Cosme Jesús Gómez Carrasco, Pedro Miralles Martínez and Ramón López Facal

Handbook of Research on Teacher Education in History and Geography

It is necessary to know the opinions, practices and expectations of teachers in training and in practicing, to improve teacher education programs. This Handdbook addresses the challenges for the profession of teaching of history and geography, who, in several European countries such as Spain and France, share initial training and teaching in both disciplines. Researchers' contributions have been collected from eight countries. The majority of Spanish universities, eleven, have shared an extensive research project, but have also had the collaboration and participation of researchers from seven other countries: Brazil, Canada, China, Colombia, Portugal, Sweden and the United States. It is about collective work, in a network, rather than the sum of individual contributions.

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Part III Heritage and ICT in the training of geography and history teachers

Domínguez-Almansa, Andrés, Costa-Casais, Manuela, and Riveiro-Rodríguez, Tania

Chapter 15 Cliffs with memory: Historical and social teacher training via climatic and environmental transformations[1]

Abstract: This paper presents a project relating to teaching innovation and research in the context of primary teacher training. It takes Place-Based Education theory as a point of reference. Over the course of several academic years (191 pupils), an experiment has been carried out by way of which schoolchildren learn about a series of geomorphologically unique formations on the coast of Galicia (NW Spain). These formations, currently active cliffs, are Quaternary deposits which provide a significant amount of information on climatic and environmental changes which took place during the last Ice Age and the Holocene. The research deriving from this intervention is mainly qualitative in nature, supported by documents created by the students, in which it is possible to find: a) the level of prior knowledge of the trainee teachers; b) their reflections and evaluations on these formations and their educational and civic dimension; c) their role as disseminators of the scientific and heritage value of these deposits by way of ideas and proposals for educational interventions.

Keywords: Climate change, Edapho-sedimentary deposits, Trainee teachers, The teaching of the social sciences, History teaching, Geography teaching

Introduction

This paper examines the possibility of offering trainee primary teachers an interdisciplinary vision in order to approach the teaching of geography and history. A fusion between physical geography and social knowledge is employed to address, from a critical thinking perspective, a problematic and present-day issue which has become a relevant topic in education, namely climate change (Gaudiano, Cartea, 2020). This approach makes it possible to incorporate knowledge from other disciplines while, at the same time, employing an educational

1 This research is part of the coordinated project COMPROP (PGC2018-094491-B-C31: *Emotional dimension and controversial issues in teacher training* with funding from the Spanish State Research Agency and European Regional Development Fund.

formula open to lines such as heritage education, Place-Based Education and socio-critical education.

This approach stresses the educational and social value brought by reflecting in the classroom on spaces with intrinsic values but with hardly any or no civic recognition, opening up ways for their possible heritage appropriation within the framework of education (Domínguez-Almansa, López-Facal, 2017). This intention is integrated in influential proposals in the field of heritage education, such as the relationship of heritage with ideological issues and the power of the elites (Cuenca López, 2016; Estepa, 2019) and the idea of changing the prominence of objects for that of people (Fontal, 2013). It can also be framed in Place-Based Education, focused on the connection between the classroom and the local community (Gruenewald, 2003; Sobel, 2004) and the recognition of everyday places which can acquire meaning for the people who live within them (McInerney, Smyth, Down, 2011).

Both points of reference, which encourage critical judgement (Herodotou et al. 2019), defend the necessary inclusion of natural spaces. In this case, a representation of spaces which, in the field of geomorphology or geology, fit into the consideration of pattern sites, best sites and representative sites (Carcavilla, 2014) is discussed. These are edapho-sedimentary Quaternary deposits located on the coast of Galicia (NW Spain), which, in the present-day, function as active cliffs (Costa-Casais, Caetano Alves, 2013). To their scientific value must be added their educational potential, both in terms of addressing cognitive aspects, making it possible to gain a better understanding of climate change, and civic characteristics steered towards the evaluation and preservation of these environmental records of the memory of the past. Although such deposits are present in other territories, they become unique on the Galician coast due to the abundance and wealth of the information they provide on a global, regional and local scale (Threnhaile et al., 1999).

A justified educational action

When dealing with issues such as climate change and its marks on the Earth, the dissociation between recent research trends and educational routines is shown. It is necessary to change these dynamics by carrying out educational actions directed at trainee primary teachers. Making such actions suitable implies the commitment of university teachers as a point of reference for a transformative and critical practice (Johnston, 2006). Some previous studies based on the development of this research have been carried out along the same thematic

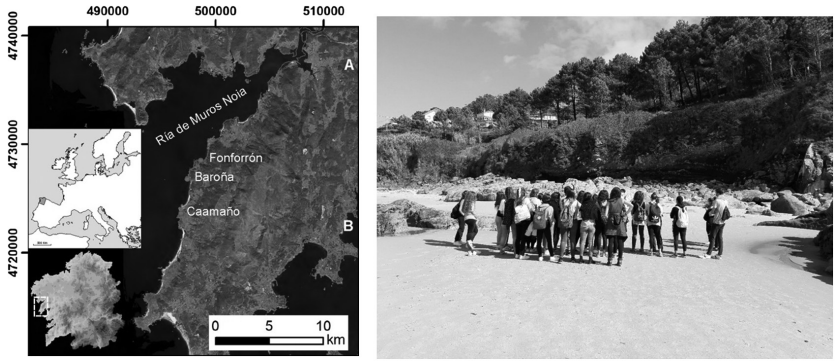

Fig. 1: Location of the field trip and Fonforrón beach

lines of this study (Costa-Casais, Domínguez-Almansa, 2018; Domínguez-Almansa, Costa-Casais, López-Facal, 2019).

The idea of the importance of learning based on the discovery and investigation of the surrounding area is shared (Hmelo-Silver, Duncan, Chinn, 2006). This action begins with an excursion to a beach bordered by deposits (Fig. 1).

Pupils are encouraged to find evidence of climate change, and a tendency to focus exclusively on the present and to leave aside prior knowledge of what is a natural process of the planet is demonstrated. When reflecting upon this, the idea of the memory of the Earth and its possible records appears. Some of these records are extremely precise but are hidden at the bottom of lakes and seas or are under ice (Hodzic, Kennedy, 2019), while others, such as the edapho-sedimentary deposits located in this site, which contain more fragmented information, are present in the landscape although they are invisible to those who do not possess the ability to recognise them (Costa-Casais, Caetano Alves, 2012). Once they have been identified, the question is asked how information about environmental changes can be obtained. This makes it possible to bring meaning to the idea of interdisciplinarity due to the fact that invisible elements of a physical and chemical nature are analysed in the laboratory, for example pollen or the variability of bromine, which is associated to a greater or lesser maritime influence (Martínez et al., 2016). Visible elements are also observed, such as how the intensity of climatic variations is reflected in the different sedimentary levels, which can easily be identified (Fig. 2).

Visualising climate change as a constant in the life of the planet leads to the appreciation of the succession of interglacial-glacial-interglacial (Holocene)

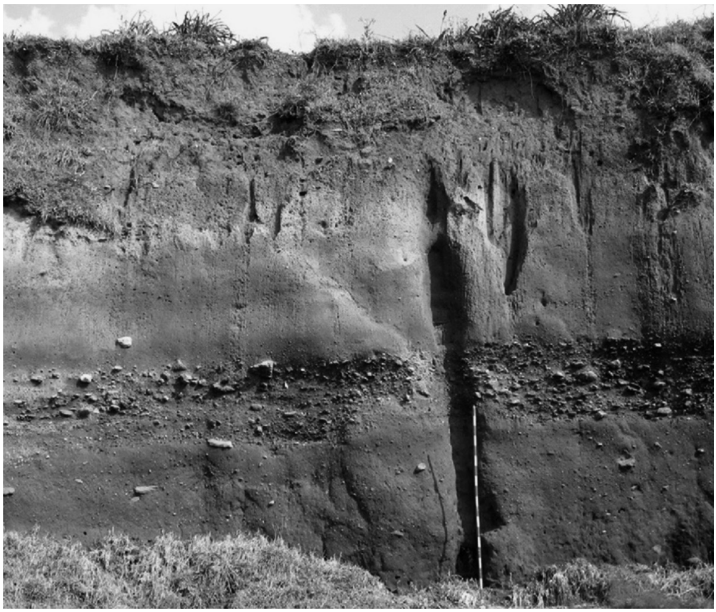

Fig. 2: Identifying the core of the sampling to analyze the invisible proxies and making visible the sedimentary levels (Caamaño deposit-Porto do Son)

periods. It also assists in understanding that, in each period, there were significant climatic variations influenced by geographical location. In this case, these deposits were located in an area between permanent ice and less intense cold conditions with greater humidity, thus leading to the abundance of both deposits and their differentiated facies (Figs. 3 and 4).

However, new questions arise: What was the landscape like in the last Ice Age? It can be stated that the origin of these deposits is continental and that the sea level was much further away than it is today, leading to a significant evocative effect considering what are today the Rías Baixas and the valued islands at their mouths. Did the landscape change during the Holocene? In order to appreciate this aspect, the excursion then took in an archaeological context, the hillfort of Baroña (Porto do Son). This is a fortified pre-Roman settlement which receives many visitors due to its unique location on an elevation exposed to the sea (Fig. 5).

When asked to identify a noteworthy aspect of its location, some pupils point out that the sea attacks part of the settlement, deducing that its construction

Fig. 3: Reflecting on this cave (Fonforrón beach-Porto do Son). It existed in the previous interglacial. It was fossilized in the glacial stage and in the current (Holocene) has been newly discovered

took place in a colder environment in which the coastline would have had a different morphology. This makes it possible to understand the context of other archaeological spaces (Blanco-Chao et al., 2020). Noting the relationship between climate change and landscape makes it possible to transform a consolidated idea: non-industrialised societies of the past which did not pollute on a large scale were not affected by climate change. This can be refuted by discovering that this settlement experienced the Roman Warm Period and its effect on the sea level (Tallón-Armada et al., 2017), which, similar to the present level, would have made the hillfort difficult to live in.

A renewed perspective on this issue makes it possible to address it in the classroom from the parameters of a meaningful educational approach in order to understand social thinking which interweaves the past, the present and the future (Israel, 2012; Santisteban-Fernández, González-Monfort, Pagès-Blanch, 2020).

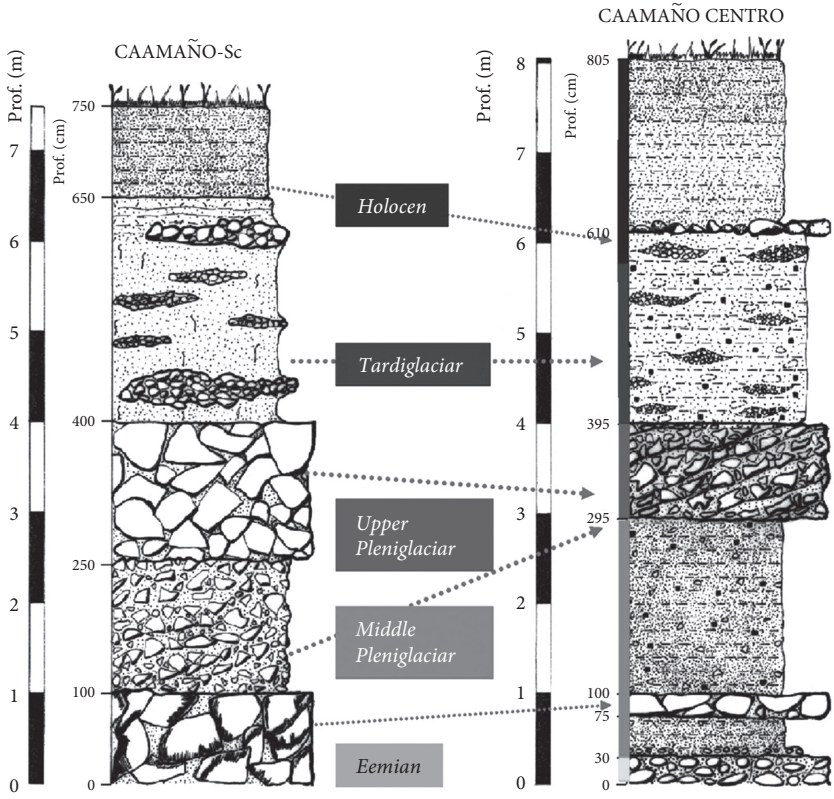

Fig. 4: Reconstruction of the levels identified in the edapho-sedimentary deposits. (Figure made byM. Costa-Casais)

In general, primary schoolchildren are introduced to historical knowledge by way of a graph of historical periods with no chronological proportionality. In a relaxed atmosphere (Hassinger-Das et al., 2017), and using 24 steps which represent the hours of one day, the temporal dimension of each period is visualised and compared, incorporating climate change as a historical determinant (Fig. 6). This issue is dealt with in research which combines documentation from the fields of history and the Earth sciences (Diamond, 2005; Brooke, 2014; Blom, 2017).

By combining these documents (Fig. 7) as a resource of great educational value (Bardsley, Bardsley, 2007), and the information recorded in the deposits,

Fig. 5: Hillfort of Baroña (Porto do Son)

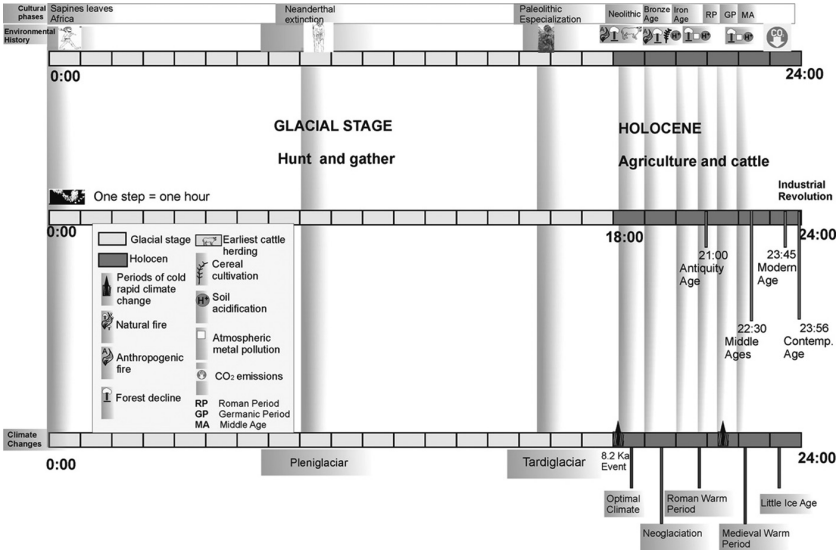

Fig. 6: Historical time and climate in history

a route is traced from the hunter-gatherers of the long Ice Age to the short warm time period of the contemporary world. This route passes through times of great climatic change, which generated the present-day climates and brought about agriculture, and a succession of climatic isolations which accompanied the

Fig. 7: Document to reflect on the Little Ice Age (approx. 1570–1700)

traditional stages of humanity. A long period dominated by agrarian activity is reflected upon, in which the need for climate stability brought about both joy and fear, giving rise to rituals and customs (Rodríguez Plasencia, 2013), transmitted by memory, which have come down to us today under the veil of Christianity. It is necessary to approach this issue in schools from the perspective of new intellectual and critical paradigms.

The contemporary world has developed up to the present moment during a growing warm period. Current research identifies this as a process of acceleration of global warming brought about by human influence. Indeed, scientists from different fields admit that we are already in a new stage, the Anthropocene (Crutzen, Stoermer, 2000). In order to discuss the didactics of climate change as a problem of the present, in addition to giving value to the past, it is necessary to:

- Be aware that we are arriving towards the end of an interglacial stage which is characterised by a natural process of accentuation of warming (Hodzic, Kennedy, 2019). This makes it possible to reflect on the true dimension of human influence, which has never before been present.
- Discover evidence (Veettil, Kamp, 2019). Without resorting to overused places, by comparing the same deposit twenty years ago and at the present time, it can be appreciated that it is being covered by vegetation, a

phenomenon associated to warming which can also be observed in dune systems (Jackson et al., 2019).
- Associate the problem to fundamental issues search as the culture of coal (Nordhaus, 2013) and economic growth. Regarding this aspect, the effectiveness of resorting to works which bring together rigour and dissemination is appreciated. In this case, Higgs (2015) shows how the investor of today does not make the most of the growth of yesterday. An individualism which preys upon resources and the planet itself imposes itself as an ideology.
- Propose the necessity of integrating climate change into education for environmental and human sustainability (Bangay, Blum, 2010; Collins, Genet, Christian, 2013). It is essential to integrate primary schoolchildren who can take in the aspects dealt with here and those who, at an early age, are educated in the responsibility of building a more sustainable society. It is necessary to exemplify this by way of real experiments carried out in schools.
- Return to the past in order to confer educational value upon the knowledge of cultures capable of generating sustainable spaces (UNESCO, 2016) and to seek educational paths which avoid the fictitious dissociation between the human race and nature.

From an educational perspective of a critical nature, it is of value to project these learnings towards the future (Estepa-Giménez, Martín-Cáceres, 2020). The memory stored both in edapho-sedimentary deposits and in other environmental records makes it possible to know that an interglacial period is followed by another glacial period. If we are at the end of an interglacial period, what hypotheses should teacher training consolidate? Two possible scenarios should be reflected upon, always debatable and controversial as scientific hypotheses and their social projection.

1) Induced global warming changes the natural dynamics of the climate (Mann, Kump, 2016). This would suppose an uncertain prolongation of the interglacial period and warming with consequences for the environment and humans. Thus, the thawing of the North Pole would reveal an infinity of resources which would ruin what, in recent decades, seems to have been the least violent period in the history of humanity (Pinker, 2011). It could also reveal viruses and bacteria of unpredictable consequences (Malavin et al., 2020).
2) The rise of the temperature would imply a rapid acceleration of thawing. That great quantity of freshwater would alter the marine currents, which regulate the climate, and it would accelerate the arrival of the new Ice Age. If these predictions, quite refuted (Waver, Hillaire-Marcel, 2004),

would finally occurred, they would cause problems of adaptation for a massified society, the inhabitants of which can no longer be described as hunter-gatherers

Working on climate change with trainee teachers is a way of conveying the need to approach a critical teaching method in the age in which they have to live. Inasmuch as they assume this method and put it into practice, natural climate change will not be avoided, but it could be avoided that a dominant ideology, based on growth and taken as unquestionable truth, defeates science, which would lead to the disappearance of critical thinking with the ability to reflect on the consequences of forcing natural dynamics or to prevent an adequate adaptation to these.

Objectives

To analyse:

1. To what extent trainee teachers understands the environmental records of the past and value those which exist in their surroundings.
2. The cognitive and civic competences acquired in the learning process, paying attention to the capacity of relating the past, the present and the future.
3. How this knowledge can be valued for their professional practice.
4. Their capacity for approaching educational designs so that primary schoolchildren can discover, know, give meaning to, and even disseminate the problem of climate change.

Method

This research is framed within the qualitative tradition (Flick, 2007) and interpretive research (Erickson, 1989). It is an inductive and bounded study which integrates the ethnographic method and the case study (Denzin & Lincoln, 2005). It is based on an educational action and its feedback carried out over three academic years (2016/2017; 2018/2019; 2019/2020) in the area of the teaching of the social sciences in a primary education teacher training degree (University of Santiago de Compostela – Lugo Campus).

191 students (n=191) took part in the study after receiving training in heritage and place-based education in the previous year. They also expressed their interests in dealing with the issue of climate change. At the end of the educational action, they were asked to produce empirical materials in order to approach this research: free individual reflections (n=191) and educational designs produced in groups (n=25) in order to put their learning into practice.

Tab. 1: Sections and key ideas

Individual reflections	**Group designs**
1. Evaluation of the deposits	1. Discovering the deposits
– Acquisition of knowledge and interdisciplinarity – Association of heritage, identity, preservation – Benefits for professional training	– Teaching the memory of the Earth – Promoting their value
2. A new understanding of climate change	2. Giving meaning and offering contents for working on climate change
– A different approach to geography and history – Connection between past, present, future – A critical and civic dimension	– Alternative procedures – Introducing time and space – A present-day problem
3. Teaching for climate change	3. The vocation of dissemination
– The importance of the surroundings – Cognitive learning – Critical education with social impact	– Pupils as agents of change

Authors' own work

The data were treated in an aggregate and holistic manner and were analysed by way of the method of constant comparisons (Glaser & Strauss, 1967), observing the ideas reiterated in the reflections and the group work. They were categorised into several sections and key ideas (Tab. 1) ascribing textual quotes to each one of them in order to exemplify them.

The quotes of the reflections are identified taking account the student and the academic year (e.g.: St1:2017/2018), the designs, work and academic year (e.g.: D1:2017/2018).

Results

Individual reflections

1. A high degree of consideration for the deposits.

   a) They are valued for being the source of appreciated knowledge and are considered as an example of interdisciplinarity:

   [...] They are an extremely good tool for learning about the history of the Earth [...] (St4:2018/2019); The discovery of these deposits made me change my way of seeing the coast [...] (St3:2018/2019); Getting to know them close up [...] now I understand

that they are archives of time [...] every climatic change undergone by our planet can be seen reflected in them [...] (St10:2016/2017); [...] they are of great interdisciplinary value [...] (St10:2019/2020); [...] They can be included in different subjects [...] from the social sciences it could be discovered that they are archives of time [...] in which climatic changes, variations of the sea, and even anthropic activity are reflected [...] from the natural sciences the composition of these natural elements could be studied (St10:2018/2019).

b) They are seen has being a heritage asset, a symbol of identity and a space to be preserved:

[...] due to the information which they provide us with [...] they should be declared as heritage (St10:2016/2017); [...] they are part of our natural heritage [...] (St45:2018/2019); They are more than a heritage asset [...] they should be declared as a world heritage site [...] (St3:2029/2020); They are unique and make [...] the Galician coast unique [...] (St10:2028/2019); Galicia is full of deposits [...] part of our heritage [...] of our identity [...] of our history [...] it is our obligation to preserve them, to take care of them and to value them as they deserve [...] (St7:2019/2020); They are an incredibly important part of our landscape [...] They confer both culture and beauty on our surroundings. They are a symbol of our identity which we must look after and value [...] (St5:2019/2020).

c) They are associated with the improvement of their professional training:

They are an important source of information which we must protect and study [...] (St10:2018/2019); [...] it has contributed to both my personal and professional training [...] (St2:2018/2019); Having knowledge of something so important gives meaning to the role of teachers (St5:2016/2017); [...] this should be a fundamental aspect in primary education [...] (St5:2028/2019); At no point in all of my education did I ever hear anything about them. Therefore, I believe that it is important to teach what they are in primary education. . .and what they hide inside them (St54:2019/2020); The more knowledge we accumulate about the deposits, the more reference points we will have in order to propose significant teaching [...] (St59:2019/2020).

2. A new understanding of climate change.

a) A different approach to focusing on geography and history is highlighted:

[...] the issue we dealt with last year about the hidden memory of the Spanish Civil War is related in that [...] both things are unknown by the population [...] (St9:2018/2019); [...] a fact of great relevance in the 21st century [...] we are talking about our own survival on the Earth [...] (St8:2016/2017); [...] knowing about the Earth throughout time [...] what climatic changes were like, the variations in the sea [...] (St45:2019/2020); it is important not to [...] forget issues like this [...] to go on maintaining the memory of everything that is alive on the planet (St50:2019/2020); [...] it is extremely important to work on these issues [...] on climate change [...] our ancestors [...] on

different stages of history (St81:2019/2020); [...] it is related with geology [...] history [...] what climate there was, what resources there were [...] (St43:2018/2019).

b) Presentism is abandoned, and climate change is reflected upon paying attention to the past, the present and the future:

[...] how the landscape changed [...] the natural processes which took place [...] and those which will take place (St6:2019/2020); [...] civilisations evolve or disappear depending upon climate. Favourable climatic conditions facilitate the development of life and its prosperity [...] adverse climatic conditions often lead to wars, conflicts and other human catastrophes (St20:2019/2020); [...] on the one hand, it is a natural phenomenon [...] and, on the other, human [...] the impact of which began with the Industrial Revolution, accelerating the natural process [...] we worsened the consequences (St20:2019/2020); [...] the climate affects human beings a great deal [...] the rise in temperatures brought about droughts [...] a lack of food, conflicts [...] climatic migrations [...] in our days (St81:2019/2020).

c) A critical and civic dimension is assumed when approaching problematic issues:

[...] our industrialised society is worried more about economic profits than [...] the transformation of natural areas (St8:2018/2019); [...] we all need to be responsible, as it is we who are causing this climate change (St14:2019/2020); [...] a consumer society [...] helps to destroy the landscape [...] it is necessary to raise awareness and to transform this into habits (St37:2019/2020); [...] global warming is a contemporary issue [...] we could reflect on what is happening (St39:2018/2019); [...] instilling the importance of the natural world [...] the critical situation of the abandonment and mistreatment of the landscape [...] we must recover it and seek solutions. . .particularly among younger people [...] (St42:2018/2019).

3. The appropriation of climate change for teaching.

a) The idea of teaching linked to the surrounding area is defended:

[...] teaching them history by way of everyday items which they possibly do not know about [...] outside of the textbooks (St1:2019/2020); [...] seeking points of reference in the local environment (St6:2016/2017); it would be good [...] to visit historical places (St7:2019/2020); [...] educational excursions [...] we should be interested in what we often have around us [...] (St59:2019/2020); [...] we underestimate our own resources and possibilities in the surrounding area [...] (St61:2019/2020); I would organise excursions [...] a closer perspective [...] not studying merely from a textbook [...] giving value to what surrounds us [...] (St12:2018/2019).

b) The cognitive and emotional dimension is appreciated in learning about climate change:

[...] along with the science and the documentation, we can come to learn many things about the past, such as our evolution or that of our planet (St20:2019/2020);

> The classroom [...] is the starting point for dealing with the variations in temperature which have taken place over time [...] human activity is bringing about an increase in the speed of the changes [...] (St34:2019/2020); [...] so that the pupils can see that nature belongs to them, to make them feel that the coasts, the cliffs and the seas belong to them, so that they are "moved" when they see an ecological catastrophe [...] (St15:2019/2020); [...] in order to achieve significant learning, to excite the pupils so that they want to learn more (St21:2018/2019).

c) They are committed to a critical model of teaching with a social impact:

> [...] we should encourage our pupils to feel responsible for its care and to fight for it [...] (St5:2018/2019); [...] we should be active and critical subjects [...] in order to transmit these things to the children in the future (St8:2016/2017); [...] we attempt to go further by speaking about related issues, seeking to create a social consciousness in the children [...] (St15:2019/2020); [...] increasing awareness and participation among the children [...] to improve the quality of education (St13:2016/2017); Critical thinking is an essential skill [...] ask for solutions, moving away from the mere transmission of knowledge (St11:2019/2020).

Group designs

1. A commitment to the discovery and appreciation of the deposits.

   a) They are shown to be archives of the memory of the Earth:

All of the designs (n=25) present the edapho-sedimentary deposits as discovery. They relate the layers with geological and human history.

> [...] a model which will represent layers of sediments in different colours [...] (D8:2018/2919); [...] they will be given a "puzzle" of a piece of cake [...] they can see the different layers [...] each layer has a climatic period written on it [...] (D1:2016/2017); [...] an urn with materials [...] salt, coloured chalk, stones of different sizes [...] (D11:2018/2019).

b) Educational activities are approached:

All of them do so (n=25). Excursions are employed (n=19) in order to generate interest. The participation of specialists is valued (n=8) and collaborative research is encouraged (n=6) along with comparative research with publicly recognised places (n=2).

> [...] we decided to take them to interpret [...] the Swabian deposits [...] in order to learn from a significant place (D10:2018/2019); on the excursion [...] a treasure hunt [...] which is the cliff itself, making them see its importance [...] (D15:2018/2019); we will need an expert who can explain [...] (D17:2018/2019); [...] a fictitious resolution [...] which says that all the deposits in the area will be eliminated [...] reaction [...] they should investigate" (D17:2018/2019); [...] one of the roads which passes next to a cliff is about to collapse [...] investigate [...] (D1:2016/2017); The Grand Canyon, The Eiffel

: Please provide opening quotation mark.

Tower, The Colosseum, the deposits [...] they are as unique as the rest [...] (D16:2018/2019).

2. Providing meaning and offering contents for working on climate change.

a) Alternative procedures are proposed:

All of the designs (n=25) move past the transmissive model. Debate and reflection are explicitly valued (n=18). Entertaining materials and resources are created (n=11). Films and audio-visual materials are employed (n=8) along with activities associated with information technology (n=7).

[...] we will give each group a series of questions to guide them [...] (D2:2016/2017); [...] we will read a story we have written [...] guided [...] to build knowledge (D3:2018/2019); [...] a story [...] about Mr Oli [...] who lives in an Ice Age (D19:2018/2019); an experiment for the greenhouse effect [...] (D13:2018/2019); a game [...] the timeline of the ages [...] if it is hot or cold [...] it will be explained (D4:2016/2017); [...] the first 6 minutes of Ice Age [...] the migration of animals and humans [...] climate change [...] survival (D10:2018/2019).

b) The dimensions of space and time are worked upon:

All of the groups proposed working on time and space. There is a commitment to approaching changes and continuities (n=7), reflections on glaciers (n=3), animal and vegetable species (n=8) and seasonal and climate changes in relation to history (n=3).

[...] regarding [...] changes in the climate which have occurred throughout history, we will jump to the present (D1:2016/2017); [...] some tribes set off on a journey in search of food [...] enormous fruit [...] if you ate it you fell asleep for thousands of years [...] they woke up [...] where before there was land, now there was sea [...] (D3:2018/2019); [...] the island of Sálvora [...] the hunter went there from where the port is located today [...] how is it possible that he went on foot? (D19:2018/2019); [...] a glacier [...] would you say that that is a typical landscape of Galicia? Could it have been in another time? (D13:2018/2019); [...] Galicia [...] ecosystems such as taiga and tundra [...] (D8:2018/2019); [...] to reflect on [...] changes in the climate [...] Galicia between the 17th and 18th centuries [...] in comparison with other parts of Europe [...] (D18:2018/2019).

c) It is approached as a problem of the present:

All of the groups approached it as a present-day problem (n=25) in three ways: pollution and global warming (n=11); the excessive consumption of resources and the destruction of landscapes; an attack against natural heritage and its necessary preservation (n=10). The future perspective is opened up by way of catastrophes associated to a climate which becomes more and more extreme (n=7).

> [...] reflecting on what is happening in the present day, changes brought about by human action [...] global warming and destruction [...] (D3:2016/2017); [...] looking for related news [...] in different parts of the world [...] (D1:2016/2017); [...] the Industrial Revolution [...] would bring with it the beginning of large-scale pollution. . .global warming (D21:2018/2019); [...] flooding on the Mediterranean coast [...] the thawing of the ice caps [...] droughts in Galicia [...] refugees (D1:2016/2017); [...] promoting the defence and respect of the environment, and understanding, from an objective, critical and scientific point of view, the concept of climate change (D13:2018/2019).

3. A concern for the civic dissemination of academic work.

   a) A commitment to educating pupils as agents of transformation:

All of the groups manifest this point (n=25) and the majority specify it with activities for disseminating the knowledge acquired (n=21); by way of converting the school into an exhibition centre (n=10); by producing reports and written assignments which involve the families (n=6); via civic initiatives which require action on the part of the community (n=5); and drama and exhibitions for younger schoolchildren (n=4).

> [...] opening the doors of the school to the surrounding area [...] (D2:2016/2017); [...] disseminating what has been learned [...] to the other children in the school and then to the community [...] (D19:2018/2019); [...] a report outside of the classroom, asking people what they think [...] (D3:2016/2017); Sending videos to the mayor, in which the deposits can be seen (D1:2016/2017); [...] asking their family members [...] to reflect on this together [...] (D19/2018/2019); [...] to transmit [...] the importance of the deposits, their history up to the present day [...] performing a play [...] actors [...] scriptwriters, directors [...] (D8:2018/2019); [...] gathering signatures [...] in change.org for climate change [...] going to the council [...] (D16:2018/2019).

Discussion

It is extremely relevant that from an action which proposes a new teaching approach regarding climate change, the trainee teachers have unanimously paid special attention to what has been presented to them as an environmental archive, the edapho-sedimentary deposits of the Galician coast. This is a confirmation of the educational importance of working with documents (Morgan, 2002; Prats, Santacana, 2011), particularly if they are places which single out everyday landscapes (Morón, 2013; Liceras, 2018). Furthermore, their high evaluation is rooted in different lines, which are, in many cases, interwoven: (1) Contributions on a cognitive level, making it possible to state that knowledge also has an emotional dimension (Domínguez-Almansa, Riveiro-Rodríguez, 2017), and understanding the value of interdisciplinarity (Jones,

2010), which is intellectually and socially necessary in order to scientifically address issues which occupy and preoccupy. (2) Without making mention of heritage in the educational actions, it has been proven how prior training in this field has generated a process of heritage appropriation, which is fundamental in the aspirations of this educational approach (Fontal, Ibáñez, 2015). Thus, the scientific value of these geomorphological formations is accompanied by a strong sense of identity (Cuenca-López, Estepa-Giménez, Martín-Cáceres, 2017),which has its origins in the reflection on their frequency and uniqueness on the Galician coast and is assumed as a differentiating element and with a certain degree of pride, thereby leading to a commitment to their preservation and dissemination. (3) In coherence, the trainee teachers attribute the deposits with a high degree of value for their future teaching work and they are able to transfer this from reflection to the design of educational actions. In these actions, it can be appreciated which aspects of what are today cliffs with memory are used, via a variety of procedures, as an educational route for discovering, providing meaning to and disseminating climate change. This demonstrates that what has been absorbed in their training process is assumed as important for proposing and designing their own educational actions.

Apart from the appropriation of the deposits, the reflections and designs show that: (1) the students have understood the scientific and educational dimension of climate change, recognising it to be a natural reality which can be integrated into social knowledge of a better quality; (2) they value the need for employing an alternative focus to geography and history in their training and teaching careers, as opposed to traditional routines (Domínguez-Almansa et al., 2020); (3) they do not deal with space and time with the desired depth in their reflections, in spite of indicating an interest in these aspects during the recent training experience. This lack demonstrates an urgent need for changes to be made the secondary education (Souto, 2011; Sáiz, Fuster, 2014). However, in the designs, the incorporation of geography and history is undertaken with more robustness, which indicates the benefits of cooperative work (Koles et al., 2010; Genç, 2016;), allowing for the skills of some to improve the competence of the group; (4) they have assumed the need to deal with present-day problems by way of the interaction between the past, the present and the future (Israel, 2012; Santisteban-Fernández, González-Monfort, Pagès-Blanch, 2020), valuing the importance of documentation in order to undertake a critical method of teaching of higher quality (Prieto, Gómez, Miralles, 2013); (5) they have demonstrated an interest in the civic and transformative dimension of education (DePalma, 2019; Schweisfurth, 2006). Thus, in addition to cognitive aspects, they reason and position themselves ethically and emotionally regarding a

conflictive issue such as climate change; a problem which they have been able to transmit in their designs, which enable their pupils to understand, think and act.

Conclusions

The objectives of this research responded to a prior educational action, which explicitly approached climate change as a problem of society today. However, it carried a sufficient burden of implicit elements upon which it was also necessary to verify the attention which the trainee teachers could pay to them. Thus, the proposal was made to analyse aspects ranging from what type of evaluation they would make of the edapho-sedimentary Quaternary deposits, which were presented as environmental archives adorning the Galician coast, to the scope of the new contents and methodological approaches for dealing with the topic. The idea was for them to abandon the social representation, too predominant and presentist, that associates climate change with starving bears at the North Pole, the credibility and emotional burden of which can engulf what should be an optimum educational approach. With this starting point, the aim was to enable the trainee teachers to carry out a critical reflection, with the freedom granted by knowledge, on their teaching role and even to approach reasoned and socially active teaching actions.

The results presented here enable us to be prudently optimistic, as, although it is true that they have detected structural cognitive problems which may impact this and any other action focusing on geographical and historical knowledge, it is no less true that they have appreciated extremely relevant aspects regarding how to approach the issue. One extremely relevant example is the high degree of appreciation of the deposits, along with their understanding of climate change by way of new parameters, which has been well expressed in their reflections and designs.

Aside from the fulfilment of the objectives, it is necessary to pay attention to two relevant issues bearing future research in mind. One of them, concerning the need for better initial training of future primary education teachers, is difficult to solve. This would imply that secondary teachers should show a commitment to methodologies focusing on geographical and historical knowledge from perspectives which make it more meaningful. The other issue will depend exclusively on the authors of this study. It concerns the capacity for designing educational actions approaching climate change in primary education and to continue their real practice in schools. This will make it possible to research another level of teaching competence, which concerns educating pupils in a

more competent manner, both in the cognitive sense and in the personal and social sense.

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