

METHODOLOGICAL FRAMEWORK FOR GEODIVERSITY APPLICATION IN GEOGRAPHIC EDUCATION FROM A CASE STUDY OF CANARY ISLANDS, SPAIN

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ABSTRACT: The concept of geodiversity is becoming more widely used every year, beyond its contribution to the development of geotourism. It is estimated that geodiversity is as important as biodiversity in the functioning of Earth's natural ecosystems. Therefore, an important problem is to recognize the possibilities on integrating geodiversity in geographic education, both formal and informal. The main aim of the study is to identify the subject of educating geodiversity, included in the core curricula in Spain and Canary Islands and to identify the forms, didactic tools and methods of geodiversity education existed in selected national, natural parks and geoparks of Canary Islands. The study has shown that the application of geodiversity in educational practice is still unsettled.

KEY WORDS: geodiversity, geography education, geotourism, Canary Islands

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Introduction

Ever since the concept of geodiversity emerged in the 1990s, there has been debate about its clear definition. There is consensus that the term encompasses elements of abiotic nature, such as geology, geomorphology, soils, and others (dos Santos et al. 2020). A widespread definition was provided by Zwoliński (2004) and Gray (2013), in which geodiversity was defined as a natural range of geological, geomorphological, soil, and hydrological features, including their assemblages, structures, systems, and contributions to landscapes. In this understanding, geodiversity

is essential not only for biodiversity but also for society (Serrano, Ruiz-Flaño 2007), facilitating the understanding of the Earth's history and its cultural and historical values or heritage, while also serving as a valuable resource for tourism and recreation (Gray, Gordon 2020, Kubalíková et al. 2021). Therefore, the decline in biodiversity, observed in recent years, is closely linked to the need to protect geodiversity, which is undeniably a biodiversity habitat (Crisp et al. 2021). In turn, in the context of Earth's history, the concept of geodiversity helps to not only better study and learn about the history of our planet but also better understand the changes currently

taking place in our environment and predict future changes of local, regional, national, and global scope (Kozłowski et al. 2004). Geosites and geomorphosites, being an important representation of geodiversity, are, therefore, an external manifestation of these processes and can be used as geoindicators to monitor physical and chemical changes in the environment (Kozłowski et al. 2004). The attempt to assess the geodiversity of an area has revealed the need for methodology to quantify it (dos Santos et al. 2020). Such assessment can be performed by applying qualitative, quantitative and qualitative-quantitative methods (Kozłowski 2004, Reynard, Coratza 2007, Zwoliński et al. 2018). Qualitative methods are descriptive; quantitative methods are based on a set of parameters and indicators, allowing the determination of the geodiversity index; and qualitative-quantitative methods are the most advanced and provide the most reliable results (Serrano, Ruiz-Flaño 2007, Ferrer-Valero 2018, Zwoliński et al. 2018).

The importance of geodiversity is manifested in the International Geodiversity Day on 6 October 2021, established by the 41st session of the UNESCO General Conference, as well as the expanding European and global network of geoparks and has a major impact on the development of geotourism. In the first half of 2021 alone, eight new sites were added to the Global UNESCO Geoparks Network, thus expanding it to 169 sites in 44 countries (UNESCO 2021). Spain, with 15 geoparks, is the leader in Europe and the country with the second-highest number of geoparks in the world, behind only China. Two of them were created in the Canary Islands – El Hierro and Lanzarote and the Chinijo Islands (Dóniz-Páez, Becerra Ramírez 2020). Within Portugal, in turn, there are six geoparks, including one covering the Azores. Thus, the set of volcanic archipelagos of Macaronesia is represented by three geoparks.

Supporting the development of geotourism is often a result of fewer tourists in typical beach-oriented tourist destinations due to the outdated nature of resort facilities and infrastructure. It also stems from increasingly aware tourists and their growing demand for a varied tourism offer when travelling to a destination (Dóniz-Páez et al. 2020a). This creates an opportunity related to the socio-economic development of the area for

geopark residents. The construction of tourist information points, restaurants, hotels, and other service facilities leads to improvements in the local infrastructure and creation of new jobs. In addition, the marketing aspect is of considerable importance. Geoparks allow local communities to promote local crafts and food products (Farsani et al. 2011). Only through the active participation of local people is the sustainable development of geotourism possible. The involvement of local communities determines the strength of a specific geopark and, consequently, of the entire network – regional and global. Geodiversity-related geotourism is, therefore, on the one hand, understood as a form of tourism that focuses, in particular, on the use of geological, and geomorphological attractions of the landscape, from an essentially aesthetic perspective, while, on the other hand, it is often extended to include historical, archaeological, landscape, architectural, cultural, and natural aspects (Najwer, Zwoliński 2014, Dowling, Newsome 2018, Olson, Dowling 2018, Jankowski et al. 2020, Dóniz-Páez et al. 2020a, b).

In addition to the preservation of geological values, geoheritage, and the development of geotourism, geodiversity undoubtedly has an educational potential that can be applied to geographic education (Dowling, Newsome 2006, Hose 2012, Farsani et al. 2017, Fernández Álvarez 2020). Thus, considering the possibility of conducting in situ observations in places characterised by high geodiversity, using geotourism infrastructure, it is possible to conduct extracurricular geographic education within it (Fig. 1), referred to, in the case of geodiversity, as geoeducation (Miśkiewicz 2017). Thanks to the presented geodiversity and geoheritage, the developing network of world geoparks is of great importance in the development of geoeducation, whose task it is to protect and manage geological heritage, conduct education in this field and present geosites for tourists (Miśkiewicz 2017). Thanks to their specificity, geoparks enable education in the natural (physical-geographical and geological-natural) and cultural aspects of the geographical environment, as well as fostering ecological attitudes through the active exploration of the environment (Fernández Álvarez 2020). Certainly, geoparks are not the only surface form of preservation of geodiversity that allows geographic education to take place within them.



Fig. 1. Didactic resource in El Hierro (top) and Lanzarote-Archipelago Chinijo Geoparks (lower).

Aims and methods

The study mainly aimed to identify the forms, didactic tools, and methods of geodiversity education used, as well as the subject of geodiversity education included in the core curricula in Spain and Canary Islands. Methodologically, the study focuses on two main pillars:

1. A comparative analysis of core curricula in terms of provisions related to geodiversity was performed, and
2. A survey was carried out among Canary Islands geoparks, nature parks, and national parks. The comparative analysis that was carried out focused on identifying the content of primary and secondary school curricula relating to the theme of geodiversity and physical diversity. The analysis was prepared based on Spanish curricula, both in primary and secondary education. Due to the legal conditions in Spain, the analysis also included the local geographic education curricula for the Auton-

omous Region of the Canary Islands (Fig. 2), which is an integral part of the national curriculum. In total, four curricula were analysed. The list of core curricula included in the study is presented in Table 1.

As part of the preparatory work for comparative analysis, two research questions were formulated concerning the place of geodiversity in school geographic education:

1. Which contents of geographic education included in the core curricula include provisions referring to the issue of geodiversity?
2. By means of which educational methods is it possible to realise educational contents concerning geodiversity?

The identification of contents related to geodiversity was done by analysing records taking the keywords 'geodiversity' and 'diversity' into account. The keywords selected for comparative analysis were analysed when their use related to the issue of geodiversity adopted in this study.

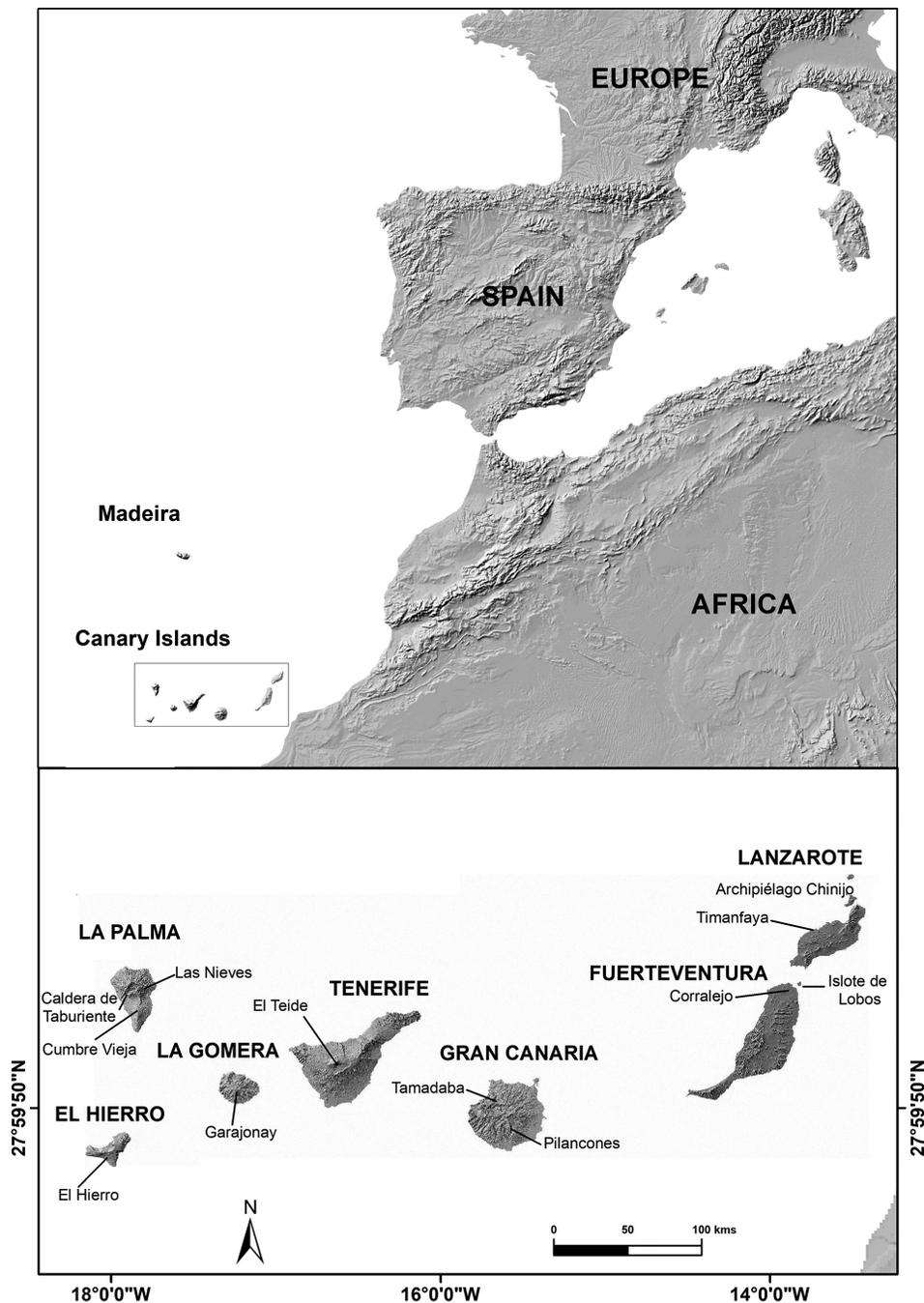


Fig. 2. Location of the Canary Islands and national, natural parks and geoparks included in the study.

Table 1. List of core curriculums included in the study.

National spanish curriculums	Regional curriculums
Real Decreto 126/2014, de 28 de febrero de 2014, Currículo básico de la Educación Primaria, Boletín Oficial del Estado n.º 52 (<i>Currículo básico de la Educación Primaria – Estado, 2014</i>).	Decreto 89/2014, de 13 de agosto de 2014, Currículo de la Educación Primaria en la Comunidad Autónoma de Canarias, Boletín Oficial de Canarias n.º 156 (<i>Currículo de la Educación Primaria – Canarias, 2014</i>).
Real Decreto 1105/2014, de 26 de diciembre de 2015, Currículo básico de la Educación Secundaria Obligatoria y del Bachillerato, Boletín Oficial del Estado n.º 3 (<i>Currículo básico de la ESO y Bachillerato – Estado, 2015</i>).	Decreto 83/2016, de 4 de julio de 2016, Currículo de la Educación Secundaria Obligatoria, Boletín Oficial de la Comunidad Autónoma de Canarias, Boletín Oficial de Canarias n.º 136 (<i>Currículo básico de la ESO y Bachillerato – Canarias, 2016</i>).

The survey consisted of inviting representatives of parks to fill in an on-line questionnaire concerning the forms and methods of education and didactic means enabling education in geodiversity. The questionnaire was developed independently by modifying the approach proposed by Dryglas and Miśkiewicz (2014). The questionnaire included identification of the geoeducational infrastructure at the parks' disposal in the form of:

- printed materials,
- virtual resources,
- permanent resources and
- activities.

The questionnaire also addressed the issue of future plans for new geoeducational solutions for the parks. The survey was conducted in 17 parks between 1 May and 1 October 2021. The criteria for selecting representative areas were to identify

such surface forms of nature conservation that aim to protect and preserve, in particular, nature values, including geodiversity in the Canary Islands. These include four national parks, 11 natural parks, and two geoparks present in all of the Canary Islands. Of the 17 requests sent, responses were received from 12 parks, including 4 national parks (Teide, Caldera de Taburiente, Timanfaya, Garajonay), 7 natural parks (Las Nieves, Cumbre Vieja, Piloncotes, Tamadaba, Islote de Lobos, Corralejo, Archipiélago Chinijo) and 1 geopark (El Hierro). Figure 2 locates parks that participated in the survey.

The geodiversity of the Canary Islands

The Canary Islands are a group of subtropical volcanic oceanic islands with diverse volcanic

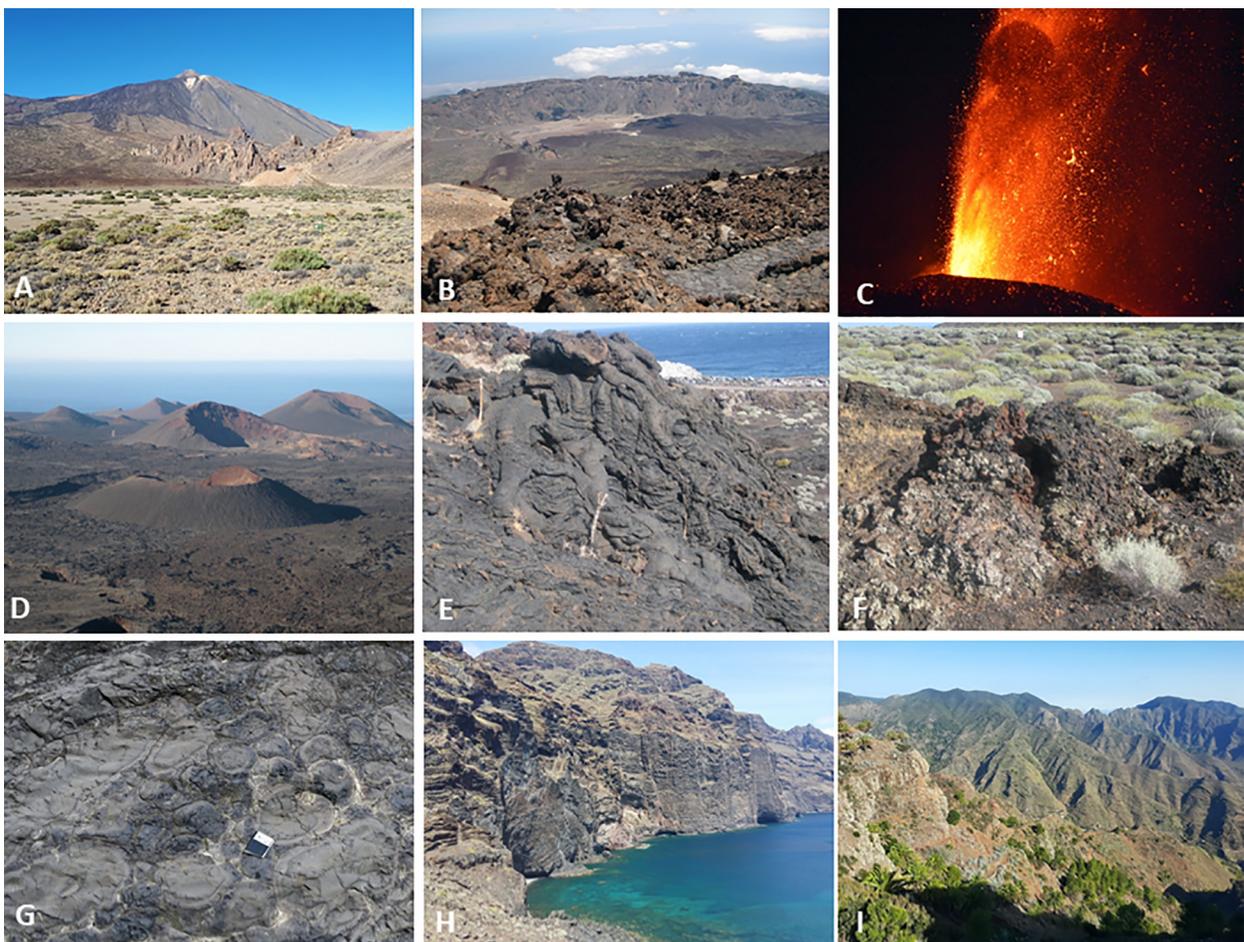


Fig. 3. Examples of geodiversity of Canary Islands. A - Teide stratovolcano in Tenerife, B - Las Cañadas Caldera in Tenerife, C - Eruption La Palma in 2021, D - Timanfaya eruption in Lanzarote Geopark, E - Pahoehoe lava flows and F - hornito in el Hierro Geoparks, G - Pillow lavas in Caldera de Taburiente national park in La Palma, H - Los Gigantes cliff in Tenerife and I - Ravines in La Gomera.

landscapes associated with rich geodiversity (Dóniz-Páez et al. 2020a). The different types of eruptions (Hawaiian, Strombolian, violent Strombolian, sub-Plinian, etc.), types of magma (mafic, felsic, etc.), and a variety of volcanic and non-volcanic landforms, are responsible for the great diversity of volcanic geoheritage in the Canary Archipelago. However, to suitably incorporate the broader definition of geodiversity provided in the literature (Zwoliński 2004, Gray 2013), we must add important terrestrial and marine biodiversity, as well as the great cultural heritage associated with coexistence between society and the physical environment, from prehispanic times to the present day, generating spectacular traditional and contemporary rural landscapes and colonial towns with a rich architectural heritage, and additionally, modern cities.

The main landforms in the Canary Islands are associated with mafic volcanism. Some, however, are identified with volcanic morphologies associated with felsic magmatism. In the first case, monogenetic basaltic volcanism is the most common volcanic landform in the Canary Islands and its main forms are cinder or scoria cones and aa and pahoehoe lava fields. These generate shield volcanoes (e.g. Anaga, Famara, Taburiente), volcanic rifts (e.g. Pedro Gil, Bilma, Cumbre Vieja, El Hierro) and volcanic fields (e.g. Timanfaya, El Hierro, Bandas del Sur, Malpaís del Norte). In these morphostructures, we found a great diversity of minor volcanic and non-volcanic morphologies, such as volcanic cones, scoria cones, domes, hornitos, lava tubes, jameos, channels of lava, ravines, cliffs, beaches, and dunes. In the second case, the main structures associated with felsic volcanism are found in Tenerife and Gran Canaria with the formation of calderas (e.g. Cañadas, Roque Nublo) and stratovolcanoes (e.g. Teide-Pico Viejo, Roque Nublo) (Fig. 3).

The importance of geodiversity in the Canary Islands can be observed in the number of natural protected areas associated with the rich variety of landforms (National Parks, Natural Monuments and Special or Integrated Natural Reserves, etc.) and management figures, such as Biosphere Reserves in all the Canary Islands and Geoparks in El Hierro and Lanzarote.

Results and discussion

Geodiversity in the curricula of Spain and the Canary Islands

According to the Commission on Geographical Education of the International Geographical Union (2016), the implementation of geographic education at a school level in a given country is determined by the current core curricula. Considering the issue of geographic education on geodiversity undertaken in this paper, it is interesting to analyse the content of the core curricula relating to this issue. In the context of the focus of this study on the forms of geodiversity education in the Canary Islands region, the geography curricula at the level of primary education, ESO y Bachillerato, both at the national (sp. Estado) and regional (sp. Comunidad Autónoma de Canarias) levels, were analysed (Table 1). First, it is worth noting that the term geodiversity does not appear at all in the analysed core curricula. However, it is possible to find entries referring to the diversity of components of inanimate nature and landscape, which, in the core curricula, is associated with the use of the word diversity (Table 2).

At the level of the national Currículo básico de la Educación Primaria (2014), reference to geodiversity is found in the Social Sciences (sp. Ciencias Sociales) education framework under "Bloque 2. El mundo en que vivimos". In this case, an indirect reference to geodiversity is included in the educational content, with reference to the geographical variation of landscapes in Europe, particularly variation in terms of relief, the climate, and hydrography. At the same time, this core curriculum makes reference, in the learning standards, to the fact that the student should define the landscape of Spain and Europe and identify its elements by assessing its diversity.

Similarly, in the Currículo de la Educación Primaria de Comunidad Autónoma de Canarias (2014), aspects referring to the issue of geodiversity are found in the Social Sciences education framework ("Bloque 2. El mundo en que vivimos"), with particular reference to the 4th and 6th grades. In Grade 4, reference is to pupil assessment criterion 4 (sp. criterio de evaluación), which concerns the ability to compare Canarian

Table 2. The context of geodiversity in the Spanish and Canary Islands' core curriculums.

Primary education – Spain (Currículo básico de la Educación Primaria, Estado, 2014)
<i>Social sciences (sp. Ciencias sociales, Bloque 2. El mundo en que vivimos, Curso 1–6.º)</i>
Content: The geographical diversity of Spanish landscapes: relief and hydrography; The geographical diversity of European landscapes: relief, climates and hydrography.
14.1. Defines the landscape, identifies its elements and explains the characteristics of the main landscapes of Spain and Europe, valuing their diversity (p. 19375).
Primary education – the Canary Islands (Currículo de la Educación Primaria, Canarias, 2014)
<i>Social sciences (sp. Ciencias sociales, Bloque 2. El mundo en que vivimos, Curso 4.º)</i>
Assessment criterion: 4. Identify and compare some of the main landscapes of the Canary Islands and the most representative of the rest of Spain on the basis of their characteristic elements and analyse the main physical and human agents that make them up, assessing their diversity and indicating examples of the positive or negative impact of human activities on them, with the aim of promoting interest in territorial conservation and sustainable development.
Content: 4. The study of the interaction between nature and human beings. The appreciation of the diversity and richness of the landscape of the Canary Islands and of the elements that shape it (volcanoes, malpaisés and beaches, etc.). (p. 22027).
<i>Social sciences (sp. Ciencias sociales, Bloque 2. El mundo en que vivimos, Curso 6.º)</i>
Assessment criterion: 4. Identify, describe and locate on maps the main relief units of Spain and Europe, their climates and hydrographic watersheds, analysing their repercussion on the different types of landscape in order to value the diversity and richness of territory and the importance of promoting their conservation. This criterion aims to verify whether students are able to handle different cartographic models of Spain and Europe, on paper and digital support, locate the main elements of inland continental relief (plateaus, mountain ranges, mountains and plains...), coastal relief (gulfs, capes and deltas...) and island relief (ravines, calderas and malpaisés...), as well as the most important rivers and lakes.), as well as the most important rivers of their hydrographic slopes and the most representative climatic zones with the aim of analysing their effects on the landscape diversity of both territories, showing attitudes in favour of their conservation and assessing the need to adopt protection measures, such as the creation of protected natural areas (national parks and nature reserves, etc.).
Contents: 1. Explaining and assessing the natural diversity of landscapes of continental and island Spain and the elements that make them up: relief, climate and hydrography. 2. Explaining and assessing the natural diversity of landscapes of Europe and their constituent elements: relief, climate and hydrography. 3. Analysing and assessing the diversity and richness of landscapes of European and Spanish mainland and island territories. The importance of their conservation as natural heritage. (p. 22047).
<i>Social sciences (sp. Ciencias sociales, Estándares de aprendizaje evaluables)</i>
42. Define paisaje, identifica sus elementos y explica las características de los principales paisajes de España y Europa, valorando su diversidad (p. 22056).
Secondary education - Spain (Currículo básico de la ESO y Bachillerato, Estado, 2015)
<i>Geography and history (Geografía e Historia, Bloque 1. El medio físico, Curso 1.º ESO)</i>
Content: The physical environment: Spain, Europe and the world: relief; hydrography; climate: landscape elements and diversity; bioclimatic zones; the natural environment: environmental areas and problems. (p. 298).
<i>Geography (Geografía, Bloque 2. El relieve español, su diversidad geomorfológica, Curso 2.º Bachillerato)</i>
Content: Spain and its geographical uniqueness: unity and diversity. Spanish relief and its geomorphological diversity.
Assessment criterion: 1. Distinguish the singularities of Spanish geographical space, establishing the aspects that give it unity and the elements that give rise to diversity. (p. 305).
<i>Geography (Geografía, Bloque 3. La diversidad climática y la vegetación, Curso 2.º Bachillerato)</i>
Assessment criterion: 7. Obtain and select information of geographical content related to the climatic diversity of Spain using available sources, whether from the Internet, social media or bibliography. (p. 305).
<i>Geography (Geografía, Bloque 4. La hidrografía, Curso 2.º Bachillerato)</i>
Content: Water diversity of the peninsula and islands.
Assessment criterion: 1. Explain the water diversity of the Iberian Peninsula and islands, listing and locating the different types of water elements that can be perceived by observing the landscape.
Assessable learning standards: 1.1. Identifies water diversity in Spain. (p. 306).

Secondary education – the Canary Islands (Currículo básico de la ESO y Bachillerato, Canarias, 2016)
<i>Geography and history (Geografía e Historia, Bloque 1. El medio físico, Curso 1.º ESO)</i>
Assessment criterion: 4, 5. Construct a global vision of the physical environment of the territory (Spanish - assessment criterion 4, Canary Islands - assessment criterion 5) and of its major bioclimatic groups, through an analysis of its characteristics and general peculiarities, and of its main environmental problems and challenges, through the use of cartographic sources, graphic, audio-visual and textual documents, etc., with the aim of understanding the territory, valuing its diversity and richness and adopting attitudes favourable to its conservation. The aim of this criterion is for students to be able to process geographical information to locate and situate on maps the main relief units and the main bioclimatic groups of territory (Spanish - assessment criterion 4, Canary Islands - assessment criterion 5), as well as describe, analyse and assess the physical, bioclimatic and hydrographic, etc., characteristics of its different natural landscapes. To do so, they will make use of a variety of sources and resources (maps, geographical and literary texts, photographs, diagrams, tables and environmental protection plans, etc.) that will allow them to explain the diversity and landscape richness of Spanish natural heritage and face its main environmental problems and challenges as responsible citizens. Furthermore, they must synthesise and integrate this information in different documents (reports, atlases, posters, infographics and leaflets, etc.), making use of ICT.
Content: 5. Appreciating natural diversity as a wealth to be protected and appreciating human action on the environment and its consequences. (p. 13–16).
<i>The History and Geography of the Canary Islands (Historia y Geografía de Canarias, Bloque 1. Canarias, Escenario de la historia, Curso 4.º ESO)</i>
Assessment criterion: 1. To analyse the diversity of island ecosystems that characterise the Canary Islands Archipelago, with the aim of investigating the geological processes that gave rise to the islands and the set of physical, climatic and biogeographical factors that explain the subsequent modelling of its territory, valuing the importance of its landscape diversity by means of an integrated reading of these elements in the territory.
Content: The use of appropriate sources and the development of strategies and procedures to investigate the climatic characteristics of the archipelago. A scientific, landscape and heritage assessment of climatic diversity (p. 16).

landscapes with those found in the rest of Spain, taking both the physical–geographical diversity of the landscape and the socio–economic diversity into account. Examples of landscape diversity in the Canary Islands – volcanos, lava landforms, beaches – are mentioned in this context. On the other hand, at the level of grade 6, the ability to assess landscape diversity should refer to the discussion of issues concerning the diversity of relief, coastal areas, islands, river basins, climate zones and forms of nature conservation (national parks, natural reserves). In this case, the core curriculum also lists the didactic tools that students should use when presenting landscape diversity, especially digital and analogue maps. Elements of this assessment are also formulated in the core curriculum under Assessable learning standards (sp. Estándares de aprendizaje evaluables).

The content of the Spanish Currículo básico de la ESO y Bachillerato (2015), similar to that of primary education, refers to landscape diversity, but this only applies to the subject “Geografía e Historia, Bloque 1. El medio físico” (sp. Curso 1.º ESO). Substantive content related to the specificity of geodiversity is included in the subject “Geography” under “Bloque 2. El español, su diversidad geomorfológica” (sp. Curso 2.º Bachillerato). The subject content refers

to geographical uniqueness and diversity, especially geomorphological diversity. The object of the students’ assessment in this subject should be the ability to spot the uniqueness of geographical space and distinguish the elements that cause its diversification. On the other hand, “Bloque 4. La hidrografía” (sp. Curso 2.º Bachillerato) addresses the content of hydrographic differentiation in both the peninsular and island areas.

In the case of the subject *Geografía e Historia, Bloque 1. El medio físico* (sp. Curso 1.º ESO), the educational content of Educación Secundaria Obligatoria, the Canary Islands (2016), highlights the legitimacy of seeing the need to protect wealth in natural diversity. This is the rationale for evaluating elements of inanimate nature from the point of view of natural richness, as natural heritage, which has a direct link with geoheritage and geodiversity. This context is extended in the framework of the formulated assessment criteria for pupils relating to the Spanish territory (sp. Criterio de evaluación nº4) and the Canary Islands (sp. Criterio de evaluación nº5). The assessment criteria presented in the core curriculum concern the pupils’ ability to see the physical–geographical environment as a whole, taking its diversity and richness into account, especially in terms of landscape, as deserving of protection.

In this case, it is indicated that students should evaluate the geographical diversity of Spain and the Canary Islands using a variety of didactic tools, especially maps, written sources, diagrams, photographs, tables, environmental projects, infographics, and folletos, including those based on the ITC software. However, in the course "Historia y Geografía de Canarias" (sp. Bloque 1. Canarias, Escenario de la historia, Curso 4.º ESO), as a criterion for assessing students' skills, they refer to characterising the ecosystems of the Canary Islands, which are influenced by both geological (volcanic) processes and climatic, biogeographical conditions that determine the diversity of the landscape.

In the documents analysed, there are no direct references to content related to the term geodiversity, but there are entries referring to the diversity of components of inanimate nature. They are recorded within content and educational standards, such as student assessment criteria, but these records are not frequent. At the level of national documents, the context is more detailed, mainly covering the issue of landscape diversity, and less frequently climatic, hydrographic and geomorphological issues. It seems that geomorphological differentiation is the issue most closely related to the term geodiversity. The scope is extended in the documents on the Canary Islands, where volcanic processes that determine the variation of relief (e.g. the occurrence of volcanoes, malpais and beaches) are included. In this respect, attention was drawn to the provision referring to the fact that this differentiation should be perceived by pupils as a natural resource in need of protection. Also, more frequent than at a primary education level, in the documents at the Educación Secundaria level, there are suggestions of teaching resources possible for pupils to use in learning about the diversity of the relief and the landscape. They involve the use of independent work and the use of source materials and are based on direct observation in the form of field activities and the use of ITC software. It is worth noting that there are significant differences between core curricula at the primary and secondary level – at the level of Secundaria Education the issue of geographical diversity is emphasised more often and in more varied contexts (Table 2).

Similarly, in foreign core curricula there are no direct provisions referring to the term

geodiversity. Most often there are indirect references to geographic diversity, diverse environmental conditions, diverse landscapes in need of protection, and the natural heritage (e.g. Regulation [Rozporządzenie] 2017, Finnish National Board of Education 2014, Comănescu, Nedelea 2021). Thus, these issues are most often related to landforms and landscapes. A good example is the direct use of the term geodiversity which appears sporadically in the Polish geography core curriculum for secondary and technical schools (extended scope), where reference is made to the importance of geodiversity, threats, and conservation (Regulation [Rozporządzenie] 2018). It is interesting that in the core curriculum, especially concerning biology education, there are numerous references to the term biodiversity, which has been used both in science and educational practice for longer (Helldén, Helldén 2008, Navarro-Perez, Tidball 2012, Wolff, Skarstein 2020). In this context, it is worth bearing in mind that the concepts of biodiversity and geodiversity depend on each other and their scientific importance is comparable (Alahuhta et al. 2019, Ren et al. 2021). The practical application of the geodiversity approach in inanimate nature conservation, for example in the form of geosites and geomorphosites (Dóniz-Páez et al. 2016, 2021, Beltrán-Yanes et al. 2020) as well as its use in the design of hiking and educational trails, make the terms geodiversity and geoheritage take on great importance in geographical education.

Geo-educational materials and activities in the national parks, nature parks and geoparks of the Canary Islands

The provision of geographical education in fieldwork is made possible by formally established institutions involved in the protection of the natural and geographical environment of a given area, as well as conducting scientific research and popularising knowledge. Therefore, forms of types of geo-educational materials available to the public in Canary Island parks or geoparks were recognised (Fig. 4).

The most common printed materials presenting the geographical environment of the Canary Islands in parks/geoparks are brochures and leaflets (67%). Maps (58%) and guidebooks (45%) are also popular. Rarely used printed materials

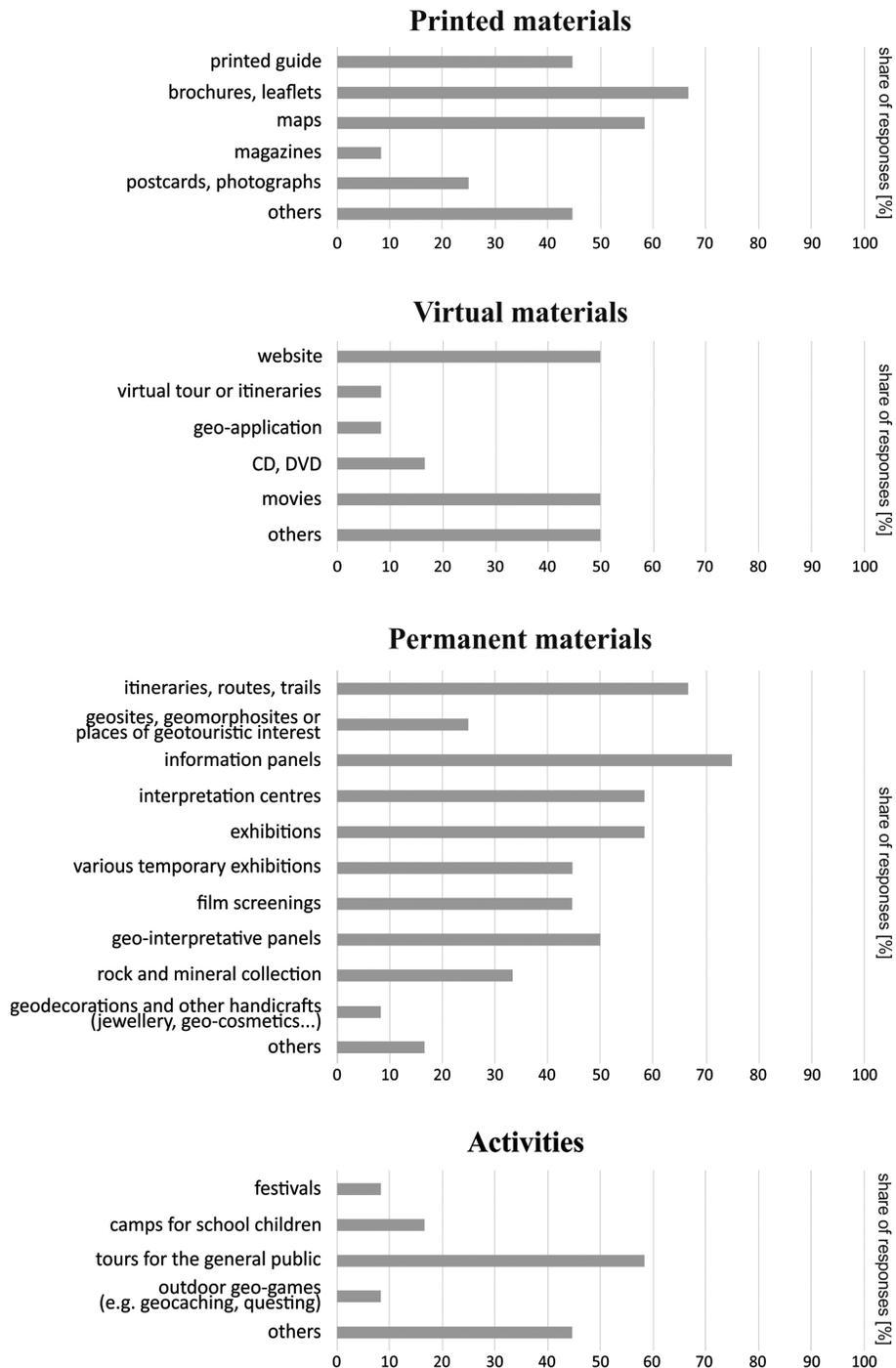


Fig. 4. Types of geo-educational materials available to the public in the Canary Island parks or geoparks.

relating to the geographical environment are thematic magazines. Among the responses, it was also mentioned that Garajonay National Park has numerous scientific and specialised studies on geology and geographical space on the island of La Gomera. In terms of virtual resources, every second park/geopark allows for basic geographic information on its website and also has a geographic video developed. The least popular

forms among virtual resources are virtual tours or itineraries and geo-applications. Among the permanent resources, information boards presenting geographical content are the most popular (75%). Itineraries, education routes, and trails (67%), interpretation centres and exhibitions (58%) are also popular. Geo-interpretative panels, various temporary exhibitions and documentary movie screenings (45%) are sometimes

used. The least popular of permanent resources are geo-decorations and other handicraft. The occurrence of geological museums and gardens displaying forms of geodiversity was not indicated. Among the activities offered by parks/geoparks, the most common form is tours for the general public. Corralejo Natural Park gave the example that it carries out excursions for school children that take place along the coast, while the Timanfaya National Park organizes guided night tours, sky-watching activities and environmental education. Other activities are rarely used. These include camps for school children, festivals and outdoor geo-games (e.g. geocaching and questing). Activities such as mineral and rock markets, geology picnics and geographical knowledge competences were not mentioned. Among other answers given by park/geopark managers, reference was made to the possibility of developing geo-educational materials and resources, giving examples of plans to make information panels on erosion (Caldera de Taburiente National Park). With regard to the development of educational services, the representative of Lanzarote and Archipelago Chinijo gave information about plans to create a scientific geocentre to promote scientific and popular knowledge about geodiversity and geoheritage.

The geodiversity of the Canary Islands, including its volcanic heritage, favours educational activities at both the formal and informal education levels (Dóniz-Páez et al. 2018). Referring to the research results presented here, it is worth noting that the characterisation of extracurricular forms of education (informal education) on geodiversity is widespread, but insufficiently described in the literature. The most common examples of conducting this type of education in volcanic areas are conducting field trips, museum lessons, drawing competitions, painting, photography, documentary screenings and discussions with scientists (González et al. 2018). These materials and resources are used in structured activities of institutions involved in the protection of the natural and geographical environment of a given area, as well as conducting scientific research and popularising knowledge. In the literature, different forms have been presented to favour the implementation of geographical education in the Canary Islands, but the most important are geosites, geomorphosites, didactic and geotourism

itineraries. Presenting geodiversity and educating tourists about it is possible through designed geotouristic itineraries, which are also examples of responsible and sustainable tourism (Dóniz-Páez et al. 2019, Hernández et al. 2020). These paths are delineated in the Canary Islands through set geosites and geomorphosites and not only serve to protect valuable natural elements but also provide opportunities for didactic, recreational, and touristic use (Dóniz-Páez et al. 2016, 2020b, 2021, Beltrán-Yanes et al. 2020, Dóniz-Páez, Becerra Ramírez 2020). Considering formal education, in the case of academic education, according to Dóniz-Páez (2019), the aforementioned geosites and geomorphosites are used in education to enable conservation, protection and the teaching of geodiversity. This theme is used, for example, in academic classes of the subject of the Planning and Territorial Management of Tourist Destinations and the Human Geography of the Degree of Tourism at the University of La Laguna (Dóniz-Páez 2017, 2019). At an academic level, in addition to the training topics implemented in the classroom, areas characterised by high geodiversity values are also used in the form of field classes (Dóniz-Páez 2018).

Conclusions

Geodiversity is undoubtedly an important concept aimed at preserving valuable elements of the geographical environment. Despite the importance of the concept, it seems that the application of geodiversity in educational practice is still unsettled. On the example of the Canary Islands region, formal (school) education on geodiversity is little used as a result of a lack of direct content on geodiversity in the core curriculum. The content of the core curricula should be supplemented with this topic. The contents related to geodiversity in core curricula are only formulated in an indirect way, mainly referring to the diversity of components of inanimate nature and landscape diversity. In the context of formal education, academic classes are conducted for students on geodiversity and the most common method of education is fieldwork.

As the research has shown, there is an educational infrastructure for educating geodiversity (e.g. printed materials, virtual resources,

permanent resources, and activities). In the case of the Canary Islands, it is being developed, but this is related to the region's unique geographical attractiveness and developed geotourism. In this sense, informal education related to geotourism is focused on the knowledge of geosites and geomorphosites that mark geotourism and didactic paths, the occurrence of which has the chance to reconcile the needs of tourists, especially. It is, therefore, important to undertake expert and academic initiatives aimed at expanding educational opportunities in the field of geodiversity.

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Author's contribution

Conceptualization and methodology: DA, JDP, MB. Manuscript writing and revision: DA, JDP, RT, MB. Acquisition of data: JDP, DA. Data analysis and interpretation: DA, RT. Visualisation: JDP, RT. Supervision: JDP. The Authors have read and agreed to the published version of the manuscript.

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