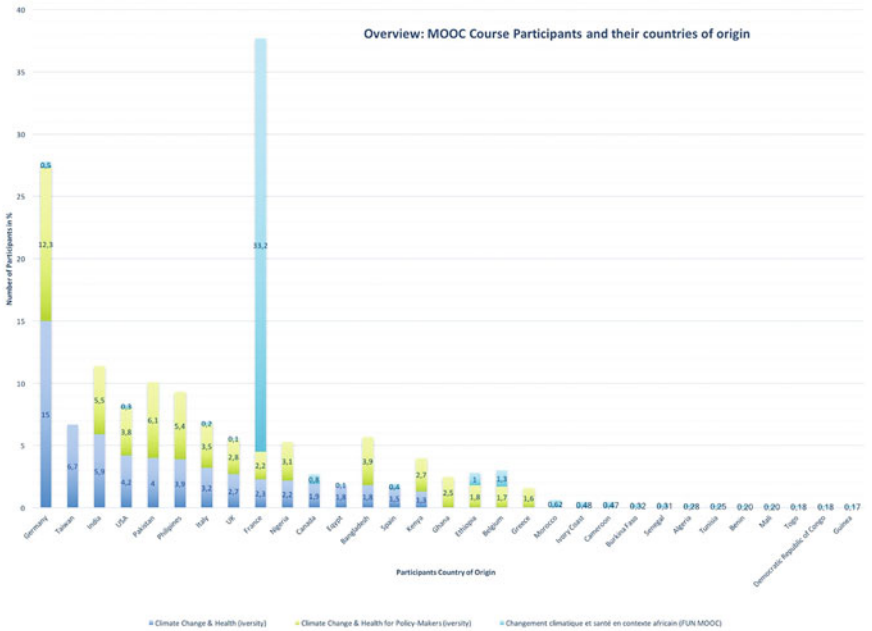

Fig. 2 Overview of the MOOC course participants' country of origin

Kenya, Ghana, Greece), whereas the MOOC on FUN-MOOC has course participants from countries with dominantly French-speaking communities (Canada, Morocco, Belgium, Burkina Faso, Senegal, Algeria, Tunisia, Mali, Togo, Democratic Republic of Congo, Guinea) (see Fig. 2). Resultantly to these

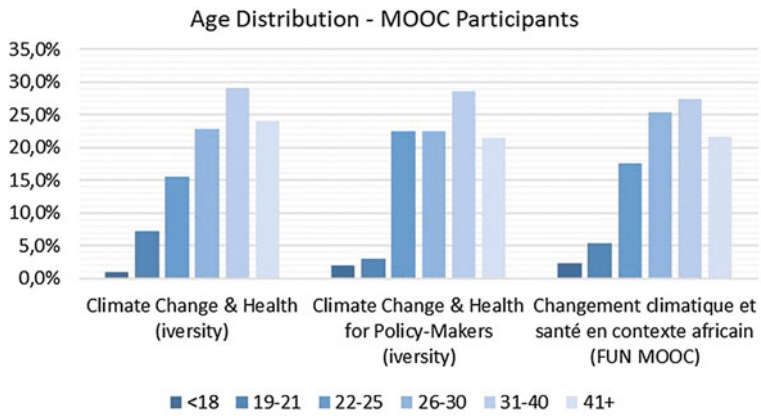

Fig. 3 Age distribution of participants of all three MOOCs on climate change and health

observations, dominant language communities of the targeted countries, cultural barriers and current extent of reach of the learning platform employed should be kept in mind when designing and producing a MOOC.

A major challenge for low and lower-middle income countries is the high cost for Internet access. In general, broadband networks are not expanding as fast as mobile data networks do and are less affordable in low and lower-middle income countries (Alliance for Affordable Internet 2017). The gap of affordable Internet access is decreasing, if at an uneven pace for certain groups such as low-income countries and the group of women. Still, a growing number of people worldwide are able to access MOOCs which makes it a valuable medium for increasing access to climate change education, especially to people that previously have been out of reach of other educational endeavours.

The total participant numbers of the MOOCs are also resultant of the overall registered users on the particular learning platforms. The German MOOC platform iversity has over 600,000 registered users, the French FUN-MOOC platform has over 900,000 registered users—in comparison to the currently largest MOOC platform Coursera[10] which has over 24 million (Coursera) and the second largest platform edX[11] which has over 11 million registered users (edX). MOOCs clearly outperform presence courses in their reach of students, yet, MOOCs have to be thoroughly evaluated in terms of system quality, perceived usefulness, net benefits, development costs, participant's attitude, intention of usage and ease of use. The development of a MOOC requires investments as experts in the field are needed, as well as technical support in the production of the video materials and setting up of

[10] https://www.coursera.org.

[11] https://www.edx.org.

the MOOC. The time to develop a MOOC from concept to a fully-fledged course takes at least 12 months.

The low completion rate (acquired certificates) of the three MOOCs (1% for CC&H, 20% CC&H PM, 9% CC&S) is in line with other MOOCs, as not all participants aspire for certificates and may benefit from the MOOC despite not finishing the full course. The median certification rate of 236 courses of MIT and Harvard was 7.7% for 4.05 million participants, with certification rates as low as 0.2% and as high as 34% (Chuang and Ho 2016). Observing the participation in the MOOC forum, it is clear that there is a small fraction of participants who actively participated in the activities and participant exchanges, pursuant to completion rates. Reasons for not completing a MOOC may be no official accreditation which may decrease motivation. Other reasons may be the employed course pedagogy or assessment types (Jordan 2014).

In order to make the MOOCs as inclusive as possible for non-native English speakers, we translated two of the MOOCs with the support of native speakers from the HIPH into 9 different languages. The open-source online platform Amara was providing the base for the subtitle translations and was found by the translators to be quite fit for the purpose—most of the translators needed only very little guidance in working with the open-source translation platform. Prior we tried to engage MOOC participants to translate the MOOC segments, however, only minor translations were accomplished. Averagely, one minute of a video lecture takes about 12 min to translate, so a ten-minute MOOC lecture is around 2 h' translation work. This kind of time commitment can be not expected of course participants and another downside of crowd-translation efforts is the level of quality, as the level of language proficiency is unknown and the level of familiarity with the domain language (Beaven et al. 2013). The subtitles were added to the MOOCs in 2016, after the start of the course.

After this first analysis of the MOOCs, further questions remain to be answered. To better understand the motivation and expectations of participants, an online survey is conducted retrospectively which covers further demographics, motivation, course expectations, user satisfaction, information quality, service quality, course use, cultural barriers and perceived benefits. It is advisable for future MOOC courses to employ an evaluation before the start of the MOOC covering mainly motivation and course expectations. Also, it would be advisable to employ a pre- and post-test to evaluate knowledge gain of the MOOC. Furthermore, for the next MOOC we want to keep track of invested efforts into the MOOC production to provide insights into cost and effect of a MOOC.

Conclusion

Effects of climate change are already taking their toll globally: a rise in sea levels and global temperatures, warming and acidification of oceans, shrinking ice sheets, declining Arctic sea ice and glaciers, as well as an overall increase in extreme

weather events (Louis and Phalkey 2016). "Climate-sensitive diseases are among the largest global killers. Diarrhoea, malaria and protein-energy malnutrition alone caused more than 3 million deaths globally in 2004, with over one third of these deaths occurring in Africa." (World Health Organization 2017). There is a dire need to include health impacts in the debate of climate change on a global level. MOOCs offer a great potential as they are getting more and more popular (Chuang and Ho 2016) and could therefore be an enabler for teaching and engaging a bigger global population within the topic of climate change and health. Alongside those lines, three MOOCs have been published that focus on climate change and health for different audiences: at Anglo- and francophone general audiences and at policy-makers. The country of origin of the learning platform has shown to define the range of MOOC participants: although the MOOCs attracted an international crowd in general, for the German iversity platform, there were predominantly German and English-speaking participants, and for the French FUN-MOOC platform there were predominantly participants from French-speaking communities, including West-African countries. The MOOCs have been translated into 9 different languages to increase the reach to people not sufficiently familiar with English. It still has to be evaluated if subtitle efforts positively influence participants' retention and motivation and how MOOCs transfer knowledge and foster learning, especially for a global audience. There is a global demand for MOOCs, and as a recent survey from Coursera shows that learners from developing countries were even more likely to report benefits (Levin 2017).

Although there is a need to fully understand the impact of MOOCs, it is obvious that the reach of participants of the three MOOCs out passes the reach of presence courses. For the three MOOCs in total almost 7,000 students as compared to a two-week presence-course with a potential reach of 25 students per course. The design and production of the MOOC involves a commitment in terms of time, finances and professional expertise.

The advantages are at hand: MOOCs offer an extensive participant reach on a global level which can be a driver for climate change education, enabling a greater accessibility into the rationale between climate change and health available to people that have been outside the reach of other teaching endeavours, such as presence courses. With the expansion of mobile data networks and decrease in prices for these mobile services, also low and lower-middle income countries are able to access quality resources such as MOOCs. The francophone MOOC designed for an African context had a greater participation of participants from low-resource countries as compared to the other two MOOCs on the German learning platform iversity. Although MOOCs are made for a global audience, our results show that there is need to define target audiences and adapt the MOOC according to participants and their cultural context. Further evaluations into MOOCs are necessary to tailor future MOOCs better to the targeted participant needs, which may be challenging keeping in mind the diversity of a global audience. Research underlines the popularity of MOOCs (Chuang and Ho 2016), which

as we have found with the three MOOCS on climate change and health is a chance for opening climate change education and making arguments and state-of-the-art knowledge available to a diverse global audience, fostering discussions and change in terms of adaptation and mitigation of climate change especially with a focus on health.

Addendum

See Figs. 4, 5, 6 and Tables 2, 3, 4.

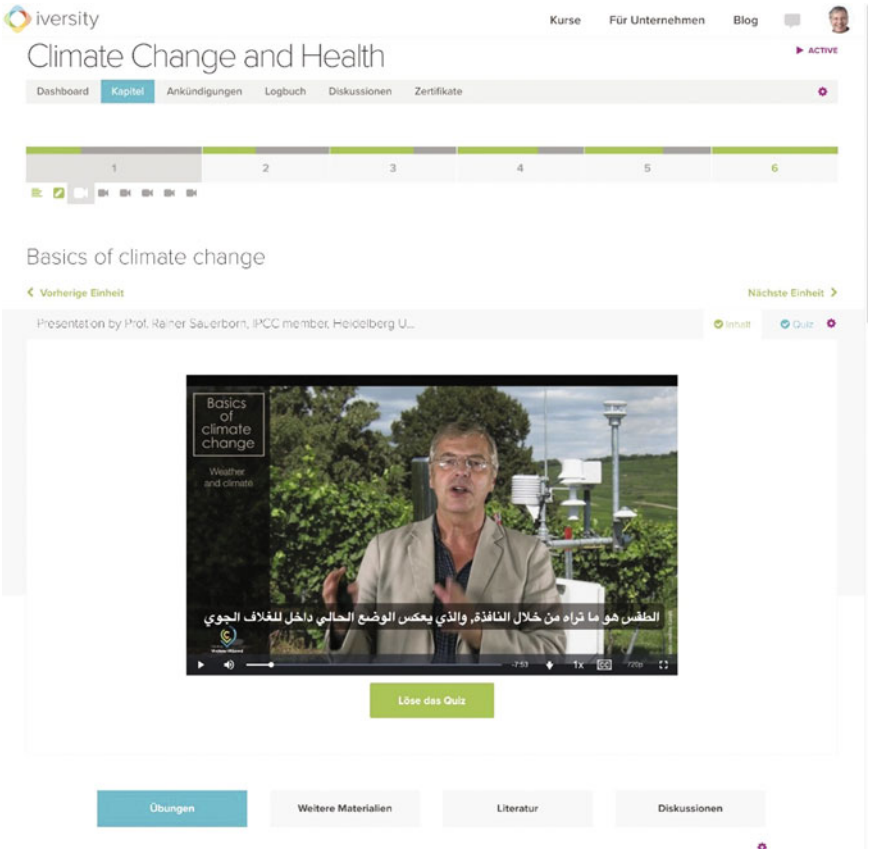

Fig. 4 iversity learning platform with MOOC climate change and health, showing subtitle in Arabic

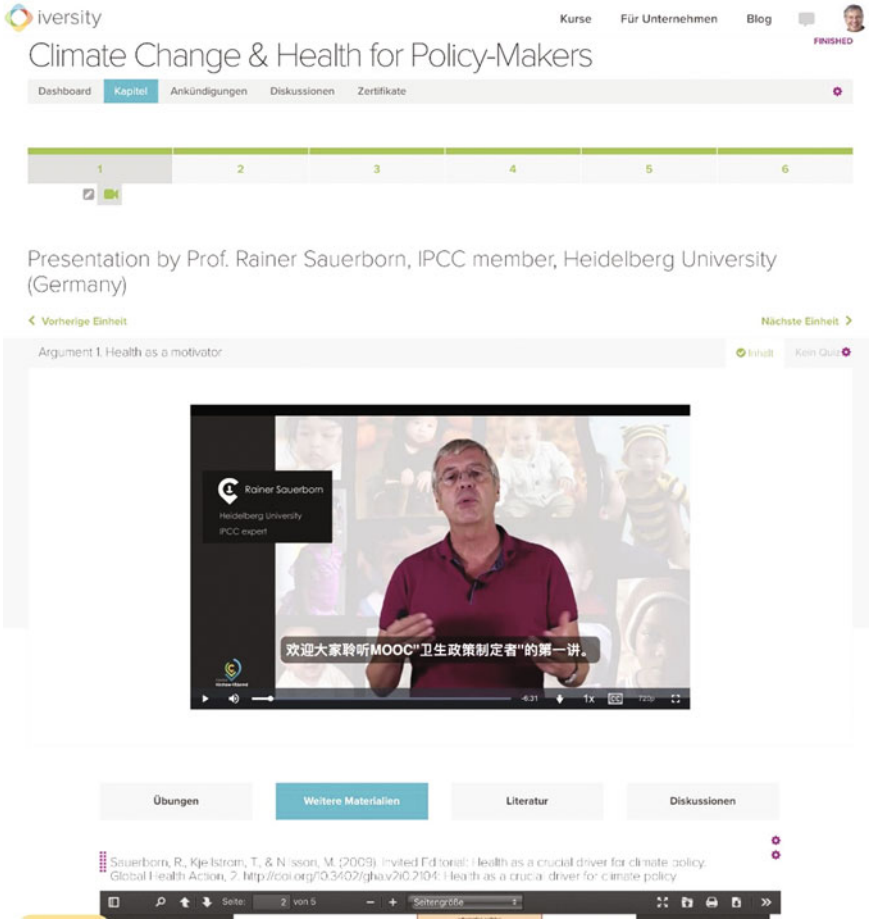

Fig. 5 iversity learning platform with MOOC climate change and health for policy-makers, showing subtitles in Chinese (Mandarin)

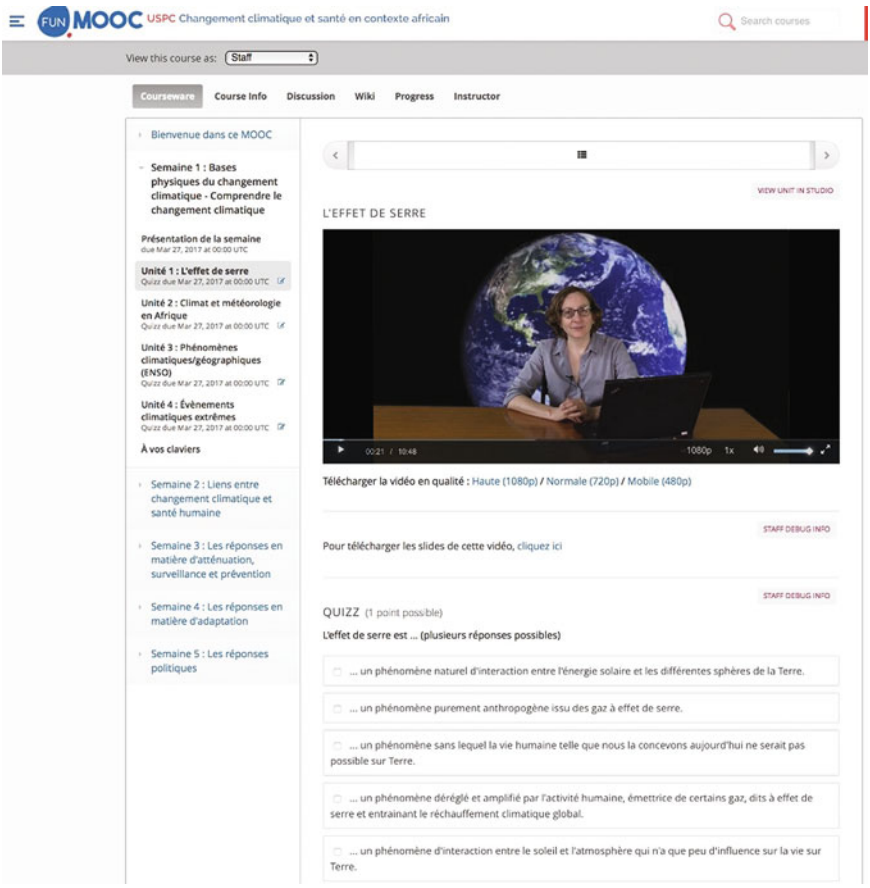

Fig. 6 Fun-Mooc learning platform with MOOC Changement climatique et santé en context Africain

Table 2 Course structure MOOC: climate change and health

Chapter name	Total runtime (in min)	Contents
What is climate change and how can it affect health?	72	1. *Interaction forum*: present yourself and your motivations to follow this course 2. *Interaction journal assignment*: climate change to you 3. Basics of climate change 4. Historical trends and future projections 5. Climate change is long-term and irreversible 6. Pathways from climate change to disease and health 7. Ethics, justice, equity, development: policy implications 8. How to find out about the impact of climate change on health?
What health effects do we cover?	70	1. Childhood malnutrition is the largest negative effect 2. Non-communicable diseases 3. Climate change and infectious diseases: the example of dengue 4. Climate change and Malaria 5. Vector-borne diseases and interannual climate changes: El Niño/La Niña 6. Health impact of other extreme weather events 7. *Interaction journal assignment*: *in your opinion?*
Reducing emission—in health terms: prevention	28	1. Health as a positive leverage for climate policy 2. What can we do to reduce emissions? 3. What can the health sector do to reduce emissions?
The good news: doing something to reduce emissions is good for your health	57	1. What are co-benefits and why they are important for climate policy? (part 1) 2. What are co-benefits and why they are important for climate policy? (part 2) 3. Health and climate benefits from reducing indoor air pollution 4. Child spacing is good for child and maternal health and for the climate 5. Riding your bike or walking is good for climate and your health

(continued)

Table 2 (continued)

Chapter name	Total runtime (in min)	Contents
		6. Improving diets in the global South and North lowers GHG emissions substantially *7. Interaction group discussion and additional reading*: doing something to reduce emissions: what do you think?
Adapting to the effects of already occurring climate change: "Therapy"	29	1. Indian climate adaption plan in light of COP21 2. The limits of adaptation for work outside and in non-air-conditioned factories 3. The health basis for absolute limits of adaptation efforts: keep the 2 °C goal! *4. Interaction group discussion and additional reading*: adapting to the effects of already occurring climate change: what do you think?
Outlook: a climate friendly world is healthier, more equitable, sustainable and fun	10	1. A climate friendly world is healthier, more equitable, sustainable and fun

Table 3 Course structure MOOC: climate change and health for policy-makers

Chapter title	Total runtime (in min)	Contents
Argument 1. Health as a motivator for taking action against climate change	8	*Interaction—assignment*: please answer the following questions (survey) Presentation by Prof. Rainer Sauerborn, IPCC member, Heidelberg University (Germany)
Argument 2. There are huge health co-benefits of climate-protecting policies and behaviour	15	Presentation by Prof. Sir Andy Haines, IPCC member, London School of Hygiene and Tropical Medicine
Argument 3. There are physiological limits to human capacity to adapt to climate change	8	Presentation by Prof. Rainer Sauerborn, IPCC member, Heidelberg University (Germany)
Argument 4. In poor countries, work productivity will decrease in a warmer world	10	Presentation by Prof. Tord Kjellstrom, IPCC member, Australian National University *Interaction—assignment*: end of the MOOC quiz
Readings for the whole MOOC	30	Core readings
Help us translate the videos in your own language!		

Table 4 MOOC course structure: changement climatique et santé en contexte Africain

Chapter title	Total runtime (in min)	Contents
Bienvenue dans ce MOOC	2:31	1. Organisation et premiers pas 1.1 Teaser (Video) 1.2 Comment organiser ma semain sur ce MOOC? (text) 1.3 Methode d'évaluation (text) 1.4 Présentons-nous les uns aux autres! (text) 1.5 Groupe Facebook (text)
Semaine 1: Bases physiques du changement climatique—Comprendre le changement climatique	15	1. Présentation de la semaine Objectifs & déroulé de la semaine 1.1 Interaction discussion forum: discussion à propos de la semaine 1 2. L'effet de serre (video) 2.1 Quizz (5 MCQ) 3. Climat et météorologie (video) 3.1 Quizz (4 MCQ) 4. Phénomènes Climatiques/ Géographiques (ENSO) (video) 4.1 Quizz (5 MCQ) 5. Changement Climatique et évènements climatiques extremes (video) 5.1 Quizz (3 MCQ) 6. À vos claviers 6.1 Interaction discussion forum: discussion: changements remarquables 6.2 Interaction group work: Travaillons ensemble 6.3 Additional reading: Liens utiles et lectures complémentaires
Semaine 2: Liens entre changement climatique et santé humaine	8	1. Présentation de la semaine 1.1 Objectifs & déroulé de la semaine 1.2 Interaction discussion forum: discussion à propos de la semaine 2

(continued)

Table 4 (continued)

Chapter title	Total runtime (in min)	Contents
		2. Changement climatique et santé humaine (video) 3. Maladies hydriques et malnutrition (video) 3.1 Quizz (4 MCQ) 4. Maladie liées à la température et à la chaleur (video) 4.1 Quizz (3 MCQ) 5. Maladies à transmission vectorielle – L'example du paludisme (video) 5.1 Quizz (5 MCQ) 6. À vos claviers 6.1 *Discussion*: plus grande menace 6.2 *Additional resources*: Liens utiles 6.3 Pages wiki
Semaine 3: Les réponses en matière d'atténuation, surveillance et prévention	10	1. Présentation de la semaine 1.1 Objectifs & déroulé de la semaine 1.2 *Interaction discussion forum*: discussion à propos de la semaine 3 2. Stratégies d'atténuation et d'adapation (video) 3. Rôle des zones humides dans l'atténuation des effets du changement climatique (video) 3.1 Quizz (5 MCQ) 4. Surveillance des maladies (video) 4.1 Quizz (4 MCQ) 5. Épidémiologie des maladies infectieuses et lien avec l'environment (video) 5.1 Quizz (4 MCQ) 6. Analyse de l'association climat-moralité, analyse de series temporelles (video)
Semaine 4: Les réponses en matière d'adapation	30	1. Présentation de la semaine 1.1 Objectifs & déroulé de la semaine 1.2 *Interaction discussion forum*: discussion à propos de la semaine 4

(continued)

Table 4 (continued)

Chapter title	Total runtime (in min)	Contents
		2. Stratégies d'adaption – Gestion des systems de santé (video) Quizz (4 MCQ) 3. Limites de l'adaption physiologique à la chaleur (video) Quizz (4 MCQ) 4. Méthodes et outils – Télédétection (video) Quizz (3 MCQ) 5. Évaluation environmentale, étude d'impact (video) 6. À vos claviers 6.1 *Discussion*: adaptation dans votre environment 6.2 *Additional resources*: Liens utiles et lectures complémentaires 6.3 Pages wiki
Semaine 5: Les réponses politique	43	1. Présentation de la semaine 1.1 Objectifs & déroulé de la semaine 1.2 *Interaction discussion forum*: discussion à propos de la semaine 5 2. Politiques globales sur le climat (video) 2.1 Quizz (4 MCQ) 3. Politiques nationales d'adaptation – L'Afrique de l'ouest (video) 3.1 Quizz (3 MCQ) 4. Impacts sur les secteurs de development (video) 4.1 Quizz (6 MCQ) 5. Droit environmental (video) 5.1 Quizz (5 MCQ) 6. Introduction au Plan d'Action National d'Adaption (PANA) (video) 6.1 Quizz (6 MCQ) 7. À vos claviers 7.1 *Discussion*: réponse politique 7.2 *Additional resources*: Liens utiles et lectures complémentaires 7.3 Pages wiki 7.4 Text Rendu exercice final

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Emerging Paradigms of Capacity Building in the Context of Climate Change

Umesh Chandra Pandey and Chhabi Kumar

Abstract As emphasized in the Paris Agreement effective capacity building is vital to enable developing countries to take strong climate action. However such capacity building systems cannot rely solely on our age old systems of individualized instructions and certification through educational institutions. The target groups to be capacitated have strong livelihood concerns and also possess tacit knowledge to address their issues. This rich pool of tacit knowledge needs to be blended with structured knowledge of the Educational Institutions and should be aimed at finding solutions in real life settings. Paradigmatically new approaches for adaptation and mitigation activities would go a long way in realizing these development goals. Distance education as a philosophy and as a methodology is favorably positioned to respond to the climate change impact by creating systems which are outward looking, reason driven and involving multi stakeholder's environment. The authors suggest a step further in this direction to create paradigmatically new capacity building systems for climate change. The idea is to have a paradigm shift in the university education from being structured with a predetermined curriculum and one which is based on individual certification to a contextualized learning based on practical knowledge, real life experiences for exploring solutions in consultation with the community. The chapter would focus on how distance learning would create such opportunities and at the same time provide for capacity building programmes for climate change impact and its aftermath.

Keywords Climate change · Capacity building · Sustainable development goals Paradigm shift · Distance education

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Background

As the National Governments globally are faced with the challenges to implement SDGs, the phenomenon of climate change has proved to be a major dilemma. This is particularly true for developing countries which are at an increased risk primarily due to high incidence of poverty and dependence of the major segment of their population on climate sensitive sectors like Agriculture and allied activities. In addition, growing population, limited resources, unplanned development and overall lack of awareness makes them all the more vulnerable to climate change shocks.

Post 2015 developmental agenda of United Nations has brought the issues to the forefront of development priorities of the national Governments. The backwardness of poor nations is no more the issues confined to such nations. It is equally a matter of concern for developed nations who cannot treat their developmental issues in isolation with problems being faced by developing nations.

There has not been a realization so strong in human history that collective interests of entire global community are the only goals worth pursuing. It has called for developing capabilities and evolve paradigmatically new ways to achieve these common objectives. Post 2015 Developmental Agenda of United Nations is historical from these points of views. Among all the SDGs, the issue of climate change has given rise to most intensified debate among the nations. Climate change is important primarily because of its potential to decisively affect our pursuit on all the other goals or even thwart the progress already made. The threat of climate change is multi dimensional with the most vulnerable and least capacitated getting the hardest hit. It is in this context that capacity building for climate change has got international attention.

Chronological Sequence of Global Concerns

The first Global Concern for the Climate Change was shown in an International Conference organized by World Meteorological Organization (WMO) at Geneva in 1979 (WMO 1979). It led to establishment of World Climate Programme (WCP), World Climate Research Programme (WCRP) and Inter Governmental Penal on Climate Change (IGPCC). Nearly a decade later on 20th Oct. 1990, second World Climate Conference was held, that also organized by WMO in Geneva. This conference led to the establishment of United Nations Framework Conventions on Climate Change (UNFCCC) which has been a major step forward. UNFCCC emphatically advocates for the direct funds transfers to support climate change mitigation and adaptation activities in the developing countries (UNFCCC 1990). Besides, the need for the access to Information, Climate Change Observations and Data Records was strongly felt. Hence GCOS (Global Climate Observing System) was established (GCOS 1990).

United Nations Conference on Environment and Development (UNCED) was held in June 1992, in Rio de Janeiro. This event held under the auspices of United Nations led to the famous Rio Declaration on Environment and Development and Agenda 21 which provided a major framework for further discussions on Sustainability and Development (UNCED 1992). In the Conference of Parties, held in Kyoto in 1997, the adoption of much controversial and debatable Kyoto Protocol was undertaken, which entered into the force in 2005 and its first commitment period started from 2008 and ended in 2012 (Kyoto Protocol 1997). Kyoto Protocol largely lays the responsibility for emission reduction targets on developed countries and recognizes the need of capacity building of various stakeholders in developing countries. Building on the Kyoto Protocol, Marrakesh accord was adopted on 29th October 2001 which contained the detailed rules of implementation of Kyoto Protocol (Marrakesh Accord 2001). The agreement brings out the two frameworks for capacity building. These frameworks provide a set of guiding principles and approaches of capacity building, set out a way forward for capacity building activities and provided guidance on the support of financial and technical resources to be addressed by the Global Environment Facility (GEF 2001). Decision 2/CP.7 (DECISION 2 2001) of Marrakesh accord brings out objectives, different dimensions and scope of the capacity building in 15 priority areas which were subsequently discussed in UNFCC, Montreal in 2005 when parties launched negotiations on the next phase of the Kyoto Protocol, and in 2007 conference of UNFCCC, held in Bali in 2007 where Bali Roadmap was adopted which includes Bali Action Plan.

Copenhagen Climate Change Conference, started from 7th to 18th Dec 2009, led to the establishment of four new bodies which also includes Copenhagen Green Funds and Technology Mechanism. In this conference developed countries promises to provide 30 billion USD and Mobilize 100 US Dollar a year by 2020 from different sources. Hence it was a milestone step towards the capacity building for the developing countries to mitigate and adapt to the climate change.

Climate Change Conference held in December 2010, in Cancun, led the parties to agree to establish a Green Climate Fund to provide financial support to developing countries for their adoption and mitigation programmes. Also agreement of technology mechanism to boost the innovation, development and spread of new climate friendly technology calibrated the capacity of world community to react towards climate in technical fronts. The UNFCCC held in Durban, on December 2011, led to the agreement on four main areas including second commitment period of Kyoto Protocol and launch of new platform of negotiations.

In UNFCCC, in Doha, on December 2012, Governments laid a lot of emphasis over the adaptive capacity building of the most vulnerable section of society. In the support of developing countries a new work programme to build climate action capacity through education and training, public awareness and public participation in climate change decision-making was agreed. This is important to create a ground-well of support for embarking on a new climate change regime after 2020. In Warsaw Climate Conference, held in Nov 2013, Governments reiterated to mobilize 100 billion USD by 2020 to developing countries as agreed in Copenhagen Climate Summit (2009). In Paris agreement, which was agreed in

2015, every country has to follow its nationally determined goals. In order to reach these goals every party especially the developing and the least developed one's require capacity to do so. Therefore here capacity building has a huge role to play. Article 11 of Paris agreement highlights the importance of enhancing the capacity and ability of developing country parties to take effective adaptive and mitigation actions. Article 11 states all the parties should cooperate to enhance the capacity of developing country parties to implement Paris agreement.

Possible Impact of Climate Change (SDG-13) on the Pursuit of Other SDGs

Climate Change can have a decisive impact on the pursuit on all the other SDGs. Its negative impact can be countered if capacities of various stakeholders can be built. The issues have been extensively discussed in the research literature. Following discussions gives a glimpse of the capacity developments required at various levels. Some of the ideas presented here have been adapted from the http://devinfo-cloud.com/sdgindiA/sdgindia-beta (Retrieved on 29/4/2017).

SDG-1 (No Poverty)

The major proportion of poor population lives in countries which are most vulnerable to climate change issues. The livelihoods of such people are predominantly based on monsoon based agriculture or allied activities which make them susceptible to climate change. Moreover the climate change has increased the frequency of the natural disasters in such geographical areas which has adversely affected the poverty alleviation programmes in such countries (UNDP Web Site). Natural disasters push the people back into poverty trap which thwart the progress made by poverty alleviation programmes of the Government. Such an impact can be minimized through suitably capacitating Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, people engaged in livelihood activities which are climate change sensitive like Agriculture, Tourism Activities and Allied Activities, Indigenous Populations, people living in Rural and other Remote areas etc.

SDG-2 (No Hunger)

Climate change causes declining agriculture productivity thereby reducing food availability at household level, unpredictable supply of food grains in the market,

declining livestock and wildlife population which has also led to increased competition for diminishing resources and increased instances of conflicts. Furthermore the people most affected due to such impacts have least capacities to cope up with them (Borgen Project 2014). It is therefore well realized that we need to build up the capacities of the Policy Makers and Planners, Personnel in Social Welfare agencies, NGOs and other Development Agencies, members of the Civil Society, people engaged in livelihood activities which are climate change sensitive, Indigenous Populations, people living in Rural and other Remote Areas etc.

SDG-3 (Good Health)

The climate change has resulted in several diseases which humans, livestock, wild life and plants cannot easily cope up with. Moreover movement of plant pests, animal diseases and invasive alien aquatic organisms across physical and political boundaries have given rise to new dimensions to such threats FAO (2008). In order to effectively combat such threats there is an immediate need to build the capacities of Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, Medical Practitioners, Pharmaceutical companies, Researchers and Scientists etc.

SDG-4 (Quality Education)

Climate change shocks have resulted in diminishing access to education particularly in developing countries where people have low level of capacity to cope up with such changes. (UNESCO 2010). In order to enhance access to quality education there is an immediate need to build capacities of Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, Educationists, Trainers, Researchers, Academicians etc.

SDG-5 (Gender Equality)

Women because of their disadvantaged socioeconomic status and low participation in decision making have poor coping capacities to handle climate change shocks (UN Women Watch 2009). It further marginalizes them and thereby enhances gender inequalities. (UNFCCC Web Site). To effectively counter the impact on climate change on gender we need to build up capacities of Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, Members of the Civil Society, Women, Academicians etc.

SDG6 (Clean Water and Sanitation)

Climate change can disturb smooth water supply by way of damaging infrastructure due to flooding, loss of water sources due to erratic rainfalls, and changes in water quality. Increased instances of natural disasters can cause damage and loss of sanitation services and infrastructure (Howard 2016). It requires effective capacity building of Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, Members of the Civil Society, Service Providers and their Technical Staff, Researchers and Scientists etc.

SDG7 (Renewable Energy)

The higher rainfall in some areas and prolonged periods of drought in other areas is likely to make it difficult to develop alternate sources of clean energy like hydro-electricity. Similarly other forms of clean energy are vulnerable for climate change. Further it can enhance the risks of shutdowns at coal, natural gas and nuclear power plants owing to the decreased water availability. The energy infrastructures located along the coasts are also threatened by the rising sea levels, increasing in storm intensity and flooding. Also, electricity distribution systems and infrastructure are faced with increasing risks of physical damage from the hurricanes, storms and wildfires as a result of climate change (Saylor, April 2012). It will require effective capacity building programme for Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, Service Providers and their Technical Staff, Researchers and scientists etc.

SDG 8 (Good Jobs and Economic Growth)

The most of the SDG target groups have livelihoods dependent upon agriculture they are hardest hit by the climate change. Further due to their poor educational level they don't have alternate livelihood opportunities. The fossil fuels being the main source of energy for these communities have further constrained their livelihood. Therefore, what is required is effective capacity building programme for Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, Industrial sector, Service Sector, Economists, Academicians, Researchers and Scientists etc.

SDG 9 (Innovation and Infrastructure)

Climate Change is likely to adversely impact the supplies of raw materials to industries thereby reducing industrial production. Some of the industries which are facing adverse impact are food processing, constructions, etc. Similarly service based industries like tourism, due to declining attractiveness of natural/cultural heritages are also facing adverse impact. It requires capacity building of Policy makers and planners, personnels in social welfare agencies, NGOs and other development agencies, members of the civil society, Industrial sector, service sector, academicians, researchers and scientists etc.

SDG 10 (Reduced Inequalities)

The climate change has differential impacts within and across the nations. It is primarily due to varying levels of capacities to cope up with such changes. The poor nations due to their resource constraints are hardest hit by climate change which has undermined their developmental efforts. It is likely to further enhance the inequalities (www.opencanada.org). Capacity building of Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, Industrial sector, Service Sector, Academicians, Economists, Researchers and Scientists etc. will help to effectively counter the impact of climate change on this front.

SDG 11 (Sustainable Cities and Communities)

Climate change is likely to intensify the already existing problems arising out of increased proportion of population living in urban areas due to migration that is expected to increase to 66% by 2050. Increased population pressure will be difficult to be managed due to large number of people competing for resources and likely damage to coastal cities. We therefore need to build the capacities of Policy Makers and Planners, Personnel in Social welfare agencies, NGOs and other development agencies, members of the civil society, Industrial Sector particularly Construction Industry, Town Planners, Service Sector, Academicians, Economists, Researchers and Scientists etc.

SDG12 (Responsible Consumption)

The climate change has disturbed the traditional food production which is likely to affect the consumption patterns as well. Research studies have observed that despite plentiful supplies of food globally, almost one billion people are undernourished. To effectively counter this gigantic problem there is an immediate need to build the capacities of Policy makers and planners, personnels in social welfare agencies, NGOs and other development agencies, members of the civil society, Industrial sector, service sector, academicians, economists, researchers and scientists etc.

SDG14 (Life Below Water)

Fisheries have heavily suffered the impact of climate change due to pollution, changing oceanic temperature, acidification of sea water due to increased absorption of carbon dioxide and sea level rise (The Guardian 2012). There is an immediate need to build the capacities of Policy makers and planners, personnels in social welfare agencies, NGOs and other development agencies, members of the civil society, Industrial sector particularly the fishing industry and oil and mining industries, communities dependant on fishing, researchers and scientists etc.

SDG15 (Life on Land)

The climate change can disturb the food webs sustaining life on land ecosystems and thereby destroy the natural habitats of the species. It is gradually shifting migratory patterns of the animal species, growth of plant species and destroying their natural balance of ecosystems (www.climatehotmap.org). It requires effective capacity building programmes for Policy makers and planners, personnels in social welfare agencies, NGOs and other development agencies, members of the civil society, Industrial sector particularly mining industry, lumbering industry, construction industry, environmentalists and ecologists, indigenous populations, academicians, researchers and scientists etc.

SDG16 (Peace and Justice)

The increased competition for resources is likely to lead to conflict within and between communities and countries. Increased inequalities within and between countries are likely to have a negative impact on the concept of Justice for All. Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and

other Development Agencies, members of the Civil Society, law and order machinery, Legal Practitioners, Armed Forces, Academicians, Diplomats etc.

SDG17 (Partnerships for the Goals)

The climate change has led to increased diplomatic efforts among the nations to protect their national interests rather than thinking globally on wider Sustainable Development Goals. It is undermining the global concerns, polarizing the debate and reducing the possibilities of genuine partnerships for sustainable development goals. In this context there is an urgent need to develop global perspectives among Policy Makers and Planners, Personnel in Social Welfare Agencies, NGOs and other Development Agencies, members of the Civil Society, Academicians, Economists, Researchers and Scientists, Diplomats etc.

Rationale for the Chapter

While the need for capacity building is well realized and understood across the world the global community is yet to discover possible mechanisms. The target groups to be capacitated are largely unconventional. The situation in developing countries is most challenging as the communities to be capacitated face diverse livelihood struggles, are engaged in climate sensitive agricultural practices, lack education and nearly cut off from extension education programmes of the Government. With the international commitments building up in the wake of the Paris Agreement, developing countries have to devise reliable Capacity Building systems for such communities.

However capacity building for climate change is not as easy as it might sound. The target groups need to be capacitated in their real life settings without any clash with their livelihood commitments and entire exercise should be aimed at giving them workable solutions. It calls for developing new perspectives and paradigmatically new approaches. The educational institutions are yet to develop the perspectives which are required for this purpose. They are yet to come out of their age old conception of individualized instructions and certification. The planners of such capacity building exercises need to well realize that people to be capacitated possess rich pool of tacit knowledge and need concrete solutions to address climate change. Their tacit knowledge if blended with structured knowledge of the Educational Institutions can give a livelihood solution to the communities.

Hence paradigmatically new approaches for adaptation and mitigation activities would go a long way in realizing these development goals. Open and Distance Learning systems across the world have already been experimenting with innovative educational delivery systems. Hence such systems are ideally positioned to develop the capacity building systems for climate change. Open and Distance

Learning systems need to move a step ahead and develop community based learning systems. This chapter intends to develop new perspectives and focuses on following points:

(a) What kind of knowledge base is required for capacity building for climate change.
(b) What kind of paradigm shifts are needed.
(c) Some innovative initiatives which are emerging.

The chapter evolves a knowledge management framework within which the capacity building programmes for climate change should be conceived and formulated.

Climate Change and Capacity Building

The major strategic approach to address climatic change requires that stakeholders should develop capacities for mitigation and adaptation (Dagnet and Nothrop 2015). All the countries have to boost efforts to reduce emissions and alongside acquire capabilities to develop resilience. However it is not an easy target. The process of climate change is slow and therefore its impacts are not easily noticed and identified (Helgeson 2012). There are striking variations which need altogether different strategies for country specific context. Furthermore individual countries' capacities to evolve strategic frameworks are different. The immediate priorities for consumption and production patterns are different which calls for policy level sensitization. The policies are driven by socioeconomic and political factors which make such issues more cumbersome and difficult to comprehend. Internationally the issues have become politicized to an extent that it has become a major determinant of international diplomacy, competition for resources and political alignments among the countries. Hence capacity building requirements have to be understood within such varying socio-economic and cultural contexts. In developing and developed world, the context of capacity building and the socio-economic priorities of communities are the major factors which decide the types of capacity building approaches. The involvement of local actors will undoubtedly be the most important factor in such a situation. All the stakeholders in climate change have to be well capacitated to bring them to a level where they can carry out the climate action they intend to pursue. Such an exercise cannot be done in a straight jacketed fashion undermining their unique characteristics. The major constraints before such countries to realize these objectives can be categorized as below (Dagnet and Northrupe 2015)

(a) Lack of sensitization in the community, their representative organizations and policy making levels to initiate climate change efforts.
(b) Lack of coherent research based information and assessment capabilities to identify training needs.

(c) The immediate socio-economic priorities of the people which take precedence over the climate change capacity building initiatives.
(d) The fragmented approaches of the capacity building largely due incoherent efforts of international funding institutions, lack of coordination and monitoring.
(e) A dominant thought process of the climate change initiatives which leaves little scope for developing countries to put across their unique requirements.

These challenges have remained largely due to fragmented approaches of international institutions which have failed to build up a robust capacity building infrastructure in target areas. Moreover, most of the target groups which need to be capacitated are mostly cut off from mainstream, living in geographically inaccessible areas and lack the capacities to adopt new ways of livelihoods. It's a huge challenge for the Governments in developing countries to devise systems and procedures to capacitate them to adapt to climate change. Moreover the conventional ways of capacity building fail to respond to such requirements. The declining livelihoods patterns of these communities largely due to climate change have made the issues more complicated, more diversified and need immediate redressal. It has been well realized that capacity building for such communities requires sustained resource allocation with coherent policies between national and international institutions. The Paris committee in capacity building has worked out a comprehensive work programme which inter alia includes need analysis, strengthening synergistic partnerships and develop tools to evolve a roadmap for capacity building.

Why Open and Distance Learning Is the Right Answer?

The traditional ways of capacity building practices for climate change lack a clear perspective. The interventions were made by the funding agencies of developed countries largely through a "Fly-In & Fly-Out" approach. The existing research studies have vehemently criticized this approach for not being sensitive to the context of capacity building.

The capacity building for climate change is not just the dissemination of structural knowledge. It is more about enhanced capacity to generate knowledge to address issues of climate change. The capacity building exercise has to be done in community setting, should build upon the existing knowledge base of the people and should be aimed at finding categorical solutions. There cannot be straight jacketed solution to capacitate the diverse target groups. We need capacity building systems which are flexible enough to give contextual solutions.

Studies have also emphasized that the class rooms cannot be the place where such paradigmatically different capacity building process can be carried out. Open and Distance Learning systems due to their unique characteristics of innovations and flexibility are ideally suited for this purpose. The Paris Message has

emphatically argued for deploying ODL systems for Sustainable Development Goals. It is in this context that ODL systems have gained prominence in the field of climate change capacity building. Hence ODL systems worldwide have now given a focus on development of strategies to accomplish this target. The ODL systems have a unique advantage to give individualized training, reconcile with the work-place commitments of the learner and relate to the context of the target groups. Hence these systems can be meaningfully deployed to achieve the unique requirements of climate change capacity building.

Knowledge Management Framework

International Concerns About Context Based Knowledge

The role of science in the progress of Human civilization is well recognized. However there have been widespread concerns which raise the inherent gaps in the development driven by modern science. The scientific development with largely global perceptions and approach has not been able to sense the local level contexts and develop specific strategies. The traditional knowledge base of local communities empirically tested over the long period of human history can prove to be handy. Whereas scientific knowledge has significantly contributed for the progression of human civilization, we find that it has turned out to be unsustainable. It indicates serious gaps in the approach of modern scientific institutions. The long term validity of modern knowledge will require deeper interaction between science and society. Scientists need to be sensitive to the contexts in which their policies will ultimately work. The laboratories are not the ultimately sites where the knowledge can be generated. The real life settings where the interaction between scientists and holders of traditional knowledge can take place will be the right place for generation and application of such knowledge to devise lasting solutions.

Harnessing the Context Based Knowledge

Sustainable Development Strategies cannot be developed solely on the basis of structured scientific knowledge which is available in limited amount. The sizeable proportion of knowledge in the world is not available in codified and structured form. It is largely available in the form of experiences, practices, cultural traits or other intangible forms which have not been available in wider public domain. The most unique feature of this form of knowledge is that it is well tested over thousands of years of human existence and has an empirical basis embedded in that. This huge pool of knowledge largely in intangible forms in the community can be a viable tool to develop sustainable development strategies. The structured scientific

knowledge has been instrumental to bring about modern development. However, such a form of development has resulted in alienating human beings from their environment. The development based on such structured knowledge is certainly faster but it has turned out to be highly unsustainable and detrimental to the environment. It is now well realized and understood that we have not been able to respond to peculiar requirements of development as embedded in the context of that developmental issue.

The context specific issues can be addressed only if we take into account the huge indigenous knowledge as cultivated by the people while living in their local environment and empirically tested over long human history. Though such a pool of knowledge may not be tangible and codified, it carries the unique characteristics of the context. Moreover such knowledge is in much more quantity. Though largely unutilized and not harnessed by the scientific community its importance has been much highlighted in the context of Sustainable Development.

Partnering with the Communities

Developmental initiatives across the world have realized that modern scientific methods have not been able to give rise to similar response in all the contexts. On the other hand if local practices and knowledge base of the people is taken into consideration then scientific knowledge becomes more relevant to boost the process of development. Such an approach becomes more relevant as knowledge in the form of people's age old practices are much more significant. Such knowledge has undergone test of the times and have been able to sustain their livelihoods. It is desirable that modern scientific knowledge should blend with such local resource base and create higher forms of knowledge. Further it leads to Nonaka's ever growing knowledge spiral which makes the process of sustainable development more comprehensible and achievable. Hence, there is a great need of partnership between scientists and local community. The unique blend of grassroots practices and modern scientific knowledge will have inherent power to address the issues of local contexts. The local communities will assimilate such scientific prescriptions readily. They will not feel it as alien to their culture. It will give due recognition to their knowledge base and therefore community members will feel as if they are co-designer of the solutions which they will implement. It will further enhance their participation in the implementation of such solution.

Multi-Stakeholder Engagement: A Necessity

The climate change issues cannot be dealt between two isolated individuals. It has to be an intensive exercise of knowledge synthesis between all the stakeholders. The stakeholders need to be partners on equal footing and their knowledge inputs

are vital to work out the solution for climate change issues. What is most important is that it has to be an action research exercise right in the community setting where that issue is to be addressed. Any mechanism which falls short of this will give a partial view of the problem. Such an approach of Multi Stakeholder engagement to find out the solution of climate change issues have been largely successful in Poland where the issues have been dealt in Workshop Modes by the stakeholders in community setting. The Multi-stakeholder engagement is advantageous in following ways.

(a) The solution can be devised right in process of knowledge generation.
(b) The entire exercise can be completed in the community setting where solution has to be implemented.
(c) It recognizes the knowledge pool of the stakeholders which prompts them to come forward proactively.
(d) Identifies the traditional processes which need to be strengthened and maintained.

Some Innovative Capacity Building Initiatives

Mobile Technologies: An Enabling Tool

As the theory of situated cognition (Helgeson 2012) suggests, the conceptual knowledge can be most effectively transacted when rooted in the given context. Hence the capacity building for climate change needs to be carried out as learning in real life setting. It should also be focused more on the students developing analytical skills to devise contextual solutions in collaborative learning environment, developing skills to meaningfully share the information and to make use of their tacit experiences in real life. Research literature strongly suggests that Mobile Technologies can enable people to connect to their contexts (Sharples et al. 2009; Brown 2010). The mobile devises can heavily reduce the cost of capacity building operations which have to be undertaken at massive scale in developing countries with most of the target population being too vulnerable. They lack the capacities to articulate their problems and therefore will need a lot of handholding to comprehend their problems. The mobile devices have the added advantage for taking out the information as ingrained in their context and remotely capacitate them. In an interesting action research project undertaken by Sheffield Hallam University at Sironj (India) a mobile solution was developed with farmers as co-designer of a livelihood solution.These interventions helped Rizvi and Dearden (2010) to help poor farmers explore solutions for their problems. This award winning initiative (Sheffield Hallam University 2009) presents interesting example of how the context based learning is important to bring about capacity building for climate change. The project has demonstrated that a right approach with appropriate mix of

methodologies and social context could lead the designing of Information Communication Technology (ICT) solutions.

In an important study carried out by Chen and Hsu (2007), a Mobile Learning Module involving Pocket Fieldwork Assistant (PFA) with mobile technology was tested. The Pocket Fieldwork Assistant (PFA) aided students to conduct a field trip without the company of teachers hence reducing the cost of the field trip. The enquiry-guided pedagogy of PFA, reading resources and local maps help the students to be active learners. Similarly studies to understand the use of Mobile devises conducted in Germany and Austria have concluded that participatory location based learning activities with mobile devices be fruitfully carried out for Environmental Education. Further it has been concluded that it motivates the learners engaged in environmental education (Ruchter et al. 2010).

The potential impact of climate change on food safety has led to a policy thrust for capacity building on these issues (Vijayakumar et al. 2015). The need for sensitization, training for trainers, education and applied research on food safety is well realised and understood now. The stakeholders are diverse and heterogeneous in terms of age, socioeconomic backgrounds and educational levels. The educational content and delivery strategies cannot be standard and straight jacketed. Instead it should be highly contextualized and consistent with the requirements of target groups who might be mostly socioeconomically vulnerable communities. Most of them might be entering into such a capacity building exercise with no prior educational attainment hence engaging content will be crucial from the point of view of such learners. The focus here should be on systemic innovations to develop capacities in them rather than developing standardized curriculum. Mobile applications can help to relate the context of the learners, to create an engaging experience and stimulate critical thinking (Lai et al. 2007).

Low Cost Technologies for Farmers

Sensitization of poor farming communities with poor access to modern technologies is a major challenge for developing countries. In specific pockets innovative initiatives for low cost technology deployments are advisable. There have been initiatives taken by some of the developing countries which are worth replicating. China with a large agricultural economic base have been facing the problems to sensitize their farmers about modern agricultural practices and thereby strengthening their livelihoods. Xiujuan (2005) has documented an interesting success story of use of loud speakers for sensitizing the farmers. Such good practices can be fruitfully utilized for capacity building on climate change. Low cost technology options have also been tried by Watershed Organization Trust of India in partnership with Indian Metrological Department, Central research Institute for dry land Agriculture and Mahatma Phule Krishi Vidyapeeth for promoting climate resilient farming. Such initiatives have helped the farmers to take farm related decisions in a more scientific and informed manner (Lobo et al. 2017).

Community Based Interventions

Community based interventions are very important for the capacity building of the rural communities particularly to capacitate them to handle climate change. In developing countries such interventions have been successfully undertaken at several places. An extensive account of such capacity building systems across the developing world has been given in an interesting report based on the online discussions published by Food and Agricultural Organization (FAO) (FAO 2009). Some examples are worth citing in this regards. Krishi Vigyan Kendras (KVKs) have been one such success stories. The mandate of Krishi Vigyan Kendras (KVK) is technology assessment and demonstration for its application and capacity development. In India currently around 668 KVKs are working under the supervision of various state and central agriculture universities, institutions and selected NGOs. Similarly, the Village Knowledge Centers of M.S. Swaminathan Foundation have been a success story which is worth replicating to address the issues of climate change particularly in agriculture dependant economies.

Conclusions and Recommendations

This chapter was aimed to find out possible ingredients of paradigmatically new approach for capacity building for climate change. We don't propose to suggest any rigid, structured and straight jacketed approach for all the countries and contexts. We rather give logical and indicative directions which any capacity building planner need to take into consideration. It needs extensive experimentations and sharing of experiences which will address this vital issue of concern across the world.

The foregoing discussions and literature reviews bring out following points which can be taken into consideration by planners of capacity building.

It's All About Knowledge Generation

It is now well realized and understood that the capacity building systems for climate change have to be paradigmatically different from the conventional ways of capacity building. The traditional systems largely utilizing classrooms as the sites for knowledge transactions are meaningless for climate change related issues. Capacity building is required at all the levels as there is no such agency which has all the solutions for climate change. The knowledge for climate change solutions has to be generated rather than transacting the already available knowledge. It unfolds an entirely new perspective for capacity building for climate change issues. The capacity building exercise should take place in real life setting and should be free from the biases of conventional mindsets.

Openness Is the Hallmark

Any initiative which leads to capacity building outside the classrooms can be called an open learning initiative. Hence openness is the hallmark of any climate change capacity building programs.

Make Use of Traditional Knowledge

Another point of view which gives rise to a different perspective for climate change is the importance of traditional knowledge. The modern scientific knowledge despite its excellent achievements has a serious lacuna. It has not led the world on the path of sustainable development. On the other hand the traditional knowledge largely embedded in the practices, habits and cultural traits of the communities have been able to sustain them for a long time. Hence climate change capacity building programmes should not lose sight of this rich repository of knowledge.

Every Context Is Unique

However it is a huge challenge. Every context is unique in itself and the tacit experiences of the people need to be documented through carefully researched tools. Little efforts have been done so far in this direction and knowledge institutions should focus their efforts on these fronts. There is a greater realization of making the process more participatory, country specific, long term, well coordinated and problem solving approach. The capacity building measures should be integrated with the stakeholder's livelihoods and lifestyles, building upon their Indigenous Knowledge Pool. The idea is to have a multi-stakeholder involvement to devise solutions. The communities to be capacitated should be the co-designers of the climate change solutions.

Think Beyond the Class Room Based Individualized Instructions

Another perspective is that we need to think beyond traditional ways based on individualized classroom instructions. This age old practice of individualized classroom instructions still continues to influence the educational planners. Climate change capacity building programmes should take into account community as a whole rather than individuals. The educational planners need to come out of the traditional mindsets of classroom based individualized instructions, should devise

new pedagogical systems and focus on capturing the new knowledge generated in the process of capacity building exercise. The openness as inbuilt in the philosophy of ODL is consistent with this requirement. In this context, ODL Systems are most suited to promote such measures by providing alternate methodology of education dissemination by using various modern tools of communication.

Adapting to Change at Various Levels

A 'transformative change' on the issue of climate governance is the need of the hour as the question is closely linked to strategic global political, economic, social and security matters owing to the competition for limited resources (Sanwal 2011). Adaptation to climate change is required at various levels. Padukon (2010) has interestingly related it to the need of political adaptation which should lead to unity among the estranged South Asian neighbors for managing the political consequences of the climate change. It will not only adapt to inevitable environmental shifts but will also help to manage the political and security oriented effects of climate change. Similarly, Capacity Building for the poor which should provide alternatives to migration should be a priority area for the Governments.

How Well We Can Relate to Collective Good?

The climate change adaptation is difficult inter alia due to increased need to relate to global climate issues (common good). Context of climate change is complicated, different actors may hold different views about specific nature and differentiated interests of various actors which may often clash with each other. People tend to relate more easily to their livelihoods contexts and day to day concerns. Lack of recognition of local knowledge will create the capacity building paradox.

Need for More Research Based Information

Adaptation pattern of the species to the changing environment is not well understood by the research studies. The existing studies have highlighted the uncertainties associated with animal adaptation to various species. The north south issues have become pertinent in the entire debate of climate change. There has been an inclination in research studies to relate it to the share of Green House Gases (GHG) emitted by the developed and developing countries and fixing the responsibilities on them to reduce the emission. Adaptation to climate change and associated economic analysis are not widely understood especially in policy making circles and to some extent in research circle in South Asian Countries. Hence there

is an urgent need to design short term training programmes for different stakeholders and for careful long term learning through collaborative research. Climate change adversely affects the women and therefore affects the rural households at multiple levels. Women's participation will prove to be important because she is a rich repository of the experiences with changing climatic conditions. Climate change adaptation has to be a long term process because of obvious reasons. Hence the corrective actions to be taken should have effective involvement of children who will be the custodians of the world which we want. Curriculum planners and educators need specific training on these issues. Climate change is manifested locally and therefore the capacity for decentralized policy making is of crucial importance. Capacity building systems have a crucial challenge to identify such requirements and address them through innovative means.

Need for More Cross Disciplinary Research

Any emerging paradigm on capacity building at individual, community, institutional and national level for climate change would have to respond to the immediate challenges of mitigating the risks associated with climate change, preventing further degradation to the vulnerable natural environment, research and development, sustainable production and consumption patterns and transfer of green technology etc. without compromising on the overall priorities of national development (INDC, GOI).This requires open, multi-disciplinary, cross-sectoral and participatory systems of capacity building in place. Societal dynamics is now increasingly seen as the root as well as the possible solutions to the various environmental problems (Sanwal 2011).

Synthesizing the Knowledge Base of Diverse Stakeholders

A multi stakeholder's view of climate change response and increased people's participation can favour the trend of 'resource decoupling', which is increasingly practiced by several developing economies. This entails a transforming change in the current patterns of production and consumption. The current paradigm of capacity building measures invariably includes structured programmes promoted by conventional institutions of learning. However, often these programmes exclude the most marginalized sections of the population who are often the hardest hit in the climate change scenario. Thus, there is an urgent need to respond to the current situation by introducing more inclusive, contextualized problem based solutions at the local level after proper consultations with the stakeholders. The current trend of individualized certification would have to be replaced by a need based and practically viable approach of responding to environmental issues locally. This may be

supported by a well placed system of reporting and documentation to provide for an open resource platform so that it may be referred to in other parts of the world for possible replication.

Open and Distance Learning: Ideally Positioned

Needless to say that the Open and Distance Learning (ODL) System of education is favorably positioned to respond to the changing scenario in capacity building on climate change. The philosophy of openness and the methodology of education dissemination followed by the ODL System support a more inclusive, learner centric and flexible system of education and capacity building opportunities. This makes it easier to bring a larger number of beneficiaries under its ambit irrespective of their age and social, educational, economic and cultural background.

Integrate It with Social and Cultural Fabric

Another approach of promoting climate knowledge and environment conservation is through working across generations within the communities by way of creating awareness on sustainable lifestyles that is one which is based on needs based consumption patterns. This can be done by integrating the capacity building measures with the cultural and social fabric of the communities. This holistic perspective on capacity building would involve learning in terms of engaging in social networks, every day practices and social relationships. This would entail using the indigenous knowledge pool of the local communities and integrating them with the climate change response globally. Thus, it is imperative that any capacity building initiatives would have to be interwoven with the fabric of livelihood opportunities for the people. This entails working closely with the communities and incentivizing cooperation for environment conservation programmes.

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A Coil-Enhanced Course on International Perspectives of Climate Change

Luis Velazquez, Krystal Perkins, Nora Munguia and David Zepeda

Abstract Climate change is a complex and multifaceted issue. It is one that must concern all people and takes the work of the entire globalized world to eradicate. Consequently, a globally connected solution is paramount to sustainability. This chapter considers the potential and significance of embedding intercultural experiences and globally networked learning into courses on climate change and sustainability. In particular, the State University of New York's (SUNY) Center for Collaborative Online International Learning (COIL) has developed a pedagogical approach aimed at fostering multicultural learning across various areas of study. Drawing from our experiences participating in the COIL Center's professional development programs and through the implementation of a COIL-enhanced course, several suggestions for infusing COIL-like models into courses on climate change and sustainability are offered. To begin, a brief review of the existing literature on distance education is provided. Then, a brief background of the SUNY COIL System is presented. This is followed by a case study analysis of the COIL-enhanced course, *International Perspectives on Climate Change.* Finally, some reflections about the COIL experience at the University of Sonora are offered, including successes, challenges, and suggestions for fostering climate change literacy and sustainable learning.

Keywords Distance education · Climate change · Climate change curriculum Intercultural experiences

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Introduction

The world is facing a large number of global challenges that requires radical modifications in the way we think and act. The United Nations, through its Global Education First Initiative, states that to achieve these desire changes, institutions of higher education must first change the way they educate because traditional models struggle to meet the global and interconnected challenges of the 21st century (UNESCO 2012). Such efforts are vitally important because they have the opportunity to influence the ways in which students engage in the world. This holds institutions of higher education responsible for the development of new ideas, new paradigms of education, and innovative ethical and sustainable solutions to these immense challenges (Cerneviciute and Petkute 2013; Holmberg et al. 2012).

Traditionally, a banking style of education has been the dominant model of pedagogy in institutions of higher education. The term, "banking education" was coined by Freire (1970), a Brazilian educator, to refer to educational pedagogy which is likened to a banking process where students store information delivered to them by a teacher. In particular, in the banking environment, a classroom is structured such that the primary objective of students is to remember and accurately recall the information provided by the teacher. They are not asked to participate in any other way, but to simply to absorb the information. In this type of approach, knowledge is static and finite and the outside world is seen as unchanging and uncomplicated. Moreover, the teacher has monopoly over knowledge. Together, the banking model of educations assumes the teacher is the narrator of knowledge and students are the passive recipients.

A banking style of education, however, is a pedagogical model incompatible with learning. It excludes diverse perspectives and privileges detachment from students. It minimizes the creative and agentic potential in them. It stifles innovation and intellectual growth. Further, it is an approach to teaching that assumes that students should merely be collectors of information that has no real connection to their lives. It masks student's ability to critically engage in and with the complexities of the world. Moreover, the banking method is a pedagogical style of education incompatible with an ever-changing, complex, globalized world. Society is experiencing changes in a fast way, therefore, everybody, but especially students must be a part of and acquire skills and knowledge to navigate this evolving present (Griffin and Care 2014; Siddiq et al. 2017). The current problems we face as a society are complex and involve many elements that interact with each other, including the environment surrounding them, producing different and new problems through feedback loops (Nuhoğlu 2010).

Taken together, traditional methods of teaching are not adequate to satisfy the new and complex challenges we face as a globe (Martin 2013). These multifaceted issues require new ways of thinking, understanding, and acquiring knowledge, in professors and students, alike (Coonan 2011). In particular, the classroom must be opened up where students and teachers together engage in dialogic enrichment through conversations, questions, debates, and inquiry. One pedagogical alternative

that has the potential to alter traditional knowledge creation is distance education. Distance education figuratively and literally opens up and changes traditional notions of the classroom. Distance education was originally designed for people unable to attend traditional schools enabling students from all walks of life and diverse backgrounds to attend school. At the core of distance education is the use of technology as a mechanism to enhance independent learning and participation from all students (Barker and Gossman 2013; Maitaouthong et al. 2011). Moreover, distance education offers a vast range of opportunities for promoting student interaction and collaboration. To date, virtual learning environments have been used in several countries, including the United States, Thailand, and Norway, starting from two decades ago (Bruce and Curson 2001).

Distance education takes many forms, but as a definition, it is a method of teaching where the student and teacher are in a remote place during the learning process and maintain communication in a variety of ways (Law and Kentnor 2015). Technologies blur the distance between students and teacher enabling students to have access to course material at any time and from any place. It can use a combination of technologies, including correspondence, audio, video, computer, and the Internet (Roffe 2004). Currently, the internet is the delivery mechanism with at least 80% of the course content delivered online (McPherson and Bacow 2015; Ospina-Delgado et al. 2016; Whitaker et al. 2016).

Online educational programs emerged in 1989 in the United States, when the University of Phoenix began using CompuServe, one of the first consumer online services (The University of Phoenix 1997). Afterwards, in 1991, the World Wide Web (Web) was unveiled and the University of Phoenix became one of the first to offer online education programs through the Internet. Nowadays, distance education is more available due to the innovations in communication technology and the connectivity of the computers and the Internet (Kentnor 2015).

According with Stankovic et al. (2015) distance education has several advantages to traditional in-person instruction. For example, distance education allows students to have 24-hour access to desired course information, providing students the opportunity to study a topic independently of space and time, eliminating spatial and temporal limitations. In addition, this kind of education reduces the costs of transportation and accommodation. In fact, online education represents the fastest growing form of distance education and it's appreciated at both traditional and non-traditional colleges and universities (Allen and Seaman 2011). Besides all of this, online education environments have been shown to improve critical thinking and stimulate student participation and collaboration. Distance education continues to grow with many universities around the world offering a large number of distance education courses on different topics with a high level of acceptance and effectiveness (Fish and Wickersham 2009).

One of the topics of high relevance to online education courses are courses in climate change literacy. Undoubtedly, climate change is one of the greatest challenges facing contemporary society (Buhaug 2016; Roberts 2016; Singh et al. 2017). In recent decades, climate change and sustainability have been present on the agenda of governments, international organizations, and even private companies.

In this same period, several large-scale sustainability initiatives have been developed (e.g., Paris Climate Agreement) in order to reduce the effects of climate change on a global scale; highlighting the environmental, societal, and economic implications of such efforts (Grittmann et al. 2017). Because of the global nature of this issue, online education stands out as one of the fundamental tools to address this problem (Nieto et al. 2012).

One factor that sets a climate change education apart from other curricula is that current and future societies are already and will continue to be affected by climate changes underway (Fahey 2012). Specifically, climate change is already causing significant harm and is growing rapidly. Its' impact on people and the environment pose serious societal challenges. As such, implementing solutions depends on an informed public. Educating future generations about the causes and effects of climate change is imperative. Likewise, the curricular discussion is not whether or not we should change the way we do things; instead the discussion is how we can do it. Distance education for climate change can allow students to inquire, question, and debate, the consequences and effects of climate change of which we are all witnesses to and are victims to from a global perspective (Dick-Forde 2013).

While courses in climate change are well suited in a distance education context, it is not without a distinct set of challenges. Climate change literacy is a complex topic to teach where many elements interact with each other. For example, from a hard-science perspective, biologic forces drive climate system variability (Wachholz et al. 2014). From a social or public health perspective, human-induced behaviors also impact the climate system. In general terms, people generally accept the hard-science perspective of climate change with a degree of certainty. However, people often resist the social interpretations about climate change; that humans are altering the climate. Prior research suggests introducing these topics with ample scaffolding and weaving tangible solutions into every discussion about climate change may be a way to reduce such resistance.

Climate change literacy also faces the challenge of obsolescence. With rapidly developing science and technology related to climate changes, research on this topic is often changing. This requires professors to keep their curricula updated (Fahey et al. 2014). If professors are not up to date with the research literature, effective delivery of a climate change curriculum can be counterproductive (Milér et al. 2012).

External factors, namely the ongoing debate about whether climate change is in fact real, poses a significant challenge to the delivery of a climate change curriculum. Some sectors of the public continue to debate the idea of climate change, despite the well-established literature stating otherwise. In addition, recent political developments in the United States suggest that climate change won't be top a priority in near future (Shear 2017; Worland 2017). On the other hand, the Mexican government has shown their support for climate change initiatives (Schmidt 2017). As analyzed by Colston and Vadjunec (2015), it is not unusual for science professors to find controversy on climate change due to political issues. Similarly, climate change literacy is also affected by socio-demographic factors and governing structures (Mycoo 2015). Dent and Dalton (2010) admitted a certain degree of

difficulty in integrating climate change issues into courses due to the fact that other topics are less complex and easier to be applied in courses. It is perhaps for this reason that Milér and Sládek (2011) suggest to increase the climate literacy of leaders first, including that of politicians, teachers, and journalists; then, educate the general public.

Taken together, an effective and innovative climate change curriculum needs a holistic approach; one that opens up the creative potential in students and takes into consideration the multiple sets of challenges as set out in The UNESCO Climate Change Initiative (2010). This means that it requires the will and ability of people to work together regardless of cultural or geographic divisions (Glasser 2009). Distance education has the potential to meet this need of creativity and innovative knowledge creation, through borderless communication and learning process. Through its multiple tools, its capacity for mass interaction, and the 24/7 availability, the goal to educate and transform lifestyles into a more sustainable one becomes achievable (Clary and Wandersee 2012; Garrison and Anderson 2011). The next sections describe a case study of a distance education course on climate change and sustainability.

Case Study: Designing a Curriculum for a Coil-Enhanced Course on International Perspectives of Climate Change

In 2016, the University of Sonora, a Mexican higher education institution, was invited by the State University of New York (SUNY) Center for Collaborative Online International Learning (COIL) to participate in the US-MEXICO Multistate COIL Program Project (MCP), which aimed at increasing inter-university collaboration between Mexican universities and American academic institutions. Beyond the main goal of this project, the program also aimed to contribute to greater cultural understanding and cross-border dialogue between students and professors in both countries.

Bachelor students at the University of Sonora are often encouraged to participate in institutional outbound mobility programs in order to gain academic credits and for their own personal growth. Although many apply for a position into the program, just a few are chosen because of economic constrains. Student participation in these programs have become even more difficult in recent years within the context of the current economic crisis. In this context, the university's authorities saw the COIL proposal as a meaningful solution for experiential multicultural learning that could supply outbound mobility opportunities to students in an affordable way. In addition, the COIL opportunity aligned with the sustainability goals of the university in that it prevented thousands of Greenhouse emissions associated with student abroad traveling.

The Rector of the university accepted the invitation to participate in the US-Mexico Multistate COIL Program Project. The course that was chosen to be *COILed* was titled, *International Perspectives of Climate Change*, taught by the

first author. This course was chosen largely because of the University of Sonora's value and commitment toward sustainability and the view that climate change is a global issue. In fact, for more than two decades, the University of Sonora has advanced climate change initiatives and has been considered an international icon of sustainability.

The SUNY COIL Center Paradigm

The SUNY Center for Collaborative Online International Learning (COIL) is one of the principal international organizations within the field of Globally Networked Learning (GNL); a type of emerging pedagogy emphasizing cross-cultural engagement experiences (Starke-Meyerring and Wilson 2008; Starke-Meyerring 2010). The SUNY COIL Center was created at SUNY Purchase in 2006. In particular, COIL developed from the grassroots efforts of a group of faculty at Purchase who were surveying ways to bring tangible international perspectives into their classrooms. Jon Rubin, the founding Director of COIL, was one of those professors. He developed a Cross-Cultural Video course where SUNY students co-produced videos over the internet with students from different countries in the world, including Turkey, Lithuania, Mexico, Belarus, and Germany.

Since then, COIL has grown exponentially with the support and recognition from agencies like the National Endowment of the Humanities (NEH), the Open Society Institute (OSI), the American Council on Education (ACE), and Banco Santander. Recently, COIL launched several large scale projects including the Steven's Initiative and US-Mexico Multistate COIL Program (MCP). The Steven's Initiative is a three-cohort project with partnerships and exchanges between SUNY and Middle Eastern and North African universities (Lebanon, Morocco, and Egypt). The first cohort resulted in 7 partnerships that reached over 350 students across 8 institutions. The MCP is a two-cohort initiative within the US-Mexico Bilateral Forum on Higher Education, Innovation and Research (FOBESII), COIL, SUNY's Office for Latin America, with the support from the USA Embassy in Mexico City and the University of LaSalle. To date, the MCP consists of 13 SUNY institutions, 4 institutions outside of New York State, and higher education institutions in 18 Mexican states. The institutional partnerships resulted in 39 courses being taught. The overall aim of the Steven's Initiative and MCP is the development of long-term COIL-based partnerships between the countries.

The COIL Classroom

COIL is not classic distance education. Instead, in the COIL model, students from different cultures register in a shared course where faculty members from each country team-teach and manage coursework. Professors' work together to generate

a shared syllabus based on the specific academic objectives of the course and discipline overlayed with some type of experiential and/or collaborative student learning. COIL classes can either be fully online or offered in more blended or hybrid arrangements with a mix of technology and traditional face-to-face-instruction. In blended or hybrid courses, the collaborative work takes place online, but the face-to-face and online activities complement and reinforce either other. To provide strong engagement to the collaborative work, in some circumstances and contingent upon funding, students from each participating institutions travel to their COIL classroom's country to meet their peers. The key to the COIL model is have the subject of the course lend itself to students working collaboratively in international groups.

In the past, courses in the Humanities, Social Sciences, Technology, and Engineering have been *COILed*. Some examples of recently developed COIL courses include: *International Development and International Migration* (SUNY Cortland and Anadolu University in Turkey), *Going Global: Intercultural Communication* (SUNY Purchase College and Universidad Iberoamericana in Mexico), *and Survey of World Cultures* (SUNY Delhi and European Humanities University in Lithuania). Accordingly, the COIL model is one that extends beyond the confines of the traditional local classroom, beyond traditional theories of pedagogy, and beyond traditional knowledge creation practices. By linking students and professors from diverse backgrounds, COIL emphasizes the value of partnered international learning environments as a tool to enhance experiential and disciplinary learning. Moreover, they also provide valuable internationally-focused professional development opportunities for faculty and participating institutions.

The COILing *Process*

The COIL Center has created a professional development program to support faculty as they develop their prospective courses. The COIL's Center professional development program consists of the COIL Course Orientation and the COIL Academy. A brief description of each program is elaborated below.

The first professional development program, the COIL Course Orientation is a 5-week online course that provides foundational information to prepare interested faculty members for partnering and *COILing* courses. In particular, faculty members learn more about the COIL Center, the partnering process, and create online profiles describing their prospective course. During this phase of professional development, professors also are asked to consider and discuss on discussion boards, a variety of critical issues including intercultural sensitivity, flexibility, and the significance of developing consistent protocols among partnering faculty.

At the end of the COIL Course Orientation, faculty members create profiles of their prospective course to be promoted on the COIL Networks website. The profile of that prospective course is then viewed by potential faculty partners from the Global Partner Network (GPN); a membership-based network of higher education

institutions around the world. Those interested in partnering then post replies to a profile. Once a potential collaboration has been identified, the SUNY faculty and the GPN faculty write a partnership proposal to be considered for the next stage of the professional development program, the COIL Academy.

Building upon the COIL Course Orientation, the first part of the COIL Academy is an in-person workshop usually taking place at a global partner campus. The MCP in-person workshop took place in Cuernavaca, Mexico. The in-person workshop is where partners meet face-to-face for three days of presentations, interactions with partners, and course development activities led by COIL facilitators. In addition, course outcomes are discussed and potential collaborative activities are identified and drafted with the help of COIL facilitators. More broadly, faculty partners are asked to consider their ideas more deeply and the strategies necessary for preparing and implementing a COIL course. SUNY partners also have the opportunity to visit their Mexican partner's university.

Following the in-person workshop, the final phase of the COIL Academy is an 8-week online program. This phase of professional development is where the faculty partners finalize the details of their COIL course. In particular, COIL facilitators guide partners to think deeply about what it means and how to collaborate online from the perspective of the student. By the end, partners develop a syllabus for their COIL-course including student learning outcomes, tasks, and experiential activities.

COIL-Enhanced Curriculum for International Perspectives of Climate Change

Climate change is, by nature, a global topic and is well suited for multidisciplinary and multicultural contexts, like COIL. Traditionally, courses on climate change are taught under a hard science perspective where understanding the natural phenomena associated with climate change is a core component. However, anthropogenic causes have accelerated global warming and consequently, the climate has changed. Thus, the course on *International Perspectives of Climate Change* offers students a broader analysis to climate change, one that includes the natural and anthropogenic forces.

A COIL-enhanced course on *International Perspectives of Climate Change* was thought of as an excellent opportunity to involve undergraduate students from several branches of engineering sciences from the University of Sonora in Mexico with undergraduate students from several disciplines from Nassau Community College in the United States in order to increase their awareness of the Paris Agreement goal of limiting Global Warning to well below 2 °C. Hence, the main purpose of the course was to increase students' understanding of their contributions to climate change and foster positive personal practices to reduce their carbon footprint. In addition, this course aimed to inspire students that look to deepen their knowledge about climate change for a better future.

This course was an English only spoken course at the honor-level. Hence, students who enrolled in the course had to be in excellent academic standing and have good English proficiency.

The course had the following four student learning outcomes (SLO):

SLO 1 You will be able to identify what creates climate change and what does not create climate change.
SLO 2 You will be able to express in a writing essay how you contribute to climate change.
SLO 3 You will be able to understand how you can mitigate climate change by doing a hands-on project.
SLO 4 You will be able to disseminate your findings.

The COIL-enhanced course lasted eight weeks and the entire course lasted sixteen weeks, whereby the Mexican students had the chance to exchange points of view about the weekly content with the American students. The course was a blended-style course structure where part of the content was through traditional face-to-face instruction. Interaction and collaboration with the American students took place online using several online tools.

During the first week of the course, students in Mexico and the United States were introduced to the course material including to COIL-enhanced component. The web-based learning platform called Blackboard was used to enable and support the interaction between students. Blackboard allowed students and instructors to maintain discussions boards and threads to enrich debate among students. The free software program called LiveBinders was used to upload PowerPoint presentations, papers, assignments, audios, and pictures.

During the second week, students in both countries were asked to prepare a short icebreaking video where they detailed what they expected to learn out of the course about climate change and intercultural learning. Students then met synchronously to discuss the videos and to the get to know each other more.

The third week was devoted to learning about the ABC's of climate change. This was done in students' in-person classes in both Mexico and the United States. Videos from The National Aeronautics and Space Administration (NASA), reports from the Intergovernmental Panel on Climate Change, testimonials in YouTube were used for reinforce learning and discussion.

During the fourth and fifth weeks, students learned how to calculate their carbon footprint, which is the total amount of greenhouse gases produced to directly and indirectly support human activities. This is expressed in equivalent tons of carbon dioxide (CO^2). To do this, they had to do an inventory of their daily activities, determinate the amount of energy consumed, and finally convert data to equivalent tons of CO^2. Calculations were made with the help of a web carbon footprint calculator. Students shared and discussed their results on Blackboard.

The sixth week was devoted to discussing and exploring alternatives to CO^2 offsetting. Students had to identify best practices in order to reduce their emission of greenhouse gases in order to decrease their carbon footprint. During this week, the second synchronous class occurred with the purpose of discussing the similarities and differences between student's carbon footprints in both countries.

In the final weeks, students were first asked to create a video to raise the consciousness of how undergraduate students may reduce their carbon footprint. This video was posted in student's social media. During the eight week, the final synchronous class took place with the purpose of reinforcing and discussing what students learned in class. In particular, students shared their final thoughts and ideas about what they learned. Beyond educational factors, professors highlighted cultural factors in both countries that influence the perception of climate change.

Reflections

This COIL-enhanced course started in spring 2017, yet partnership among the Mexican and the American class was not completed due to technological problems. However, the foundation to try again in future semesters have been set. The remainder of the course was taught in a traditional face-to-face instruction with the same objectives.

Despite the technological challenges, a lot was gained by the COIL model of pedagogy. Many lessons are to be drawn from this year. The main lesson being that the COIL philosophy fits well with the University of Sonora's institutional planning to offer a high standard of education mainly, in the way of offering education in a multicultural environment.

International student mobility is something that all students should take part in however, current economic situations in Mexico makes it difficult for many students. In a certain way, the COIL model allows more students to get close to the benefits of intercultural learning in a cost effective way that are usually only available by international student mobility. The potential and significance of embedding intercultural experiences and globally networked learning into courses on climate changes cannot be understated.

However, diplomatic frictions between the American and the Mexican presidents do not augur well for any type of cooperation between both countries. The continuation of COIL among Mexico and the United States could be threatened in the near future by issues like the wall, immigration, the North American Free Trade Agreement, jobs, and unfortunately by the climate change perspectives in both countries. In particular, it is may be difficult to reconcile the different diplomatic perspectives about climate change that divides the United States and Mexico. It is possible that cultural differences in views about climate change will widen further. Consequently, the need to foster climate change-literacy innovation will matter even more.

Mexican students who took the COIL-enhanced course were engaged with increasing their level of climate change knowledge to make appropriate decisions to decrease their carbon footprint. They also showed enthusiasm to exchange ideas with American students. This suggests that the provision of basic climate change

literacy to undergraduate students is an appropriate approach for helping them to learn, and pursue more complex system knowledge in the near future.

In closing, professors and students in Mexico and the United States still have a lot to learn from each other in order to keep fostering climate chance literacy and behaviors. From now onwards, the COIL framework can be the guideline for the University of Sonora and other higher education institutions to teach the basics of climate change, taking into account cultural differences to envision and create a more sustainable society.

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Climate Change and e-Learning: Interdisciplinarity and Interculturality Challenges

Fátima Alves and Ulisses Miranda Azeiteiro

Abstract Climate change is a key issue on today's scientific, social and political agenda. The United Nations Sustainable Development Goals reinforce its current priorities in this regard (e.g. SDG 13 Take urgent action to combat climate change and its impacts) and is one of the five priority areas of the Strategy 2020 of the European Commission. This chapter discusses the specificities of climate change online learning in respect to syllabus contents and highlights its multidisciplinary and multicultural components. One of the characteristics of online learning is its capacity to reach an extensive number of people, scattered around the world and with diversified cultural backgrounds. This opens an extremely valuable path to research and societal responsibility, filled with potentialities and challenges. Student's cultural diversity and geographical belonging must be reflected in the syllabus contents, as well as in the objectives of the courses and in the competencies that should be promoted. Furthermore in the design of the courses it is increasingly relevant to reflect and value an interdisciplinary approach to teaching and learning, because it is a key factor in Climate Change Education and Awareness. In this interdisciplinary and multidisciplinary dialog, it is crucial to evidence the cultural and contextual validity of knowledge and the impact of socioenvironmental dimensions in the configuration of Climate change challenges. For the purpose of this study we took as an example two course proposals: "Environment, Health and Wellbeing" for social sciences undergraduate students and "Governance of Climate Change Adaptation" for postgraduate students, presenting teaching contents,

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teaching and learning methodologies, effectiveness through e-learning in higher education institutions (HEIs) and the potential for increase in public climate science literacy.

Keywords Online teaching · Climate change · Societal challenges
Climate science literacy

Introduction

A close look at the evolution of teaching and learning online will show us that students have diversified geographical and cultural backgrounds however facing similar societal and scientific challenges related to global environmental change.

Enlarged access to information, globalization and new communication technologies together with the present societal challenges we are facing, demands for new competencies and created an educational niche opportunity for e-Learning (Azeiteiro et al. 2014a, b, 2015). An e-Learning education online system, independent of our chronologic time and place, that allows students to proceed studies at their own places and to identify their own personal course timeline and self-regulated learning processes (Azeiteiro et al. 2014a, b, 2015; Bacelar-Nicolau et al. 2009; Bacelar-Nicolau e Azeiteiro 2016; Moura et al. 2010), promotes the existence of learning communities (Moura et al. 2010) and addresses the Challenges of Multicultural Education for Climate Literacy and Innovations in Climate Change Education (Azeiteiro and Leal Filho 2017).

E-learning acquisition of competencies, employability and entrepreneurship (Amador et al. 2008; Bacelar-Nicolau et al. 2007, 2009; Martinho et al. 2014, 2016; Moura et al. 2010), attitudes, barriers and motivation (Bacelar-Nicolau et al. 2015), perceptions (Bacelar-Nicolau et al. 2012), have been studied and the results show their effectiveness and full pedagogical scope (Azeiteiro et al. 2014a, b, 2015). Some European initiatives and reports (e.g. "*Modernisation of Higher Education in Europe: Access, Retention and Employability*", "*ICT-20-2015:* "*Technologies for better human learning and teaching*", "*The eLearning Awards (…) rewards excellent practice in using ICT for learning across Europe*" and "*Erasmus +*", namely the "*Long Life Learning programme"*) promote this Digital Inclusion Strategy and are at the same time promoters of Sustainable Development (Aires et al. 2014).

Our experience as online teachers, as well as our training, has warned us of the importance to consider the socio-cultural background and identity of our students as conditioning factors of the process of teaching and learning, especially in what concerns the contents taught to our students. We argue that a special investment in intercultural research is needed in order to guarantee that content taught is adequate and reflects the different geographical and cultural contexts and specificities (Alves and Araújo 2012). We also aim to show that an exercise of opening up to different contexts, where the phenomena under analysis show different contours (for

instance, the way climate change is conceived, explained and dealt with (Viegas et al. 2016; Alves et al. 2014)), represents a valuable potential for a break with traditional thinking, for relativisation and for the establishment of new relationships that require critical thinking and adaptation to socio-cultural flexibility and plasticity (Alves and Araújo 2012).

This chapter discusses the specificities of climate change online learning in respect to syllabus contents. For the purpose of this study we took as an example two course proposals: "Environment, Health and Wellbeing" for undergraduate students and "Governance of Climate Change Adaptation" for postgraduate students presenting teaching contents, teaching and learning methodologies, effectiveness through e-learning in higher education institutions (HEIs) and the potential for increase in public climate science literacy. We conclude this chapter by giving further clues for research.

Online Distance Learning

Online Distance Learning reaches multiple territories and requires the recognition of the existing multiculturalism and diversity, which should lead to the choice of contents and pedagogical practices that are significant to the concerned students. If, on one hand, it is crucial to establish the connection between syllabus contents and geographical and cultural diversity, on the other hand it is no less important to recognize the plurality and cultural mixture that exists in every apparently homogeneous culture (Alves et al. 2012). As such, all practices developed to prepare students for co-existence and cultural sensitivity must be seen as powerful heuristic instruments for the analysis of society and for the promotion of citizenship and social emancipation (Alves and Araújo 2012; Alves et al. 2012).

According to Alves and Araújo (2012), in pedagogical terms, online learning allows students:

- To access information anywhere there is a computer with Internet access;
- To use various types of tools and to communicate through discussion forums, chats, conferences, instant messages, e-mails and other forms of online communication;
- To access information anytime they want. For the majority of activities and tasks, the access schedule is decided by each students;
- To follow their own pace of learning, which is different for every student;
- To take advantage of having a teacher that acts as a tutor, a facilitor of learning. The teacher organizes contents, sets objectives and targets, negotiates and follows the process of knowledge acquisition, evaluates the performance, offers solutions and makes sure that all the resources necessary to execute tasks are available;

- To communicate with other students, namely through forums (of the curricular unit, students and others) that may or not be mediated by the teacher/tutor, and to execute collaborative projects that are critical to their success as students;
- To enjoy the benefits of multimedia resources, such as video, audio and animation, that help to mitigate the difficulty of reading information displayed on a screen;
- To have access to contents with a flexible structure; this is important to encourage students in their process of learning, independently of their level of experience.

Following Alves and Araújo (2012: 189) work, so far as we are talking about a learning environment asynchronous, from which gestures, facial expression and corporal interaction as a whole are absent, all aspects related to contents, exchange of ideas and knowledge and the way to achieve interaction become even more important. All doubts, impressions, conclusions need to be clarified in writing. And what happens frequently is that questions related to cultural diversity are not clarified because students often assume a more secluded role when it comes to using written language. Writing confines thoughts and perceptions and exposes their symbolic universes.

Reflection Based on the Organization of the Curricular Unit of "Environment, Health and Wellbeing"—Social Sciences Degree

Based on our experience as online teacher we will proceed to the presentation of the specificities of a theoretical, conceptual and cultural approach to the contents taught to students of the curricular unit (CU) of Environment, Health and Wellbeing (EHW) (6 ECTS; Online teaching contact: 26 h contact in 156 h, total study hours of student). As social scientist and teacher of this CU it was defined as a priority from the very first moment the investment in intercultural research and also the need to integrate research related to different geographical contexts on its syllabus contents. As we have done in previous work in the health field (Alves and Araújo 2012), we would like to demonstrate how a simple exercise of opening the Environmental field and Climate change analysis to different contexts, in which the phenomena have diverse cultural representations can result in a wonderful opportunity to make a relativisation (e.g. the way people attribute means, explain and deal with climate change is different across cultures) and to establish new relationships that demand critical thinking and the capacity to adapt to the liquidity of the social, cultural, political and ethical world of each student. The potentiality of such a practice can be explored on the work done by students in virtual classes and on their examination scripts—for example, one of the exercises they are proposed in virtual class is to map environmental problems in their context of living, and to illustrate them with scientific data. The result is very encouraging and provides an overview

of the plurality of locally valued environmental problems in geographies that are so diverse (especially between Portugal, the European countries receiving emigrants and the Lusophone countries).

That's why in this sense online learning syllabus tends to adapt to the needs of learners and the way they access contents. However this flexibility in integrating phenomenon diversity and variability does not means that there is no structure and sequence on the Curricular Unit Plan. The main dimensions of the Plan aim to develop specific competencies. Nevertheless, we have integrated some of the multicultural components, opening up this CU and making it more flexible to the universe of students that composes it.

Objectives and Expected Competencies

As defined in its CU, this course evidences the complexity of environment and health fields and the importance of understanding them as social constructions. The environmental crisis, the degradation of ecosystems and their impact on health and wellbeing of populations, resulting from the current demographic transition as well as from the increasing depletion of 'natural resources' (whose access is unequal), losses of biodiversity and aggressions on geodiversity and climate change, challenge societies in their organization and ways of life. To understand its configuration, causes, and deal with the consequences it is necessary to consider the multiple dimensions established between the environment, social structures and agents. Its complexity requires an holistic approach.

The theoretical approach derives from sociological and social sciences studies belonging to multiple theoretical-methodological traditions that have dealt with socio-economic, geographical and cultural contexts. Throughout the semester we post information on the specific thematic topics not only with bibliography but also with practical examples and formative exercises, that is, empirical studies and/or questions that will help students to understand the main aspects of the proposed contents, complemented by practical work applying the theoretical instruments to the context in which they live.

In accordance with the objectives, at the end of the CU of EHW students are expected to be able to:

- Discuss the environment, health and well-being as social constructions;
- Know, analyze and understand the impacts of environmental crisis in social organization in general, and in human health and well-being, in particular;
- Critical analysis of the environmental field governance in order to identify the underlying concepts in policies, programs, and professional organizations that implement them;
- Identify and discuss the economic dimension of 'environmental phenomena' (turning knowledge and goods into resources);

- Identify and critically analyze the societal challenges that the environmental problem introduces in a multiscale global context;
- Know and discuss the plurality of knowledge and socio-cultural practices around the environment and the challenges to the social sciences;
- Deconstruct social participation incorporated in the overall management of environment and their importance for social change;
- Analyze contexts and develop local action plans directed to the prevention of environmental and health crisis.

To achieve these goals and competencies, a "Table of Contents" is proposed to the students, as follows:

- Environment, Health and Wellbeing as social constructions;
- Environmental crisis, social organization, lifestyles and socio-environmental inequalities;
- Governance of the environment and health: between the state, the market and the community;
- Societal Challenges in the Age of Globalization: science, economics, society, plural knowledge, interculturalities and environment;
- Case Study: Adapting to Climate Change.

In virtual classes, we systematically encourage students to contribute to the discussion by sharing their knowledge and experience. An analysis of the central concepts of the course (environment, health and wellbeing) in diverse cultural contexts is also submitted to the screening of cultural-social-geographical relativization and their relationship with the multiple dimensions of the phenomenon, namely with the development of an E-Folio work based on the particular case of their own context of living: in particular, they are asked to map and analyze environmental problems in their locality.

As a result of encouraging the students to discuss these matters in virtual classes and in E-Folio forums, we witnessed that in most cases students in the curricular unit forum are not always able to mobilise their contextual and cultural everyday knowledge, mainly because they do not value it or because it corresponds to routines that they believe to be outside the scope of the CU, as we have also found in previous work (Alves and Araújo 2012). On the contrary, in the E-Folio forum, 'forced' by the evaluation they need to obtain, we witnessed interesting debates on the role of cultures in the social production of environment, health and wellbeing, and on the way they understand, explain and deal with these phenomena. Here a key example is Climate change. As we have already analised in previous studies with other curricular units (Alves and Araújo 2012) this fosters the emergence of important breaks from common sense, particularly when it is already shaped by western perspectives that reflect a certain knowledge and power relations that hidden other types of knowledge and interpretations based on other symbolic universes (Alves et al. 2013, 2014). This is, no doubt, one of the axis future researches should explore—the establishment of a link between the curricular components, cultures and globalization, which will hopefully allow a more

contextualized and co-productive type of learning. We are certain that this issue is central to the educational success of our students. Cultural stereotypes about their performance are common and, in the case of students from the Portuguese speaking countries in Africa or Brasil, that stereotypes along with the inequalities they face, establish a connection between the lack of success and the origin from different cultural contexts (Alves and Araújo 2012). The central question here is the plurality of symbolic universes and the need to integrate this (of representations, explanations, interpretations, meanings, senses and actions) in the conception of the courses. Is a complex and hard task, but it is a wonderful opportunity to promote success and to value diversity. This will captivate the attention and the interest of students in a learning process with close cultural related contents, which are meaningful for them. This can be done using other materials than the ones provided by the occidental science, valuing local production of knowledges.

Working Methodology

In this CU we problematize the concepts of environment, health and well-being. Given its multidimensionality we resort to the contributions of the social sciences and the environmental sciences. In this curricular unit and without the pretension of entering the quarrels around the classic positions that underline the dichotomies between nature and culture or nature and society, the environment, health and well-being are analysed also as social constructions. The current world can no longer fail to reflect on the environmental crisis and its impacts on the health of populations and their well-being, thus taking as a point of reflection the relationship between environment, health and society and ethical dilemmas that impose on us. Health understood here in its broadest sense that includes the well-being and quality of life that are determined by environmental, biological, social, cultural and psychological factors. The World Health Organization estimates that 24% of the disease burden and 23% of premature deaths are attributed to environmental factors. This trend has been increasing in recent years as a result of global warming and extreme events in the context of Climate change. It is the complexity of the interrelationship between society, environment and health that will provide a critical reading on the phenomena with which we are confronted today, as scientists, professionals and citizens and that will make us aware of the emergence of action. As Giddens (2009) tells us, we are in an era of doing something that no civilization was responsible for doing. This will mark the future story and determine our life on earth.

In this CU, environment, health and societies are used to demonstrate their interconnection with geographical and cultural diversity, inequalities, gender, social class, ethnicity, religion, etc. To analyse and study these issues, we rely on texts either from social sciences and environmental sciences, as well on movies and other resources available through the Internet as open access material.

The working methodology adopted comprehends individual reading and reflection, the sharing of the reflection and the study done with other colleagues, clarification of doubts in forums and the carrying out of training activities concerning the thematics that are dealt with. From the moment they enroll in the CU, students have access to a working plan, discriminating the distribution in time of the several topics/themes, the activities and their working guidelines, so that they can plan, organize and carry out the study. This is complemented by other information that is regularly given in the virtual classroom.

What we have seen is that the activities developed throughout the semester are highly dependant on the interaction and involvement of the students. Interaction is a field that should be further analysed in order to understand which factors could influence the relationship between interaction levels and effective learning (Alves et al. 2012). In fact, we witnessed that the levels of interaction are related not only to the students' available time and the old habit of postponing the study to the very last day but also to cultural issues as we have already seen in previous study (Alves et al. 2012). In practice, it appears that when a student mobilizes knowledge, presents different or complementary proposals to what has been suggested, gives examples, shares reference bibliography, videos or other resources, he ends up by achieving a better result both in the continuous evaluation (work conducted on the virtual classroom) and in the final exam. And this works as a reminder that there is another area of research that should be taken into account: the competencies of the teaching team, which must include the capacity to continuously encourage students to actively participate in the learning process, as we have already stated in previous study (Alves et al. 2012).

Enrollment in the CU

Social Sciences students enroll in this CU, which is optional, for different reasons. We encourage students to explain those reasons and to introduce themselves to the class, either on the students' forum or during the presentation class.

Tasks

Tasks to be performed by the students are listed on the predefined schedule programme, which is available online.

The CU is organized by topics, which are opened every week.

Tasks to be performed are listed on each topic, are announced on the news forum and are also discussed on forums.

Evaluation

As in class attendance teaching, students may choose between two forms of evaluation: continuous or final exam.

Students who opt for the continuous evaluation have at their disposal a personal Learning Card, where their evaluation gets registered throughout the semester. The Learning Card is a user instrument and students can only access to their own card.

Students who opt for the final exam can follow the guidance given on the platform, as well as the formative training activities that are made available throughout the learning period. Informally they can be able to access the evaluation instruments used for the continuous evaluation scheme: E-folio and P-folio.

Delivery and Evaluation of Work

After handing in their works, the teacher evaluates them and makes comments. The student has access to the evaluation criteria and can make his own evaluation and learn from it. This CU takes evaluation very seriously and the teacher and tutors make an extra effort to try to understand the way students appropriate syllabus contents.

The information given to each student explains the score obtained and gives suggestions on how to improve further their work.

Reflection Based on the Organization of the Curricular Unit of "Governance of Climate Change Adaptation"

This CU (6 ECTS; Online teaching contact: 26 h contact in 156 h, total study hours of student) intends to award and promote actionable ideas and concrete projects designed to support communities in preparing and responding to climate change, improving local resilience through enhanced preparedness and also focuses the attention on core aspects of the 2030 Agenda for Sustainable Development—namely Goal 13 (*Take urgent action to combat climate change and its impacts*).

Online learning syllabus tends to adapt to the needs of students (learners) and the way they access contents. In the programme of this CU, diversity/variability is, however, limited: control over contents to be taught and their sequence is predetermined on the Curricular Unit Plan. Ideally, the objective of the work proposed should be built in such a way as to allow the development of specific competencies and, in that sense, the sequence of events and proposal should be predictable. However, for each subject analysed we have increasingly tried to integrate the multicultural components, opening up this CU and making it more flexible to the universe of students that composes it.

The contents are:

- The nature of the problem;
- Impacts of Climate Variability on Ecosystems;
- Interactions of Environment and Society (Impacts of Climate Variability in Societies and Economies);
- Climate Change and Health (Environmental, Public, Human);
- Local perceptions, understandings, and explanations;
- Climate Change Research, Dissemination, Communication and Information;
- Governance of Climate Change Adaptation.

Objectives and Expected Competencies

Expected learning outcomes are:

- Understand the elements of Climate that affect Climate Variability (Climate Change, Global Warming and Extreme Events);
- Understanding and Explaining the Impacts of Climate Change on Biological, Ecological, Environmental (including Environmental, Public and Human Health) and Socio-Environmental Systems;
- Analyze and Compare Mitigation Measures and Instruments and Strategies for Adapting to Climate Change;
- Interrogate, Argue and establish the relationship between Knowing and acting: how to change behaviors?
- Evaluate and Criticize the Policy Instruments/Plans/Strategies for Adaptation to Climate Change at Regional, National and Local Level;
- Promote and act in the definition and implementation of adaptation strategies to climate change.

Knowledge and skills will be achieved through: (i) Progressive awareness of the problem (considering its multidimensionality and inter- and multidisciplinary understanding); (ii) Significant Learning and Mobilization of Knowledge (learning concepts, understanding meanings, confronting problem situations, constructing arguments and drawing up proposals/plans and strategies/action); (iii) Problematization and discussion of research results (whenever possible resulting from the scientific activity of the teacher and the team that coordinates) by adopting PBL strategies (Problem Based Learning).

Working Methodology

Teaching-learning methodologies (including evaluation)

According to the pedagogical virtual model of UAb and its four major principles.

In this CU only continuous evaluation is used (100%). The evaluation activities (research, individual and collaborative work and debates with peer-review

dimension) are designed for students to acquire and consolidate the acquired knowledge. The learning materials, course e-activities in the form of written assignments (individual and collaborative) and collaborative discussions allow students to achieve course competencies and objectives of knowledge acquisition, comprehension and practical application of the acquired consolidated knowledge.

The continuous evaluation includes several tasks/strategies and pedagogical instruments e.g. blogs, individual and group projects, essays, Problem Based Learning, Case Studies, participation in the discussions, research reports and online tests). Individual evaluation activities can contemplate the elaboration of short papers or a project with online presentation, discussion and defence.

The Challenges of Cultural Diversity to Higher Education

Diversity is an instrument that enhances research and teaching. Its recognition in the 21st century opens up higher education to unprecedented challenges that require new positions, new theories and new actions, that is, new policies. Diversity of experience, age, gender, ethnicity, religion, social backgrounds, cultures, and many other contributes positively to the enrichment of teaching and researching context. Several countries have created special laws to integrate these diversities. Brasil is an example of positive discrimination of black people to be admitted in universities. For various reasons, including technological responses, universities have been receiving and integrating an increasing demand for education from populations that had been traditionally excluded from pursuing their studies in university. The democratization of Internet and their development allowed institutions to find new ways of teaching and learning and also doing research (Chávez 2011).

But our reflection is about the multicultural and geographical diversity that characterises our students. In fact, distance learning, by allowing people who are far away from university centres to conduct higher education studies, has contributed to qualified people who would not have that opportunity. In this particular case we have students from the interior and rural areas of Portugal at the same time that we have students that live in other European cities or in countries where the official language is Portuguese (like Mozambique, Angola, Brasil). Despite this diversity, generally the contents integrated in the Curricular Units are homogeneous and don't take into account the cultural specifics and differences.

Educational policies on higher education have not yet addressed the problem of the cultural specificities and their impact on the learning process of students, and that reflects a weak link between universities, societies and the socio-cultural needs of local populations. This must influence research agenda in order to invest in theoretical and empirical research on the possibility and the need to develop contents that shape cultures and local realities.

The research agenda must also evidence the multidisciplinary and interdisciplinary approaches that some fields of knowledge require, as it is the case of Climate change. Interdisciplinarity and multidisciplinary requires first of all a depth respect

for all disciplinary contributions to the understanding of the multiple dimensions of the phenomenon. That multicultural/intercultural and interdisciplinary/multidisciplinary vision must reflect on the different components, contents, competencies and evaluation systems to be developed.

We are certain that the establishment of closer ties between the interdisciplinary and multidisciplinary components of the CU and the students' cultural environment will result in learning that facilitates autonomy and social emancipation and that value the diversity of knowledge and contexts.

Conclusions

On the organisation of the programme of these CUs, we decided to make a break with the "universality" of the educational policies and contribute to the need to break with the apparent universal categories that science discloses.

The educational institutions in general have following a model of teaching in which the specificities of each student, gender, age, lifestyle, ethical, educational and social origin are not taken into consideration. This is even worse in the case of distance learning where education have become standardised worldwide. Analizing this two CU we tried to evidence the importance of addressing these challenges posed by multiple cultures and the need to integrate this knowledge on the learning contents. Also, perceiving the multiple dimensions of knowledge that contributes to understanding climate change, became evident the need to cross disciplinary borders in the analysis of Climate change challenges.

In order to prevent education from reproducing social inequalities, we have to recognize the existence of diversity of our students and value their cultural and intercultural understanding in order to achieve the needed articulations. We must value that diversity in our teaching practice is a potentiality that must be addressed and that requires new theoretical and methodological interdisciplinary instruments and procedures aiming the success of learning and bringing sciences closer to societies.

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Innovations in Climate Change and Sustainable Management in Higher Education. Training and Evaluation

Maria Julia Rubio Roldán, Glauco Gomes de Menezes and João Carlos da Cunha

Abstract Spain and Brazil have played two significant roles in the field of higher education through inter-university cooperation; on the one hand, highly updated contents relating to sustainability and, on the other hand, an innovative system for the evaluation of education through competencies. This chapter presents an analysis of the model of integral sustainable administration. This model combines social, economic and environmental factors based on the most outstanding contributions in this topic, and coins the concept of "socioecosustainability" as a necessary model for the 21st century. Furthermore, an educational process on the basis of the model of climate change is evaluated. Conclusions provide useful recommendations in order to improve higher education around sustainability from the point of view of acquiring fundamental competencies for the development of professionals in truly sustainably organizations.

Keywords Sustainability · Administration · Competencies · Climate change education · Distance learning

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Introduction

This assessment model is designed to verify the performance of the Education in Climate Change and Sustainable Administration project put into practice by the Applied Social Sciences Sector of the Department of General and Applied Administration at Brazil's Federal University of Paraná (UFPR). The project develops a model for instructing students based on an awareness of the fact that sustainable management models are now vital given the environmental and socio-economic conditions within which institutions operate; they are also crucial in terms of the social, economic and personal implications that are unfolding as a result of climate change and its effect on human and industrial development processes.

The project, whose prime movers are the UFPR and FIEPR (the Industries Federation of Paraná State), aims to provide an education in climate literacy as part of the sustainable management and climate change models, and is targeted at students on undergraduate courses in Administration; this investigation project aims to extract key guidelines in order to reformulate and update the training offered to graduate students so that it is more in line with the realities of sustainability and climate protection on an international level. The project includes the development of a course to train and prepare teachers with the idea of producing specialists capable of incorporating the principles of sustainability in their undergraduate students, as well as taking an active part in other pedagogical projects that focus on the new requirements that distance education demands, with special regard for the contribution that sustainability can make to the protection of the environment.

The experience acquired shows that it is important to analyse the results obtained from a perspective that includes the objectives of the agents most directly involved in their development, namely the students, the educational bodies responsible for providing the education and the FIEPR, within the PRME/UN[1] model. This involves an assessment model that is to be sustainable, given that it includes the demands of both the institution that has convened the course as well as those of the students who attend it; and by definition it respects current climate protection demands. This assessment model is innovative because the criteria used for evaluating the quality of the course imparted by the UFPR are not only marked by the professors but also by the students, who participate in the definition of the objectives of the education they receive, and hence in the appraisal of the Sustainable Management course.

This chapter examines in depth the concept of sustainable administrative management by describing the training project in Sustainable Management, and then presenting a model that can assess the students' level of climate literacy, to conclude with suggestions for new strategies to enable implementation of the educational model.

[1]Principles for Responsible Management Education. http://www.unprme.org/.

The Concept of Sustainable Administrative Management

The meaning of sustainable administrative management is monosemic in that it cannot be applied to other disciplines as its context is strictly limited to the administrative processes that develop in all institutions, be they public, private, foundations, businesses or non-profit organizations. It is a holistic and ambitious concept that embraces social, political, economic and environmental elements, and which advocates a model for the usage of these elements that guarantees the "achievement of the objectives of today's generations without jeopardizing those of future generations" (Ramirez and Sánchez 2009).[2] In this chapter, we present the concept of "socio-econosustainability" as an integrated vision of the analyses that must be made in order to guarantee the feasibility of the management model required by the complex and increasingly compromised times in which we live, in which humans must learn to coexist within an endangered world ecosystem (Houtart 2014). Human beings exist in an extremely complex ecosystem in which numerous factors intervene; when the fine balance between them is disrupted, the effects can be highly negatively (Global Conference on Business and Finance Proceedings 2014, p. 971). Thinkers in ancient times, referred to the need to find the right balance in each individual, as a guarantee of personal satisfaction and as the basis of personal development. Ancient civilizations had already worked out that neither power, money nor pleasure guarantee human beings complete satisfaction, and ever since we have been striving towards that goal. So, resolving problems must include finding solutions that account for human needs, and which respect not only the environment but also our own personal and social nature.

The concept of socio-econosustainable administrative management is based on a perspective of nature as a whole. This holistic approach to the concept of "nature" coalesces, from the macro to the micro perception, in a single decision-taking form. So, sustainability is perceived not just as a form of decision-taking, by preserving the environment, but it also aims to guarantee quality of life and human, social and personal well-being based on the model Triple Bottom Line (Kannan et al. 2012; Giannetti et al. 2012). Far from considering well-being as society's capacity to consume, we see it as a deep form of satisfaction with life and the decisions taken throughout (Sen 1999, 2002, 2004). Seen from this comprehensive perspective, sustainable management plays a fundamental role as it aims to reconcile human needs with the socio-economic requirements of organizations together with conservation of the environment and cultural heritage. According to the United Nations:

> Concurs with the commission that the critical objectives for environment and development policies which follow from the need for sustainable development must include preserving peace, reviving growth and changing its quality remedying the problems of poverty and satisfying human needs addressing the problems of population growth and of conserving

[2]And also at http://www.un.org/sustainabledevelopment/es/la-agenda-de-desarrollo-sostenible/.

> and enhancing the source base, reorienting technology and managing risk, and merging environment and economics in decision making (Comisión Brundtland. UNITED NATIONS 1987)

Traditional institutional problem-solving models formulated a need to be covered, and the necessary mechanisms were set in motion to invest sufficient resources to satisfy this need. For decades, the natural resources closest to hand were deployed to satisfy such needs but without applying the same criteria as those used in assigning economic resources.

Figure 1 shows how the traditional model, when dealing with a need to be satisfied, managed the resources within its reach in various ways according the model's understanding of their availability. Natural resources were available and accessible. Exploiting them required certain means, human and/or technical, for their extraction and/or manipulation. Obtaining specific natural resources, or to access labour or technology, sometimes involved managing and adapting policies and regulations in order to get the product or service to cover a specific need; social resources refer to the political administration and management systems that each territory develops. In this figure, economy is understood to mean the management of scarce resources, so the figure as a whole describes economic management, to which monetary factors can be applied, or not.

The inefficiency of this model applied from the era of economic development policy of the 19th and 20th centuries has resulted in the creation of a growing and widespread awareness since the 21st century stablish the need to attend to the equilibrium that climate change demands in order make it compatible with human life; it therefore requires that we design a suitable form of management in which all the elements concerned in covering needs are represented, so that the product and the process become part of an integrated management system and hence conceived in a global and sustainable way.

Figure 2 explains the sustainable management paradigm through a search cycle of sustainable solutions to needs or problems. This paradigm is based on the Triple Bottom Line and Leont'ev's model. The question-and-answer cycle enabled us to generate what we have termed the Sustainable Organizational Response Staircase. Each stair represents a sustainable response which, in turn, then creates new contradictions to be resolved by new and improved sustainable responses.

The contradiction involves the dialogue between the solutions to certain problems and the conflicts that arise, which generate new problems or needs that up to then did not exist. The contradiction assumes that development is not attained by one single response but rather through a sequence of responses and resolution of

Fig. 1 Synthesis of the management of scarce resources model in the 19th and 20th centuries

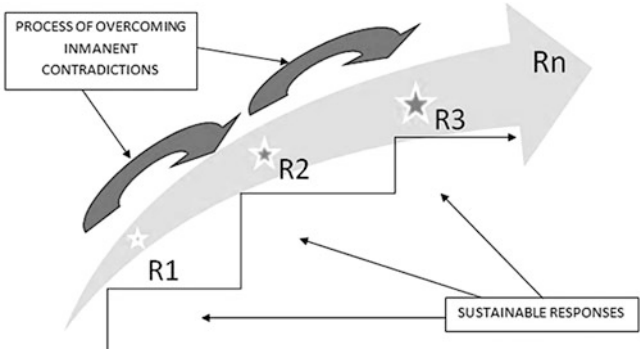

Fig. 2 Sustainable organizational response staircase

problems and needs that have emerged progressively throughout the history of Humanity. In this sense, Engeström (1987, p. 82) states that "(…) any specific type of production is simultaneously independent and subordinate to total social production (…). Within the structure of any type of productive activity, a contradiction is renewed as a conflict between individual actions and the total activity of the system."

The presence of contradictions within the solutions found to resolve problems or cover needs occurs naturally as one solution is implemented and interacts with other factors. This dynamism sees the environment evolve and new problems or needs generated as a result of those contradictions that must also be resolved in a sustainable way. Figure 3 shows an administrative functioning paradigm to find socio-econosustainable responses. This paradigm is built on a sustainable approach that must act as the pillar, base and substratum of any change in organizational behaviour for taking decisions in the areas involved.

As already mentioned the paradigm is cyclical, since a new organizational response, through its process of implementation and application, poses a new set of contractions. The new problem or need takes shape around three axes which have been called the Triple Buttom Line and which considers that the problems or needs that emerge in organizations coalesce around three key questions, the economic, social and environmental. So, any problem that emerges is the result of a lack of harmony between these three factors, and opens the possibility of achieving sustainable development in the solution of their contradictions.

At this stage of the process, a profound dialectic takes place between all potential options, with debate centred on each possible solution during the analysis of the interaction between these three key elements. This conflict embraces technological, technical, moral, philosophical, ethical, anthropological, geodemofigureic and political questions, among others, and the solution frequently adopted is not a total solution but one that is deemed to be the best possible solution at the time, as it must try to balance the social, economic and environmental axes. The model that we present is a paradigm, and so the response that is found materialises in a series

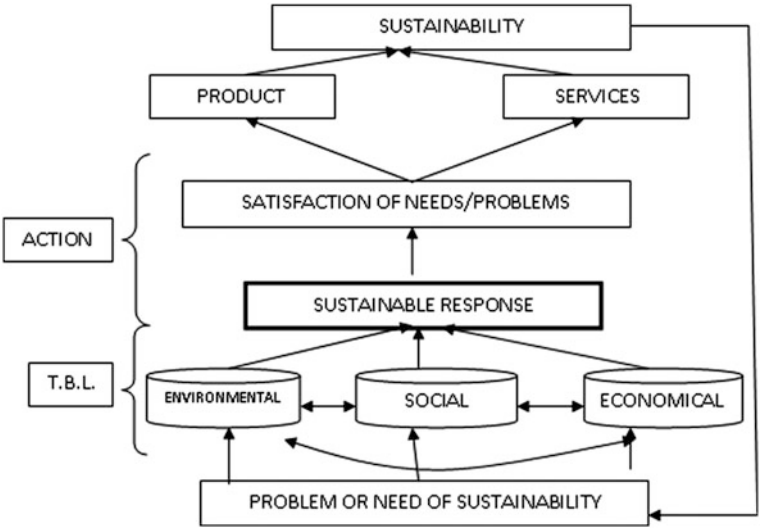

Fig. 3 The sustainable management model

of actions that affect products and services that are either new or which already existed and which had to undergo sustainable modifications.

Proposal for the Assessment of Climate Literacy

Assessment plans are often ambitious and cover a wide range of aspects for evaluation. A typical assessment plan considers elements that go beyond students' learning, such as the methodology applied, the classroom environment, the didactic material, the management of the course and its impact. In line with the objectives of the training course presented in this chapter, assessment focuses on the students' learning and the impact of the course in relation to climate literacy and education in climate change; so, the assessment in this work centres on the acquisition of attitudes that are appropriate for a manager in sustainability who is keenly aware of climate change.

We therefore need to formulate these expectations in an objective way, and clearly define the type of graduate profile the course wants to achieve. The aim of the course is for students to acquire skills that complement their training to ensure that they can apply and develop sustainable management models in accordance with the requirements of a new society committed to the human being and its habitat, and respect for the environment and its various ecosystems.

Sustainability can be considered an end in itself, and in these circumstances it constitutes a suitable medium for protecting the environment. However, the evolution of the project presented in this chapter reveals that sustainability is not just an

objective but it is also a means by which decisions influenced by the very features of sustainability are adopted. Sustainability is an end in itself, and also a means for achieving a goal, and in this working group we see that it also responds to a particular attitude that is suitable for searching for solutions and resolving problems within their corresponding economic, social, cultural and personal framework. This has led to the main rectors of the course to add attitudinal aspects to the instruction of sustainable managers, and these aspects are:

- A holistic and systematic vision of the world and its natural, economic and social relations
- A collaborative and inclusive approach instilled from the beginning
- A research-action-research attitude
- Respect, integrity and solidarity
- An "everyone's a winner" work model
- Dialogue: a space to express oneself and understand
- Discover and consider mutual interests
- Experimentation
- Commitment and responsibility
- Vision of the future in reflections on the world that we want and the world being built around us
- Reformulate the meaning of short-term success

This holistic attitude responds to a profile of a person with special managerial and administrative characteristics that can provide the organization with a new focus on management models according to tried and tested general systems theories. The course we evaluate defines the features of a sustainability manager as:

- Innovation and Openness to change
- Enterprising
- Leadership
- Sustainable values
- Collaborative working method
- Research and sustainable development
- Association and systematic work
- Dialogue and organizational communication

The assessment of the results took into account that the student who did the course had previously been selected in accordance with strict criteria. The selection process involved the UFPR's Department of General and Applied Administration and the FIEPR, and it considered the student's academic record, a piece of written work presented by the student and a personal interview by each body involved in the course.

The assessment model we propose is based on the analysis of the competences acquired in relation to four categories. Checking whether skills had been learned and assimilated was done by monitoring interaction in four categories that we subdivide, and which the course aims that each student attains. The categories are:

- Content:
  This is the most theoretical part of the course and relates to concepts, categories, classifications, models, paradigms, authors, etc., all of which a student must know in order to undertake the sustainable management of the organization and uphold respect for the environment within the entrepreneurial sphere.
- Skills:
  This deals with learning processes whose goal is products and concrete results. These include procedures; the operational nature of what one needs to know to get something done in order to coordinate spaces and tasks in a sustainable setting and produce services or products that respect the environment.
- Attitudes and values:
  These are of an intrinsic and extrinsic nature, and constitute the most intangible but significant aspect of the changes that the course aims to foment in the new managers.
  - Intrinsic: the student's own values that have been adopted in a responsible way; these are non-transferable and difficult to know without dialogue and acquisition of a deep knowledge, with emphasis on the student's sensibility towards caring for the environment.
  - Extrinsic: these are acquired by interactions that the students establish; they refer to their setting and each element that forms part of it, emphasizing a markedly sustainable innovative spirit.
- Learning strategies[3]: especially those related to team work and leadership.

What follows is a formulation of the items for validation derived from the course and the information extracted by coaching experts.[4] It is a tool to be applied by the promotors of the course to the students to verify the validity and quality of the education they have received. It is important to note that the categories are not closed but act as keys for commitment in the assessment and acquisition of knowledge that is global and applicable to the world of management from an innovative and sustainable perspective.

Here we describe the indicators extracted from the information obtained. The leadership characteristics we identify are:

- Ability to communicate, communication being an assertive act that understands the interlocutor's points of view and respects his/her interests without losing sight of your own.

[3]The student undergoes a self-management process of change and improvement based on the learning they acquire. At this undergraduate level, the student is associated to processes of metacognition, meta-comprehension, self-training and transference.

[4]Interview with L.E. Munevar, an expert in coaching with over 15 years' experience in the field. The interview discussed the leadership characteristic of Charisma; however, we did not include this feature as an indicator in our model given the nature of the course. We understand coaching to be "*as a process of growth and change*". (Williams and Menendez 2007).

- Understand and control your feelings and, in the medium term, those of the interlocutor. Recognize that what moves people is not application of pressure but the emotions, and how to apply that to motivate people to take action, because involving people on an emotional level elicits better results.
- The ability to visualize yourself and your team in the way and a place where they want to be seen. Establish the mission and plan objectives coherently with good use of human resources, materials and time with regard to the sustainable organizational focus.
- Know yourself, identify your own strengths and weaknesses and know how to identify them in team members, in order to be able to cover the various needs posed in the achieving of established objectives, based on the team's potential. Encourage and enable each person to do what they know how to do best.
- Maintain a constant level of personal growth and development, and promote the development of each group member.
- Letting go of control of the projects by knowing how to delegate functions. Ability to allow group members to carry out independent actions when performed responsibly, naturally and efficiently.
- Ensure you are always well-informed.

To understand the entrepreneurial features that respect environmental sustainability, and which are based on a climate perspective, requires an analysis of the person's own development. Its starting point must be what is to be achieved within a precise timeline, and what a line of personal and professional development is to be. These entrepreneurs must be able to see themselves in a personal and professional context, and view their project in the world which they are part of and which they want to form part of. The success of the entrepreneur occurs when both lines run in parallel. With this in motion, their main characteristics are:

- Persistence and perseverance, as the ability to be constant in striving to achieve an objective; even obstinacy in adverse situations in order to extract learning from each situation and readjust processes.
- Innovation as the capacity to create new settings and plan new ways of doing things that disrupt old routines and patterns of doing things in order to resolve old problems.
- Resolving situations with pragmatism and determination, even assuming that it is necessary to advance without the right resources. Ability to get involved in direct and coordinated action.
- Begin by operating in areas in which you are an expert, so that this interest deepens your involvement in these areas.
- Make your ideas attractive to others. Ability to convince others, which depends on four factors: creativity, innovation, usefulness (offering society a valuable product or service) and sustainable benefit.
- Flexibility and adaptability to the real environment without deviating from the direction of the base idea.

- Ergonomy in products and facilitator of services that simplify people's lives, respecting the medium in which we live.
- Positive attitude. Keep reactions balanced: sensitive to people and their bioclimatic medium; optimism and capacity to create an optimum climate and atmosphere.
- Being realistically aware of the potential of the situation and the expectations for balanced sustainability between profit and respect for the environment.

Finally, the indicators that describe "openness to change and innovation" are the following:

Disrupting paradigms, which means being open to proposals for new ways of doing things. Innovation only really occurs when the product or service is successful because if it is not spontaneously successful it has no value. The key to innovation is mass use[5] (Figueiredo 2009, p. 31) of the product or service. Disrupting established patterns of behaviour and routines enables vital transitions on the path to innovation. It is necessary to work with these established ways in order to introduce innovations. These routines are related to people's paradigms so it is important to modify the paradigms. Changing the paradigm depends on the personality of the team member.

- Be alert and pay close attention at all times to understand the barriers to change, identify old patterns of behaviour, routines and paradigms in order to anticipate their responses and help to break them down.
- Emotional intelligence, which is achieving a balance in order to withstand the personal pressures that can build up at work.
- Understanding that needs can be turned into opportunities that can promote change in the team members and in the material aspects of the organization, and especially in harnessing the needs and potential of the biological, environmental and climate setting.
- Keeping communication channels open between all working groups, both vertically (superior-subordinate) and horizontally (among coordinators).

The information in Tables 1 and 2 enables us to formulate the keys to the questions that we need to assess.

[5]"Ou seja, inovaçao implica unir diferentes tipos e partes de conhecimientos e transformá-los em novos productos e serviços úteis para o mercado ou para sociedade." (Figueiredo 2009, p. 31). ("That is, innovation implies join different types and parts of knowledge and transforming them into new products and services useful for the market or for society" T.N.).

Table 1 Design of the items for assessment

Categories	Competences	Objectives	Items
Content	Openness, integration and context analysis	Integration of participants and social contract	Theoretical exams prepared by the teachers.
		Globalization, geopolitics and geo-economics	
		Sustainability and professional training	
		Evolution of the organizations	
	Cross-curricular subjects	Change and strategy in the Organization	
		Systematic analysis	
		Social and ethical behaviour	
		Innovation and sustainability	
	Functional and technical subjects	Marketing with sustainability	
		Production with sustainability	
		Logistics with sustainability	
		People management with sustainability	
		Social analysis of projects	
	Consolidation of theoretical stages	Sustainable globalization: challenge and opportunity	
Skills	Practical work	Develop a sustainable project inside the company	Differentiate between a sustainable and non-sustainable project
	Leadership	Ability to communicate with a wide range of different people	Can you recognize the different types of emotions and feelings in people when you are speaking to them?
		Control your feelings	Can you control your emotions?

Table 2 Design of items for assessment

Categories	Competences	Objectives	Items
Skills	Leadership	Establish targets and plan objectives	Do you know how to plan targets and objectives?
		What are your strengths and weaknesses?	Can you identify your strengths and weaknesses?
		To be constantly growing	Do you know how to relate the disciplines of administration to the various social, economic and environmental contexts?
		Delegate functions	Do you know how to delegate responsibilities?
		Ensure that you are always well-informed	Do you read journals, chapters, blogs and websites covering a wide range of subjects?
Attitude and values	Enterprising	Persistence and perseverance. Extract learning	When things aren't going well, do you keep on trying?
		Innovation as the ability to create new ways of doing things.	Do you usually come up with new ways to resolve problems?
		Pragmatism and determination	Do you take the initiative in order to solve problems?
		Begin by working in areas in which you are an expert	Do you know the areas in which you are an expert?
		Making ideas attractive to others	Can you convince others of your ideas?
		Flexibility and adaptability	Do you adjust your plans according to events as they unfold?
		Make things easier for people	Are your ideas easy to execute?
		A positive attitude	Are you optimistic and cheerful?
		A realistic awareness	Are you objective in your thinking?
Learning strategies	Openness to change and innovation	Solutions applied on a large scale	Are your ideas accepted by other people?
		Disrupting established patterns of behaviour and routines	Do you usually accept that others do things in their own way?
		Be alert and pay close attention in order to identify barriers	Do you know how to read between the lines in terms of what people say and do?
		Emotional intelligence	Can you keep your emotions under control in personal conflicts?
		Taking opportunities	Can you identify opportunities for change and improvement?
		Maintaining communication channels open	Can you get people to communicate clearly?

Conclusions

The total population of students who received the training numbered 100, spread over two academic years. Of these, 68% of the students from one year and 18% from the other completed the questionnaires. We assume a bias in the results that could be significant, however we were unable to quantify it. The results of the questionnaires were then subjected to a quantitative and qualitative analysis (Fig. 4).

(a) Objectives achieved
The questions posed aimed to find out students' objectives in attending this course. The answers have been grouped into a set of categories that synthesize the valuations expressed by the students. The direct data show answers that are fairly centred in which a single preferred alternative clearly predominates among the students who responded.
In general, students stated that their objectives regarding the theoretical part of the course had been achieved. It is worth considering whether there is a direct link between *Professional Development* (17%) and *Understanding Sustainability* (17%). If so, it means that a not inconsiderable percentage of students consider sustainability to be a key alternative in the future of industry and the labour market.

As these were the desired objectives, the results have proved satisfactory in the achievement of the targets proposed. The fact that no single student expressed total dissatisfaction in terms of personal objectives points to bias in the group (Fig. 5). This could be interpreted in two ways: considerable and unanimous satisfaction with the course; no deep dissatisfaction with the course to cause a student to give a specific negative response in the questionnaire. So, we can say that the course has more than satisfied students' objectives.

We also need to examine the negatives revealed by the questionnaire, and Fig. 6 indicates students' dissatisfaction with the distinct lack of practical and operational activities; so, the course needs to improve considerably in this aspect.

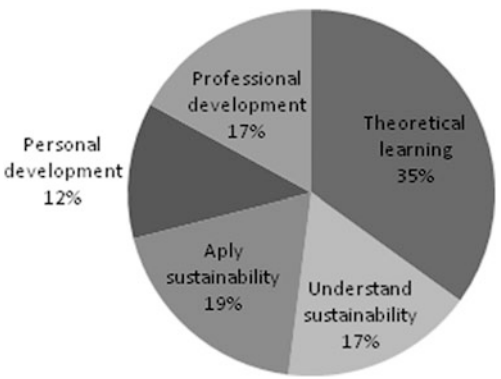

Fig. 4 Students objectives

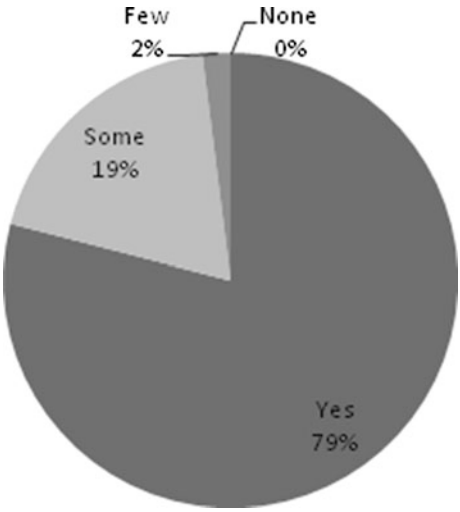

Fig. 5 Achievement of personal goals

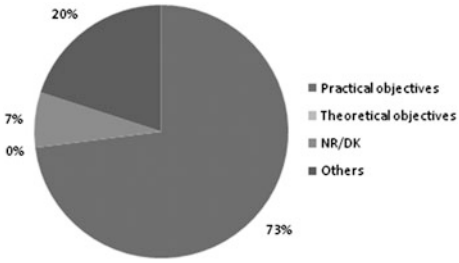

Fig. 6 Unreached objectives

The data marked "Others" relates to agreement among the students regarding a lack of cohesion among the academics in the development of theoretical content. Nevertheless, the quality of the content was not in doubt as the theoretical aspect of the course matched their expectations.

There are other types of learning that the students consider as novel and worthy of comment: these are the achievements of learning acquired by the students on the course although it was not specifically planned that way. The data reveal a wide range of accomplishments, some very general such as *Personal Development*, which includes the knowledge acquired in Philosophy, Ethics, Humanities and other aspects; and others that are more specific such as learning about *Regulations* and standards like the ISO. Students rated very highly their knowledge acquired in *Appreciative Inquiry* and *Leadership* as part of sustainable development and instruction in climate sensibility. We consider that this finding could be developed to compensate for the lack of practical activities in the workshops and seminars ("Oficinas").

(b) Analysis of *Skills*
The responses in this category refer to a set of questions aimed at measuring two objectives: to evaluate the learning and achievements, and to stimulate reflection and acceptance of new guidelines on conduct that foster the appropriate attitudes and behaviour in administrators who promote sustainability.
It is surprising that the response to the question of keeping up to date by reading *journals*, *blogs*, etc., scored low. This is an indicator for new challenges that the university must address. It is one of the responsibilities of the academic staff to form professionals who are up to date with, and well-informed about, current developments; they can do this by providing databases and references in the bioclimatic subject areas that come under sustainable management. Taking into account that the students selected to do the course are the best of their year, the conclusion is that teachers must strive to encourage their students to consult and monitor the relevant databases in the sector.
The general conclusion is that the students rate themselves on average as B-graders in terms of the skills required to be a dynamic manager of sustainability and for generating respect for the environment as part of sustainable management.

(c) Attitudes and values
This is probably the most complex aspect in the training of undergraduates who come to the course with their own set of values and expectations. In general, the results show an average of around B++, yet these stood alongside some very low scores that contrast markedly with the much higher valuations.

(d) Learning strategies
The priority in educating students within a society characterised by technology and access to knowledge is to teach them to learn how to process information and determine the reliability of the source of that information. The average results were quite satisfactory (B++) but again these stand alongside other scores that are considered too low for a group of high-performing students.

We present a general analysis of elements that constitute course competences, which are described below:

(a) Content related to the theoretical and conceptual part of the course.
(b) Leadership, understood as a skill that students acquire as a process that takes place throughout their undergraduate studies.
(c) Enterprise in sustainability, defined as an attitude and a value for which students must acquire a special sensitivity.
(d) Openness to change, being constantly alert to new developments and aspiring to self-improvement.

Of the results we expect to see, we believe that there will be little deviation from the standard in all the responses to various premises:

P1: The students have been selected on the basis of a standard model.
P2: The students have been selected according to criteria of excellence.

Table 3 Option A: validation and implementation as a university extension course

Design phase	Design of the educational programme with experts in the field, and development of the training in collaboration with the students the course is aimed at, these constituting an ideal universe of students selected from the middle years of the undergraduate course in Administration
Test phase	Having confirmed the relevance of the design of the training plan, and validated the material, the extension course is implemented and is open to a group of undergraduate students as heterogeneous as possible; it should always take place during the middle semesters of the Administration course • Compare the results obtained by students using the proposed assessment model, in the evaluation of the results and in the longitudinal evaluation • Promote the distance learning facet of the course, since a significant number of the students who might be interested in the course are working adults with personal and family commitments. It would help them achieve optimum results if 20% of the course was in the distance learning format, and would boost the opportunities for these management specialists without affecting those students who study in the traditional way[a]
Implementation phase	Having confirmed the relevance, need, appropriateness and viability of this training course, as well as the results obtained, the final phase begins by opening this extension course to all students who request a place, to be imparted during the middle semesters of the degree in Administration

[a]Resolução nº 72/10-CEPE Regulamento na oferta de disciplinas na modalidade a distancia nos cursos de graduaçao e educaçao profissional e tecnológica presenciais de UFPR. Brazil

Table 4 Option B: specialist course or doctoral course

Design phase	Design of the educational programme with experts in the field, and development of the training in collaboration with the undergraduates the course is aimed at, these constituting an ideal universe of students selected from the middle years of the degree course in Administration. Compare the results obtained by the students according to the assessment model proposed, with particular attention to the monitoring and follow-up of students once the course is finished
Test phase	Having adjusted the training to the students' institutional demands, as well as considering social, political and economic changes, request approval of the training designed as a doctoral course
Implementation phase	Open this extension course to all students who request a place and who fulfil the conditions set by the doctoral committee; this enables the university to select the best students to form the ideal universe and guarantees maximum use of the course

The possibilities are considerable in terms of the aims of each higher education centre. Here we discuss some of the possible options and suggest strategic guidelines (Tables 3 and 4).

Another innovative application of this course could be the development of the Sustainability Adviser or Specialist Consultancies in Sustainable Management

whose training affords them a broad vision that respects the specific needs of the ecosystem in which human activity takes place, and they are qualified to search for syncretic solutions that respect the aims of the economy, society, culture, politics and people.

For this course to be successful, and in order for it to be implemented across a wide range of higher educational bodies in Brazil, it is vital to start by establishing an interdisciplinary group of teachers who are specialist researchers in sustainability that can serve as a national reference point, in order to develop the scientific and didactic documents with sustainable and innovative contributions, and to promote and advise on sustainable projects.

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Towards Climate Change Awareness Through Distance Learning—Are Young Portuguese and Brazilian University Students Vigilant?

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Abstract Although distance learning and e-learning are currently acknowledged as important training tools for higher education institutions, they are seldom used as a way of disseminating environmental sustainability, climate change and its implications. The work presented here is the result of a teamwork between two universities, one from Brazil and the other from Portugal, which joined efforts to promote an interdisciplinary massive open on-line course associated with the environmental sustainability. We have inquired young university students from these two countries in order to understand which are their main conceptions and ideas about the climate changes as well as proposals they have for its mitigation. From these dialogs, we observed that, irrespectively of the geographical distance/location, those young students, share similar concerns, conceptions and proposals but it is also noticeable a clear lack of scientific knowledge when discussing these topics. This is an important starting point for the creation of a set of learning resources accessible to different audiences and with different and diverse backgrounds that can stimulate the interest on scientific knowledge. In this context it is our believe that eLearning and distance education supported by the information technologies can efficiently and effectively contribute for a well-supported knowledge on environmental sustainability, namely climate changes its causes and effects.

Keywords Climate change awareness · Distance learning · University students Portuguese students · Brazilian students

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Introduction

Back in 1977, UNESCO in its Report on the Intergovernmental Conference on Environmental Education stated that environmental changes were a recent and serious preoccupation despite the existence, already for some decades, of several expressions of concern related to the environment. It was then recognised that the human activities were related to these environmental issues and the scientific and technological development, which also triggered many social changes, supported the acknowledgement of these environmental changes. The development brought by the technology helps to reduce poverty, improve quality of life and increase average life expectancy. Simultaneously it should provide the well-being of future generations. There is, therefore, a vital need for the sense of responsibility in order to achieve a significant awareness of the environmental problems.

This means that environmental education, formal and informal, must play an important role in providing the knowledge, understanding, values and skills needed by general public (UNESCO 1977a).

Climate change is nowadays an important issue for most of the countries in the world since there is a shared concern for all and each one of them. It is a global problem and this means that all countries must cooperate in tandem in all matters in order to evaluate and adopt the most effective mitigation options after taken an economic evaluation for policy design (IPCC Working Group III Assessment Report 5 2014).

Although in some cases they are correlated, common knowledge is often confused with scientific knowledge. In many areas, like agriculture, the importance of the adoption of sustainable soil management practices requires that farmers are scientifically literate (Barbero-Sierra et al. 2016). The growing concern about environmental sustainability from the industries in general can help to achieve better work practices and the integration of sustainability knowledge in many areas is getting more important every day (Ismail et al. 2017; Chugh et al. 2016). Also, there has been a great effort working with young students in order to provide skills to achieve an environmentally sustainable human development (Ull et al. 2014).

There are many daily examples that highlight the importance of formal and informal education, including lifelong learning, for promoting environmental awareness. Moreover there are many NGOs and also the media and even many individuals responsible for this environmental awareness and the use of Internet has been enabling this. In many cases, due to the individual's limitations, the learning process can only be achieved using distance learning systems, usually called open distance learning (ODL) (Anbalagan and Srivastava 2016). Also the continuous development of ICT technologies has been providing new and powerful tools for the scientific knowledge and resources dissemination thus creating the opportunity for universities to reach more and more individuals everywhere.

The interdependency of economic, social and environmental factors for a sustainable development is getting more and more complex, which makes it harder to reach for best actions and solutions. Having this in mind, education for sustainability can help society to be more aware and positively contribute for reducing the

impact of the bigger problems such as energy and climate change but also others more close to each individual fright such as food and water availability and environmental disasters.

According to a recent survey published in Nature Climate Change (Lee et al. 2015) awareness and concern to the climate change differs between countries: adults in developed countries are more likely to be aware of climate change. In developing countries the awareness rates are inversely proportional to the concern: low awareness but very high concern rates. The results suggest that respondents with a higher level of education were more likely to be aware of climate change. Based on these results and further analysis reported in the same study it seems that we can infer that as people become more educated and also experience more unusual weather patterns, awareness and concern of climate change is likely to increase around the world. Thus, education may be an effective instrument.

Shealy et al. (2017) recently reported that in a national survey made in the USA with more than 900 engineering students the civil engineering students are those who less believe that climate changes have anthropogenic causes. The reason for this seems to be their lack of will to address climate change problems during their professional careers. These authors also state that there should be a more complete education program, starting in high schools, covering the climate change topics which could increase students' awareness on these.

On the same note and agreeing with UNESCO: The goal of education is to make people wiser, more knowledgeable, better informed, ethical, responsible, critical and capable of continuing to learn. Were all people to possess such abilities and qualities, the world's problems would not be automatically solved, but the means and will to address them would be at hand. Education also serves society by providing critical reflection on the world, especially its failings and injustices, and by promoting greater consciousness and awareness, exploring new visions and concepts, and inventing new techniques and tools. Education is also the means for disseminating knowledge and developing skills, for bringing about desired changes in behaviours, values and lifestyles, and for promoting public support for the continuing and fundamental changes that will be required if humanity is to alter its course, leaving the familiar path that is leading towards growing difficulties and possible catastrophe, and starting the uphill climb towards sustainability. Education, in short, is humanity's best hope and most effective means in the quest to achieve sustainable development (UNESCO 1997b).

Distance Learning and Its Contributions to the Global Environmental Issues

Information and communication technologies (ICT) are getting more powerful everyday with faster interconnections through the Internet. New applications were created during the last years that have enabled new forms of communication and also new methodologies: teaching/learning spaces are no more space or time limited and

the response is going towards the needs of most of the citizens. Even students that are enrolled in face-to-face graduation courses seek to complement, or increase, their knowledge online. Networks like YouTube or Vimeo have many videos giving them the opportunity to learn more and more. Social networks like Facebook are used by groups of students to share a significant amount of important information. Most of the environmentally related organizations around the globe have invested in having their own mobile applications in order to present their knowledge and environmental concerns, reaching more and more people.

In fact, the use of digital technology is facilitating general access towards new views for the conservation of Nature (Arts et al. 2015) enabling faster and reliable ways to communicate, analyse and discuss data related to Nature and people and, therefore, being more aware about global environmental issues.

Learning using information and communication technologies has gained different approaches—students can enrol in a closed environment, which they must pay, but simultaneously have access to open and free courses. Sometimes this can be a faster and more massive way to achieve some important goal in transmitting crucial information and knowledge. Particularly in the last decade many online communities have emerged corresponding to digital environments applying different collaborative practices, hybrid contexts and shared responsibilities which significantly contribute to the relationship between education, participation and digital inclusion (Aires et al. 2014). It is possible to find many different application examples of the use of these new digital environments. Singh et al. (2015) reported the use of ICT in India envisaging the crop quality certification in order to implement awareness to the importance of safe food since there is a worldwide increasing concern for the food quality and food supply chain. Also Suryawanshia and Narkhedeb (2015) report that due to the sustainable development challenges, universities around the world need to rethink their courses and mission by implementing green ICT—a way of using ICT adopting environmental sustainable policies and practices, minimizing carbon footprint, optimizing energy consumption and conserving natural resources—as a crucial motor towards those challenges. Klimova et al. (2016) also report the implementation of educational programs in green ICT through the creation of an international Master's degree program combining advanced ICT with environmental, economic, and social awareness.

In India there was also reported (Chugh et al. 2016) the growing concern of the industries in environmental sustainability and their will to achieve significant benefits through sustainable work practices namely adopting green ICT practices and also turning professionals more aware to the environmental sustainability. However in countries with serious economic problems like Uganda in Africa, where the population has a low income and education level, Okaka and Apil (2013) reported that there should be used a combination of ICT and personal, face-to-ace, interaction to expand the audience exposure to sustainable environmental messages.

Distance learning is a powerful mean for teaching most of the topics and those related to climate change are not exception. The methodologies used can strongly help to teach and contribute to increase the science literacy of most people and, in particular, their awareness, from the younger to the elderly. In time, distance

learning will become the most used way for teaching, giving everyone the possibility to learn all about any topic they might need either for professional or just any other reasons.

eLearning Towards Global Climate Change Awareness

Understanding the concept of global climate change is not easy for people to reach, despite being a widespread theme. The scientific research and knowledge in this area has been growing every day, but the access of people to it and the viability of tangible actions against the advance of these unwanted environmental transformations, still happens at slow steps.

Often, climate changes and anthropogenic actions are recognized as being correlated (England et al. 2014; Easterling and Wehner 2009). However, the excess consumption, limited food production and land occupation, increasing energy demand, changes in the original vegetation and changes in aquatic environments are many of the anthropogenic actions and the consequences to life on Earth as we know it are of great concern. It is also necessary to understand the real extend of the natural causes of these climatic changes and to establish the debate on the controversies on the subject. Crucial and global environmental problems, such as desertification and the interference of these changes on human health and the planet's biodiversity are still poorly understood. But studies show that the increasing frequency of droughts, rising warming and rapid human population expansion will aggravate the risk of land degradation and desertification in the near future in the dry areas of developing countries (Huang et al. 2016). In this sense, it is always necessary to think in new and better actions in order to achieve greater awareness related to the understanding of the causes and impacts of climate change, promoting greater knowledge on the subject in an interdisciplinary perspective and combating the vision of a purely environmental character, still predominant, associating this theme to sociocultural and economic dimensions.

The role of education for the understanding, protecting and solving environmental problems has been universally recognized (Littledyke 2008; Van Poeck and Vandenabeele 2012; Gadotti 2016; Vilaverde 2005), while at the same time we have a global trend towards a society driven by the acquisition of digital media (Bulman and Fairlie 2015). This access to all kinds of information not only in general terms but also scientific knowledge is facilitated by the information technologies and can promote active learning (Mendoza and Ezequiel 2011), if it is carried out in an appropriate way, with reliable sources of information.

Martinho et al. (2014) have presented a study on the importance of the preparation environmental professionals—from an e-learning undergraduate program in environmental sciences—preparing them to cope with societal, economic and technical changes to perceive and help to solve environmental problems.

E-learning, as a method of distance learning which enables self-learning, through the mediation of didactic resources, allows the wide promotion of environmental

theme discussions, on a global scale. It represents a real possibility that, as citizens willing to contribute to overcome social crises globally, create an opportunity to gradually perform profound changes in the patterns of resource use from criteria of ecological sustainability and social equity.

Therefore communication and information technologies can be configured as powerful tools for the dissemination of qualified scientific information on global climate change, making possible the understanding of the information, aiming to improve socio-environmental quality.

Young Student Opinions About Global Environmental Issues

An interview in the campuses of two universities, one from Brazil and the other from Portugal, was made to a small group of 14 students, randomly chosen based exclusively on their willingness to participate. The interviewed students, with ages between 18 and 23 years old and mainly women, were enrolled in different graduation courses namely social sciences, management, geography, engineering, tourism and international affairs; the interviews took place between October and November 2016. It should be noted that no interviews were conducted on students enrolled in courses related to environmental sciences since we considered that those students would have a greater awareness in what concerns climate change issues.

Educating for environmental science contributes to the development of citizenship, promoting knowledge on issues such as global warming, the greenhouse effect and climate change. It is, however, essential to understand what are the students' conceptions about these themes, particularly young people enrolled in an university degree.

In this context, we developed a descriptive work that involves a Brazilian university and a Portuguese university. The two countries speak the same language, and although they are in the opposite hemispheres of the globe have many common interests regarding the environmental problems, global warming, climate change and biodiversity protection.

The starting point of a larger investigation project was to understand if university students from these two countries really have similar understanding and knowledge related to the above-mentioned topics and have an equivalent attitude facing them. This would give us clues to better organize the subsequent work.

The small set of questions, so they would not take too long, that were placed to the students we have interviewed, were as follows:

(A) What kind of environmental problems exist on the planet?
(B) What are the causes of these environmental problems?
(C) What are the possible solutions for the environmental problems?
(D) Do climate changes have influence on biodiversity?

Naturally, due to the limited number of interviews that were made, and to the fact that this was not a larger and more organized study it is not possible to draw general conclusions about the knowledge these students have presented on environmental problems or to perform a detailed study when comparing them. It is, however, possible to present their views about climate change, its causes and achievements, in order to consider it as a starting point for the development of a training in sustainability education.

It is important to highlight that the conceptions described in this study reflect the sample as a whole and not individual students or of any nationality. Let us consider that, individually, and in a different context from the one used here, we could find different conceptions of those generalized here. We are trying to express the main and most prevalent ideas about the issues raised in interviews with these volunteers.

Thus, a content analysis of the students' answers was made, with the identification of their main ideas. The interpretation of the data did not seek predetermined patterns, but the themes emerged from the data themselves as they took on meaning.

For the first question regarding the identification of environmental problems students referred the topics are summarized in Table 1.

As it can be observed from Table 1, topics as desertification and acid rain were not mentioned. In addition, there seems to exist some confusion between the actions that may lead to some important environmental problems and the environmental problems themselves when, for example, they indicate the over fishing and the increase of the number of industries. The inadequate disposal of waste is mentioned both as an environmental problem (Table 1) and as a cause of environmental problems (Table 2).

It should also be emphasized that health problems due to environmental problems, in particular the human health itself, are not mentioned once by these students.

Fossil fuel burn, sewage disposal, environmental accidents caused by industries and also nuclear accidents were not mentioned from any student when answering to this question although some remembered and indicated topics like the pollution caused by the cosmetic industry. It is interesting to observe that several students referred greed as a cause for the environmental problems—this seems to be a matter

Table 1 Environmental problems indicated by the students

Pollution of water, air and soils	9
Global warming	6
Deforestation	5
Climate changes	5
Inadequate residues disposal	3
Increase of the number of industry plants	2
Sea level raise	1
Greenhouse effect	1
Hurricanes and cyclones	1
Overfishing	1

Table 2 Causes of the environmental problems indicated by the students

Anthropogenic interference, greed, bad use of the natural resources	8
Undue discharge of pollutants (water and soil)	5
Deforesting (problem)	4
Pollution (generally speaking)	2
Lack of education (and attitudes)	2
Unconscious consumption	1
Nature's natural cycle	1
Destruction of ozone layer	1
Climate change (consequences)	1
Soil wear	1
Domestic pollution	1
Cosmetic industry	1

Table 3 Possible solutions for the environmental problems indicated by the students

Awareness of people	7
Education for the next generations	4
Stricter laws and punishments for environmental crimes	3
Change in lifestyle/less consumption	2
To value nature	1
Take the bus and bicycle	1
There is no solution for some existing problems	1
Be careful when disposing individual waste	1
Reduction of gas emissions	1
Social program	1
Rethink the product life cycle	1
Attention to the CO_2 emissions	1

of concern to these young people being the ones from Brazil that most mentioned it. There seems to be a significant conscious about the anthropogenic importance on the climate changes, which also seems to be directly related to a bad use of the natural resources. The water and soil pollution particularly from a lack of a conscious waste disposal is also somewhat important for these young people but the pollution itself, generally speaking, or the domestic one, appeared in their answers. However, the pollution caused by the industry was not mentioned, with the exception of the cosmetics industry.

When asked about what are the possible solutions for the environmental problems, the answers mainly focused on specific and concrete actions. It should be noted that no one mentioned the need to adopt and implement more effective and efficient environmental policies—Table 3.

It is noteworthy that one of the solutions most referred was to increase the awareness of the individuals, which is somehow aligned with their own notorious capacity to address these environmental issues when asked to talk about them.

Solutions proposed like to increase the use of the bicycle and collective transportations in order to reduce gas emissions and carbon dioxide emissions were not presented in a large scale. There was even an answer indicating that there is no solution for the climate change problems indicating already some disbelief in Human capacity to reverse it.

When asked if the climate changes have influence on biodiversity all the answers agreed affirmatively due to the interference in breeding species and causing a loss of habitats.

In general there seems to be a lack of conscious knowledge about the causes and consequences of climate changes in both students from the two countries. However there were no significant differences between the answers of students from both countries concerning climate changes awareness and knowledge. Moreover, when confronted to the questions they evidenced some difficulty in finding and expressing the topics presenting only a small set for each one.

In view of the problems pointed out, there is no change for a more citizen and environmentalist position, demanding policies that lead to an intensification of preventive actions and programs, geared towards economic development based on sustainability principles. Only the word "awareness" is expressed more often.

As in other environmental survey studies (Shepardson et al. 2011) those interviewed students also showed little knowledge about the interrelationships between problems on a global level and many important aspects were not cited as a consequence of human practices.

In Fig. 1 we summarize the main opinions expressed by these Portuguese and Brazilian students that were interviewed.

It can be observed that the answers point mainly to the concern related to the global environmental problems and the lesser answered is related to the main solutions for mitigating them. It seems that these young people are conscientious about the importance of the environmental problems but have difficulty in pointing out some solution. Despite this, most of them seems to agree that the population awareness is an important way to mitigate the global environmental problems—better policies and laws or even more education is little valued. It is almost like if they do not really believe in the human capacity to reverse climate changes problems. The social networks globally available may somehow be responsible for this feeling that there is no need for any formal education as there is a fast information dissemination through the social networks. However, this can turn to be a dangerous factor because that information circulating may be untrue or not confirmed leading to actions that may not be the most adequate.

Deforestation is a common concern when identifying the global environmental problems and its causes although it seems not to have a major impact in the students, even in those from Brazil where deforestation has great impact and has been of general and global concern.

On the other hand, pollution of water and soil are considered as a cause for the environmental problems and is identified as an environmental problem itself. Additionally, air pollution is not directly indicated as an important cause for climate change and global warming.

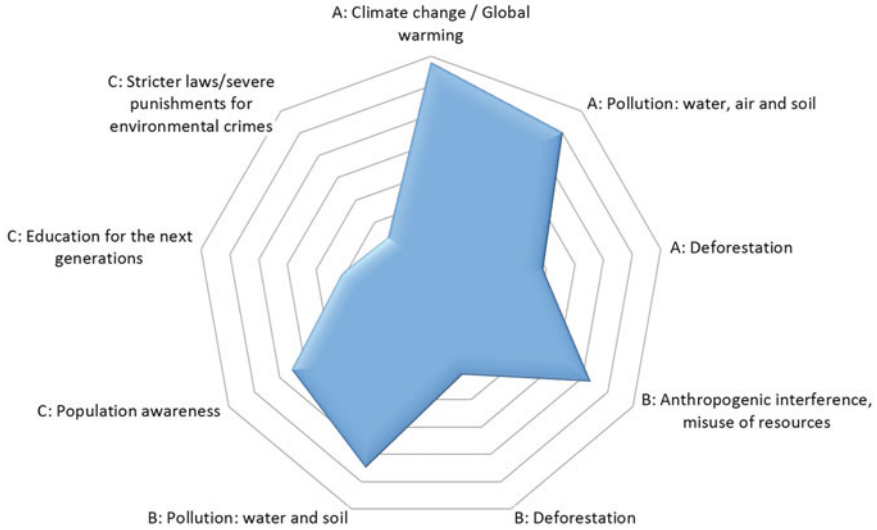

Fig. 1 Main opinions expressed by the group of Portuguese and Brazilian students when interviewed about environmental issues on the planet. A: Global environmental problems; B: Causes for environmental problems; C: Main solutions

As stated before, the most cited causes for the environmental problems were the anthropic interference, greed, misuse of resources, deforestation and undue dumping of pollutants in waters and soils—in contrast the burning of fossil fuels, environmental and nuclear accidents were not cited.

Possible solutions included actions for the awareness of people, education for the next generations and stricter laws for punishments of environmental crimes, but the need to design and implement effective environmental policies was not mentioned. Everyone acknowledged that climate change has an impact on our biodiversity by interfering with species reproduction and causing habitat loss, but changes in livelihoods and sustainable consumption have been little remembered.

Thus, their opinions do not demonstrate the need for a more citizen and environmentalist position, claiming from the public power, for example, an intensification of preventive actions and programs, focused on economic development based on sustainability principles, but only the word “awareness” is expressed, most of the time.

Conclusions

The analysis carried out showed that the students interviewed had a basic understanding on climate change issues mainly acquired/resulting from the media information and not necessarily supported on scientific knowledge. The lack of

ability to establish global relationships between different issues namely fossil fuel burn, sewage disposal, or environmental accidents confirm the need for building some competences, skills and abilities on scientific literacy and even some improving on scientific knowledge.

Although students revealed a general conception of the climate change subject, its causes and consequences, they lacked a more robust conception. They seem to show simplistic ideas limited to their own universe, failing to establish global relations with environmental issues.

At a time of crisis in contemporary society, it is necessary to show, particularly to young people, the idea that the planet will not support infinite growth. Coupled with the desired economic growth, we also need a life with the guarantee of human rights, a fraternal, solidarity and egalitarian society and this implies recognizing environmental problems in their causes and consequences for human life and for biodiversity as a whole. Further, it is necessary to understand that these issues are related to economic and social aspects, and that science and technology should collaborate in the use of natural resources in harmony with the rights of the local populations.

Therefore it is important to engage students and all those that are interested in these environmental and climate changes issues or might need to develop their knowledge for professional or only personal reasons. Non-formal courses can have a crucial role in order to ensure the transmission of scientific knowledge and to create more awareness on the need to better understand the climate change implications to the planet's life and for the Human kind. Massive Open Online Courses (MOOC) are among those non-formal courses and people will be able to gain more knowledge that empowers them to be more aware of climate change issues and environmental phenomena, enabling them to participate more effectively and knowingly in the environmental policies at their areas of residence or work.

This transmission of concepts and knowledge was easier and possible with the aid and the enormous development registered in recent years of the new information and communication technologies that allowed schools and universities to start a set of methodologies in order to organize and offer to large community's different types of courses. In fact, universities have an important role to play in transmitting this type of knowledge on environmental issues, which is so important in today's society, and to its students enrolled in the most diverse courses they offer, but also to the society as a whole, which also shows the importance of lifelong learning.

The present work, even if limited in the number of interviews, showed that there is still a clear need for developing effort towards scientific literacy. Pursuing this purpose we are committed to contribute to a greater awareness and scientific knowledge about climate change through short learning online programs on climate change awareness through distance learning.

This work also encourages us to prepare one or several short eLearning courses aimed not only at university students from Brazil and Portugal but also at the general public to contribute.

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Dealing with Climate Change as a Wicked Issue via Innovative Approaches

Dz. Iliško and O. Dedels

Abstract As this is stressed in the international legislation and research, climate change is a serious global problem that has a negative impact on the quality of life which needs solutions at both global and local levels. The chapter reflects on good practice of integrating innovative pedagogical approaches dealing with a climate change as a complex and wicked issue in a blended university study course: "*Educating for sustainable social and cultural changes*" at the Master's program level. The course is carried out at a regional University and highlights a promising practice of engaging students as transformative actors in their local contexts for initiating sustainable changes. It was concluded that the climate change issue needs to be dealt with as a wicked problem within a sustainability framework, and it needs to become an integral part of learning for a sustainable development. By learning about climate change, students acquired not only knowledge but they developed competencies to adopt sustainable lifestyles leading to a climate-resilient and sustainable behavior. The authors believe that a sustainable development requires changes in the way people think and act, and they see education playing a critical role in teaching relevant skills for the application of change in this issue.

Keywords Complexity · A wicked issue · Blended course · Innovative pedagogical approaches · Trans-disciplinarity

Climate Change as a Wicked Issue Within a Sustainability Discourse

Sustainability issues are linked to each other and need to be seen at the intersection of social and natural systems. Climate change as a complex issue also lies at the intersection of many disciplines and involves numerous ethical and values aspects. Climate change consequences are far-reaching and unpredictable. Expert knowledge

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is partial and uncertain and is lacking agreement in terms of solutions while dealing with climate change, therefore it requires systematic thinking. Because of the incomplete understanding of how climate change affects socio-ecological systems, fluctuation processes, severity magnitude and the impacts on the planet, resilience is necessary for the flexible adaptation to changing circumstances without losing reliability (Duitt and Galaz 2008). As Aldunce et al. (2015) assert, climate change poses a real problem and requires building resilience and adaptation. This requires a collaboration of all actors involved: policy makers, cities, scientists and NGO's in co-producing knowledge based on their experience. This would lead to a more efficient and systemic governance of socio-ecological systems.

Climate change as compared to other environmental problems involves uncertainty, complexity and numerous ethical considerations since the nature and the scope of this issue is highly contested (Giddens 2009; Hulme 2009). Climate change as a "wicked" issue is characterized with high levels of complexity, ambiguity, and uncertainty, and dealing with it requires the use of innovative approaches. Complex issues are vaguely defined and cannot be understood without knowing the context. Wicked issues cannot be solved by conventional strategies that require clear objectives, rational planning and well-defined solutions. A simple and reductionist approach cannot be used in approaching wicked issues.

Considering the complex nature of climate change, education needs to play a significant role in initiating reflection and discussion in order to provide a way to imaginative solutions and a diverse dialogue accompanied by a synergetic way of exploring the issue. Denying or ignoring the complexity of the issue will bring new types of problems. Students need to learn to embrace and to deal with this complexity by seeking connections. They need to perceive themselves not as being outside this complexity but as the ones who are able to shape a better world by asking questions, expressing willingness for action and acknowledging themselves as a part of this complexity. This will help them to accept ethical obligation in dealing with this and similar issues. The complex issues have no clear solutions. Instead, the course facilitators used a system approach to understand the climate change issue in a broader way. Holling (2001) asserts that complex issues need to be examined through the adaptive systems in a perspective that requires a consensus-based decision-making of multiple stakeholders. Dealing with wicked issues requires learning how to deal with change, uncertainty, thus finding the sources of resilience. Work with complex issues requires systematic thinking that includes future envisioning, contextualization, critical thinking, decision-making capacity, a dialogue across and between disciplines and adapting sustainable behavior (Tilbury and Wortman 2004; Tilbury 2011).

As a complex issue, climate change cannot be resolved within the dominant models of thinking and conventional governance approaches. It needs different approaches and different perspectives while maintaining openness to a plurality of perspectives and differences. This requires a reflexive and dialogical process where students articulate their personal worldviews and share them with others. Termeer et al. (2015) asserts that dealing with wicked issues require understanding of one's limited understanding, sensitivity to its complexity and multiple perspectives in

dealing with each issue. Besides, these issues cannot be solved completely but require one to live with them or even to embrace each one (Xiang 2013).

Interdisciplinarity Framework for Dealing with Wicked Issues

Because of complexity, each climate change issue cannot be solved from a single discipline perspective but rather by transcending boundaries and reaching beyond and between disciplines. This requires establishing a common ground among the stakeholders from various disciplines leading to 'transdisciplinary syntheses' or 'multi-domain ontologies' (Wiener, in Madni 2007). Therefore, dealing with climate change requires different strategies from the ones offered by traditional science. Transdisciplinarity is seen as a key for dealing with the issues such as climate change by many scientists (Clark and Button 2011; Weinberger 2011). Clark and Button (2011) suggest that transdisciplinarity involves imagination, innovative thinking, thinking outside the borders of traditional disciplines. This involves the encounter of paradoxes, the ability to think in a complex way, the integration of knowledge from various disciplines, involving multiple stakeholders in dialogue. As Weinberger (2011) argues, that dealing with wicked issues requires post-epistemological conceptual framework and a collaboration of stakeholders outside the academic field. The complexity of the climate change issue blurs the boundaries between the responsibilities for dealing with it. By discussing real world issues with the involvement of multiple stakeholders, one opens the space for epistemological pluralism, system thinking and resilient thinking (Krasny et al. 2011). By educating students to play a meaningful role in shaping their future, we develop their capacity to shape their future.

The Progress Made so Far

The issue of climate change has been the center of attention in international legislation for two decades when it was addressed by *the United Nations Framework Convention on Climate Change* (UNFCCC) (1992). Since then, climate change has become an issue for discussion in forums, public debates, and school curricula. By summarizing existing research on a planetary state of being, Anderson and Strecker (2012) concluded that climate change still remains a serious problem and one can notice even a reverse progress towards meeting the Millennium Developmental goals (MDGS). The United Nations Decade of Education for Sustainable Development (2005–2014) has also played its significant role in integrating principles, values and practices of sustainable development in educational courses. New Sustainable Development Goals' (SDGs) framework, post-2015 agenda, and Global

Action Plan (GAP) (2014) present a promise for dealing with major global challenges, including the climate change issue. As this is reported in a number of significant documents, education is the most effective means for solving the issues we are confronted today (UNESCO 2014). To deal with the challenges of the 21st century, we need new thinking and innovative pedagogical approaches to address contemporary ecological and societal issues in their complexity.

By designing future strategies for action, several documents, such as UNFCCC (1992), Agenda 21 and GAP (2014) have identified youth as particularly significant players in shaping a sustainable future. Since the climate change issue is a multi-scale issue, the documents stress the need to integrate climate change education in teacher training programs, thus empowering and engaging youth to implement decisions set in the strategic documents on climate change. Therefore, any university's educational environment is favorable for implementing those initiatives set in the significant local and international strategic documents. Many publications on climate change provide examples of youth acting as agents of change in their local communities. Youth can develop leadership skills to participate in the decision making processes at national and international levels and play a role of educating their peers and building capacity and advocacy, initiating new projects and building strong resilience to climate risks for further generations. The Lawier and Patel (2012) study reports that youth play a significant role as advocates in helping their families, schools and communities to look for solutions for climate change.

The Rationale of the Course: The Case Study

The course was designed as a blended course composed of classroom and e-learning modules. Among the modules the authors included an e-learning climate change module, followed by discussions and reflections during regular classes. The main focus of the course is on expanding students' understanding of interconnectedness between all aspects of sustainability: political, economic, environmental, social, and culture.

The course focuses on developing students' basic understanding of scientific concepts, certainties, uncertainties, risks and consequences of environmental degradation, climate change and how those issues contribute to an unsustainable state of being of the planet. Considerable attention is paid to the issues linked to climate change such as a well-being, greenhouse effect, impacts of a climate change, adaptive governance, and carbon footprint calculation. This as well as other modules of the Open Online Course (MOOC) on the Ecosystem Approach and Systems Thinking (EAST) developed by the Loyola Sustainability Research Centre at Concordia University, Montreal, and the United Nations Environment Program (UNEP) in Nairobi, Kenya have been integrated in the Master's study course on a voluntary basis. The Climate change module in this course focuses on climate change as viewed via the social-ecological framework and the systematic thinking approach (EAST).

The students were invited to work in heterogeneous teams that allowed various perspectives to co-exist. The course participants were students from the fields of education, culture studies, environmental studies and the IT field. They were working together on a specific issue in a blended learning environment. They identified problems related to climate change in an interdisciplinary dialogue and worked together on developing solutions. Inter-disciplinarity served to encourage reflection and interdisciplinary collaboration. Dealing with complicated issues required them to use creativity, flexibility, problem solving, shared intelligence, and risk-taking.

The students were offered a wide range of web-based resources that supported exploration of a diverse range of issues in relation to climate change and this was aimed at developing competency to evaluate resources and to apply critical thinking in processing information.

Methodology

The research methods used for data collection were pre-course survey on students' understanding of sustainability challenges and how they relate sustainability to their individual lifestyles and how their actions can contribute to the climate change issue (n = 39).

After completing the course, the students were asked to reflect in their essays on their learnings during this course. The analyses of essays (n = 39) had a focus of a holistic view of a learner, particularly of all domains of learning, such as: cognitive, affective, attitudinal and behavioral aspects of learning leading to making a positive contribution to other people and their social and natural environment, locally and globally. It was aimed at gaining feedback about what students learned in a blended course design. Its aim was to focus on the developing students' competencies to deal with unsustainability and\ a climate change as a wicked issue. The other method employed in this study was focus group discussion after the students completed the course. The aim of the focus group interviews was to identify changes in students' cognitive, attitudinal, value and behavior aspects with the regard to environmental issues.

Research Findings

The course has its **transdisciplinary character**. The participants of this educational course were the students representing different fields of science, therefore they contributed to the debate by the specific knowledge from their field of study. They analyzed the issue by synthesizing information from various disciplines: from the physical, natural, and social sciences (n = 39). During the course the students have learned about the interconnectedness between climate change, economic matters,

and social justice discourse. Students also became aware of the multifaceted impact of climate change in its diverse forms: social impact (health issues, poetry, migration of environmental refugees, conflicts over limited resources); economic impacts (negative impact on agriculture, changes in expiration patterns), and environmental impact (melting of polar caps, droughts, loss of biodiversity). The blended module of the course on climate change was aimed at developing students' understanding of how this issue is interlinked with such considerations as economic growth, environmental degradation and poverty reduction.

Within the context of reform processes in Latvia, the course authors set the aim to develop ESD competencies. For the graduates to be competent of problem solving in sustainability, they need to acquire competencies that are necessary to analyze sustainability problems systematically and to act upon those issues in order to reach sustainable solutions. Innovative aspects of this course highlighted the integrating of real-world sustainability issues like climate change, through combining formal curriculum and informal e-learning environment. The authors of this research believe that educational programs should focus on preparing students as "systemic problem solvers and change agents" (Wiek et al. 2011, p. 204) (Table 1).

Pre-course Survey

The data gained from the preliminary course survey indicates that students have a lack of understanding about how their actions can contribute to climate change and a lack of information about the issues at a local level. Almost all students stated that

Table 1 ESD competencies defined prior implementing the course

Competencies	Sub-categories
Transversal competencies	Promoting individual and collective responsibility
	Working with different and controversial perspectives
	Welcoming transdisciplinary discourse
	Seeing the interconnectedness of all sustainability aspects
ESD competencies	Developing critical thinking
	Promoting a sense of belonging to the environment
	Participate meaningfully in decision making processes
	Exercising the right and the responsibility as citizens within a democratic society
Science education competencies	Exploring phenomena scientifically by providing scientific explanations
	Identifying causes of climate change
	Analyzing the impact of human activities on the environment
	Analyzing controversial theories

Adopted from Cebrian and Junyent (2015)

environmental degradation is one of the most challenging global issues. Many students reported that they are now informed about action being taken. The students of this course have an interest in climate change issue and they consider it to be an essential component in their studies.

Pre-course survey indicates that 80% of students believed that global warming is a real problem as recognized the consequences of it. 65% of students identified the link between carbon emission and global warming. 67% believe that recycling, the use of public transportation and energy conservation can reduce global warming. Although 87% of students failed to see the links between meat consumption, the use of artificial fertilizers and climate change. The course aimed to empower students to seek solutions not only to climate change, but also to its causes.

During the course, the students have realized that climate policy needs to recognize the community's rights to deliver governance for climate change. During the course discussions, students encountered many unanswered questions that were raised in the lessons leading to research on topics of direct relevance to their lives. By addressing different topics students developed a comprehensive understanding of societal and environmental issues.

The course built students' **knowledge** on sustainability issues, including the climate change issue. The students developed a basic understanding of scientific concepts, developing the ability to distinguish between risks and consequences of environmental degradation. They have analyzed different responses to climate change and their applicability to local actions for sustainable development.

Conclusions Gained During Focus Group Interviews

Students have built their understanding on interlinkages among all aspects of sustainability: social, political, economic and culture aspect. By working with different dilemmas, students engaged in in-depth solutions on a conflict between economic development and environmental protection. The focus of the course was on developing students' competencies and rethinking their ways of living and consuming by developing new attitudes and skills for environmental protection, and by changing consumption patterns.

The other aspect of the course highlighted by the students were new competencies developed during the coursework, such as critical thinking, problem solving, managing uncertainty saying that these are critical for living in the sustainable community. As it was asserted by many scientists and stressed in numerous international documents: the ability to see the interconnectedness between different dimensions of sustainability and the complexity of systems can contribute to problem solving of sustainability issues (Dalors 1996; Sterling 2004, 2012; Sharp 2002; Filho et al. 2010). Such competencies as interdisciplinary and systemic thinking have also been emphasized by the expert review commission of UNESCO in 2011. This result appeared as well at the ESD World Conference on Education for Sustainable Development (2014) in Nagoya (Japan), putting the emphases on

the educational process which needs to be aligned with the engagement between the whole system, innovative pedagogies and participatory learning.

Several course participants pointed to the competencies they have developed during the course: "During the course I was encouraged to see the interdependency of issues and how to analyze each issue from the system's perspective," "by working together with the other participants from the other fields, their knowledge from the other fields enriched the discussion about the climate change issue."

Engagement of the course participants with the real life learning situations involved all aspects of learning: cognitive, affective, and practical domains, allowing the students to see themselves as agents of change in their local environments. This developed students' competency in dealing with uncertainty, together with a competency of participatory engagement with the real life issues, opened mindedness, cooperation, and reflection. These competencies are particularly essential in developing sustainability literacy (Stibbe 2009). As one of the course participants wrote: "The course broadened my view on global challenges, including disaster risk education challenges, climate change, issues affecting seas and oceans."

Both, focus group interviews and the analyses of students' essays indicate that the course raised environmental consciousness of students but did not fully modify their habits and behaviors towards sustainable consumption and lifestyles, desired by the course mentors.

Post-course survey allowed a realization that the students can explain tensions in sustainable development much better, although they focused more on the environmental dimension.

Attitudes. In the framework of the course the climate change issue was discussed in relation to values, equity and social justice.

One of the aspects disclosed in the group discussions and post-course essays was **a behavioral change**. The use of innovative pedagogies in a blended course fostered competence—ability to cope actively with the complex situations, acting upon and making decisions.

The transition towards sustainability requires action that is guided by understanding the various complexities of the processes and the ability to collaborate with people from diverse backgrounds. There are numerous studies that explore why people act the way they do because of the complexity of multifaceted human behavior in diverse contexts. Some argue that procedural knowledge is more effective in promoting behavioral change.

Several authors believe that knowledge and skills can lead to behavioral change. Many scientists argue that interest about climate change does not necessarily lead to action. Still, feelings of personal responsibility for climate change, the perception of influence of one's actions for a common good may lead to a change of behavior (Heimlich and Ardoin 2008). In essays the students pointed to small behavioral changes that they noticed in their everyday routine:

> "After completing this course I realized that I pay closer attention to some of my actions, like the amount of water and electricity I use. I become conscious of some aspects which I

neglected before." "The course encouraged me to rethink my way of living, consuming and purchasing, as well as the consequences of my choices."

The other revealing moment during the group discussions was a discovery of how students' actions can be linked to global actions and benefits. An example mentioned by the students was their involvement in Environmental Week. One of the limitations of this course was that one cannot expect changes in behavior overnight but they can take place only in the long run.

The reform processes in education in Latvia put the main focus on developing ESD competencies. This was also taken into account while evaluating students' achievement during this course. Students' performance during the course was evaluated according to acquired competencies, comprising knowledge, skills, values, and attitudes (Table 2).

Table 2 The analyses of students' responses in their essays (n = 39)

Category	Subcategory	Units	Examples of students' quotations
Knowledge (cognitive aspect)	Knowledge about a climate change	29	"During taking e-modules of the course I learned more about the risks and consequences of environmental degradation and different responses to climate change, as well as their applicability to local contexts concerning my life"
	Connectedness of personal world view and cultural assumptions and worldview of others	18	"When I evaluate how my grandparents live I see sustainability in every aspect of their life, when I observe the life of my parents, their choices are determined by economic needs and aspects of life which is quire sustainable, when I analyze my generations' lifestyle, it can be described as more consumerist"
	Integrative thinking about interrelatedness of social, economic, culture and political dimensions of sustainability	19	"While discussing with others I realized how interconnected is the surrounding world" "While exploring environmental issues with my classmates, we traced economic, political and cultural impacts on the problem of study"
	Relation of one's own thinking and action to sustainable development	25	"The more we discuss those issues during our classes, the more we understand that something needs to be done for the wellbeing of the Earth, and the actions of every single individual mean a lot"

(continued)

Table 2 (continued)

Category	Subcategory	Units	Examples of students' quotations
	Understanding of a need for change from unsustainable practices towards equity, solidarity, and environmental sustainability	31	"I understand the need to make at least small changes in my lifestyle. If each of us does at least a few things, the world would become a better place to live"
Skills	Ability for action	9	"I started to pay attention to how I can reduce the causes of climate change by doing small things, like consuming less, using less of public transportation, recycling"
	Work with different perspectives on dilemmas, issues, tensions and conflicts	15	"While doing my case study with my classmates I found quite controversial interpretations of the issue, and tensions in defining the issue"
	Evaluation of potential consequences of different decisions and actions	23	"While drawing future scenarios about the potential dangers of environmental problems I realized the potential danger of doing nothing to introduce some sustainable changes."
	Engagement in real-world by making a difference in practice	36	"I hear lots of alarming information about the ecological crises, but exploration of real cases makes environmental problems of personal importance"
	Recognition of impact of a human action on climate change	29	"I realized how much I abuse resources that has an impact of the planet" "Me and my classmates' consumeristic lifestyle carries its negative impact on climate change"
	Acting upon ways to reduce climate change	18	"I try my best to introduce small changes in my lifestyle, like walking more, buying less and using electricity less"

(continued)

Table 2 (continued)

Category	Subcategory	Units	Examples of students' quotations
Values	Awareness of climate change gravity	27	"I am becoming more aware of how my actions influence the wellbeing of all and the health of the Earth"
	Responsibility	12	"I realized, if each person takes a small action to preserve the Earth"
	Commitment for active participation to reduce the risks of climate change	7	"After completing this course I am more responsible in use of water and energy as well as of my consumption patterns"
Emotions	Sense of connectedness/ belonging to the environment	8	"I get inspiration from nature" "I restore my energies in the forest" "It is in nature where I feel restored and refreshed"
Actions (behavioral aspect)	Ability to change one's lifestyle	9	"I cannot transform my life style radically as it was in the film "No impart man" but I am ready to make small changes in my lifestyle"
	Achieving transformations: Willingness to challenge assumptions underlying unsustainable practice	21	"I am willing to reexamine my lifestyle and unsustainable practice by making some small changes"
	Envisioning change: making a positive contribution to other people and their social and natural environment, locally and globally	27	"I have realized how my small action can contribute to global changes and as a youth leader I am willing to make changes not only in my life but to organize the others to be more enthusiastic introducing positive changes"
	Envisioning change: taking considered action even in situations of uncertainty	18	"The more I studied about the sustainability issues, the more I see that there is a controversy in offered solutions and consequences of this question"

To conclude, prior to this study, students' knowledge was mostly centered around the environmental dimension of sustainability. During the course the students developed broader understanding of the sustainability issues by linking institutional and social aspects and become aware of controversies and tension, and potential effects of dealing with the climate change issue. While dealing with other issues, environmental issues could be seen as a starting point for exploring other dimensions of ESD, gradually developing into systemic and critical thinking actions (Reickmann 2012). Students are engaged now with the issue of study of more personal significance for the student specially when related to real world cases.

This case study was an attempt to implement SD and the study of ESD related issues such as climate change in one of the university's educational courses organized in blended modules and focused on the development of students' ESD competencies. This is a small attempt of integrating ESD. The findings of a post-course survey show that those who demonstrated holistic, long term thinking and broader understanding of ESD, are a minority. For integration of sustainability to become a holistic effort, the university needs to integrate SD in all its core activities. Still, universities should be seen as an ideal ground for developing research and innovations as a basis for discussion of the need of SD in universities.

A small scale of a case study restricts making generalizations but allows to trace the positive aspects of awareness of interconnectivity of environmental issues to social, economic and political aspects of sustainability, attitudinal changes and commitments of students to relate climate change issues to their everyday life, consumption habits. The course contributed to the development of students' transversal competencies, such as undertaking individual and collective responsibility, working with different and controversial perspective and thinking across disciplines.

Conclusions

There is undeniable evidence that climate change is a danger which compromises the sustainability of our planet. The importance of climate change to a large extent was neglected in school and the university's curriculum. Therefore, the study presents a challenge to integrate the issue about climate change by the use of innovative approaches in the university setting.

Education plays a crucial role in informing and empowering students to discover the possibility of their contribution in solving environmental issues by adopting a sustainable lifestyle and finding innovative solutions. Education can enable individuals to make informed decisions and to take actions for a climate-compatible sustainable development. What is missing, is a holistic vision of how sustainable society can be translated to the local level.

The course was intended to equip students with relevant life skills such as critical thinking skills, climate change literacy, problem solving skills, sustainable consumption and evaluation of one's lifestyles. The mentor of the course provided a

safe learning environment for discussion and for sharing ideas by offering blended learning strategies and multiple learning formats.

Education for sustainable development provided a framework for climate change education, thus encouraging students to be more informed about everyday life decisions accompanied by the responsible action. The course was intended to develop students' knowledge in conjunction with the evolution of their awareness and changes in personal behavior. The limitation of this course was that while the course outlined the scope of issues, there was not much time to explore issues in greater depth.

Climate change in the university study course was studied in relation to smart governance, policy debates, and in relation to societal issues, thus examining the implications of climate change in local contexts. The students developed an understanding about the impact of climate change on a local and future society. The analysis of students' essays indicates that they developed an understanding about the contexts as well as a developed flexibility to deal with uncertainty concerning climate change.

The students have learned that a climate policy needs to recognize community's rights to governance for climate change and the interconnectedness between climate change, economic matters, and social justice discourse. The course reached its broader aim to empower students to seek solutions not only to climate change, but also to its causes. This has led towards changes of attitudes, and to responsible action.

To be efficiently taught, the climate change issue needs to be taught in an accessible way and through multiple formats, such as e-learning, photos, films, video fragments, exercises and interactive games. Climate change issues need to be studied in relation to smart governance, policy debates, and societal issues, in order to examine the implications of climate change in local contexts.

For the climate change issue to be relevant for the students, it has to relate global and abstract issues to how one impacts on climate change and to how to equip students with skills, knowledge and values to deal with future challenges. Education should empower the students to see environmental, political, social and economic aspects of climate change in a more holistic way.

Considering the serious impact of climate change on our lives, educators need to frame climate change studies in a way that can be better acted upon by youth using diverse experiences, life circumstances, worldviews and values (Maibach et al. 2011).

As a major limitation and constraint of this case study is that it cannot be generalized to other contexts since it reflects the efforts of educators at one of the regional universities aimed raise students conscience about the causes, consequences and possible solutions of environmental issues, particularly, the issue of a climate change within a wider system framework of sustainable development. The gravity of consequences of environmental issue are worldwide still the problematics varies from the context to context. Pedagogical solutions and tools used to tackle these issues also vary from one institution to the other. The experience and the involvement of institutions in dealing with those issue are also diverse even within

the institutions of one country. This case study is a tentative innovative attempt to use innovative approached, including a blended course design, and other tools to touch the student a s holistic being: cognitive, emotional, value, behavioral aspects developing one's personal responsibility and commitment to work for a well-being of the planet.

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e-Learning Diversification in Higher Education: Conceptions of Participation

Paulo Dias, Luísa Aires and Darlinda Moreira

Abstract In this chapter, we reflect on the conceptions and different forms of participation in e-Learning contexts in higher education and its influences in climate change literacy. Although the literature review highlights intense research on the value of participation in informal contexts, we argue that the construction of a pedagogical discourse on e-Learning cannot be sustained without the pedagogy of participation. Such participation also acquires new meanings when analysed using socio-constructivist and cultural approaches. In this study, the analysis of participation in e-Learning contexts is based on categories such as leadership, sharing and cohesion. The empirical data we present are the result of more wide-ranging research carried out at the Observatório da Qualidade da Educação a Distância e e-Learning (Distance Education and e-Learning Observatory) at the Universidade Aberta, Portugal. Data were collected from the online questionnaire given to a sample of 26 e-Learning course leaders and pedagogical coordinators in face-to-face higher education institutions. The conclusions of the study highlight the different conceptions about the nature of e-Learning processes and practices in higher education, which we believe highlight the need to promote a participation-oriented pedagogy as a fundamental aspect of both climate change literacy/education and online education and based on the construction of both pedagogical innovation and teachers' education to teach in virtual environments.

Keywords e-Learning · Participation · Higher education · Pedagogy

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Introduction

In 2013, about 82% of European higher education institutions offered online learning courses (Gaebel et al. 2014), thus giving rise to an educational framework where various HEIs coexist with a diversity of teaching methods and pedagogical models for e-Learning courses. This scenario is particularly important for distance learning universities, because it poses various questions about what is considered and understood to be e-Learning.

The authors of this chapter belong to the faculty of a distance learning institution where online learning has been used since 2001. The e-Learning we practise adheres to principles and quality guidelines, both in terms of course design and pedagogical practice. As an increasingly widespread teaching method, e-Learning sustainability must be ensured.

During an exploratory research undertaken in 2014–2015 for the Distance Learning and e-Learning Observatory, which is based at the Universidade Aberta (Open University), Portugal, various pedagogical concepts and practices regarding e-Learning courses were identified (Dias et al. 2015). Surveying a sample of 26 e-Learning course leaders and coordinators taught by Portuguese higher education institutions (HEI), this study identified three subgroups: one (around 38%) with organisational and pedagogical concepts similar to those of online distance education; another (approximately 36%) advocating concepts similar to blended learning, emphasising face-to-face contact in teaching and learning processes; and a third (about 25%) that seemed to distance itself from these concepts, focussing on e-Learning from a technological perspective, reducing this type of teaching and learning to the online availability of content, typical of face-to-face teaching. The abovementioned research also observed that the first two subgroups are not static. On the contrary, they are fluid, sometimes moving towards an online distance education perspective, other times, defending concepts like those of blended learning. When the analysis focusses on practices, the learning processes data shows that the group with concepts most similar to online education drops to 28%.

Other aspects emerging from research also required further investigation, such as respondents' contradictory answers regarding pedagogical aspects of participation in online distance learning, which in theory and in practice are connected, as well as the need for changes in institutional cultures regarding online teaching and teacher training in this area.

We highlight the study's conclusions to underline the importance of recognising the differences in distance education and the institutions that use it within the context of higher education policies, as well as the need to incorporate new ways of promoting a culture of participation in face-to-face HEIs.

Active participation and digital education are interconnected areas that politicians, employers, educators and other social agents must take into account to consider climate change education. Managing information is not all an exclusive competence to answer multiple challenges of digital society. Citizens must appropriate social competences to be part of online and face-to-face communities

and teachers and digital media must promote innovative approaches for teaching and learning climate change problems in different tips and levels of schooling (Azevedo 2016).

The aim of this chapter is to analyse participation in e-Learning contexts, based on the empirical data obtained in the abovementioned study, which is part of research undertaken for the Distance Education and Learning Quality Observatory.

Participation in e-Learning

Although there is widespread agreement that participation is a key aspect of online education and e-Learning, this concept has been studied from very different perspectives. In simple terms, interaction in the virtual classroom equals participation, while, a more complex approach views participation as intrinsic to learning and, in particular, to the dialogue and social relationships developed within such educational contexts.

Hrastinski (2008) situates participation in the complex and relational processes using the socio-constructivist approach of Vygotski (1978) and Wenger (1998), defining participation in learning as:

> a process of learning by taking part and maintaining relations with others. It is a complex process comprising doing, communicating, thinking, feeling and belonging, which occurs both online and offline (Hrastinski, 2008, p. 1761).

Hrastinski's (2008) proposal is reflected in Carrie James's statement, when she describes participation "as the very nature of our online conduct" (James 2014, p. 83). In fact, participation has been the focus of other approaches that, due to their cultural and ecological emphasis, can be considered complementary to Hrastinski's perspective (2008, 2009). Learning ecologies presuppose unstructured contexts of participation, trust, simplicity, decentralisation, tolerance of experimentation and error, and a range of mediating tools (Siemens 2003). Offering an ecological approach to learning processes, Siemens (2003) suggests the existence of dynamic contexts that are open and in permanent construction; communities with common interests and intense participation flows that are constantly evolving and self-regulating.

Siemens' proposal can be expanded with Jenkins' approach (2009), highlighting the cultural dimension, the interrelation between different digital media and cultural communities that develop alongside the processes mediated by these technologies.

According to Jenkins (2009), participation cuts across educational practices, creative processes, community life and democratic citizenship. This participation is conducted through affiliation to communities with different vocations, public participation, new creative methods and collaborative problem solving.

Hrastinski's (2008, 2009) and Jenkins' (2009) perspectives on participation laid the foundations for the development of a pedagogy of participation in online distance education, calling for a complex analysis of the concept supported by cultural

and relational processes of doing, communicating, feeling and belonging (Hrastinski 2008, 2009; Freire 1982; Jenkins 2009; Carter and Arroyo 2011).

Different Types of Participation

The concept of participation has become central and crucial in several social contexts, including the digital one. Here, participation may be part of distinct dimensions and have different purposes, problems and possibilities, as well as tending to interfere with power relations.

According to Vieira (2015), participation requires learning and the acquisition of competences, which are constructed "from the interaction-action of the actors" (p. 105). Along similar lines of thought, Jenkins et al. (2016) present the idea of participatory culture as a culture:

> … which embraces the values of diversity and democracy through every aspect of our interactions with each other – one which assumes that we are capable of making decisions, collectively and individually, and that we should have the capacity to express ourselves through a broad range of different forms and practices. (p. 2)

Participatory culture in online educational environments boasts unique features that should be highlighted for a better understanding of the diversity of e-Learning contexts in higher education. Focussing on these technological artefacts and contexts, it should be mentioned that e-Learning can range from environments based on text availability to the inclusion of virtual worlds based on three-dimensional graphics in educational scenarios. These different contexts require different forms of participation which, in turn, develop different ways of being, communicating and interacting, and the existence of a learning community presupposes a complex and demanding degree of interactivity and sharing. As highlighted in perspectives on participatory culture, learning comes from collective interaction, often in a learning community, which allows individuals to develop competencies and feelings of involvement, belonging and protection. To this end, we return to Lave and Wenger's (1991) thinking about communities of practice as places of action that develop within contexts of experience, particularly through the involvement of a social voice as a means of promoting sustainability and the development of communities.

Participation in the educational experiences and activities has been considered one of the essential stages of learning since Kolb (1984). Combined with the educational scenarios underlying a particular learning context, student participation may range from a single answer on a multiple-choice test to being an avatar in a simulation or game environment in online learning communities.

However, non-physical presence in the online learning environment involves context-specific characteristics that need to be considered and analysed. One of the consequences of non-physicality is related to the unique characteristics of online communication (James 2014), which, in addition to possibly including a mixture of

text, video, audio and other fantastic elements, can also be expressed via a simple anonymous click on a predefined icon. Another detail is the size of the community where we participate and speak, which, in educational contexts, can range from virtual groups with the usual 20–30 students to the fabulous amphitheatres seating over 500, a metaphor that can be compared to the learning environments used as part of Massive Open Online Courses (MOOCs).

We may consider the lack of non-verbal signals of online speech—usually described as non-verbal communication—as something negative in terms of interpretation and cognitive, social and cultural interaction, however, it can also be advantageous for certain participants who "may be marginalised in other contexts" (Stirling 2008, p. 171). In addition to this, the asynchronous mode of communication allows some readjustment, as repeated reading of the message helps control emotional or cognitive reactions.

Another aspect to consider when analysing students' participation in online educational environments are expectations regarding educational participation, which should be made explicit and eventually negotiated among teachers. These expectations may, on the other hand, influence the type of student involvement. In other words, course design influences or determines a certain type of participation, to which we should add the possibilities provided by digital environments and tools. Considering technological progress, we believe the latter elements tend to become a bound variable in educational settings. We can also say that participation in online educational contexts may be associated with unavoidable telecommunication costs or different geographical times, as online courses bring together students from anywhere in the world.

However, as we mentioned previously, an online learning community presupposes a complex set of relationships, interactivity and sharing that involves symbolic, relational, emotional, axiological dimensions or, if we prefer, different participatory cultures. The pedagogy of participation, in which internet use and virtual worlds are increasingly "transparent" (Bolter and Grusin 2000), seeks to strengthen different aspects of multiple social contexts and learning guided by an inclusive approach. This principle will lead to group and individual development of community members (Nunes 1998, 2002; Moreira and Fantinato 2014).

Climate change is a central issue in education that requires new practices of citizenship. Learners create their own meanings about climate change participating actively in digital media such as social networks, blogs and other virtual environments. Education can mediate different understandings about global warming and encourage changes in attitudes and behaviours to innovate in urgent answers to climate change (UNESCO).

According to Dias (2016), "there is no possibility of autonomy based on desire or willingness, but rather in action through the type of sharing that values participation as a means of constructing intellectual freedom. Intellectual freedom is in the social voice that transforms something private into collective expression, shaping the community's identity as a common asset".

In the study undertaken previously (Dias et al. 2015), the key aspects of participation were identified as attitudes and feelings of sharing, leadership, cohesion and

mediation that shaped the quality of community relations. In this study, participation is analysed according to informants' conceptions of interaction, leadership, sharing, cohesion, mediation, trust, authenticity of information and knowledge and credibility. The participation analysis employed is based on Dias (2014) and Aires et al. (2014). The data that follow are interpreted within this theoretical framework.

Methodology

The data we analyse in this section comes from research undertaken by Dias et al. (2015) in 2014 and 2015. The empirical research was based on the development and use of an online questionnaire for 26 e-Learning course leaders and coordinators in higher education.

Sample

A theoretical and purposive sample was created for this study. During the initial phase, participants were contacted via e-mails sent to universities and polytechnics, inviting the institutions to participate in the project's online questionnaire.

Only some universities participated. The reasons for not participating are unknown. They did not respond, either because they did not have distance education and e-Learning courses, or they simply decided not to participate for other reasons.

The sample is made up of 16 women and 10 men (N: 26). Respondents work at different universities and polytechnics throughout the country (Fig. 1).

Data Collection Tool

The questionnaire used was developed via a literature review and the contributions of teaching staff and researchers who analysed the different versions. A closed-ended questionnaire was constructed with Likert-type questions with five

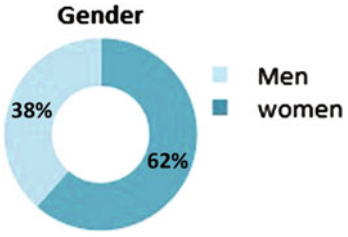


Fig. 1 Sample: percentages by gender (*Source* Dias et al. 2015)

answers: 1—strongly disagree; 2—disagree; 3—tend to agree; 4—agree; 5—strongly agree.

The pre-test was done with 16 teachers working in face-to-face and online higher education, which led to various changes, both in terms of structure and content, improving the tool significantly. The latest version of the questionnaire was analysed by a group of researchers in distance education. This last stage produced the final version of the questionnaire, which was divided into five parts:

1. Description of the institution and respondents;
2. Distance education and e-Learning course design;
3. Pedagogical guidelines for distance education and e-Learning;
4. Pedagogical participation;
5. Technological and support infrastructures.

Although the original research boasts a wide scope, for this study, we focussed solely on the notions of "participation" of course leaders and coordinators working in public higher education institutions and who take part in research. Participation is interpreted using the categories in Table 1.

The data obtained from the questionnaire was analysed using descriptive statistics techniques (SPSS, version 23).

On the Pedagogy of Participation

The combination of the literature review and the collection and analysis of data allows us to outline pedagogical perspectives on participation *as* a key principle in digital citizenship and consequently in online distance education.

General Participation

Informants consider students to have high levels of participation in online teaching activities (4.0) (Fig. 2).

Table 1 Analysis categories

	Analysis categories
Participation	• General participation • Interaction • Leadership • Sharing • Cohesion: groups • Cohesion: dynamics • Mediation: teacher-community • Trust • Authenticity of information and knowledge • Credibility

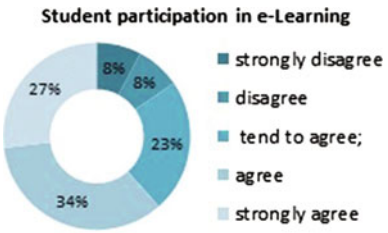


Fig. 2 Students participation in e-learning (*Source* Dias et al. 2015)

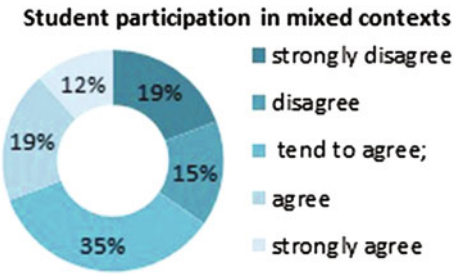


Fig. 3 Students participation in mixed contexts (*Source* Dias et al. 2015)

In contrast, student participation in mixed situations (online and face-to-face teaching) is considered moderate (3.0) (Fig. 3). These results are in line with other studies that indicate high participation rates on online courses (Gibson 2003).

Interaction

Interaction between students is considered moderate in online, mixed and face-to-face contexts (average: 3.0). Conceptions regarding the link between the type of teaching employed and interaction with the teacher divides the informant group. As can be seen in Table 2 (item 54), 9 respondents' assessment ranges from "completely agree" and "strongly agree" to another 9 between "completely disagree" and "disagree". The other 7 informants' assessment is mid-range—"tend to agree".

Leadership

Leadership is primarily associated with the teacher and, to a lesser extent, learning communities, i.e. for most respondents, leadership does not involve the learning community but does have an important role for 9 respondents. The role of distributed leadership is not consensual; the teacher leads more for some (13) and less for others (6). Seven respondents chose the "tend to agree" option (Table 3).

Table 2 Interaction (*Source* Dias et al. 2015)

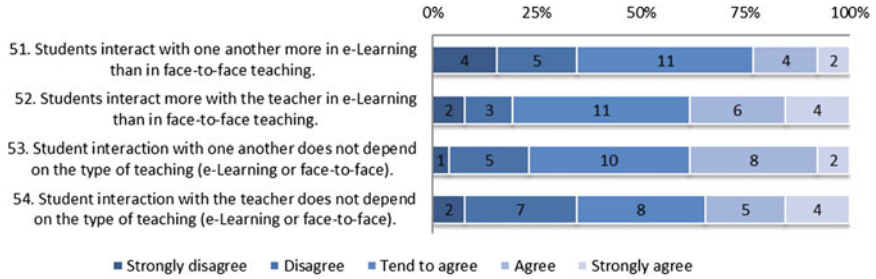
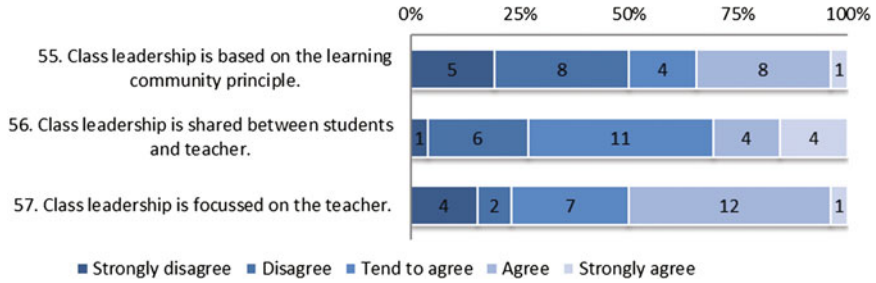


Table 3 Leadership (*Source* Dias et al. 2015)



This indicator requires further development, given that, in other aspects not analysed in this chapter, when we examine the assessment process, peer assessment scores the highest.

Sharing

In contrast to the results for interaction (moderate), virtual sharing is very important, according to the respondents. The role of virtual contexts in sharing among students is highly valued by 19 of the 26 respondents, while 7 consider it to be of little (2) or moderate importance (5) (Table 4). If we compare this data with the moderate scores for interaction, it seems to us that this indicator requires further research, in terms of understanding the informants' ideas on the link between sharing and interaction.

Table 4 Sharing (*Source* Dias et al. 2015)

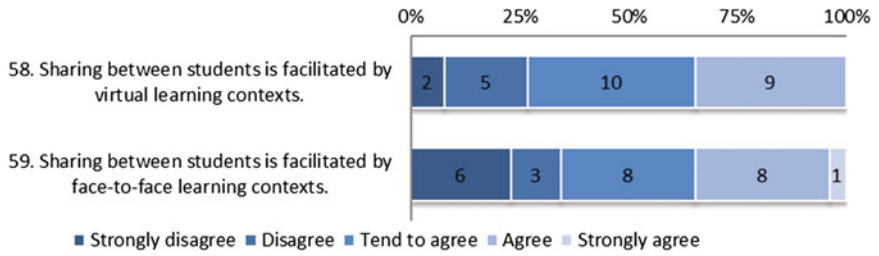
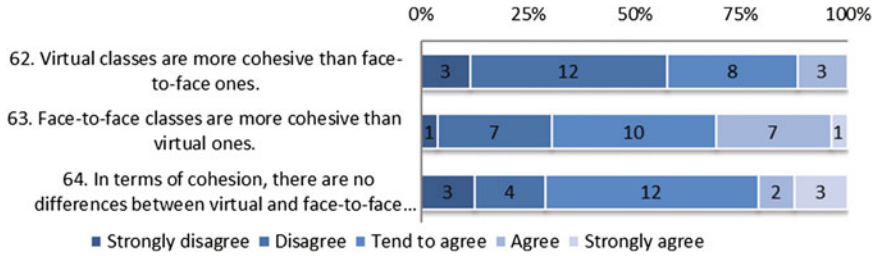


Table 5 Cohesion: groups (*Source* Dias et al. 2015)



Cohesion: Groups

In relation to group cohesion, there does not seem to be a clear demarcation regarding any differences between online and face-to-face teaching. In item 64, the most popular option was "tend to agree" (Table 5).

Cohesion: Dynamics

The relation between shared leadership and cohesion in face-to-face teaching scores moderately, but scores better when considered in face-to-face situations (averages: 3.0 and 3.5, respectively). When asked for an assessment of the statement "virtual classes are more cohesive than face-to-face ones", once again, the sample divides (15 do not agree with the statement and 11 tend to/strongly agree) (Table 6). These data lead us to reflect on the importance of face-to-face interactions on class cohesion for the latter informants and, generally, on the pedagogical relationship on e-Learning courses.

Table 6 Cohesion: dynamics (*Source* Dias et al. 2015)

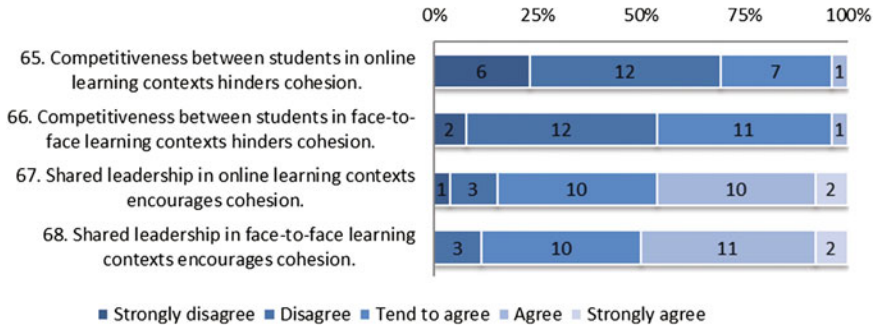
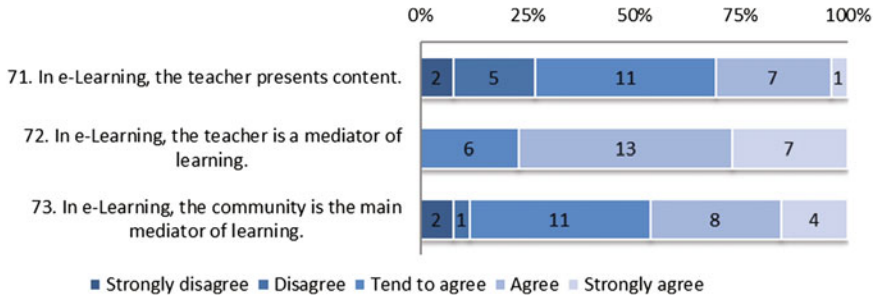


Table 7 Mediators of learning (*Source* Dias et al. 2015)



Mediators of Learning

The teacher profile is not clearly defined and is constructed via the mediation of learning (broad consensus) and, to a lesser extent, the presentation of content. The learning community being associated with the mediating role is scored positively by 11 respondents and moderately by 11 informants. Three respondents also consider that the community does not have/ has little value in the mediation of learning (Table 7).

Trust

For most respondents (average: 4.0), trust between teachers and students is not directly linked to learning situations, whether online or face-to-face (Table 8). This is one of the aspects that require further development using narrative methods.

Table 8 Assessment of trust (*Source* Dias et al. 2015)

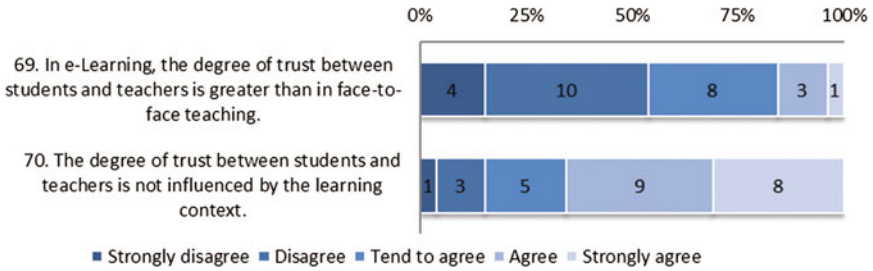
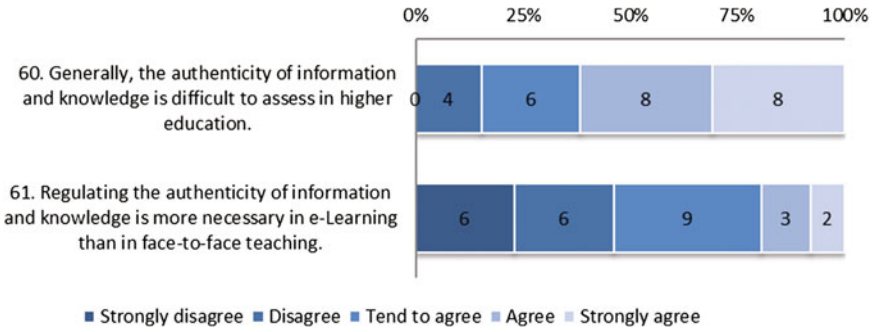


Table 9 Authenticity of information and knowledge (*Source* Dias et al. 2015)



Authenticity of Information and Knowledge

Regarding the authenticity of information and knowledge as an issue of face-to-face and online teaching, although the average is 4.0 on a scale of 1–5, in Table 9, we can see that wide range of scores (the assessment of 10 respondents ranges from disagree/tend to agree) (Table 9). This data is corroborated by Bacow, Bowen, Guthrie, Lack, and Long's study (2012), which states that issues of authenticity and its opposite are common to online and face-to-face teaching.

Credibility

The credibility of face-to-face teaching scores higher than that of online teaching. The idea that e-Learning may have a complementary role with face-to-face teaching

scored poorly with most respondents (average: 2.0), although, in the data collected by the survey, the prevailing concepts are closer to blended learning.

Nevertheless, the proportion of "tend to agree" responses should be noted, following the overall trend of scores in terms of participation. It is also worth mentioning Allen and Seamen's (2014) study, which concluded that both subsystems are closer to each other in terms of credibility (Table 10).

There are no extreme scores (1 or 5) in this category. 13 of the 28 answers were at level 3 (tend to agree), 5 disagreed (level 2) and 7 agreed (level 4). As such, it is important to gather more data on the meanings of credibility in both subsystems for informants.

In short, the leadership, authenticity of information and knowledge, cohesion: dynamics and trust indicators indicate the same quartile distribution profile and averages (3), while the sharing and mediation: teacher-community indicators boast similar distributions and averages (4) (Table 11).

The "moderate" nature of the answers indicates a margin that requires further analysis. On the other hand, it presents the need to understand the existing pedagogical skills that influence the answers and specifically in the contexts in which online teaching occurs.

In short, the dominant tendency for informants to choose level 3 (tend to agree) highlights the need to discover the reasons for these opinions, when the aim is to contrast the scores in the different categories regarding face-to-face and online teaching. As previously mentioned, these data underline the need for a more comprehensive next stage that uses, among other things, interviews and discussion groups.

Table 10 Credibility (*Source* Dias et al. 2015)

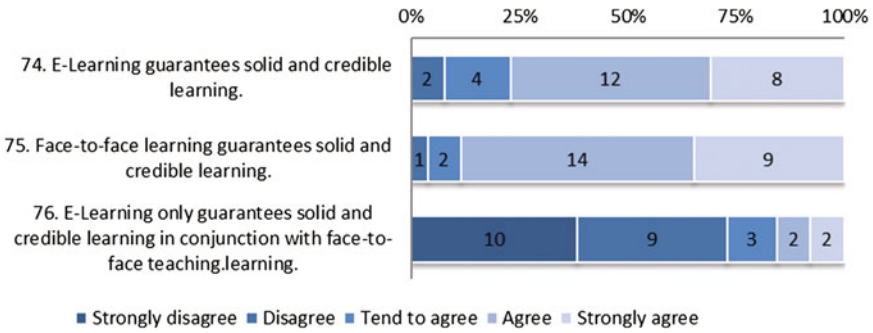
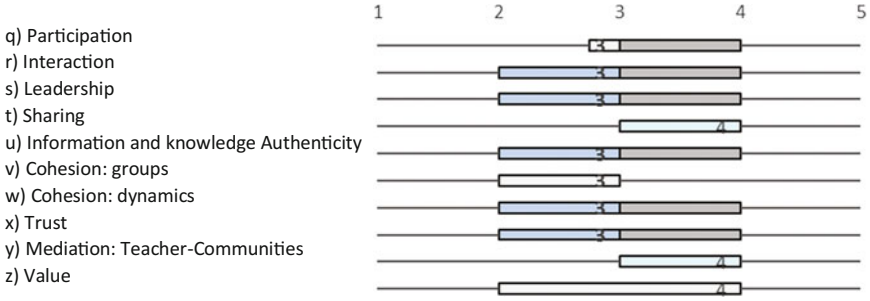


Table 11 Distribution of quartiles and averages in participation and adjacent categories (*Source* Dias et al. 2015)



Conclusion

In this chapter, we analysed different perspectives regarding participation on e-Learning courses from a theoretical and empirical perspective.

The analysed data was obtained from a questionnaire given to 26 e-Learning course leaders and coordinators in higher education institutions.

The questionnaire, which uses the Likert scale, was developed, systematically contrasting face-to-face and online teaching.

The "moderate" assessment of participation, as well as the fluctuating responses in analytical categories associated with this concept, highlights the need for a better understanding of participation in e-Learning. The development of these notions should include face-to-face HEIs' strategies for online learning, as well as pedagogical processes in teacher training for this type of learning, also corroborated in studies undertaken in other contexts (Krull and Mallinson 2013).

It is also important to reflect on what role the pedagogy of participation plays in how online courses are designed, as well as the pedagogical strategies that teachers should adopt.

Given the exploratory nature of the study and, particularly, the type of sample selected (convenience), as well as the type of tool used to collect information (questionnaire), it is necessary to extend this study by identifying broader and more diverse samples, as well as applying comprehensive and interpretive research methodologies.

Finally, we highlight that freedom of thought finds its greatest expression in participation, sharing and action to create collaborative learning communities in digital education. In what concerns to climate change education, learning communities need to encourage innovative teaching approaches that enhance interdisciplinary practices and new digital competences to participate and transform in formal and informal networks. We believe that this is a key value for promoting climate change education.

Building education for the future means promoting a strategic vision for sustained innovation, which will help develop new competencies for action and creativity within learning situations that emphasise the integration of social experience within education. This should help blur the boundaries between knowledge areas, establishing participation, dialogue and questioning, linking the formal with the informal, transforming the experience of knowledge into a meaningful process that solves not only today's problems but, most of all, those of tomorrow.

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Training Teachers Committed to Climate Change Mitigation

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Abstract The environmental crisis, caused by unsustainable development and an unjust model, requires a global change in a political, social and environmental context. To promote this change we need to redirect Higher Education to train citizens to be able to make responsible decisions and act in a sustainable way. This requires educational initiatives promoted by universities to redirect teacher training towards sustainability. With this objective we present and focus a teacher training proposal based on treating the problems of Climate Change, the climate education and the development of teaching skills. Its purpose is to enable students of the Faculty of Education Sciences, future teaching staff, to participate, individually and collectively, in improving this socio-environmental problem of a local and global nature, which also has a multiplier effect for society in their later professional development. The proposal is based on a holistic and participatory methodology, promoting the development of sustainable skills, participation, information processing, critical thinking and autonomous and informed decision-making using ICTs and a platform providing distance learning. The experience can be the foundation for future proposals in different contexts and for different professional profiles.

Keywords Climate change · Environmental education and sustainability Teacher training · Teaching skills · ICTs

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Introduction

We are in the midst of a major environmental and human crisis, heightened by a period of unstoppable changes (Worldwatch Institute 2015). This crisis is defined by multidimensional interrelated problems that are not restricted by political barriers (GEO-5 2012), where Climate Change (hereinafter CC) plays a prominent role. Its impacts on the environment and on people are asymmetrical, in such a way that they depend on their skills and on real possibilities of adapting to new situations, where gender, poverty conditions and vulnerability are fundamental factors (UN 2009; IPCC 2014).

Because of this, progress towards Sustainable Development requires new international policies and agreements (Klein 2015), as well as changes in the lifestyles of communities. This is one of the main challenges that the education of the 21st century is faced with (Boff 2011). Therefore, there is a need for education, specifically for Environmental Education (hereinafter EE) that contributes to achieve sustainability and along with it, to reduce problems such as the emission of greenhouse gases.

However, the promotion of sustainable lifestyles is a tremendously complex objective (Stern 2000). After forty years of research in the field of EE, there are still unanswered questions, aspects that require further study and certain gaps (Reid and Scott 2013). During the last few decades, many authors have suggested that EE should be focused towards action, strengthened by critical thinking as an educational ideal from a democratic perspective (Mogensen and Mayer 2005; Jensen and Schnack 2006). People need to be empowered in order to become an informed, capable and environmentally active society (Ferreira 2013). From this perspective, schools must encourage participation, information handling, and free and mindful decision-making.

Therefore, schools need to undergo a transformation process (Tilbury 1995) that encourages an education that addresses the environmental problem; and specifically Climate Change Education for Sustainable Development (UNESCO 2010). Here, because of their direct responsibility and daily contact with students, teachers are a key factor (McKeown and Hopkins 2002).

Teacher Training

In this context, what is required is adequate teacher training that promotes innovation and compromise and seeks ways of guiding student learning based on the development of skills (Vega-Marcote and Varela-Losada 2016). Thus, the competencies that teacher training should pursue in EE focused at sustainability and consequently at mitigating CC are linked to a new model that is being promoted by international organisations in order to respond to the demands of today's society (EU 1999; UNESCO 2010). Its development involves activities connected to

reality, to the need for social interaction and to the questioning of models based exclusively on the transfer of knowledge (Stiefel 2008).

A review of the research on the competencies that future teachers should acquire with regard to sustainability and EE provides interesting proposals. Educational actions should seek the development of specific skills that encourage sustainable actions. Wiek et al. (2011) identify five basic sustainable competencies for facing real and complex situations. In the field of teaching skills, Aznar Minguet and Martínez Agut (2013) suggest a series of competencies for educators in the area of sustainability, based on the four pillars of Delors (1997): Learning to know, Learning to do, Learning to live together, and Learning to be. Likewise, Cebrián and Junyent (2015), based on previous proposals suggest a competence framework consisting of: envisioning future/alternative scenarios, contextualizing, working and living with complexity, thinking critically, adopting decisions, participating and acting in favour of change, clarifying values, establishing a dialog between disciplines, and managing emotions. The UNECE (2013), from an international context, defends a more complete and complex proposal through competencies that have a visionary and transforming holistic dimension.

Through this approach, the development of these competencies should result in training teachers who are committed to action, to sustainability and to mitigating CC; teachers who are aware of the need to change our lifestyle and of the importance of creating links with the community to impulse this change (Varela-Losada et al. 2016). Therefore, the institutions that train teachers should provide training that is consistent with its role as transforming agent of the new model of citizenship that society demands (Leal Filho and Pace 2016). However, research reveals that there are major weaknesses in our basic teacher training model with regard to EE and sustainability (Yavetz et al. 2009; García Esteban and Murga Menoyo 2015), and also with regard to CC (Hufnagel 2015; Boon 2016; Herman et al. 2017). Likewise, the barriers and obstacles that teachers must face to implement educational initiatives in this area are documented and can be summarised as follows:

- Institutional barriers related to the ideology and basis of the prescriptive curriculums, lack of financing, and teacher time (Gough 1997; McKeown and Hopkins 2002; Feinstein and Kirchgasler 2015).
- Educational barriers that include insufficient knowledge, lack of training and conflicts between present-day philosophy and school practices (Eurydice 2011; García Esteban and Murga Menoyo 2015; Pérez-Rodríguez et al. 2017).
- Cultural barriers, related to habits, knowledge, beliefs and traditions; of an educational, social, and financial nature, etc., and with the lack of awareness regarding the need for change and attitudes against the school community (Scott and Gough 2003; Sund and Wickman 2011; Pérez-Rodríguez et al. 2017).

To face these difficulties, a number of proposals that contribute to this field have appeared. Some focus on their abilities for teaching EE, such as the proposals by Moseley and Utley (2008) who used a curriculum based on interdisciplinary

hands-on learning, or that of Arreguín-Anderson and Kennedy (2013), who designed an educational proposal based on a program for the preservation of wildlife. And the majority, which focus on the achievement of sustainable competencies and changes in attitudes and habits, such as the one designed by Karpudewan et al. (2012), who use a didactic model focused on the analysis of the economic and social aspects of local and global activities, or the one by Fernández et al. (2016) with a multidisciplinary educational research project. However, what is necessary are more approaches that seek the double purpose of training committed teachers who are autonomous and responsible towards the environment and towards people, and that at the same time have the necessary teaching competencies to promote these same qualities among students.

Similarly, with regard to CC, innovative and educational experiences have been designed and implemnented (Niebert and Gropengiesser 2013; Öhman and Öhman 2013; Caird et al. 2015), some of which are focused on teacher training (Varela-Losada et al. 2014; Seow and Ho 2016). All of them contribute to shaping a teacher training framework with regard to this topic, but there is also a lack of initiatives that impulse an understanding of the nature of the science of this global environmental problem and of how to teach it in the classroom (Tugjamba et al. 2016).

Therefore, new educational proposals are needed that contribute to train teachers with sustainable and teaching competencies, who are able to endow it with an innovative character committed with sustainability and the mitigation of CC, such as the one we present below.

A Proposal for Competence Teacher Training on Climate Change

Schools should prepare people to think and understand the world, to make informed decisions and to act as a community in a responsible, sustainable, and democratic manner, in such a way that they can face present-day and future problems. It is a complex process that entails the acquisition of a conceptual type of knowledge and of values, but also of the development of attitudes, aptitudes, and ways of socially interacting, in collaboration and through dialogue (Tilbury 2012). Moreover, the search for sustainability involves a holistic and critical perspective towards today's social and economic models (Vega-Marcote and Varela-Losada 2016).

An EE of these characteristics can only be possible if it relies on teachers who are reflexive and innovative, who know how students learn and what the best methods are for fostering that learning. Therefore, a teacher training model should seek the development of students' meta-cognitive skills (Gunstone 2000), that is to say, those that enable teachers to know what students know and what they should learn to stimulate their learning in a different way. In addition, teachers should understand the holistic nature of environmental situations and place themselves in a

critical paradigm (Varela-Losada et al. 2016). All this represents a profound change in the teaching models of teacher training institutions (Ulls et al. 2010), which should promote that students experience different ways of teaching and learning and take a stance before socio-environmental issues, such as CC.

In this context, the proposal is set out seeking scientific, environmental and climate education, and to do so it is based on the suggestions by authorities in the field of EE focused towards sustainability:

- It uses methodologies built on research on sustainability and the solving of relevant/real/close problems, such as CC, with approaches based on reflecting on the complexity of environmental issues with a globalising perspective of the causes, consequences and possibilities for action. It rests on the assumption that starting off from real issues can stimulate the complementariness between criticism and possibility (Mogensen and Mayer 2005; Vega-Marcote and Varela-Losada 2016; Wals 2007).
- It encourages information literacy, the development of critical thinking, giving rise to the formulation of critical questions, debate, and the analysis of the world through multiple perspectives, taking into account conflicts of interest. It pays special attention to the role of people in the system and the influence of socio-cultural and economic factors in their lifestyles, which contribute to CC (Wals 2007; Frisk and Larson 2011; Kyburtz-Graber 2013; Gifford 2014; Varela-Losada et al. 2016).
- It makes it possible to bring to light models of action and unconscious assumed values, analysing them, highlighting contradictions… encouraging autonomous decision-making that is responsible with the environment and with people and the promotion of sustainable lifestyles and the reduction of greenhouse gases (Elliot 1995; Mogensen and Mayer 2005; Abrahamse et al. 2007; Stern et al. 2014).
- It encourages individual knowledge within a social environment and students' real participation in the process, seeking not only motivation and learning, but also the development of a democratic culture based on dialogue and participation (Lave and Wenger 1991; Wals 2007; Varela-Losada et al. 2016).
- It integrates the community, fosters collaboration with people and the creation of learning networks that favour transfer of learning (Hart 1992; Vosniadou 2001; Wals 2007).
- It involves knowing, experiencing, reflecting and applying innovative methodologies in the context of an EE that is focused at students achieving the proposed knowledge: the basic sustainable and educational competencies that allow them to contribute to the mitigation of CC, through a learning that is contextualised and participative (EU 1999; Vilches Peña and Gil-Pérez 2013; Stern et al. 2014; Tugjamba et al. 2016).

Building on this framework, we have chosen a proposal that is closely linked to the socio-constructivist model, to the theory of activity and development of self-regulating processes (Pujol 2007). Thus, the approach is based on a learning

cycle by Karplus (1977) in such a way that activities are organised in (i) initial exploration activities, (ii) activities for the introduction of new knowledge, processes, concepts, procedures or modelling, (iii) activities for the structuring of knowledge, and (iv) application activities.

Furthermore, this EE that is linked to sustainability and climate education should imply a positive approach to group decision-making, respect for democracy and an understanding of participation processes (Vega-Marcote et al. 2015). Therefore, for the development of this experience, what is adequate is to organise students into small collaboration teams and to use cooperative strategies and dynamics. The final purpose is for students to act as a community that produces and mobilises its own knowledge (Uskola et al. 2010) and fights against CC. The role of teachers is also important, for they must accompany and guide the learning process, providing continuous regulation. Thus, the learning, evaluation, and regulation activities have to be mutually interrelated and coherent.

With this approach, the teaching proposal we present not only seeks a compromise between teachers' Sustainable Development and the mitigation of CC, but also the acquisition of teaching competencies related to EE. Accordingly, matters related to sustainability and CC are addressed on the one hand, while their way of understanding EE is addressed on the other hand, in such a way that these two aspects are complementary and interrelated. Therefore, this experience involves teachers experimenting on their own new ways of learning that are distant from the transmissive model, while learning about sustainability in order to, in due course, be able to reflect critically on the process carried out, seeking the development of the sustainable and teaching competencies described in Table 1.

An aspect that needs to be highlighted is that the process can be carried out face-to-face and online, for the use of ICTs is an important factor in today's world (Roy et al. 2008; Zawacki-Richter and Naidu 2016). In our case, the teaching platform LSM-Moodle [http://eduponte.cesga.es] was used, where students and teachers can upload and look up the most important information for the research process and to carry out tasks in a collaborative manner. In addition, the communication of ideas and debates can be performed virtually through the social network that supplies this platform. The debate is therefore open to all the participants in this social network, not only to the students participating in the action, but also to other students of other subjects for the same university degree. This approach contributes towards students feeling more motivated when carrying out their interventions and brings about the spreading of ideas and conclusions drawn by the students throughout the process. Likewise, this communication phase makes it easier to establish that which was learned and gives rise, as well, to an external evaluation of the work and adequate feedback (Arias Correa et al. 2009).

The proposal consists of a learning cycle on sustainability and CC and a cycle in methodology in EE, which were developed in an integrated manner (see Fig. 1), but that we are presenting here separately to permit a more detailed analysis.

Table 1 Competencies that can be acquired through this proposal, with regard to EE and sustainability

Teaching competencies related to EE and sustainability*	Sustainable competencies**
– Understanding why there is a need to transform the educational systems and the way we teach/learn – Understanding how to involve students in real issues to improve learning and help them to change effectively – Be able to address dilemmas, problems, tensions and conflicts in the classroom, with different perspectives, especially in the interrelation of the scientific, economic and social aspects – Be able to create opportunities for the exchange of ideas and experiences from different disciplines/cultures/generations and without prejudices – Help students to clarify their own views of the world and those of others through dialogue and to acknowledge that there are alternative frameworks – Understand the need to encourage independent and informed decision-making that contributes to the transfer of knowledge to the different contexts and to re-evaluate daily actions – Be a mediator and participant in the learning process in such a way that positive relations are established with students – Provide student-centred education to promote the development of critical thinking, active citizenship, and participation – Be a critical reflexive professional	– Systems-thinking, to collectively analyze complex systems across different domains and across different scales, thereby considering systemic features related to sustainability issues and sustainability problem-solving frameworks – Anticipatory competence, to collectively analyze, evaluate, and craft rich "pictures" of the future related to sustainability issues and sustainability problem-solving frameworks – Normative competence, to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals, and targets – Strategic competence, to collectively design and implement interventions, transitions, and transformative governance strategies toward sustainability – Interpersonal competence, to motivate, enable, and facilitate collaborative and participatory sustainability research and problem solving

*Competencies adapted from UNECE (2012)
**Competencies proposed by Wiek et al. (2011)

Learning Cycle on Sustainability and Climate Change

Our proposal seeks the development of sustainable competencies with the purpose of reducing greenhouse gases. It is a role play that includes a research type of task on CC, put forward in such a way that students can link it to their immediate surroundings. These issues can be approached through methods that structure the activities in accordance with the cycle by Karplus, or with adaptations such as problem-based learning, or project-based work. The key is to always take close-up problems related to the lack of sustainability into the classroom and experience them. In this case we have chosen a role play because of its power to specify values

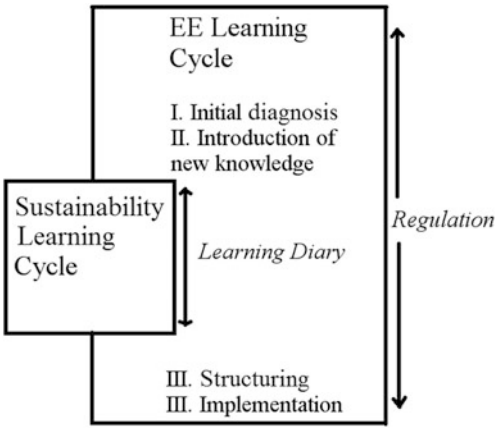

Fig. 1 Diagram of the integrated proposal

and promote democratic participation (Todd 2009; Öhman and Öhman 2013), as well as providing an extraordinary experience on the situation presented. Thus, the proposal poses a debate regarding the installation of an alternative energy platform and its contribution towards the mitigation of CC, where the cooperation teams allocate different roles based on the institutions and social agents that are involved in the problem.

The didactic sequence follows the same structure described in the previous section. The learning cycle on sustainability begins by introducing into the classroom various news items related to CC (especially the causes and consequences of their immediate surroundings), that students must compare and interrelate in such a way that encourages the formulation of questions and the raising of doubts. The role play begins with an item of news on the installation of a new alternative energy plant in the area, giving rise to a reflection on the different people and interests involved. In this way, the proposal of simulating the adoption of a decision on this new plant on the surroundings and the assumption of the different roles identified (Local government, Civic Association for the Defence of Clean Energy, Union of Spanish Petrol Companies, Community of Farmland Owners, Nuclear Safety Board, etc.) is presented.

With the help of cooperative strategies, the research questions that are to serve as a driving force for seeking information are established. Here it is fundamental to encourage the analysis of the situation, taking into account the Science-Technology-Society-Environment interrelations through matters such as: causes and consequences of CC, possible ways of addressing the problem (of a techno-scientific/social transforming nature), solution through the production of wind/solar/nuclear energy, advantages and disadvantages, consequences, etc. This starts off a team search and it encourages the critical use of information, the consulting of experts and the joint preparation of educational field trips. The information gathered needs to be restructured and subsequently synthesised collaboratively, where each part involved must prepare its grounds based on the

role assigned, giving rise to the analysis of the information collected, and the explanation of the beliefs and values that are behind each stance.

Prior to the debate, a reflection should be encouraged on certain fundamental issues:

- Is the use of alternative energies a good solution? Is it enough to solve the problem?
- What role do we play in the solution to the problem? What is our behaviour with regard to the energy problem?
- Are we aware of the attitudes/values behind them? How do the political, socio-cultural, and economic factors affect our behaviour?
- Are social transformation and a change in the present-day economic model necessary?

The learning cycle culminates with a debate and consensual and reasoned decision-making, based on the difficulties and priorities for action that are addressed not only by the issue set forth, but also by our individual responsibility and that of our community towards the problem. It is also very enriching to hold the debate and show its conclusions through a social network like the one provided by the educational platform LSM-Moodle, which makes it possible to open the discussion to other people. Other possibilities for sharing these conclusions are to host conferences, set up web pages, post videos on You Tube, etc.

Finally, a shared evaluation has to be executed through co-evaluation, where evaluation rubrics should be used. It is also convenient to reflect on the learning process, reviewing what has been learned and how our original ideas have evolved.

Learning Cycle on Environmental Education for Sustainability and the Mitigation of Climate Change

As we have already pointed out, the proposal has been set forth in such a way that teachers acquire first-hand experience of learning styles that differ from the traditional educational model (Vilches Peña and Gil-Pérez 2013), in order to encourage their reflection on the process they have just carried out. The purpose of this is to develop teaching competencies (see Table 1) that promote the mitigation of CC.

Consequently, at the beginning of the process students have to reflect on what they know and what they think they know about an EE that makes it possible to change lifestyles (reducing greenhouse gases). A brainstorming session where these ideas are contrasted and where questions are posed can help to promote research on the topic.

Then, while the learning cycle on Sustainability and CC (described in the above section) is taking place, students are required to record in a diary their analysis and evaluation, from a didactic point of view, on everything that takes place in each

phase. The contents of the team diaries are then shared in such a way that the students can evaluate their experiences and get feedback.

After carrying out this experience, students are asked to globally analyse it to decide if it is an adequate experience to use in their future classrooms. Here it is necessary to provide a reflection on the different teaching models we can use during the learning process for this environmental topic (CC) that make it possible to contrast one's own ideas with the proposal, where the tendency to reproduce the teaching models experienced is critically analysed (Garmendia et al. 2014). With the purpose of supporting the analysis, it is crucial to foster a grounded reflection on matters such as:

- What should the aim of an EE (focused on sustainability and on mitigating CC) be?
- What characteristics should it have?
- What are the obstacles of addressing it in the classroom?
- What methodological directions should be followed?
- What contents and competencies related to this topic are prescribed in the curriculum?

For its substantiation, students must carry out different tasks: seek and manage information, carry out a curriculum-based analysis, consult experts and visit schools that work with sustainability and the reduction of gases. Thus, during this phase an individual educational framework is created, through the review of different knowledge. The analysis of the experience makes it easier to understand this framework and to evaluate learning, which should provide a new joint assessment of the entire process.

Finally, students can carry out other implementation activities, such as designing a team educational proposal based on CC, which can be later experimented with during the training process that culminates their university studies.

Implementation of the Proposal

The implementation of the proposal was developed in a positive way. An initial analysis, based on the data collected during the experience, showed that there is an evolution in learning. This can be seen in the diaries, which show how students' early ideas about how to learn and how to teach changed throughout the process. Being accustomed to a transmissive model, initially they did not reckon that their learning would benefit from the action. At the end of the experience, the future teachers highlighted the importance of using motivational methodologies based on globalized approaches which favour interaction and participation, and where students go from being spectators to becoming actors.

Regarding CC, the future teachers began to make more complex interpretations on the issue of power, showing a greater understanding of the interaction between factors (social, environmental, scientific, technological, etc.) and sustainability.

After the educational intervention, the students pointed out that this proposal had helped them to become more reflective and critical, to have a better understanding of the socio-environmental issue and to raise their awareness regarding their capacity to contribute towards its improvement and transformation.

Conclusions

There is a need to boost the transition towards schools and communities that are informed of and aware of our planet's socio-environmental deterioration, who are capable of participating in sustainable actions, individually or collectively, in order to mitigate a problem such as CC. This transformation requires an education that is based on holistic methodologies that are close to reality, that encourage participation, information handling, the development of critical thinking and autonomous and informed decision-making. It should not only provide information on the environment, but it should question the unconscious values and models that are behind our lifestyle, to produce and use energy from our communities.

Throughout this process, teachers are a key factor, whose training has a multiplying effect on society through their future professional career. Therefore, we must seek educational models that contribute towards training teachers who are reflexive and committed to climate education, who have the necessary skills to educate citizens that have these same qualities, who are capable of facing today's socio-environmental challenges as well as those to come, such as the reduction of greenhouse gases.

This proposal that we present here and support addresses the issue of CC, assuming the principles mentioned above and originating from the importance of undergoing innovative educational experiences that allow students to widen and find new approaches that promote an education based on the climate with the purpose of acting in order to reduce emissions and to acquire the competencies typical of their teacher training, according to present-day trends in this field. In addition, its approach allows for online development, taking advantage of the possibilities that are offered by the new technologies in the educational field (Zawacki-Richter and Naidu 2016).

To conclude, we would like to highlight that experiences based on this approach and on its different variations have been evaluated and have provided positive results (Varela-Losada et al. 2014; Araujo-Álvarez et al. 2015; Vega-Marcote et al. 2015), which are in line with the initial analysis that we show here. Therefore, this proposal could be the basis for future experiences, adapted, and used in different contexts in such a way that it can be built upon as progress is made in teacher training research and development.

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Supporting Sustainable Policy and Practices for Online Learning Education

Diogo Casanova, Linda Price and Barry Avery

Abstract This chapter describes an approach to the adoption of online learning in Higher Education. It is particularly relevant for readers interested in Online and Distance Learning initiatives that enact an agenda of climate change education through being sustainable and future proof. We present a pathway for ensuring sustainable educational initiatives, drawing from research that identifies crucial factors in this endeavour. In particular, it addresses how the adoption of Online and Distance Learning can be used as a catalyst for changing the pedagogical paradigm of universities and how this change may impact on the development of new policies and guidelines. In this chapter we report on how policy, guidelines and professional development can be designed for sustainable and consistent learning design and teaching practices.

Keywords Sustainability · e-Learning policy · Technology enhanced learning Higher education · Learning design

Background

> It was bought as a 'tool' and now finds itself in the guise of a somewhat wobbly arrow of change. In practice, changing the way thousands of teachers teach, learners learn, innovation is promoted and sustainable change in traditional institutions is achieved across hundreds of different disciplines is a demanding endeavor that will not be achieved by learning technologies alone. It involves art, craft and science as well as technology (Salmon 2005, p. 201).

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Fundamental questions about the sustainability of online educational practices and processes have not lessened in the ten years since Salmon highlighted the complex nature of these changes. The proliferation of bring your own device policies (BYOD), tablets, smartphones, social media and Learning Management Systems has exacerbated changes in academia. In order to use technology wisely and, more importantly, sustainably, we need to develop principled frameworks that guide effective policies and practices. This is particularly important if we, as educationalists, are to lead the way in enacting a sustainable approach to online education that demonstrates how changing practice can help contribute to addressing climate change.

Salmon (2005) proposes several factors that are paramount for sustainability: Innovations need to

- be situated at the macro institutional level;
- have appropriate financial support;
- be aligned with institutional aspirations for teaching excellence; and,
- have institutional structures that promote wider adoption.

The variety of stakeholders within institutions need to understand that online learning projects are part of core student learning processes that are inextricably linked with teaching excellence and institutional policies and aspirations. Online learning has often been perceived as being disconnected from pedagogical processes; those more familiar with new trends in educational technologies are often '*accused of using them regardless of whether or not they are pedagogically effective, and even in ignorance of the long tradition of pedagogical evidence and thought*' (Beetham and Sharpe 2007, p. 3).

Online learning initiatives are often small-scale projects supported through external or internal funding, driven by bottom-up approaches. These start with great enthusiasm but are often abandoned when they exhaust their resources (Trentin 2007). They fail to achieve a wider and more sustainable life for two reasons. First the scope has limitations and cannot easily translate to scale (Stepanyan et al. 2013). Secondly, without embedding and aligning the initiative within current institutional processes from conception, it is difficult to maintain and sustain beyond the lifetime of the project (Kirkwood and Price 2016).

Recent Horizon Reports (Johnson et al. 2014) present further evidence that acceptance of online practices in higher education (HE) is being impeded by a lack of explicit sustainability practices; a factor required for better adoption. They point to several issues:

- low level skills among staff who are not effectively supported in develop appropriate skills;
- lack of policies that reward and recognise effective teaching and learning practices;
- lack of dissemination of the practices from small scale projects; and,
- lack of perceived relevance.

These factors present challenges that HE institutions need to address in order to capitalise on our ever-decreasing resources and to use them wisely, now and in the future.

Technology as a tool or as concept usually fails when it is not supported by institutional vision and policies (Kirkwood and Price 2016). Currently institutional guidelines and procedures in relation to online learning typically focus on assessment practices or academic misconduct. Much work is still to be done in order to adopt a holistic institutional approach that can support online learning *sustainably*. The focus is still on technology and efficiency rather than 'craft' and 'science' as Salmon (2005) discusses.

Despite the considerable HE investment in technology, little research has demonstrated how it has impacted on wider institutional policy and practices (Angelo 1993; Breen et al. 2001). Much of the research is driven by small case initiatives, and typically their influence upon the institutional as a whole is still limited (Price et al. 2015). More frequently observed are the localised implementations, which usually lead to fragmentation of practices across the institution and a 'disintegrated' student experience (Kirkwood and Price 2016). While large-scale projects do exist, they are often presented as a new technical solution that seamlessly replaces previous obsolete ones with better efficacy and more simplicity. Little discussion focuses on the underpinning processes, robustness or inadequacies of the current solutions and fail to go beyond how to technically transfer to more modern instantiations. This has a serious implication for how resources can be shared, used wisely and how economics of scale can be achieved.

A recent meta analyses of sixty-four empirical papers describing small scale e-Learning initiatives (McGill et al. 2014) identifies the critical factors for the continuation of e-learning activities beyond locally funded projects. At least twenty of those projects were fully discontinued after three years of the publishing of the papers. The authors argue that the literature is fertile in describing research-grounded initiatives, but few have been shown to be effective in the long term. The challenge lies in scaling-up from small, locally funded projects to wider, institutionally-sustainable ones.

The greatest challenge in advancing online learning institutionally is to go beyond the noble, and often disconnected, educational technology innovations developed by TEL enthusiasts. Typically, local small-scale initiatives tend to lead to wide institutional variation. They also often operate outside the underlying institutional infrastructure and thus become marginalised or fall foul of continued or sustained IT support (see, for example, UCISA, Walker et al. 2014). Such TEL initiatives, although well intended, are often designed for specific circumstances, frequently detached from the pragmatic practices of staff. Equally, they can also be difficult to implement in other contexts. Although these initiatives may potentially be linked with main institutional agendas and policies, they often fail to be explicit. Hence academic staff fail to understand their relevance for their daily activities: again, a waste of resources.

What has become clear is the need for sustainable approaches to developing online learning that link with underlying institutional infrastructure and policy,

whilst also providing students with a stake in their educational opportunities and experiences. Coherent and maintainable structures for supporting changes in the longer term need to involve art, craft and science (Salmon 2005) as well as the technology if we are to use our resources wisely.

In this chapter, we present an institutional approach for the sustainability of online learning. We specifically present the adoption of a new Virtual Learning Environment (VLE) as a catalyst for sustainable change in a UK University. We illustrate how the use of a framework from conception, enables a holistic institutional approach. This encompasses the complex relations between institutional, teaching and learning perspectives, and fully engages different stakeholders in the provision of long-term scaffolding for sustainable online learning. The 'Succeed by Canvas' project from its inception was developed as an agent of change and a vehicle through which to develop new policies and practices that not only enhance the overall quality of teaching and learning but also address the effectiveness of strategy in providing sustainable and resource-sensitive education.

The participatory approach presented here began with a 'top-down' approach and then evolved to include 'bottom-up' approaches so as to enable a sense of ownership and involvement from all stakeholders.

Knowing the Context and the Stakeholders

Implementing sustainable online learning changes in a HE institution is difficult and complex. Institutions are not heterogeneous and encompass a large range of stakeholders (Figs. 2 and 3) (Brown 2014; Kirkwood and Price 2016). Historically, HE institutions have often been formed from a conglomerate of smaller institutions, which have their own idiosyncrasies and identities. Hence a top-down senior management-driven approach, may not be welcomed or completely adopted. Likewise, bottom-up changes encounter difficulty due to lack of senior management support. These are typically initiated by small groups of 'early adopters' led by innovative individuals. While the innovations themselves may be valuable, they fail to gain the institutional traction and engagement required with the critical mass in order to achieve institutional-level adoption (Brown 2013; Marshall 2010).

Research has shown that achieving effective online learning adoption has been more difficult than policy-makers had foreseen (Walker et al. 2014). This has been manifested not only at an institutional level, but also at programme, course and module level, where module design and assessment policies are not congruent with each other or with a course or programme as a whole (Price et al. 2017). Concomitantly, it is not a surprise that a third of management bodies in US HE institutions, providing programmes with online learning and teaching, believe that the learning outcomes of these interactions have a lower quality when compared with learning outcomes of traditional face-to-face teaching (Allen and Seaman 2013). Online learning is still seen as an adjunct to learning and teaching, and is used mainly as a passive and unidirectional way of transmitting content and/or to

support administrative tasks, such as online submissions or the delivery of announcements. Latchem (2014) refers to the plethora of meanings of e-Learning by suggesting a continuous line of evolution: at one end there is the translation of didactic texts or presentations to a digital format with little opportunities for engagement, and at the other there are technology situated communities of students operating in a peer-based collaboration supporting learning and knowledge creation. The UK HE sector is still on the prior stage of this line of evolution. Walker et al. (2014) found that online learning is still largely confined to accessing web-based resources or digital repositories, e-submissions, and the use of software for detecting plagiarism. Less than 25% of academics design student-centred learning strategies with asynchronous collaborative working tools, peer-assessment or e-portfolios. Similar findings in a recent in-depth analysis of blended learning programmes found that the VLE was mainly being used to distribute resources and to manage assignments submissions (van der Sluis and May 2015). Teachers in these programmes are not reflecting on the different characteristics of online delivery, but rather focus on transposing face-to-face practices to the institutional VLE. Typically, the designers of online learning 'teach' how they were taught, attempting to replicate face-to-face teaching online (Englund et al. 2016; van der Sluis and May 2015). This is unsurprising considering staff often lack support, evidence-based research knowledge or appropriate institutional contextualization (Price and Kirkwood 2014). Hence considerable resource is wasted in preparing online learning designs that lack effectiveness and engagement for the learner.

A further highly influential factor in how academics practice is the underlying context within which they work (Fanghanel 2007). The departmental and institutional culture is highly influential. For example, if an institution has a research-intensive culture, academics are more likely to concentrate on their research as a more definitive means to gain promotion (Kirkwood and Price 2016). This inadvertently focuses attention away from teaching (Boyer 1990) with the result that engagement with online learning interventions becomes more difficult.

There is much discussion in HE about improving the quality of students' learning. However, strategies to improve this quality are typically assumed and uncontested (Coffield 2008). This is more acute in online learning where the body of knowledge is less mature and comprehensive (Kirkwood and Price 2016). As Bates (1995) argued more than twenty years ago, the problem is not with the technology per se but our hesitation in embracing the complexity and different stakeholders that are involved in it. Although daunting, the requirements of diverse stakeholders with their different perspectives, varying departmental and institutional contexts, and variations in academic ideology and teaching practice have to be addressed (Fanghanel 2007). Price (2014) argues for a more holistic approach that acknowledges the inter-related factors of the different stakeholders. Kirkwood and Price (2016) propose a model for exploring this complexity as a way to understand the influences and competing drivers from these stakeholders when developing a TEL project in HE (Fig. 1). This is in order to consolidate efforts and waste less

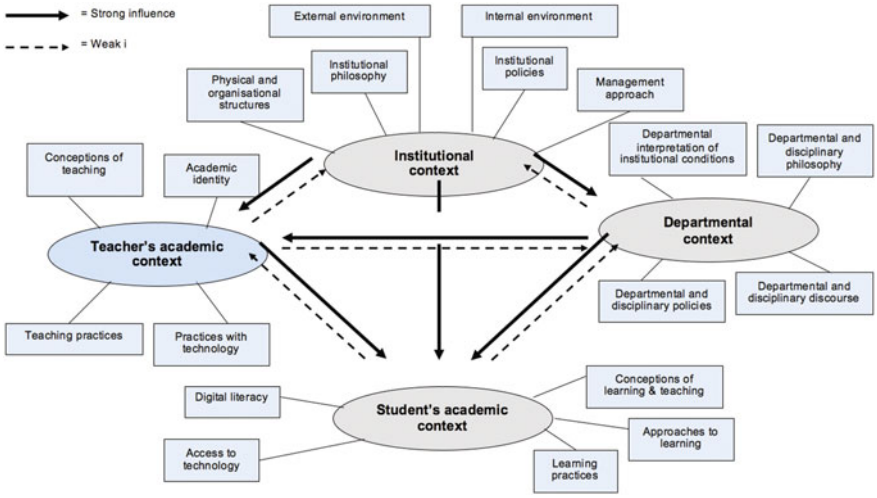

Fig. 1 Factors influencing teaching and learning with technology in HE: a framework (adapted from Kirkwood and Price 2016) made available in this chapter with the authorisation of the authors

resource in the pursuit of better online provision. The four main areas are the teacher's academic context; the student's academic context; the departmental context; and the institutional context.

The teacher's academic context focuses on their individual conceptions of teaching. This is how teachers individually perceive teaching; reflecting how they were taught and how they empirically learn what works during teaching (Prosser et al. 2003; Trigwell et al. 1999; Trigwell and Prosser 2004). Academic identity relates to an academic's own *persona* and overall academic profile. This encompasses teaching, research/scholarship, management, and leadership (McLean and Price 2016; McLean 2012). Teaching practices are manifested in real scenarios and these are directly related to how they use technology in their teaching (Englund et al. 2016). The teacher's academic context strongly influences the students' context but is highly swayed by both their institutional and departmental context. Similar relationships are created between other stakeholders: this requires a combined and comprehensive approach to online learning to engender sustainability. Keppell et al. (2010) suggest a more participative approach to implement online learning, referring to a 'distributive leadership'. This is where a project is jointly managed by more or less equal participants or stakeholders.

Evidence suggests that the more distributed and comprehensive online learning is, the more capable it will be of representing the different stakeholders and influences of the institution, and thus its identity and values. We believe that this is a first step in ensuring the sustainability of online learning.

What Is Sustainability and How Can It Be Manifested in Online Learning?

The term sustainability spans many disciplines, although it is usually more closely associated with environmental science and economics. Sustainability has been considered from philosophical, historical, economic, political, social, and cultural perspectives (Stepanyan et al. 2013). The term 'sustainable' is defined by the Cambridge online dictionary (http://dictionary.cambridge.org) as: 'the ability to continue at a particular level for a period of time'. While definitions vary, there appears to be a common agreement on continuity over time, implying both permanence and consistency with the same degree of efficacy. In education the discourse around sustainability has been developed in two broad directions with clear distinctions being made between education for sustainability and climate change and sustainability of education (Stepanyan et al. 2013).

Whilst education for sustainability and climate change focus on environmental sustainability through educational solutions and curriculum design (Azeiteiro et al. 2015), sustainability of education aims to promote the notion that changes are lifelong and promote consistent efficacy. Gunn (2010) supports this by arguing 'sustainability' should not only promote practices that lead to teaching and learning benefits, but should also guarantee the existence of potential that goes beyond the use in the original contexts. Trentin (2007) agrees, adding that if a project has the characteristics required to integrate itself effectively and efficiently in the wider institutional context, then the more sustainable and innovative it will be. He argues that innovation and sustainability are linked and that online learning is less innovative if it is not sustainable. Both authors agree that online learning needs to be integrated into the institution's policy and needs. This will create wider adoption and an increased sense of relevance for all stakeholders. This requires the development of institutional policy (Czerniewicz and Brown 2009) that embraces online learning, as strategic, providing therefore appropriate financial support (Nichols 2008). Gunn (2010) argues that three conditions need to be met for online learning to be considered sustainable:

- A Learning Design that supports the overall design of the programmes of study. It should be developed through a proof-of-concept stage, on the basis of evidence, and has to be judged by stakeholders as beneficial to teaching and learning.
- Online learning concepts, designs, systems and resources have to have proven potential to be adopted and adapted for use beyond the original development environment, i.e. to the wider context of the HE institution.
- Maintenance, use, and future development of online learning must not be dependent upon the few individuals who created them so that future developments are not compromised by their absence.

We propose five levels that influence online learning sustainability that directly affect personal and institutional motivation (Fig. 2).

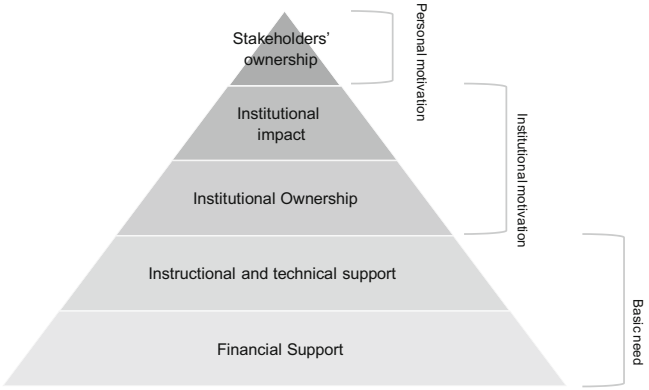

Fig. 2 Levels influencing online learning sustainability

Similar to Maslow's Hierarchy of Needs, each of the levels have to be accomplished to provide foundational support for the next level. So, for example, without proper financial support it would be difficult to provide the necessary technical instructional support and this will affect both institutional and personal motivation.

Financial Support

This is the primary factor for supporting different developments and underpins the recruitment of the implementation and development team (Nichols 2008; Salmon 2005). Different stakeholders have to perceive the project as having appropriate financial support as this indicates institutional commitment and engagement with the project. Sustainable projects have to acknowledge the transition that will be required when the initial project funding ceases; institutions must provide financial and structural support for business as usual after project completion. If this financial support is missing, the initiative will not be sustainable.

Instructional and Technical Support

Online learning initiatives need to be supported throughout the development, implementation and maturity phases, especially during the latter when resources and funding may be constrained (Bates and Sangra 2011; Salmon 2005). Building on a proper proof-of-concept stage that evidences the quality of the initiative (Gunn 2010), pedagogical and technical support have to be provided through training activities, helpdesk, online documentation and one-to-one support

(technical, instructional or librarian support). This support also signals the investment in IT infrastructure and a commitment to providing reliable support for online learning (Åström 2008; Bacsich 2009; MacDonald and Thompson 2005; Marshall 2012; Masoumi and Lindström 2012; McPherson and Nunes 2008; Selim 2007; Sims et al. 2002; Sun et al. 2008).

Institutional Ownership

Online learning initiatives need institutional support for success. Ownership needs to transition from the project-initiators to the institution in order to instantiate better and more institutionally-driven support for policies and guidelines and wide adoption (Bates and Sangra 2011; Salmon 2005). Alignment of the project with institutional policies and regulations are important steps for sustainability. Policies around assessment and feedback, academic misconduct and copyright and quality assurance (Åström 2008; Bacsich 2009; Marshall 2010; Masoumi and Lindström 2012; McPherson and Nunes 2008) all have to be adapted and evolved to include online learning perspectives. Importantly, these policies consolidate a common understanding across the institution of best practice.

Institutional Impact

The ultimate goal of online learning is to lead to institutional impact (Stepanyan et al. 2013; Trentin 2007). This may result from the improvement of institutional practices or from changes in institutional policies. This only happens when there is institutional adoption of the initiative. However, it is important that this impact is acknowledged, publicised and supported, through narratives to different stakeholders. This reiterates that the project is supported and embraced, and allows stakeholders to reflect on the direction of online learning initiatives.

Stakeholders' Ownership

This is the final step of sustainability. This is where actual practitioners begin building their own conceptions and usage of online learning and evolving habits and dependencies that ensure its continuance. Successful and sustainable integration requires institutional impact evident in ownership and adoption by the stakeholders. Stakeholders need to embrace the relevance of online learning in their own practice and accept ownership of the project by transforming what is provided into their own reality and needs (Gunn 2010; Trentin 2007).

The next section provides a specific example of a wider institutional adoption of online learning based on the five-level model, and describes the practicalities required for each level.

From Top-to-Bottom and from Bottom-to-Top—A Bi-Directional Approach to Sustainability

The 'Succeed by Canvas' is a participatory approach for online learning adoption at an institutional level that began with a 'top-down' approach and evolved to a 'bottom-up' approach. This enabled ownership and involvement from all the relevant stakeholders. This required engagement from the university's senior management team, the Associate Deans of Learning and Teaching, Faculty representatives, Central Departments, TEL enthusiasts and students in a shared, institutional-wide project.

The 'Succeed by Canvas' initiative aimed at changing how the university was using online learning by introducing a new VLE, Canvas, which provided new features to support policies enabling its roll-out. The university is a middle-size in the UK with approximately 17,000 students and offers mainly Blended Learning programmes, combining face-to-face teaching with online delivery and assessment. The university comprises five faculties, each divided into Schools and Departments. It had been using BlackBoard as its VLE since 2002. Although staff were familiar with BlackBoard, evidence showed that they had developed limited active learning and student interaction (van der Sluis and May 2015). Student feedback showed significant difficulties in locating resources, assessment and feedback. They also complained about the lack of consistency in how modules were presented, even within the same programme, with low accessibility and usability. As both online assessment and learning materials storage were seen as the two main VLE features, both in the university and in the wider UK HE sector (van der Sluis and May 2015; Walker et al. 2014) it underscored less effective learning designs and a lack of transparency. The evidence also showed that current approaches to supporting the teaching and learning processes were fragmented, uncoordinated, and in some cases labour-intensive. The use of the VLE was not guided by over-arching university principles, but had evolved through well-meaning individual and uncoordinated enthusiasts initiatives. Although the university supported around 17,000 students, economies-of-scale had not been achieved and resources were being wasted on supporting this distributed and autonomous instantiation.

The VLE initiative was used as 'Trojan horse' (Trentin 2007) to implement a set of new learning design principles and policies to provide a more sustainable and better quality experience of online learning. This underpinned with evidence from research into appropriate institutional policy and goals that would help achieve sustainability and better quality student learning.

The ‘Succeed by Canvas’ project is structured into three levels: the TEL Steering Group; The Learning Design Group and the Stakeholders Group (see Fig. 3).

The TEL steering group is chaired by the Pro Vice-Chancellor (Learning and Teaching) and met every month. It comprised the Associate Deans for Learning and Teaching in each Faculty, the Heads of Central Departments (Academic Development; Information and Technology Services, Library, Services for Students, Academic Registry and Equality and Diversity), and the TEL team. This group was responsible for approving new policy and guidance and escalating issues beyond their remit to the university Educational Committee.

The Learning Design Group consisted of the TEL team, Associate Professors representing each faculty, and Graduate Assistants, former university students. The Learning Design Group was responsible for listening to stakeholders, and based on this feedback, designing, developing and implementing changes approved by the TEL Steering Group. The stakeholders level was comprised of teaching staff who were trained during the implementation, TEL enthusiasts, students and the Faculty Associate Deans for Learning and Teaching. This level was responsible for feeding in concerns and new ideas to the Learning Design team.

The structure of the project provides an indication of the different stakeholders and how they can be involved in a wider institutionally-supported project. After the implementation phase the project entered the maturity stage with a set of structures

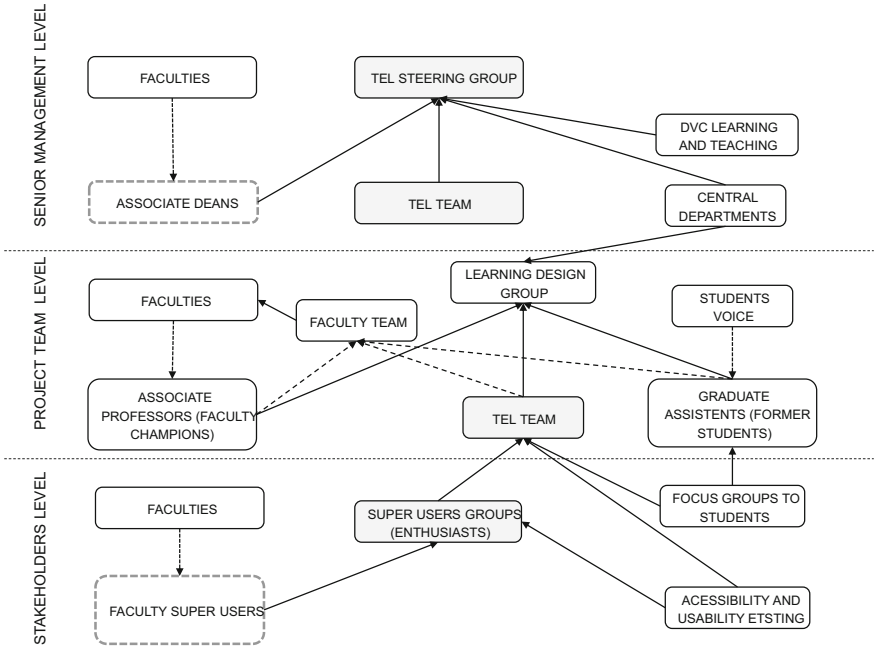

Fig. 3 Presents the streams of communication and representation during the project. Lighter grey background represents the structure in place after the implementation phase

that were designed to maintain the technical and training support needed for sustainability. Faculties are still represented by their Super-Users and Associate Deans and the TEL structure responds to the challenges and decisions coming from users to the TEL steering group. This structure engages staff at all levels and provides a structure and mechanism for resolving future challenges; this gives the sense of relevance and ownership, shown in Fig. 2, which are necessary for online learning sustainability (McGill et al. 2014).

Using Fig. 2 as a reference we now present how the 'Succeed via Canvas' initiative is meeting the five different levels influencing sustainability.

Financial Support

The first step in gaining financial support is to develop a sound business case. This needs to encompass the scope of the project, the rationale, the risks and impact, quality and evaluation, a project plan and a budget. While it is time consuming initially to construct such a lengthy and detailed document it serves several very important functions. First it enables clarity around what will be delivered, how, and the associated costs. Secondly it provides a clear statement of why the project is needed, what it will achieve, and how it advances the university's objectives. The business case is a very important step in initiating the project as an under-resourced project can fail to achieve its goals and potentially do more harm that good. The business case is also a vehicle for engaging top-level stakeholders across the university, including Faculties, IT support, student support services, library services and estates. It allows all these important groups to understand how the project will affect their areas and how the university will move forward as-a-whole with the project. The business case needs to be circulated to all relevant committees in the university for scrutiny and agreement. While this can be a lengthy procedure, often involving critique and revisions, once it has been reviewed, agreed and signed off by all relevant committees, there is institutional buy-in and support for the project as it moves forward. This is the cornerstone of initiating sustainable online learning.

Instructional and Technical Support

A successful business case enables the required resources for implementation to be in place and enables identification of the necessary technical and instructional support. In the 'Succeed by Canvas' project this resulted in the creation of a new team comprising a reformed TEL team with six academic lecturers responsible for instructional support; Teaching Graduates to ensure a student voice and to provide technical and admin support; and seconded senior academic staff (faculty champions), liaising with Faculties Associate Deans, and representing disciplinary interests in the development of online learning. The TEL team was responsible for

guaranteeing sustainability as they ensured that developments made the best use of resources both now and in the future through maintaining their links to the different Faculties.

Institutional Ownership

Ownership is a fundamental step for sustainability, both institutionally and individually. In this project there was a clear commitment to involve the whole university. The transition to a new VLE represents a big change, in terms of existing procedures (Learning and Teaching, Assessment and Quality Assurance), and involves different stakeholders, who see this transition an opportunity to change their practices or to express their point of view. The TEL steering group guarantees a space for senior stakeholder management engagement and active engagement in changes. It also enables the TEL team to communicate operational activities and to build specific strategies across Departments and Faculties that respond to those challenges. At the lower levels, Super-user groups meetings, both academic and admin, also provide vehicles of communication of ground-level activities. They are able to communicate their concerns and needs, which, if needed, are escalated back to the TEL steering group. Finally, Student-user groups report on how implementations of the new VLE are affecting their experience as learners. This provides a more holistic approach to make more effective use of precious university resources.

Institutional Impact

Although the instantiation of this online learning project is still on-going, a significant impact we are already experiencing is the change of policies and practices, which is connected to the institutional ownership of the project. Academic Registry, Library and Learning services, and the Assessment task Group, have all seen in this project an opportunity for collectively advancing their agendas by implementing new policies and procedures that impact on institutional and individual practices. The manifestation of these changes evidence the impact of the project and led to its sustainability after its developmental phase, as they are coupled with institutional policy and regulations. We also have preliminary data that suggests this approach provides a better understanding of the value of a VLE in enhancing students learning, staff awareness of best practices for online learning, and an increase in the implementation of rubrics for better online assessment.

Stakeholders' Ownership

Stakeholder ownership is a crucial component for engaging staff in the successful sustainable implementation of online learning. Staff are already embracing the frameworks for sustainability while also engaging with the opportunities in Canvas to tailor the learning designs for their particular student's needs. We have embraced staff suggestions for enhancement in the online learning design templates, adding in new components and functionalities, creating new content and exploring new solutions. These stakeholder requests demonstrate ownership and engagement and offer real opportunities for sustaining online learning in the future. The user groups have guaranteed that individual voices are continuing to be heard and that contributions to the project development ensure a on-going co-ownership that helps the whole institution in achieving sustainable online learning.

Final considerations

One of the important aspects of developing any online learning innovation is having a vision for sustainability from the outset. This is fundamental to ensuring that planned use of technology becomes embedded into the university's normal processes and practices. The move to 'business as usual' requires a systems approach to development that holistically addresses institutional needs whilst also understanding the delicate and complex eco system around sustainable online education that exist within universities.

Any higher education institution that aims to promote awareness in climate change education should begin by leading from the front. In other words, they should enact the principles of addressing climate change in their own institutional initiatives. Sustainable online education should be instigated as a strategic and institutionally-led initiative that engages all stakeholders if this goal is to be achieved. Salmon (2005), Gunn (2010) and Trentin (2007) agree that stakeholders need to understand the relevance of the implementation to their own practice and engage with owning the project by transforming what is provided into their own reality and needs. Providing sustainable online education is the responsibility of the whole university and it is only by engaging all university stakeholders in this venture that we can hope to address the issues of climate change in online education.

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Sustainable Mobility in Higher Education Through Virtual Attendance

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Abstract In this chapter, we present various proposals for improving student mobility on their journeys to and from university. Specifically, we describe a student service delivered by the virtual attendance system implemented by the National Distance-Learning University (UNED) which is not only a reference in terms of support for the teaching-learning process, but also enables the reduction of student journeys to UNED-associated centres and university campuses, thus reducing both the air and noise pollution caused by the use of motorized vehicles. Furthermore, we analyze from the perspective of social networking analysis (SNA), the network of interactions obtained in online discussion forums about the benefits of using virtual attendance at University. The results show that students' perceptions about this system enables the reduction of private motor vehicles, contributes to the elimination of mobility wastes and fosters academic networking and collaborative work at university.

Keywords Sustainable mobility · Virtual attendance · Higher education
AVIP classrooms

Introduction

Mobility is one of the main problems affecting modern cities today, and this is not just a question of traffic congestion or poor communication networks but also the impact of transport on the environment and society, in particular motorized vehicles. Sustainable mobility means satisfying the needs of the current generation

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without compromising the ability to satisfy the needs of future generations. It suggests that the existing paradigm ought to be more flexible, particularly if the sustainable mobility agenda is to become a reality. The intention is to design cities of such quality and at a suitable scale that people would not need to have a car (Banister 2008: 74). Sustainable mobility is therefore the mobility model that enables movement with minimal environmental and territorial impact. Nowadays, mobility has serious repercussions for the quality of life of a city's inhabitants. The problems caused by urban mobility have specific features: they affect all citizens, especially the most vulnerable and disadvantaged, and in some cases these negative effects extend from the urban area to the periphery and beyond; secondly, they are serious and widespread due to their direct and indirect effect on the quality of life; thirdly, they intervene extensively in people's daily lives, and yet they generate only meagre and incoherent criticism, a sure sign of society's acquiescence, which is paradoxical given the social outrage expressed in demonstrations on issues whose collective ramifications are far less—on drugs, workplace accidents…—which seem to arouse a greater sense of intolerance. According to a recent report by the World Health Organization (WHO 2016), reducing exhaust emissions from cars would not only avoid millions of deaths but also cut the incidence of heart disease and respiratory illnesses such as asthma. More than 80% of European inhabitants are exposed to levels of contamination that exceed WHO recommendations, which is the equivalent of the average citizen losing 8.6 months of life expectancy, not to mention suffering from illnesses and a reduction in the quality of life.

Urban congestion in Europe costs in the region of 100 million Euros a year, 1% of EU GDP, according to the European Commission. It also costs lives: 482,000 premature deaths from lung cancer and respiratory and cardiovascular diseases in 2012 in the EU, according to WHO calculations. "It has been demonstrated that the excessive use of cars results in a disproportionately big risk for human life, habitability and wellbeing, and not just in our cities but worldwide". In this sense, the EU has proposed a package of measures on climate change and energy that sets new and ambitious goals for 2020. In relation to 1990 figures, the EU is committed to:

- Reducing greenhouse gas emissions (GGE) by 20% (30% if an international accord is reached).
- Saving 20% in energy consumption by generating greater energy efficiencies; in addition, each country must ensure that 10% of transport needs are covered by biofuels.
- Boosting renewable energy sources to cover 20% of the energy market.

In this context, it is vital that as many institutions as possible contribute to alleviating the serious effects of pollution in our cities. For this reason, Spanish universities have put forward proposals to minimize the environmental impact of their students as they commute to and from campus. These initiatives include promoting the use of bicycles, public transport, hybrid and electric vehicles and shared car rides.

The reason of developing this case study on Spanish Universities is derived from the necessity of meeting Kyoto target. Although Spain has made significant progress, its greenhouse gas emissions in 2009 were about 30% higher than in 1990, substantially short of its Kyoto objective which was to cap growth at 15% between 2008 and 2012. Spain's growth in CO_2 emissions between 1990 and 2009 was among the highest in the OECD (OECD 2011). So any initiative as the implementation of the sustainable mobility strategy at Spanish Universities could help to reduce emissions in the transportation sector, which is an increasingly important source. For this reason, in this chapter, we present various proposals for improving student mobility on their journeys to and from university. Specifically, we describe a student service delivered by the virtual attendance system implemented by the National Distance-Learning University (UNED) which is not only a reference in terms of support for the teaching-learning process, but also enables the reduction of student journeys to UNED-associated centres and university campuses, thus reducing both the air and noise pollution caused by the use of motorized vehicles.

Environmental Pollution and Sustainable Mobility in Student Trips to and from University

The mobility of students as they head to campus, like all journeys to and from work or for trips of a personal nature, all add to a country's levels of contamination. Various studies in Spain have shown that students' favourite means of transport to campus is their own car, which is true in 60% of cases (Ecologistas en Acción 2007).

In Spain, the sustainable use of private vehicles is minimal. Spain's fleet of private cars currently stands at around 28 million, six times higher than all the cars in China and India, whose joint population numbers around 2.4 billion, 60 times bigger than Spain. The USA's 190 million vehicles for 275 million people is equally disproportionate; applying this ratio worldwide would mean some 4 billion cars on the road, seven times more than the 560 million already in circulation (Santamarta 2002).

Transport adds to greenhouse gas emissions, accelerating climate change and the destruction of the ozone layer due to the presence of chlorofluorocarbons (CFC), or their substitutes (HCFC, HFC), in the foam used to pad car seats and in vehicle air-conditioning systems. The automobile destroys the ozone in the stratosphere, where its presence is most important. But here below, in the troposphere, where we least need it, motorized vehicles are responsible for producing large quantities of tropospheric ozone when nitrogen oxides react with hydrocarbons in sunlight; this damages people's health, affects crops, trees and plants in general, and also causes 8% of greenhouse gas emissions. Transport, together with coal-fired power stations, are the main causes of acid rain due to the emission of nitrogen oxides and sulphur dioxide. The noise caused by traffic comes mainly from engines and the contact of the tyres on the road surface. Trucks, motorbikes and buses make the most noise,

which starts to become unpleasant to the human ear at 55 dB. Between 40 and 80% of the people living in so-called developed countries (OECD) reside in areas that register noise levels that exceed 55 dB and between seven and 42% of the population (more than 130 million people) live in areas with unacceptable noise levels that are above 65 dB. Spain is second only to Japan as the loudest industrialized country, and the first in the EU: 74% of the population in Spain are exposed to noise levels superior to 55 dB on the A-weighted curve (referring to the sounds most audible to the human ear) and 23% have to cope with noise levels above 65 dB (Santamarta 2002).

According to the WHO, reducing current atmospheric pollution levels in big cities would save more than three million lives a year from now until 2030. So, a new mobility model based on sustainability is needed, together with a strong, efficient and competitive proposal for public transport use that would enable significant reductions in the use of the private car. This requires designating separate lanes exclusively for buses, stricter law enforcement (to penalize double parking, parking on traffic light areas, and in pedestrian or public transport zones), new tram lines, promoting non-motorized transportation (walking, cycling) for short trips, programmes to improve access for wheelchair users and people with restricted mobility, and car sharing schemes.

Spanish universities that are aware of the problem are actively promoting initiatives such as carpooling, whereby two or three people commute in a single private vehicle normally during the rush hour to work or educational centre. For example, the University of Valencia has launched a ride-sharing scheme they claim will save 186,000 L of fuel a year, which means not just a significant cut in CO_2 emissions but considerable cost savings too. Students at the University of Lleida have created a Facebook page, which now has more than 2,000 members, that regularly publishes the routes and schedules of those willing to share their car to go to and from the campus. With the aim of promoting car sharing among students and teachers at the University of Girona (UdG), the university's Centro Easy (I + D), which is part of the Tecnio network, together with the UdG's Green Office, developed the Fes Edit platform (for electronic hitch-hiking) at the end of 2011. Both the website and the mobile app link drivers to potential passengers to commute along the same route. The initiative, which arose to satisfy a growing need among students in Girona, has extended to three other universities in Catalonia, the Universidad Rovira i Virgili (Tarragona), the Universidad Politécnica de Cataluña (UPC) and the Universidad de Barcelona (UB), and to other universities across Spain.

As well as car sharing, other university initiatives to help the environment include promoting bike riding for getting to and from campus. One such example is the Autonomous University of Madrid's CibiUAM (Centro Integral de la Bicicleta de la Universidad Autónoma de Madrid) plan, which aims to encourage bicycle use as a means of daily transport and to raise awareness of sustainable urban mobility. The centre offers students a set of services and activities such as bicycle lending, secure areas for parking bicycles, a bicycle shop with repair facility, a workshop where users can repair their own bikes, a second-hand market for bikes and

accessories, changing rooms and courses on bicycle mechanics. Quantitative data on CibiUAM use show that it has been a big success among students, but its most impressive achievement has been to encourage students to use their own bikes to get to campus, since there are now far more private bikes in use at the university than there are available in the bike lending scheme. More than 4,750 people have used the centre's services since it was set up in 2009, and 850 members of the university are CibiUAM card holders (48% students, 46% teachers and researchers, and 6% administrative staff and others).

With the rise in the use of electric cars, several universities in Spain have begun to take an interest by installing free recharging posts in order to encourage the use of this type of vehicle. Electric cars represent a saving of 50% in consumption since a tariff of 2.50€ is sufficient to pay for an electric car to cover 100 km, compared to a conventional diesel car which needs 3.8 L to travel the same distance at a cost of 5.25€.

Such initiatives should go hand-in-hand with university actions to inform, instruct and persuade students regarding mobility, as well as dissuade them from environmentally unfriendly travel habits. Strategies aimed at convincing students to commute more sustainably could focus on providing detailed information on travel alternatives, and the economic advantages and benefits to the environment of their actions in cutting contaminating emissions. Health experts could give talks to drivers on the benefits of walking and cycling instead of taking the car. The government of the Community of Madrid has undertaken an initiative to raise environmental awareness among university students with its "University Caravan for Sustainable Mobility". This project encompasses six public universities in the Madrid area, and organizations such as the Fundación Movilidad and the regional transport authority. It gathers student volunteers to organize a caravan of non-contaminating vehicles driven by the volunteers themselves, mainly on bicycles, which follows a route around the city that takes in various university campuses, and they perform activities aimed at encouraging other students to reflect on the sustainability of the current mobility model.

In Europe, awareness of sustainable mobility is on the rise and one clear indicator of this is the "U-MOB LIFE" (http://2017bcn.u-mob.eu/es/) project that aims to set up a network for the exchange and transfer of knowledge on good mobility practices among European universities. In the next five years, a consortium consisting of Novotec, the Polytechnic University of Krackow, the Erasmus University of Rotterdam, the University of Bergamo, the Autonomous University of Barcelona and the Fundación Equipo Humano will work together by integrating their broad experience in the fields of sustainable mobility, communication and teaching.

U-MOB LIFE's aims are:

- To raise awareness of the need to reduce CO_2 emissions arising from daily commutes to and from university by staff and students, and the role of universities in educating the new generations on this issue.
- To create and consolidate a European University Network for Sustainable Mobility capable of transferring good practices in this field.

- To communicate and disseminate knowledge of good mobility practices among university communities throughout Europe.
- To define and promote the role of the mobility manager, as the person responsible for implementing good mobility practices at each university.
- To define and implement good practices across European university campuses in order to reduce their level of emissions.
- To promote the development of sustainable mobility policies by public authorities and transport companies.

The contribution of the universities towards alleviating the effects of contamination caused by mobility is fundamental, as is the opening up of spaces for learning that respect people's health and the environment. Measures that can be adopted by these institutions not only relate to greater sustainability in terms of the means of transport used but also in their removal as a contaminating factor. The potential of technology today can simulate face-to-face classroom teaching and learning through what we have termed "virtual attendance" (Vázquez-Cano et al. 2013), thus strengthening learning methodologies and, by extension, reducing the pollution caused by student commutes to and from university.

The National Distance-Learning University and the AVIP System

Spain's Open University (UNED) is the largest distance-learning body in Europe and one of the largest in the world, with more than 300,000 students, 1,300 teachers and more than 6,000 tutors. Its distance-learning system combines ICT with personalized attention for students through a central site in Madrid and a network of over 60 associated centers across Spain and four continents (South and North America, Europe, and Africa). Open University students need continuous support during their knowledge construction process and, for this purpose, UNED tutors produce optional face-to-face workshops every seven days to guide students in their self-learning processes in which they incorporate new knowledge in their daily personal, academic and professional lives. This tuition, adapted to the needs of the European Higher Education Area (EHEA), was organized using blended learning methodology via an online learning platform called "aLF" and a variety of digital resources for networking through the Regional Campus. In this context, technology specialists at UNED recently developed a program called ATECA (Educational Technology Architecture for the Associated Centers) with the help of European "FEDER" funds. The objective was to strengthen "virtual attendance", which involves creating classrooms by videoconferencing via synchronous IP ("AVIP-Classrooms"), enabling the associated centers to deliver tutoring and mentoring services to geographic areas that were previously beyond reach. This means that the student does not have to commute to the associated centre and can keep up with his/her classes via any digital device and from any place location, thus

minimizing the effect on the environment since no commute is necessary. The tool combines high-end videoconferencing with low-end web-conferencing and smart board-based learning. It also enables resource manipulation, besides developing digital content repositories in a way that allows the use of virtual attendance within the EHEA in a blended learning environment. The new AVIP classroom system allows almost the same types of interaction in distance learning as in traditional face-to-face learning scenarios (Dennen et al. 2007; Chou and Min 2009; Rehm 2009; Hurtado and Guerrero 2011; Chickerur and Kumar 2011).

To support tutoring and to create a common ICT-mediated learning environment, these services require efficient interactivity through video, audio and educational content of the highest quality, and in this sense it is important to use the visual language effectively (Fombona 2008). This interactivity is achieved through proprietary communication software developed at UNED, called "AVIP Classrooms Level 1 + Audiovisual IP". Aided by this video-conferencing system and with tutor support, UNED generates shared workspaces to minimize training requirements and to extend the tutoring services nationwide at a reasonable cost. AVIP Classrooms are organized on two levels:

- Level 1: AVIP classrooms, equipped with videoconferencing systems and interactive whiteboards using Multipoint Control Units (MCU) that enable simultaneous connectivity to centers and classrooms.
- Level 2: (Capture sessions [seminars, tutorials…]): Content is transmitted from classrooms and online conference rooms for storage and delayed live broadcast.

The AVIP (AudioVisual over IP) tool provides "virtual attendance"; that is, students and tutors can access the classroom activities of any center from any center or classroom. This facility can be developed "live" (online) for broadcasting seminars or classes at scheduled times, and for "on replay" (off-line), through access to information on demand (VOD), along with related documentation that may have been stored on the same server.

This technology facilitates robust interpretation of blended learning, which promotes social presence with the benefits of online teaching and learning (Kumar and Benbasat 2002; Shin 2002). It further enables exploration of learning designs which utilize social processes in promoting understanding of users' social motivation, improving social affordances of telecommunications systems, and in enhancing research of social cognition, interpersonal communication and theories of mind (Biocca et al. 2003; Lee and McLoughlin 2010; Vázquez-Cano 2011; Vázquez-Cano and Sevillano 2012; Vázquez-Cano and López Meneses 2012).

Virtual Attendance: More Than Blended Learning

Blended learning is favored in teaching and learning environments where there is an effective integration of different modes of delivery, models of teaching and styles of

learning as a result of adopting a strategic and systematic approach to using technology in combination with the best features of face-to-face interaction (Tu and McIsaac 2002; Krause 2007). According to Garrison and Kanuka (2004), the simplest model of blended learning "is the thoughtful integration of classroom face-to-face learning experiences with online learning experiences", which aims to make the best use of a synchronous face-to-face situation and the asynchronous, text-based Internet. Typically, this means traditional face-to-face teaching or lecturing with additional online materials and learning assignments, using different learning management systems, such as Moodle or other digital platforms. Thus, from the blended learning point of view, social software provides interesting opportunities for supporting collaborative learning (Ferdig 2007; Brindley et al. 2009; Conole 2010). However, researchers have approached this concept from different perspectives. The three most commonly mentioned definitions documented are as follows:

1. Combining instructional modalities (or delivery media) (Singh and Reed 2001; Orey 2002).
2. Combining instructional methods (Driscoll 2002; Rossett 2002).
3. Combining online and face-to-face instruction (Reay 2001; Young 2002; Sands 2002; Rooney 2003; Ward and LaBranche 2003).

The new system of audiovisual attendance, in comparison to the usual blended learning systems, improves both task performance and perceived affordances. Virtual attendance generates social presence in one aspect: "it involves the degree to which media are capable of making users perceive other users' sociability, warmth, sensitivity, personality and closeness in a mediated communication situation." Others interpret the concept in different ways: "the feeling that others are involved in the communication process" (Whiteman 2002: 6); "the degree to which a person feels 'socially present'" (Heeter 2003: 340); "the degree of person-to-person awareness" (Leh 2001: 10); "the degree of person-to-person awareness" (Tu 2002: 1662); "the sense of being present in a social encounter with another person" (McLellan 1999: 40), and "the degree to which participants are able to project themselves affectively within the medium" (Garrison 1997: 6).

As Whiteman (2002: 8) states, "people feel more comfortable around us when they believe we share a kinship and common values". When the environment lacks social presence, the participants see it as impersonal and, as a result, the amount of information shared with others decreases (Leh 2001; Tallent-Runnels et al. 2006). The overall goal of creating social presence—online or face-to-face—in any learning environment is to create a level of comfort where people feel at ease around the tutor and other participants. Failing this, the learning environment cannot be fulfilling or successful for either instructors or learners.

VideoTutoring Model Over IP: AVIP Classrooms 1 and 1+

The AVIP classroom structure is organized in one of two modes: Classrooms AVIP (Level 1 and Level 1+) or online tutoring (Level 2+). These classrooms allow synchronous teaching and tutoring at different locations.

AVIP Classrooms (Level 1+)

Level 1 is provided with high-end videoconferencing over an interactive whiteboard (PDI) in associated center classrooms. The goal is to conduct tutoring classes simultaneously in several physically separate classrooms. The content offered can be "live", which necessarily requires the student and tutor to be in an AVIP classroom or in streaming "off-line". The videoconferencing equipment includes items such as *Polycom* or *Tandberg*. Videoconferencing technology is built up with ISDN or Internet (with sufficient bandwidth guaranteed). Interactive whiteboards also require an Internet connection to Network-UNED for interconnection with others. The most widely used interactive whiteboard tool is the "online whiteboard" which allows connectivity between whiteboards of different manufacturers. This type of synchronous tool 2.0 is characterized by the following features:

- It is possible to create whiteboard rooms.
- Each room supports a maximum of eight participants.
- Access to each room requires a password to prevent entry of unauthorized persons into the system.
- All students can interact with the board, and if someone creates a new page, everyone else can view and save the page as PDF with annotations for future reference.
- "Document viewer" is available to enable documents for presentation to be uploaded.
- Tutors' presentations can be downloaded to different AVIP classrooms.

The main objective of this new technology architecture is to offer the user a teaching-learning environment that ensures "virtual attendance". It is also portable and versatile without sacrificing audio and video quality. This virtual attendance is achieved through empowerment of the following aspects:

- Audio: For communication among multiple users, it is imperative to transmit and receive audio without defects, micro-cuts, return-audio, echo, noise, etc.
- Video: The high-definition video quality offered by AVIP classrooms Level 1 is difficult to achieve with any other type of equipment. However, high-definition video may not always be necessary for simple interactivity.
- Content: Besides video and audio, one fundamental requirement of the AVIP tool is interactive content sharing. This content can be images, office documents, notes on a blank page or document, desktop sharing, etc.

For equipping classrooms AVIP 1+, UNED has adopted multi-platform and technology policies, meaning that the choice of equipment is restricted to the best possible software to complement the tools 2.0, prioritizing quality, interoperability, ease of use and affordability. The basic equipment in the design of these new classes is as follows:

- Computer
- Projector
- Webcam
- Peripheral Room audio with echo cancellation
- Interactive Whiteboard.

Connectivity between videoconferencing equipment can be established in two ways, depending on the number of participants: *Point to point*: between two distant locations.

Multipoint: People participating in videoconferencing are at three or more locations. To conduct a multipoint videoconference, at least one MCU (Multipoint Control Unit) is required, which can be a unit that is integrated or external.

The sessions in the AVIP Classroom can be recorded in high quality (HD), including signal capture, videoconferencing equipment (H.323) and graphics that come from the PC (presentations, web board), generating a video in FLV format (Flash Video), which can then be played via streaming. Thus, UNED's teaching and learning processes are developed according to four parameters: face-to-face tutoring, virtual tutoring, blended learning and distance learning. Figure 1 illustrates the relationship between them.

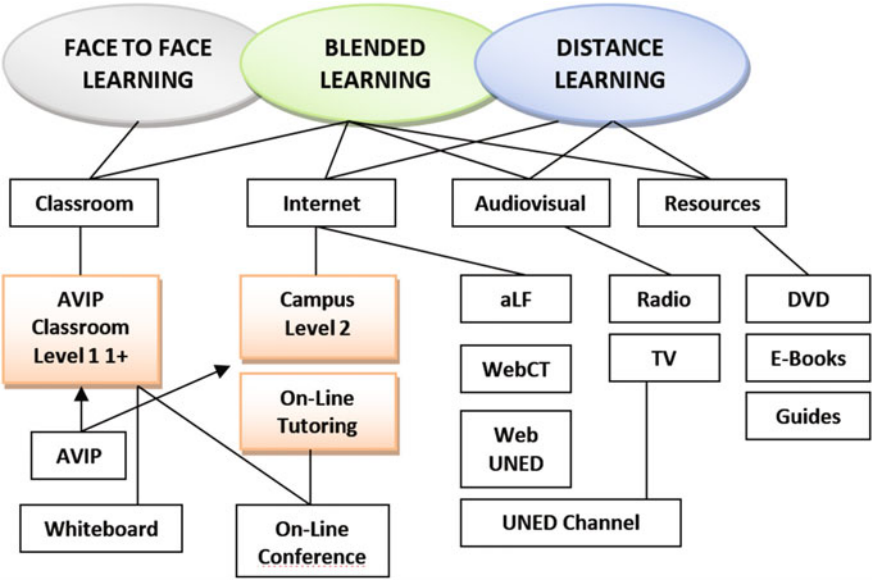

Fig. 1 UNED model of distance learning

UNED has chosen this model in order to meet the demands placed on teaching within the EHEA, and it has adapted its VLE, called aLF, with web conferencing functions to fulfill the demands of virtual attendance. All activities, tests and exams done in AVIP are transferred automatically to aLF in order to assess and orientate the students' learning progress, and so that all students' profiles and activities can be seen by each professor at the UNED central site in Madrid. The differences between the AVIP system and others are: these capabilities convert AVIP into a flexible tool that combines aLF and web conferencing; it enables students to maintain a rich and fluid communication with their tutors, lecturers and peers, and enables them to work collaboratively in the preparation of the assignments they have to undertake on these courses. UNED is currently connecting the AVIP system to social networks (Twitter, Facebook, etc.) and creating apps for students to view video lessons on their smartphones (available at the Goggle Play store: https://play.google.com/store/apps/details?id=air.es.uned.intecca.MeetingMobile&hl=en). With this application, students can play recordings and video, and interact with the notes made by the speakers, check the chats or download the documents used in the session.

Method

The main objectives of the research can be formulated as follows:

1. To analyze virtual attendance functionalities to reduce students' mobility at University.
2. To assess the effectiveness of didactic approaches with the use of virtual attendance.

For the development of these two objectives we implemented two forums to discuss about benefits of virtual attendance. The cohort that took part in this research project was comprised by those students who attended the subject: "Media, Didactic Resources and Technology", corresponding to Degree in Pedagogy during three academic years 2013–16 at UNED (Table 1).

Table 1 Cohort

Variables	Items	F	%
Gender	Male	93	47.44
	Female	103	52.55
Age	22–25	112	57.14
	25–30	45	22.95
	30–35	26	13.26
	35–40	10	5.10
	+40	3	1.53

The method was based on social network analysis (SNA) for the analysis of participation in online discussion forums. The messages in online discussion forums were analyzed from the perspective of social network analysis (SNA); this methodology provides a relational approach following the reticular morphology of social connections. It enables an understanding of the form and structure of the relationships established as a whole, something which is essential in order to reach an understanding of the underlying mechanisms in the students' statements in educational forums, facilitating hidden interaction patterns (Barabási 2002; Knoke and Yang 2008). With that aim, this SNA methodology has been applied to identify text units that may justify the reasons declared by students when assessing virtual attendance from a didactic and social point of view. The matrix scheme used to generate the graph has been the following:

$$\Pr(\mathbf{Y} = \mathbf{y}) = \left(\frac{1}{\kappa}\right) \exp\left\{\sum_{A} \eta_A g_A(\mathbf{y})\right\} \tag{1}$$

where ηA is the corresponding configuration A parameter (whose outcome cannot be zero if all pairs of variables in A are assumed to be "conditionally dependent"). Also, gA(y) = yijIIAyij is the statistical network configuration corresponding to A; gA (y) = 1 if it coincides with the observation "and" on the network, and if the network does not appear in the result is 0. κ is an amount that ensures standardization (1) is a proper probability distribution. All models of exponential random graphs take the form Eq. (1) which implies a general probability distribution of graphics in "n" nodes considering that there are different assumptions dependence with the consequence of choosing different types of configurations as relevant to the model. Considering this equation, the only configurations that are relevant for the model are those in which all possible links are mutually configuration contingent with each other.

Results

We analyzed from the perspective of social networking analysis (SNA), the network of interactions obtained in the topics of the online discussion forum with the most significant connections. The average density of the two threads of the forum with the dichotomized matrix was 0.51 with 0.20 of standard deviation; which represents a high value for a sample of 202 students and an average rang of the network of 3.132; which indicates that the key word is interrelated with the average of about 2.4. This a high value for a total of 17 nodes. Almost everyone in the discussion acknowledged, directly replied to and commonly interpreted other members' posts in writing (Fig. 2).

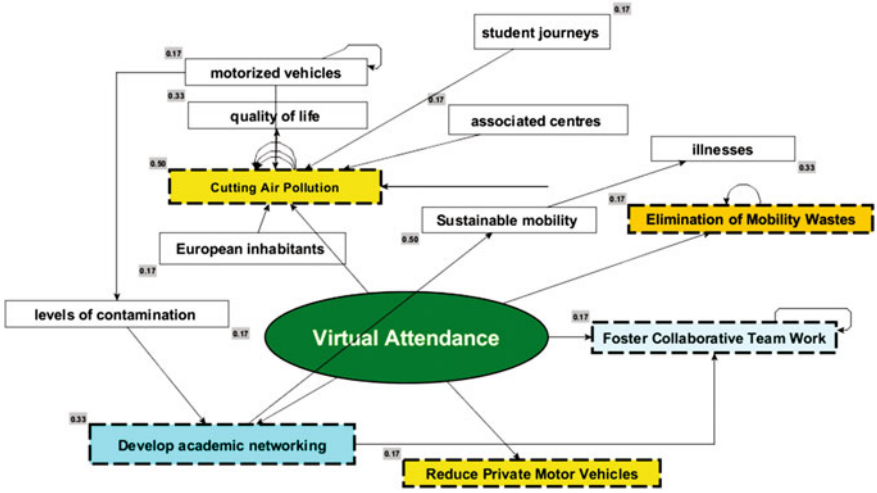

Fig. 2 Graph

Table 2 Nodal value of intermediation and proximity in the online discussion forums

Main Topics	Nodal Grade		Betweenness Grade		Closeness Grade	
	Degr.	Nrm Degr.	Betw.	nBetw.	Far.	Clos.
Reduce private motor vehicles	20.0	52.150	63.5	31.0	71.0	39.00
Cutting air pollution	21.0	56.075	65.0	30.5	72.2	41.70
Elimination of mobility wastes	15.0	46.100	56.5	22.5	52.0	30.50
Develop academic networking	18.0	48.120	60.0	24.5	56.5	37.50
Foster collaborative team work	20.0	51.115	62.0	30.5	72.5	40.50

Additionally, the majority of participants received acknowledgement, replies and interpretations of their posts from other members. There was also a good balance among types of participation each member engaged with and the types of feedback each member received. To this end, we have referred to the analysis of the nodal value of intermediation and proximity (Table 2).

Our discussion thread topology illustrated five types of dynamics, the short thread pattern that consists of one post and one reply only; the extended thread pattern that consists of several consecutive posts corresponding with the previous post and the branched thread pattern where multiple replies were made to a single post. This last pattern has the highest nodal degree (Table 2). The centrality shows the position of the concepts featured in the network and reveals a rather high result of 59% with a total number of 5 nodes. The maximum value (maximum number of connections of a node in the network) is 21 (“Cutting air pollution”) forming nodes with 20 (“Reduce private motor vehicles” and “Foster collaborative team work”), the nucleus of the graph, according to the concept of “k-cores”.

Conclusions

The indiscriminate use of cars as the only means of transport has had consequences that could be compared to those of a bomb attack in slow motion: "a bomb whose blast would have the virtue of uprooting buildings and activity and setting them down kilometres away from their origin, and whose main effect on the centre would be to destroy the very essence of urban life: coexistence and communication between human beings (IDAE 2006). Students commuting to and from university add to the degradation of the environment. We have seen how universities are slowly but surely taking initiatives that help to diminish mobility's effect on the environment by prioritizing means of transport that respect the environment and which are more sustainable. These include public transport, whose impact is much less than that of private vehicles; non-motorized transport, with zero impact on the environment; initiatives such as ride sharing via apps and social networks. Indeed, universities that do not promote sustainable student commuting are not only have greater costs and consume much more energy, but they also marginalize those who do not have access to a car.

Distance-learning can contribute to these initiatives with virtual attendance systems and mobile and ubiquitous teaching strategies that not only support distance-learning methodologies but also help reduce the number of student commutes to and from the campus, and so, cut levels of noise and air pollution in our cities. The new technological tools that support "virtual attendance", based on the principles of ubiquity and virtual reality, are poised to improve distance learning by greater interactivity. These methodologies are significantly improved by the new layout of AVIP classrooms, based on video-conferencing services that contribute to their widespread use as a teaching tool across the country. The AVIP classroom is based on a cross-platform and open standards that ensure interoperability by combining different tools (aLF educational platform, digital repositories, etc.), which lend support to the pillars indicated below through the virtual private network, "Network-UNED":

- Training methodology, based on "blended learning", augmented to virtual attendance.
- Information based on the use of the tools and techniques of Business Intelligence.
- Communication-based groupware concept, which encourages collaborative team work.
- Helping to cut the number of trips the student makes to and from the associated centre and university campus.

University institutions also need to encourage healthy habits and respect for the environment, including measures such as: greater use of bicycles and journeys on foot, boosting efficient collective forms of transport that are less contaminating, cut the use of private vehicle in cities in favour of less contaminating vehicles. These measures need to be matched by individual actions on the part of students to raise

the level of physical activity required in their movements to and from university, in order to control excess weight, diabetes and high blood pressure. Reducing pollution in the atmosphere and improving the quality of life will prolong life expectancy and reduce the chances of contracting cardiovascular and respiratory diseases, and lower noise levels will reduce stress and noise-related illnesses. Didactic strategies based on virtual teaching methods as "virtual attendance" develop by the UNED can contribute to the reduction of private motor vehicles, the elimination of mobility wastes and foster academic networking and collaborative work at university.

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E-learning in Higher Education: Academic Factors for Student Permanence

Filipa Seabra, Susana Henriques, Teresa Cardoso, Daniela Barros and Maria de Fátima Goulão

Abstract E-learning has increasingly been acknowledged as a legitimate option which contributes to the democratization of higher education. One of its advantages is the possibility of reaching non-conventional publics for higher education, including workers, adults, and people who live outside the main city centers. This is also an important aspect with regard to sustainability education, particularly when addressing climate change education, as these publics may be less easily reached by conventional educational settings. Permanence is a key issue and a significant obstacle to the success of any e-learning based initiative—in order for the educational goals to be met, one must ensure, in the first place, that students who enroll in a program are able to persevere, successfully learn, and reach graduation. This chapter presents a framework of the concept of permanence in higher education, particularly in e-learning contexts and concerning adult populations. It presents an empirical research concerning the academic factors related to good permanence outcomes. Data were gathered using a survey by questionnaire answered by students of an undergraduate degree developed through e-learning in a Portuguese public university.

Keywords E-learning · Permanence · Higher education · Sustainability education

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Introduction

European curricular policies have been strongly influenced by transnational organisms both internal and external to the European Union, in a context of globalization and of pressures associated with competitiveness at a global scale (Seabra 2010). Higher education, intersected by the Bologna Process, has not been unaffected by this homogenizing tendency. We have defended that the impacts of those international and transnational institutions is largely produced through the influence of key-concepts that are forged and disseminated by those organisms and later differentially assumed by national educational systems (Seabra et al. 2012). In this context, Steiner-Khamsi (2012) refers to travelling reforms or policy lending and borrowing, underlining the active role played by both the lender—that is, the coiner(s) of the reforms, and the borrower, responsible for their re-contextualization and resignification. Similarly, Teodoro (2003) clarifies how national governments have resourced to transnational guidelines according to logics of mandate, and of legitimization of decisions that internally were deemed necessary. Globalization is therefore not a unilateral and homogenous process, but rather a complex, and multi-determined processes, crossed by pressures of contrary direction (Pacheco and Pereira 2007; Sousa Santos 2001).

One of the key-concepts that have permeated transnational discourses on education, in several organisms, is that of Sustainable Development. UNESCO has dedicated a decade to that theme and to its pursuit through education, originating several reports, a declaration and even a multimedia teacher training program (*Teaching and Learning for a Sustainable Future*[1]). UNESCO's approach to education for sustainable development includes biodiversity, climate change, accident risk reduction but also cultural diversity, poverty reduction, gender equality, health education, sustainable lifestyles, peace and safety, water and sustainable cities—which demonstrate the comprehensiveness of the concept.

The United Nations Organization has been dedicated to sustainability, namely by defining competencies necessary to education for sustainable development (United Nations Economic Commission for Europe—UNESCO 2012b).

As Portugal tends to be defined as a «good student» when it comes to the adoption of measures defined in a superior plane, it is perplexing to find that debate of these matters at the higher education level is still not very widespread. We believe that in the framework of universities' social responsibility, complemented by the social extension dimension of teachers' responsibility, there is room to discuss and implement such concepts, adapting them to the contextual need and audiences they are directed to.

In this context, we believe that distance and online e-learning play a particularly relevant role, as they are particularly suited to reach non-conventional students, and therefore may contribute to the spreading of sustainability education to harder to influence strata of the population, such as adult learners. High dropout rates among

[1]Retrieved from: http://www.unesco.org/education/tlsf/

that population and among e-learning students in general, present a particular challenge to the efficacy of this strategy. Therefore, we defend that focusing on aspects related to permanence in distance higher education is a fundamental aspect, which we will address in greater depth.

Sustainability—A Brief Outline

Leal Filho (2000) referring to the polysemy and evolution of the concept of sustainability, clarifies that it emerged in the context of forest development, being then widely used in different academic, political and social contexts, with meanings ranging from «durable» or «systematic». He proceeds to present a definition of sustainable development as: (a) "the systematic, long-term use of natural resources" (p. 9); (b) "the modality of development that enables countries to progress, economically and socially, without destroying their environmental resources" (p. 10); (c) "the type of development which is socially just, ethically acceptable, morally fair and economically sound; and (d) "the type of development where environmental indicators are as important as economic indicators" (p. 10). The dissemination of the term took place largely as a consequence of the report «*Our Common Future*», in 1987.

Sustainability relates to limits—namely limited resources and the interdependency of all the elements of an ecosystem. It therefore is set against the term development, associated to expansion, and conceived as limitless. Sustainable development contains in itself a dialectic relation between the expansionism of development, and the constraints represented not only by resources, but also by ethics and informed by a future perspective. Thus, the concept of sustainability also encompasses the notion of equity in the distribution of resources and the assurance of the basic needs for all, including future generations (van Weenen 2000).

Education for sustainable development (ESD) is defined by UNESCO/DESD (2012b, p. 12) as follows:

> Overall, ESD seeks to enable citizens around the globe to deal with the complexities, controversies and inequities rising out of issues relevant to environment, natural heritage, culture, society and economy.
>
> Simply put, ESD is education for the future, for everyone everywhere. It is an essential ingredient to ensure quality education and a successful transition to green societies and economies.

As early as 1997, UNESCO defined education as "humanity's best hope and most effective means in the quest to achieve sustainable development". The Bonn declaration defines sustainable development as that which approaches the interdependencies among the social, economic, cultural and environmental development and education for sustainable development as education which promotes the balance between economic growth, environmental conservation, cultural diversity and social well-being in an inclusive perspective (in UNESCO/DESD 2012a).

Thus, the UN, through UNESCO, has defended over several decades the pursuit of a path through education towards sustainability, broadly conceived.

In the second half of the decade for ESD, the focus has shifted from the uniformity of definitions of sustainable development to the recognition that each context may lend to a greater emphasis on different dimensions of the concept. Attention was then focused on the educational processes that allow for the promotion of ESD, emphasizing critical thought, participation, the co-creation of knowledge within education directed towards change and competence development. Approaches such as collaborative learning, problem based learning, interdisciplinary learning and learning based on critical thinking are particularly highlighted (UNESCO/DESD 2012a, b), as well as a more global perspective on science and of the role of the University, more oriented toward complexity, uncertainty and systemic thought. Portugal was not involved in the answer to the questionnaires guiding the elaboration of this report (UNESCO/DESD 2012b).

The United Nations Economic Commission for Europe (UNECE 2009) has also presented a perspective on ESD compatible with that of UNESCO. The recommendations it promotes also stem from a broad conception of SD understood dynamically and adjusted to different local contexts. The ethical dimension, related to solidarity and interdependence among generations, among human beings and nature, and among rich and poor, is considered a fundamental dimension of ESD. More relevantly to the scope of this chapter, a lifelong ESD is proposed, and the role of universities, directed to the production of knowledge and to the development of competencies is highlighted. In practical terms, this requires education to have a dimension of application of knowledge to the solving of concrete and real problems in an interdisciplinary logic and consequently a re-equation of the roles of teachers and students.

In 2011, the UNECE presented a set of guidelines encompassing the professional development of educators, governance and management of institutions dedicated to teachers' continuous education, curriculum development based on the competencies identified by the organization and the monitoring and assessment of teaching institutions. The key-competencies for teachers to promote ESD are organized on three axes concerning (a) a holistic approach integrating theory and practice; (b) a perspective for change exploring future possibilities and learning from past experience and (c) the search for transformation in how people learn and the supports for learning. At this level, ESD requires transformation of educators, of pedagogy and of the educational system.

Universities and Sustainable Development

The relation between the mission of universities and ESD was pointed out in the *Magna Charta Universitatum* (1988), signed by the rectors of 388 European universities, which states:

1. that (…) the future of mankind depends largely on cultural, scientific and technical development; (…)
2. that the universities' task of spreading knowledge among the younger generations implies that (…) they must also serve society as a whole; and that the cultural, social and economic future of society requires (…) a considerable investment in continuing education;
3. that universities must give future generations education and training that will teach them, and trough them others, to respect the great harmonies of their natural environment and of life itself.

At that time, concerns for the natural environment and also the cultural, scientific and technical development which are a part of the broader concept of sustainability were already present. Following several other initiatives in that sense[2], in 1994 the Association of European Universities promoted the *University Charter for Sustainable Development*,[3] which highlights the role of universities for the promotion of SD:

> (…) universities are increasingly called upon to play a leading role in developing a multidisciplinary and ethically-oriented form of education in order to devise solutions for the problems linked to sustainable development. They must therefore commit themselves to an on-going process of informing, educating and mobilizing all the relevant parts of society concerning the consequences of ecological degradation, including its impact on global development and the conditions needed to ensure a sustainable and just world.

The *Copernicus Guidelines for sustainable development in the Higher Education Area* (2010) frame the development sought by the Lisbon strategy aiming to making Europe the most competitive knowledge economy of the world in the Bologna Process and the University charter, descending to a more concrete level of questioning the policies and practices necessary to their development. It refers to sustainability in economic, ecologic, social and cultural terms and sustains that SD responds to areas which are central to the future of most higher education institutions: the cost-efficiency of higher education systems; the quality of higher education, its attractiveness and future orientation; the internationalization of higher education and its relation with civil society. The same document refers to, on the one hand, the universities' contributions to the development of a more sustainable society, and on the other, how the concept of sustainability can lead the university to reconsider its own sustainability, namely in the economic vector.

This duality raises difficult questions—on one side, a University at the cutting edge of research and development, capable of educating active citizens, and productive and competitive employees concerned with contributing to a society which is more just, culturally diverse and attentive to environmental problems is pursued; on the other that university should be economically more self-sufficient and find

[2]University Presidents for a Sustainable Future, the Talloires Declaration, October 1990; Urgent Appeal from the CRE, the association of European universities, presented to the Preparatory Committee for the United Nations Conference on Environment and Development (UNCED), Geneva, August 1991; Creating a Common Future: An Action Plan for Universities, Halifax, December 1991

[3]http://www.iau-hesd.net/sites/default/files/documents/copernicus.pdf.

alternative means of funding. Economic sustainability may come into conflict with ecological, social or cultural sustainability. Also the report by UNESCO/DESD (2012, p. 5) cautions in the same direction when considering that the P in prosperity (profit), may tend to trump over the other two P's that constitute the basis of sustainability—Planet and People. Faced with these and other challenges, "an understanding of the role universities may play in implementing sustainable development" is one of the requirements to its effective introduction in the practices and curricula of universities (Leal Filho 2011), including those addressing climate change education.

E-learning in Higher Education—The Challenge of Permanence[4]

E-learning has increasingly been acknowledged as a legitimate option (Casey 2008), particularly since the emergence of collaborative and multimedia based education allowing real-time interaction both between teacher and student and among students (Gomes 2008), and one which contributes to the democratization of higher education (Almeida et al. 2012). One of its advantages is the possibility of reaching non-conventional publics for higher education. This concept includes a multiplicity of life circumstances, including workers, adults, cultural minorities, older students, and students who represent the first generation in their family to pursue higher education, among others (Fragoso 2016). This is also an important aspect with regard to ESD, as these publics may be less easily reached by conventional educational settings.

This is the case of open universities, particularly directed to a population constituted by adults, workers, and sometimes migrants or people who dwell far from the main urban centers, and who tend to accumulate learning with the responsibilities of family and work. Often, these are students who enroll in university after a long period without relation to formal educational contexts. This student profile is associated to particular potentials and a wealth of experience, as well as with specific needs that may hinder their permanence and success.

Permanence is a key issue and a significant obstacle to the success of any e-learning based initiative—in order for the educational goals to be met, one must ensure, in the first place, that students who enroll in a program are able to persevere, successfully learn, and reach graduation (Araújo 2013; Fiuza and Sarriera 2013). As access to higher education is increasingly massified, issues of success and permanence arise as main concerns for this level of education. Although traditionally the focus of research on this matter has been on attrition and preventing dropout, this focus has been shifting towards the identification of the factors that help students persevere and succeed in their educational trajectories (Freitas 2009).

[4]This description is partly adapted from a previous publication (Seabra, in print).

The concept of permanence tends to be superficially theorized. Some definitions of the concept require not only the conclusion of the course of studies but also its completion in the predictable number of years (Araújo, 2013)—in this project, we do not subscribe to this condition, as we consider it to be inadequate to the trajectories of adult and non-conventional students.

Rather, we assume the perspective which describes dropout as the definitive desistence of a student at any stage of the course (Abbad et al. 2006) leading to a decline in the number of students from the beginning to the end of the course under analysis (Berge and Huang 2004). Thus, this concept does not include temporary brakes, lengthier trajectories that what is foreseen by the course's curricular structure or the cases where the student never actually frequented a course he/she enrolled for.

In counterpoint, permanence corresponds to the students' continuing participation in a course until its completion that is, as the number of students who successfully complete their academic or school courses (Rosli and Carlino 2015).

We believe that a better understanding of the students and of the motives leading to their adhesion and permanence to distance higher education is essential to devise strategies to promote the success of this modality (Fiuza and Sarriera 2013; Pachler and Daly 2011). This approach is centered on modifiable factors associated to permanence, particularly academic factors, in detriment of a perspective focused exclusively in the elimination of risk factors for dropout.

In the scope of this project, we use Fiuza and Sarriera's (2013) classification of factors of permanence in higher education e-learning courses: (1) personal factors; (2) academic factors; and (3) contextual factors. This typology helps organize the multiple factors that have been associated to permanence, as studies on this issue tend to use multiple denominations, categorizations and even focus on a single factor, leading to conceptual dispersion. Among several possible categorizations, the choice fell on this particular one due to its comprehensiveness, reflection of the concept's multidimensionality and empirical practicality. In this article, we focus on the academic factors associated to permanence in higher education e-learning courses.

Several academic factors have been associated with permanence.

Dropout in e-learning courses tends to take place during the first week of a course (Frydenberg 2007). This highlights the importance of implementing acclimation processes to the e-learning modality, as once this first barrier is met, dropout rates are not substantially different from those of in-presence higher education.

Apart from the important role played by support during the training's initial stages, support and interaction remain relevant throughout the course. Interaction with teachers and tutors, academic support, administrative, and technological support are crucial factors (Almeida 2008; Lehman and Conceição 2014; Santos and Neto 2009).

Jun (2005) identifies aspects related to social integration (time management, support from family and friends, unexpected events, distractions, etc.), academic integration (feedback, interaction, language skills, community of learning, etc.) and

technological support. Comings (2007) also identifies factors related to the support of people involved in the course—including teachers and colleagues.

Brown (2002) defines academic integration as the student's sense of belonging to the academic life of the institution and considers it to be a relevant factor for the persistence of non-traditional and adult higher education students. This concept includes dimensions such as the usefulness of the degree, commitment with goals, average (academic results) achieved, and commitment with the institution.

Among the academic dimensions presented by Cislaghi (2008) are: issues related to the social academic environment, issues related to the curriculum (ex.: length and actuality of contents), characteristics of the course such as retention rates, workload, practical applicability, and institutional issues (such as support to students in need, focusing on research rather than on teaching, etc.). These aspects were systematized as social integration, academic integration, and commitment with the institution (Bolliger and Wasilik 2009; Cislaghi and Luz Filho 2009).

Given the pertinence of academic integration, it is noteworthy that research developed in a presence-based higher education institution reveals a tendency for nontraditional students to feel excluded from the academic learning community, expressing "feelings of alienation, disconnection, and dissatisfaction with the institutional response to their presence on campus" (Witkowsky et al. 2016: 36).

In synthesis the academic factors identified as relevant include interaction (with teachers, students and colleagues), support (academic, technologic and administrative), integration (academic and social), commitment with the institution, curriculum topicality and relevance, relation with the work environment (applicability, employability and job progression or transition opportunities) and perceived quality of the course.

Methods

The research project here partially presented, named PEESAD—Permanence of Students in Distance Higher Education, is based in the Open University (Universidade Aberta, UAb), the only public distance higher education university in Portugal. Among its objectives are the identification of personal, academic and contextual factors associated with permanence trajectories, with emphasis on those that are modifiable and the characterization of distance education students who present permanence trajectories.

As part of this broader project which uses a mixed method approach, and in order to contribute to those objectives, a questionnaire was developed. A pilot application of this instrument was conducted with students of the degree in Education of this University, between the months of February and March of 2017 through an online platform. The data gathering took place during the transition between the first and the second semester, a time frame which allowed us to conclude respondents had already overcome the more critical period for dropout. Characterization of the students' trajectories also allowed for the identification of

students who had successfully concluded several curricular units, who were therefore less likely to drop out.

The questionnaire intended to encompass a wide variety of indicators, reflecting the multidimensional nature of the concept under analysis. It includes items allowing for a socio-demographic characterization, such as gender, age, nationality, country of residence, area of residence, or family situation as well as items designed to describe the student's position concerning the personal, academic and contextual factors. In particular, concerning the academic factors, the following dimensions were included: commitment with the institution, academic trajectory, academic integration, social integration, factors associated with the course and goals. This article focuses on the academic indicators most relevant to the issue under analysis.

Ethical concerns, including anonymity were taken into account when conducting the research.

Results

Seventy-eight (78) students answered the questionnaire, 66 female and 12 male, with ages comprehended between 27 and 66 years of age, and a mean age of 45. The majority (62 out of 78) are married or in a civil union, and have children (55 out of 78).

Almost all the respondents are Portuguese (n = 77) and reside in Portugal (n = 74). The majority are employed, either in the public sector (n = 35) or the private sector or third sector (n = 27).[5] Among these, 36 are working in areas related to their degree, and 35 in unrelated fields.

This profile of professionally active and socially integrated adult learners corresponds to what was previously identified among students in distance education (Fragoso 2016).

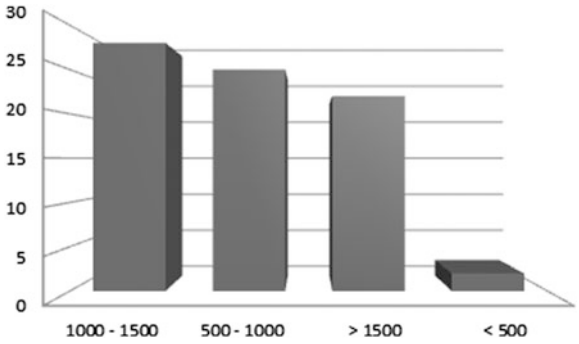
The following graphic (Graphic 1) shows that the average monthly income of most the students' family aggregates is encompassed between 1000€ and 1500€.[6]

The absence of a fixed timetable for the frequency of the course, as well as the fact that students were not required to commute to and from a teaching institution to take part in the learning activities, made time and space flexibility main reasons for choosing the Open University (Portugal). Other factors, such as those related with information about the university have residual expression, in comparison (Table 1).

These results are in line with what Fiuza and Sarriera (2013) defend, stressing the importance of the academic dimension for the processes of student permanence in online higher education. In fact, flexibility is assumed as one of the main factors

[5]7 students who answered the questionnaire were unemployed at the moment.

[6]At the time, the minimum wage in Portugal was 649,83€/month, and the average income was close to 1000€/month (Source: Pordata.pt).



Graphic 1 Monthly income of the family aggregate—€

Table 1 Factors for choosing the Portuguese Open University

Factors	Frequency	%
Place flexibility (not needing to commute frequently to and from the University)	5	6.4
Time flexibility (being able to study whenever is more convenient for the student)	68	87.2
The pleasure of studying made me research and I found the Open University (Portugal)	1	1.3
The opinion of friends on the Open University (Portugal)	1	1.3
Suggestion by friends/colleagues/family members or publicity	3	3.8
Total	78	100

for these students' option for the distance learning regimen and for the Open University (Portugal).

The importance of flexibility is also reflected when 33 students refer they are following the academic course at their own rhythm, that is, pursuing less than 5 curricular units per semester and concluding them successfully.[7] This finding relates with the fact that although the undergraduate degree in Education has a planned duration of three curricular years, 27 students were, at the time, frequenting this course for 4 or more years.

The non-conventional characteristics of this population were emphasized by the means by which they accessed higher education. Only 8 accessed this degree in the most conventional way—the 12th grade of secondary education followed by national exams for access to higher education. Half the students accessed through a special exam, directed at adults aged 23 and over. Apart from other pathways towards higher education, 4 reactivated their enrollment after a period of having

[7]The curricular plan of the undergraduate degree in Education includes 6 semesters, with 5 curricular units each—http://www2.uab.pt/guiainformativo/eng_planoestudos1.php?curso=12&ma=5.

interrupted the frequency of the course which highlights the not always linear nature of the pathways of students who ultimately complete their degrees.

The vast majority of students (n = 63) consider the knowledge they have acquired during the course to be valuable or very valuable. Many of these, expect the frequency of this undergraduate degree will have a positive and significant effect on their perspectives for professional progression (n = 54). The issue of knowledge usefulness has increasingly become an imperative with the democratization of the access to higher education, reaching non-conventional audiences and sustaining lifelong learning (Almeida et al. 2012).

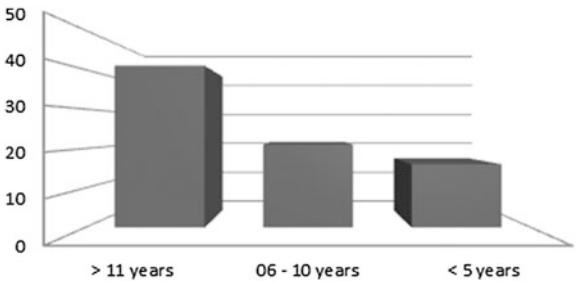
It is also noteworthy that an expressive majority intend to continue studying after they conclude the undergraduate degree (n = 52). This aspect is particularly relevant, when analyzed along with the interval that took place between the conclusion of previous formal education (non-higher education) and enrolling in this undergraduate degree (Graphic 2).

Regarding success, nearly half the students had never failed a course (n = 35), but relevant numbers have experienced some degree of failure; in fact, 11 had failed 4 or more distinct curricular units. However, most had never failed the same curricular unit more than once (n = 66).

Regarding the level of difficulty of the undergraduate degree, students' answers clustered around intermediate values, not finding it very difficult or very easy. Also, the majority were satisfied or very satisfied with the degree they were frequenting (n = 57) and with the University (n = 56). Also, a slight majority considered their feelings of belonging to the university to be intense or very intense (n = 41), despite the fact that many don't report participating in activities organized by the university (52 never or hardly ever participate). Also, although the majority were satisfied or very satisfied with their relations with colleagues (n = 52), responses were divided among those who connected with colleagues in non-academic contexts and those who did not.

A majority of students also reported being satisfied or very satisfied with support from academic services (n = 55), teachers and tutors (n = 49) and the course coordination (n = 60).

Difficulties which persist throughout the course of the undergraduate degree are also worthy of attention. Respondents stress difficulties related to time management, and lack of fundamental knowledge underpinning subsequent learning. These



Graphic 2 Number of years between last formal education frequented and initiating the undergraduate degree

difficulties stress the need for students to acquire study habits which are adjusted to distance learning.

If difficulties related with time management and the need to create and reinforce study habits are critical factors which may compromise the permanence of students in the formative path they have initiated, issues related to flexibility and usefulness are simultaneously, critical to the success of that permanence (Fiuza and Sarriera 2013). In that sense, both sets of critical factors point to areas of intervention that higher education institutions should pay attention to.

Concluding Remarks

It is argued that higher education has a fundamental role to play in the promotion of ESD, which can be understood as a key-concept, influencing educational policy and practice at a supranational level, although with limited expression in current Portuguese higher educational contexts. In particular, online distance higher education has been associated with the reaching of non-conventional audiences, including workers, adults, and people with family responsibilities, whose personal and professional lives can make it harder to access other modalities of higher education. Thus, by contributing to the democratization of higher education, and brining it closer to those audiences, distance education can also be thought of as a privileged means to bring knowledge and competences directed to the promotion of sustainable development to those non-conventional students. This goal, however, is faced with an important hindrance—the high dropout rates which have been associated with distance education and e-learning.

The research presented in this article explores the concept of permanence and particularly on academic factors which are associated to student permanence, aiming to identify factors which can be intentionally promoted by universities promoting distance higher education. We believe focusing on permanence and the factors contributing to its promotion highlights intervention possibilities focused on promotion, and invites higher education institutions to assume a proactive role. Therefore, by considering academic factors associated with permanence, higher education institutions may find pathways to intentionally foster the conditions in which permanence has greater possibility of occurring.

As previously noted, several academic factors have been identified by revising previous studies, including interaction (with teachers, students and colleagues), support (academic, technologic and administrative), integration (academic and social), commitment with the institution, curriculum topicality and relevance, relation with the work environment (applicability, employability and job progression or transition opportunities) and perceived quality of the course.

Based on these aspects and others not relevant to the specific dimension in analysis but contributing to a broad and comprehensive perspective of student permanence, a questionnaire was developed. Results presented in this article reflect

the answers of 78 students, enrolled in the undergraduate degree in Education of the Open University (Portugal) who have completed at least one semester.

These data allowed for the confirmation, on a first level, of the non-conventional nature of the students' profiles and of their educational pathways, and the perspective that this modality of higher education can be a very relevant vehicle to the wide spreading and democratization of education, including ESD.

The lack of continuity of the students' pathways, characterized by large periods of interruption, as well as their perspective and desire to continue educating themselves after the completion of their degree are testament to the effect the frequency of this course has played towards the promotion of lifelong learning.

As expected, the flexibility concerning time and space of learning are key aspects to the students' choice of this modality and institution, and are therefore aspects to protect as much as possible, when trying to reach diverse audiences.

Also permanent students revealed moderately high to high levels of satisfaction in relation to the support they receive by the course coordination, administrative staff and teachers—although more support from teachers was felt as a welcome improvement. Levels of academic and social integration were somewhat limited by the students' relatively low participation in university activities and extra-university activities with colleagues—easily explained by their work and family demands which are unlike those of traditional students. Nevertheless, students were satisfied with the university, and more than half expressed intense feelings of institutional belonging and satisfaction with the interaction with their peers. Finding alternative ways of increasing student participation and involvement, as well as institutional support considering the specific needs of nontraditional students, appear as relevant avenues for the pursuit of permanence among students with similar profiles. Given the previously noted relevance of flexibility, distance based initiatives, such as online meetings, as well as small scale local initiatives, among others, may prove to be of value in this context.

Difficulties concerning previous knowledge, time management and study are closely related to individual factors of permanence, but also highlight the need of intentionally promoting opportunities for enhancing such competencies at the institutional level.

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Climate Literacy and Collaborative On-Line Landscapes: Engaging the Climate Conversation Through Drama Facilitation in Distance and e-Learning Environments

Linda Hassall

Abstract The dramatist and the scientist have similar goals as they both attempt to 'create unique, engaging and insightful texts about the humancondition' (Saldina in Youth Theatre J 14:60–71, 1999, p. 60). As the risks of devastating climate change becomes more and more apparent there is a growing understanding of the role the creative arts can play in making sense of the ecological challenges we encounter. Drama processes and performance can widely engage with sustainability issues across a number of Year levels and it's behavioural activism appeals to its audiences to think for themselves and 'act'. Dramatic form is premised on critical and creative thinking. As an art form it is only a complete learning activity when it engages the learner to experience the drama and 'do' or 'act'. This chapter discusses the potential to introduce climate literacies into on-line learning platforms through drama curriculum processes and practices. While utilising drama in on-line learning landscapes is still largely a theoretical proposition, this chapter suggests that the dramatic form could provide a unique means of fostering climate literacies with distance learners. A focus on environmental and ecological issues in the curriculum through drama collaborative processes and practices can potentially increase the possibilities for global climate change education and promote the importance of sustainability for future generations. This chapter therefore proposes that dramatic investigations of scientific discourse may provide unique ways of developing climate literacy through alternative understandings, through adopting scientists' amassed knowledge and transforming it into something that can be experienced and explored kinaesthetically in the representational worlds of the drama.

Keywords Climate literacy · Drama on-line · Kinaesthetic learning

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Introduction

If we choose to include themes of global climate change in the curriculum outside of and apart from science education, where would they fit and how could we address them? Within theatrical education contexts in higher education environments[1] drama performances, classrooms and workshops are increasingly exploring climate change literacies in unique imaginative, collaborative contexts. The climate is investigated through themes that consider the relationship between perceptions of what is absent and what is present, between what is past and what is future, between climate, nature and disappearing landscapes and geographies. It is within this contradiction of perception that drama educators can respond to climate change literacies through non-traditional and on-line forms of delivery. Research indicates that teachers place high priority on climate change, as a topic their students should know about but report their own knowledge is inadequate for teaching it (Fortner 2001, p. 18). In the past Boyes and Stanissteet (1993) and Fortner (2001) noted that as well as students and higher education students, pre-service and career teachers have held incorrect perceptions about global climate change and warming as well as about how human activities impact on Eco-systems. This may possibly account for the slow implementation of climate literacies in the broader spectrum 21st century Australian curriculum. Gowda et al. (1997) posit that incorrect perceptions and understanding about the ozone hole and climate change and its impact on escalating weather events have contributed to the confusion (pp. 2232–2240). While this research is twenty years old, it is my experience that this confusion is still prevalent in an Australian context.

Within dramatic investigations climate change and associated representations of nature are re-articulated as explorations of *landscape*, from theoretical, behavioural and psychological and sceneographic perspectives. What eclipses landscape from historical traditions of climate, environment and nature is as Gaudio (2008) suggests, materiality, the process of how we as human beings have shaped it into what it has become in this time of ecological crisis and environmental instability. Landscape encompasses human activities; individual, social, organisational, industrial, familiar and inadvertent and suggests that these activities have affected the precarious environmental and ecological balance of Earth's systems. Global warming and climate change pays testament to these particular recent historical human actions. It is the material 'ecological result of certain master-narratives' that Western culture has told over a short period of time (May 2007, p. 96) and to which artists and educators are responding to. Theatre and drama education processes suggest an encounter between people and place and consequently can be acknowledged as powerful cultural tools that can be utilised to shift societal perceptions around ecological issues (May 2007). As the risks of catastrophic climate change accelerate there is a growing understanding of the role art making can play in making sense of the ecological challenges we encounter. As theatre makers and

[1]See Hassall (2013) *Salvation*, Charles and McGahan (2009) *The White Earth.*

drama educators we are able to respond to these challenges by posing provocative questions to our learner audiences around climate change issues.

As I begin writing this Chapter, the disturbing news comes through that President Donald Trump has just signed an executive order overturning regulations previous President Barak Obama had put in place to combat climate change and global warming. At the same time Australian communities across an area covering hundreds of kilometres in the State of Queensland, are being devastated by 260 kph winds and flooding rain generated by the 2nd worst Cyclone to smash the country on record. I am preparing to evacuate my home as the floodwaters rise in the street I live in. One in one hundred year events are happening, monthly, weekly even daily across the Earth. At least three plant and/or animal species are becoming extinct every hour (Schultz 2006). Recent re-confirmations of global warming predict a 21st century 'in which we as humans will come to terms with our relationship to the natural world' (May 2007, p. 95).

Lorenz (1999) claims and Duxbury (2010) agrees that scientists are given an unenviable role in predicting the escalation of climate change and are often faced with conflicting information when advising nations, leaders and communities and they warn that:

> Discussions that produce vast quantities of contradictory, abstract statistics and data have the potential to alienate the general public and render them helpless in the face of such overwhelming problems (Duxbury 2010, p. 295).

Weather, as Duxbury (2010) discusses is a formidable topic that commands attention and is known 'not only through scientific data and statistics but is also implicit in our bodies and in our phenomenological interactions and experiences in and of the world' (p. 295). He further claims 'we are inseparable from it and we participate in it' (p. 295). This is particularly true in Australia. While Australians are somewhat shocked with the seriousness with which climate change and global warming are being taken by the rest of the world (Schultz 2006, p. 9), it is incontrovertible that we are 'entering a new planetary era in which the actions of human beings have become the dominant influence on Earths environment and climate' (Wiseman 2016, p. 10). Wiseman (2016) further states that there is a critical scientific case for emissions reductions yet there is however 'increasingly broad recognition that the biggest roadblocks to preventing swift implementation of large-scale de-carbonisation strategies are political, social and cultural rather than scientific and technological' (p. 6). Investigation into individual and community reactions 'to potentially catastrophic events such as bushfires and pandemics' [in Australia] suggest evidence of a 'rapidly approaching existential threat' which can potentially induce 'reactions including denial and complacency, despair and paralysis' (Wiseman 2016, p. 7). Whitmarsh (2011) further claims that political beliefs and values may play important roles in measuring scepticism on climate change issues (p. 690). Isolated as we are by distance and political discourses that are nothing short of cynical and a nation economically reliant on coal mining export to China and India and alarmingly with 'Australians being acknowledged as among the most profligate users of fossil fuels in the world' (Schultz 2006, p. 9), climate

change education and action has not been a priority on the government agenda. Yet our lives in this country are dictated to by cycles of escalating drought, flood and fire weather events. Global climate change is focussing the attention of science communities. However it is a complex issue that is not well understood by the broader population, and promotes levels of uncertainty, conflicting responses and conflicting knowledge's about its science and about its severity (Fortner 2001, p. 19). In Australia like in many other countries the damage to the environment is not contained to industrial, mining and agricultural sites but is gnawing at the heart of the country itself, at our unique native species, at the inimitable landscape itself. Consequently creating a sustainable future for future generations will take courage and tenacity in our education systems (Schultz 2004, p. 9). Schultz (2006) refers to Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) data that predicts that

> Australia will become more arid, that the average temperature is likely to rise by at least one to six degrees or more over the next half century, sea levels will rise, El Nino will become even more frequent, the Great Barrier Reef will continue to deteriorate, fierce fires will become common place wiping out entire communities and tropical cyclones and their widespread effects, as the one recently experienced in March 2016 will become more fierce and frequent (p. 10).

It seems evident that this is a topic that needs to be addressed in the Australian curriculum with some urgency. The escalating catastrophic weather conditions in this country and the rate of extinction of species and failing eco systems while seemingly difficult to comprehend are in fact a very frightening reality and will impact on sustainable futures in generations to come. To assist in promoting understanding and awareness, Duxbury (2010) believes it's crucial to engage populations, including learner populations on a personal level. In doing so we begin to address the ways we perceive our surroundings and open up the possibility that all individuals are capable of contributing to the changes required to stem the rapid deterioration of the climate (p. 295). Dramatic and performative exploration is a unique way to not only explore the topic but can provide a practical kinaesthetic learning experience that can promote sustainable education in both learning and real life environments.

Utilising Drama in On-Line Learning Landscapes

As discussed above, climate change literacies are becoming prevalent in drama education curriculum and higher degree theatre courses in university environments. While utilising drama in on-line learning landscapes is still largely a theoretical proposition, developing the idea further could provide a means of fostering climate literacies to extend climate discourse into unique learning platforms. Artistic representations of scientific discourse in on-line learning platforms could provide new ways of introducing the possibility for 'alternative understandings' of climate

literacies in learner environments 'through translations of scientists' accumulated knowledge, data and statistics into something that can be understood by the public' (Duxbury 2010, p. 296). Bosse (2016) also believes that unique disciplines and platforms outside established systems will foster the most 'fertile ground for developing solutions' to problems we encounter (p. 14). Climate change education is considered essential on global scales and it is now taught in schools and universities in this country (Fahey 2012, p. 704) yet there seems to be little research about its inclusion and effectiveness in on-line learning environments. It may be acknowledged, however that even with escalating weather events and disasters, the enormity of climate change may be 'difficult to comprehend or connect within an appreciable way' regardless of format or delivery 'because of its remoteness in time and unpredictability' (Duxbury 2010, p. 294). Affective engagement in learning and how students understand climate issues and engage with climate literacy through both intellectual and emotional connections is most pertinent when considering the risks of climate change, as 'the risk of doing nothing is quite considerable' (Slovic et al. 2004). Fortner (2001) suggests that younger learners may not be at a mentally cognitive development level to deal effectively with the magnitude of climate change and its global effects. Consequently as educators and artists we must address climate change literacies and landscapes through appropriate course design and delivery methods that consider non-traditional delivery models for distance and remote access learners. Importantly in fostering climate literacies in young learners we must also ensure we understand the necessity of supporting learners who access distance education especially in such a highly emotive subject areas such as climate change. Levels of support should be paramount when planning distance and on-line programs as research suggests students want to be supported as part of a larger learning community (McInnerney and Roberts 2004). McInnerney and Roberts (2004) strongly believe that we can support distance learners by paying particular attention to the ways we implement and deliver learning. They further posit that by adhering to appropriate and reliable communication protocols (p. 74) we can consider ways of designing and structuring collaborative and inter-active distance learning in what can be acknowledged as isolating on-line environments.

In the area of climate change education it is possible to facilitate climate change literacies through non-science study focuses. Clary and Wandersee (2012) hypothesise that on-line learning communities who access scientific media and discussed issues with peers might exhibit greater scientific understanding of the global issues through engagement in on-line collaboration (p. 71). However the preparation of future generations for the responsibilities of citizenship in a global society, as well as education for sustainable development literacies and practices prescribes that scientific investigation and discussion on global climate change can appear in on-line formats through various methods of delivery (Fortner 2001, p. 19; Burandt and Barth 2010) and in varying curriculum subject areas such as drama and theatre, English literature and creative courses such as visual and media arts. These are essentially storytelling arts that have the potential to engage with the learner's imaginations and consequently can provoke empathetic or sympathetic action.

In Australia climate change and its continuing effects on the land and environment may be considered as being specifically relevant to distance education students in rural and remote areas of the country. Like in many Western countries, rural and remote communities in Australia are serviced through developing distance education technologies in education however traditionally this form of education has often been weighted toward text-based instruction with students expected to demonstrate knowledge in writing (Rao et al. 2011). These learners experience very real climate change issues specific to their isolated communities including high temperatures, drought,—salinization soil erosion, pestilence and disease, experiences that can last for years (Morrisey and Reser 2007). Often learners are isolated geographically as well as physically and psychologically in the vast Australian distances. Martin (2005) believes the psychological distance is significant and believes that there is a need for it to be bridged for distance learners. McInnerney and Roberts (2004) and Palloff and Pratt (1999) agree that feelings of isolation and aloneness that students may feel is the hardest symptom for distance educators to address and these feelings are 'often based on the physical separation between student and educator' (McInnerney and Roberts 2004, p. 74). Also there are recognised dangers in sustaining interest in distance learning as Martin (2005) warns, the lack of specific training and guidance for teachers, concerns about supporting the technology (p. 402), the reliability of national broadband efficiency and isolating and isolated learning environments and the emotive subject matter can become very real issues in sustaining distance learner interests and participation. McInnerney and Roberts (2004) warn that for students studying in isolating and isolated on-line environments, social interaction with peers and educators can often be an exercise in frustration (p. 73). If frustration is to be minimised they continue, 'much thought needs to be given to the methods of communication' that facilitate the learning environment and 'fulfils the human desire for social interaction' (p. 73). However, if, as Martin (2005) suggests, an aim of distance learning platforms is to enrich taught curriculum and to foster collaborative learning by connecting the learner with peers, the use of drama in the on-line environment can bring climate change themes to life regardless of uncertainties with technology or fears of learning being an isolating experience. In educational contexts that entail facilitation of learning through on-line platforms such as necessitated by geographical distance in Australian we must consider what is the best way of engaging, communicating and combatting feelings of isolation for students in their engagement with climate change education and consequently sustainability development.

While there is little doubt that on-line teaching can provide effective learning in a number of subject areas including climate change, Clary and Wandersee (2012) question how on-line instructors and teachers can facilitate science analysis of current climate issues and successfully promote understanding of the issues (p. 70). A focus on environmental and ecological issues in the curriculum through drama collaborative processes and practices can potentially increase the possibilities for global climate change education and promotes the importance of sustainability for future generations. Educational strategies in on-line platforms are best designed when they are based on awareness of the learners' level of knowledge and

preconceptions about issues being taught. Introducing on-line practices and distance education delivery on climate change themes suggests critical information specific to the learner can be selected organised and disseminated to fill knowledge gaps across numerous disciplines to not only enhance understanding but also can 're-mediate misconceptions' (Fortner 2001, p. 21). Bringing the facilitator, educator and/or artist face to face with learners virtually in real time can as Martin (2005) suggests enrich the learning process. In doing so the collaboration can satisfy a range of intelligences and importantly learning styles. Clary and Wandersee (2012) discuss that some of the biggest challenges in on-line instruction are the development of effective communications and the establishment of collaborative communities of learners as they pose different constraints for student collaboration and for student-instructor communication (p. 71). Clary and Wandersee (2012) further claim that the inclusion of 'community' can include both local community connections and online learning communities. In doing so educators and artist educators can promote sustainability practices to address climate issues but as Johnson (2002), King and Hildreth (2001), Means et al. (2009), suggest this form of education is only effective if the method of delivery is effective. Drama education processes provide a form of socio-cultural learning that promotes collaborative and communal practices and reflections and as such can effectively raise awareness about climate change and can promote sustainable development literacies though behavioural participations. As drama practice is a participatory visual medium, teachers, artists and facilitators can utilise the political dimension of theatrical and dramatic images to as Deluca and Demno (2000) suggest become a point for theoretical analysis. While our messages may be political and based in scientific fact, drama practice offers a way of seeing and learning that sits outside purely political rhetoric or scientific data. Dramatic form can offer political rhetoric and scientific data as popular culture and as such the visual nature of drama and the dramatizing experience offers ways of seeing that can be unique, evocative and experiential. The dramatic form asks us to question what vision of nature does the play, process or performance authorise and/or make legitimate and for what purpose. Drama as a pedagogical tool can therefore place climate change in the arena of cultural practice and in doing so can provide a unique and innovative platform to present, represent and engage in discourse around the very real climate and warming issues we have ahead of us.

Utilising Drama in On-Line Learning Landscapes

The growing popularity and necessity for on-line learning has as McNair-Crews (2015) claims, altered the culture of modern pedagogy and in the process has highlighted the importance of the role of the teacher. Drama teaching fosters kinaesthetic learning and in its most elementary sense is, an embodied event (Shepherd and Wallis 2004) and a collaborative and shared experience. It is a behavioural activity and is therefore contained in our bodies and in our

phenomenological exchanges and experiences in and of the world and with our relationships to both to the environment and to each other. Drama education encourages kinaesthetic learning by *doing* and uses experiential approaches that require students to explore and investigate content from physical, behavioural and psychological perspectives. Drama methods emphasise processes of reflexive and reflective actions and consequently require learners to use their bodies systematically over time while reflecting on physical, emotional and cognisant learning experiences. Drama encourages imagination, aesthetic representation, immersive exploration, collaborative relationships, analysis and problem solving through participatory action. Consequently theatre and drama practice and processes in distance education environments enables and encourages possible ways of addressing climate uncertainties and literacies in ways that pure scientific learning may not. On-line curriculum and course design may be considered as similar to designs in theatre and stage performances as both are concerned with depictions of worlds that are similar to reality (Fjuk and Sorensen 1997). Teaching drama in virtual worlds advocates kinaesthetic experiential learning. Unlike teacher centred models, pedagogical approaches to drama are collaborative and by its very nature drama practice engages the learner as a teammate, a cast member, an active and reflective participant in a collaborative community. Drama teaching is practiced in ways that enhance intellectual, expressive and psychological learning rather than practiced as a mode that imparts authoritative knowledge. It is widely accepted that good teaching and facilitation in the classroom environment recognises the value of interactivity, variation and various delivery strategies and may be suggested it may be similar in the distance-learning environment. In contemporary education teacher artists can play key-roles in on-line learning environments including educator, collaborator, information provider and sympathetic listener, especially with learners in remote areas who rely on distance education learning and who are at the forefront of climate change experiences in this country. Through its inherent immersion into dramatic worlds, through enacting the tensions between the real and the representational and in the requirement of participating in creating dramatic solutions through kinaesthetic learning participation, theatre and drama processes offer a unique way of addressing climate uncertainty and change at global and local and personal levels in ways that science education may not. While science education successfully addresses climate uncertainty in learners in many ways drama processes can complement and enhance science understandings of the environment, the natural world and our fragile eco-systems by utilising the scientific data in alternative imaginative and representational ways.

The representation of Nature and the natural world through drama education can symbolically link to themes that explore the ecological well-being of species and spaces (May 2007). Drama education in on-line environments can draw effectively from methodologies including environmental history, landscape theory, cultural geography, post-colonial studies, performance studies and phenomenology as well as from scientific analysis and investigations. Fish and Wickersham (2009) and Zsohar and Smith (2008) believe that effective on-line learning environments have the ability to engage student's critical thinking, and believe that on-line education

environments can promote student's practical thinking and practices, accommodate differences and encourage student's behaviours. O'Neill and Hulme (2008) propose that non-expert values, concepts, emotions and experiences of artists can significantly extend the field of expertise and consequent discourse in the field and can effectively engage and educate. Contemporary drama processes and performance can widely engage with sustainability issues across a number of Year levels and its behavioural activism appeals to its audiences to think for themselves and 'act'. Drama practice and performance is premised on critical and creative thinking. As an art form it is only a complete learning activity when it engages the learner to experience the drama and 'do' or 'act'.

Artists have interests in the representation of the world and of our relationship with each other in the world. Artists therefore have the unique ability to use their expertise to frame climate change themes in powerfully evocative ways. Historically drama and theatrical forms have proven a powerful cultural tool in responding to sociological and political issues and importantly to scientific issues and challenges. As a practical behavioural and emotive art form drama has the potential to transcend socio-cultural barriers through its participatory form and live activeness. It has the ability to unite learning societies on climate issues through focussing on how we sense and perceive the changing climate around us. The sceneographic environments and the worlds explored can link atmospheric conditions to psychological, social and environmental concerns that can be comprehendible across the national cultural and ethnic divide (Duxbury 2010). Contrary to scientific analysis and rationale, drama processes feature theatrical landscapes and representations and prioritises dramatic imaginative explorations to link experiences to emotion. While it is obvious that we cannot expect drama teacher artists to come up with solutions to the climate change phenomena, we can recognise that they can engage their student audiences through physical participation and perception to explore measures of adaption and mitigation through drama education. By utilising on-line tools for reflection, dialogue and awareness, knowledge about the broader scientific challenges such as over-population, environmental degradation, pollution and species extinction can be addressed and as Buckland (2015) suggests, 'art [forms] and science can work together to illuminate the scale and speed of the approaching crisis (p. 9). Art forms, especially visual art forms such as drama can, as Duxbury (2010, p. 298) and Bourriaud et al. (2002, p. 114) discuss, turn audiences into 'direct interlocutors' through activities that produce relationships with the world through signs, symbols, objects and actions. Learners can utilise the distance mode to their advantage by accessing compatible synchronous and asynchronous technologies to enhance and develop understanding. Web-based performance and drama activities can successfully incorporate the use of multi and social-media resources (not just text-based resources) to promote climate change learning literacies. Climate change resources can be readily researched on the Internet. Students can also access virtual performances, films, documentaries, music, poetry and other performative and visual mediums about climate change

including news reports and various responses to the climate discussion. Learners can use You-tube, Facebook, vimeo and other shared social media platforms through collaborate participation to their advantage to compile web site addresses and web links and information in virtual journals that story their personal journey into the climate change phenomena. The virtual resources and information can bring the climate and our human response to it directly into the world of the learner and into the world of the collaborative learning community. On-line discussion boards in this situation can become the heart and soul of primary collaborative research tools and resources in on-line communication participation. The collaborative platform can be designed to motivate students, promote higher order thinking and foster participation, communication and collaboration (Boettcher 2013, http://www.designingforlearning.info/services/writing/ecoach/tenbest.html). Learners can meet once a week or at convenient times on-line and collaborate during the class or workshop. Individuals can behave and work as a cooperative cast and develop dramatic scenarios and ideas from the research collated, and/or and devise and rehearse performance, discuss and analyse themes and reflect on subject, form, style content. Drama processes can therefore contribute to climate change education in the curriculum by enabling learners to:

- Experience and explore climate change events and experiences in imagined and creative safe environments.
- Immerse in drama and theatrical worlds to investigate and develop sustainable practice narratives while devising dramatized solutions to address climate change issues.
- Explore the unique learning settings of the learner in a deliberate manner by addressing their real world immediate challenges.
- Consider world-view, cultural and/or traditional knowledge and community-based lifestyles and practices.[2]
- Utilise the virtual space as a meeting/social space for cross-cultural interactions in which student artistic investigations are given equal value to scientific analysis.
- Collaborate and participate in drama activities to develop real life responses that promote dialogue and discussion specific to learner environment, culture and experience.
- Respond to needs of climate change themes through unique methods.
- Share and engage in collaborative problem solving hypotheses.

[2]Many authors stress the importance of asynchronous communication, as social media technologies are not as useful for group interaction in certain contexts. See McInnerney and Roberts (2004) and Aitken and Shedletsky (2002).

Conclusion

Morton (2008) suggests that art making can direct focus to a specific place, a precise moment and a particular people or community in the constructions of fictional worlds. Climate change investigation in collaborative on-line drama education can therefore be said to be experienced in the rendering of the fictional dramatic world explored. That world in turn sets up a relationship between teacher and learner and the world and the learner and establishes a point of contact between subjective expression and objective perception. Drama can do this in a space where learner, educator and audience inhabit the same dimension. Drama processes can explore an inter-relationship between eco-critical theme and performance behaviours and can negotiate time, space and place with theatre makings materiality, the performative body and the learner community. The translation of meaning, the understanding of the implications associated with learning and the consideration and implementation of sustainable practices across perceived space and time in the on-line education environment is central to the learning behaviours and rituals of everyday life. As such the drama process presents a hypothetical shared collective history that can be changed and/or transformed into future sustainable behaviours.

Drama offers possibilities and opportunities for imagining and encountering climate change and broader scientific themes such as human impact on the environment. The on-line format can negotiate a realm of uncertainty and present ambiguities and possibilities to engage learner audiences and participants in a process of explanation, speculation, representation and interpretation. Drama is a storytelling medium and as such drama can reconstruct representations of climate change with students and learners, by allowing them to develop their own stories around climate change themes. Importantly within these stories they can explore ideas for sustainable development practices in an effort to identify and address areas in the fight for a sustainable future. Teacher artists are now able to draw on vast amounts of valuable scientific data, information and critique to build and explore drama worlds that can investigate diverse challenges in imaginative and participatory ways. As such the drama activities can offer students alternative means of knowing, engaging and reflecting on and in the world. In participating and experiencing drama activities developed around climate change themes and sustainable practices the student is invited to engage and experience sustainable behaviours and practices, imagine and develop sustainable solutions, and reflect, evaluate, critique and interpret both information and experience to make sense of a serious global reality. If facilitators are considering curriculum enrichment relating to climate change themes beyond the textual for distance learners the virtual shared classroom can provide participants with:

> Experience[s] of collaborative learning and of becoming part of a larger community of learners and of having a meaningful and beneficial distance learning experience[s] (Martin 2005, p. 399).

The potential for using drama in the on-line education environment brings the subject of climate change to life through the learners' active and behavioural participation in imagined worlds. Learners have the opportunity to investigate models of behaviour that utilises factual scientific statistics and data in unique and creative ways. Their understanding of the subject and their individual and collective responses to the themes experience occurs through a kinaesthetic participatory interaction that can as Martin (2005) believes, significantly enrich the learning involvement (p. 400) and can as a result foster and develop important and significant climate change literacies through innovative curriculum development and engagement. As Duxbury (2010) suggests, there seems to be much potential for science and creative arts education to work together, to learn from each other (p. 296). History reveals that there have been moments in time when 'artists and scientists followed the same endeavours to probe a reality beyond immediate appearances' (Miller 1995, pp. 185–192). In promoting a drama, science collaboration through on-line learning platforms we as artists, scientists, scholars can work positively together to promote climate literacies in the hope of fostering sustainable futures.

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