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.

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 & 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 & Mayer, 2005; Jensen & 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 & 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 & Varela, 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 Withycombe and Redman (2011) identify five basic sustainable competencies for facing real and complex situations. In the field of teaching skills, Aznar and Martínez (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 Junyet (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 *et al.*, 2015). 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 & Pace, 2016). However, research reveals that there are major weaknesses in our basic teacher training model with regard to EE and sustainability (Yavetz, Goldman & Peer, 2009; García & Murga, 2015), and also with regard to CC (Hufnagel, 2015; Boon, 2016; Herman, Feldman & Vernaza, 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 & Hopkins, 2002; Feinstein & Kirchgasler, 2015).
- Educational barriers that include insufficient knowledge, lack of training and conflicts between present-day philosophy and school practices (Eurydice, 2011; García & Murga, 2015; Pérez *et al*., 2016).
- 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 & Gough, 2003; Sund & Wickman, 2011; Pérez *et al*., 2016).

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 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, Ismail and Roth (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 & Gropengiesser. 2013; Öhman & Öhman. 2013; Caird *et al.*2015), some of which are focused on teacher training (Varela *et al.*, 2014; Seow & 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 & Varela, 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 *et al*., 2016). All this represents a profound change in the teaching models of teacher training institutions (Ulls, Martínez & Aznar, 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 & Mayer, 2005; Vega & Varela, 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 & Larson, 2011; Kyburz-Graber, 2013; Gifford, 2014; Varela *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 & Mayer, 2005; Abrahamse, Steg, Vlek & Rothengatter, 2007; Stern, Powell & Hill, 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 & Wenger, 1991; Wals, 2007; Varela *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 y Gil, 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 (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 *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, Maguregi & Jiménez, 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.

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.	-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

- 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.	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

Table 1. Competencies that can be acquired through this proposal, with regard to EE and sustainability. *Competencies adapted from UNECE (2012): **Competencies proposed by Wiek et al. (2011).

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, Potter & Yarrow, 2008; Zawacki & 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, Navaza & Rial, 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 Figure 1), but that we are presenting here separately to permit a more detailed analysis.

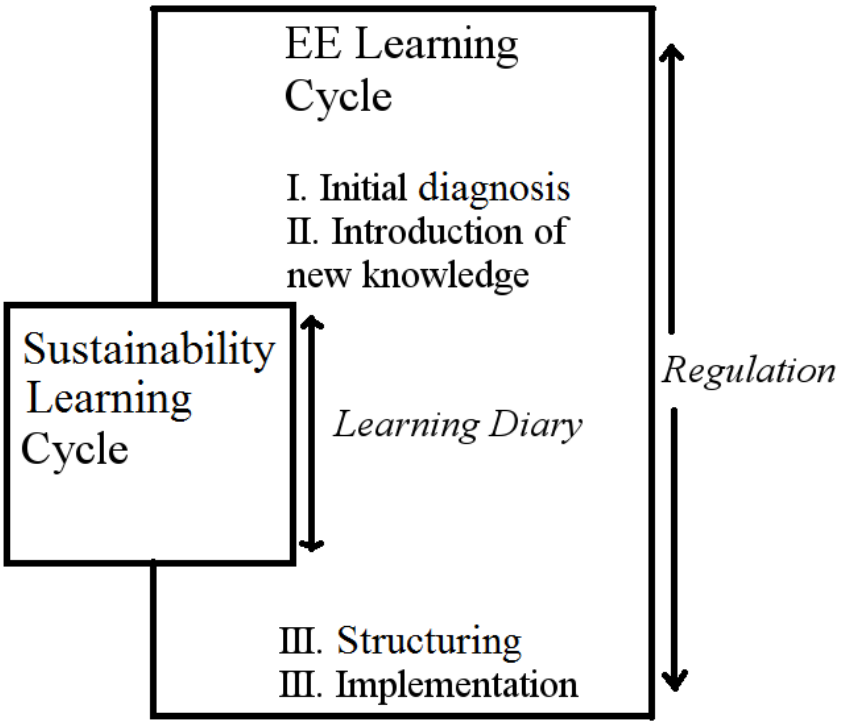

Figure 1. Diagram of the integrated proposal

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 and promote democratic participation (Todd 2009; Ohman & Ohman, 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 & Gil, 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 & 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 *et al.*, 2014; Araujo *et al.*, 2015; Vega, Varela & Álvarez, 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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