Estudios Geográficos
86 (299), julio-diciembre 2025, 1206
ISSN: 0014-1496 | eISSN: 1988-8546
https://doi.org/10.3989/estgeogr.2025.1206

ARTÍCULOS / *ARTICLES*

A PROPOSAL USING GEOTECHNOLOGIES FOR TEACHING THE PHENOMENON OF DEPOPULATION

Carlos Martínez-Hernández
Universidad Complutense de Madrid
cmartinezhernandez@ucm.es
ORCID ID: https://orcid.org/0000-0002-6526-6905

Carmen Mínguez
Universidad Complutense de Madrid
cminguez@ghis.ucm.es
ORCID ID: https://orcid.org/0000-0002-9544-3802

Received: 20/03/2024; Accepted: 08/10/2025; Published online: 19/01/2026.

Citation/cómo citar este artículo: Martínez-Hernández, C., & Mínguez, M.C. (2025). A Proposal Using Geotechnologies for Teaching the Phenomenon of Depopulation. *Estudios Geográficos,* 86(299), 1206. https://doi.org/10.3989/estgeogr.2025.1206

Abstract: The magnitude of the depopulation phenomenon in Spain and its economic, social, demographic, and environmental consequences have made it a national challenge, while also sparking intense political and public debate. For decades, this phenomenon has been of interest for both research and university teaching. More recently, it has been explicitly included in pre-university education curricula as part of geographical learning. The recent inclusion of the topic in these stages requires reflection within the framework of citizenship education and the design of didactic activities that facilitate understanding of such a complex phenomenon. The aim of this work is to present a didactic strategy for preparing a territorial report on a depopulated area, methodologically configured as Project-Based Learning (PBL) with the support of geotechnologies and flexibility for any educational stage. The results demonstrate the grounded design of such a strategy based on a systematization of the learning sought in the successive steps of the project, which are discussed according to their curricular, pedagogical, and didactic interest. It is concluded that the pedagogical and didactic benefits already researched in PBL and the educational use of geotechnologies can be transferred to this proposal, improving the teaching of depopulation within the current curriculum framework of the topic's basic contents, digital competencies, critical thinking, and autonomous work. The proposal thus becomes a pioneering example of a didactic strategy for comprehensive and competency-based teaching of the depopulation phenomenon, thanks to the methodological support of PBL and geotechnologies.

Keywords: Empty Spain, geoviewer, education in values, education for sustainability, Project-Based Learning, GIS, Agenda 2030.

Una propuesta de uso de geotecnologías para la enseñanza del fenómeno de la despoblación

Resumen: La magnitud del fenómeno de la despoblación en España y sus consecuencias económicas, sociales, demográficas y medioambientales lo han convertido en un reto de Estado, al tiempo que ha suscitado un intenso debate político y ciudadano. Desde hace décadas este fenómeno ha sido objeto de interés para la investigación y la docencia universitaria, y más recientemente ha sido incluido explícitamente en los currículos educativos de las enseñanzas preuniversitarias como parte del aprendizaje geográfico. Su inclusión curricular reciente requiere una reflexión en el marco de la formación ciudadana y el diseño de actividades didácticas que faciliten la comprensión de un fenómeno tan complejo. El objetivo de este trabajo es presentar una estrategia didáctica de elaboración de un informe territorial sobre un área despoblada, configurada metodológicamente como un Aprendizaje Basado en Proyectos (ABP), con el soporte de geotecnologías y flexible para cualquier etapa. Los resultados muestran el diseño fundamentado de dicha estrategia basado en una sistematización del aprendizaje buscado en los pasos sucesivos del proyecto, que se discuten según su interés curricular, pedagógico y didáctico. Se concluye que los beneficios pedagógicos y didácticos ya investigados del ABP y del uso docente de las geotecnologías pueden ser trasladables aquí, mejorando la enseñanza de la despoblación en el marco curricular actual de saberes básicos, competencias digitales, pensamiento crítico y trabajo autónomo. La propuesta se convierte así en un ejemplo pionero de estrategia didáctica para la enseñanza comprensiva y competencial del fenómeno de la despoblación, gracias al soporte metodológico del ABP y las geotecnologías.

Palabras clave: España vacía, geovisor, educación en valores, educación para la sostenibilidad, Aprendizaje Basado en Proyectos, TIG, Agenda 2030.

1. INTRODUCTION AND OBJECTIVES

The phenomenon of depopulation is essentially territorial. Its magnitude in Spain and its economic, social, demographic, and environmental consequences have made it a current topic and even a national challenge. Depopulation is related to negative values in natural population growth and migratory balance, typical of economically depressed areas. However, its causes are diverse and complex, requiring in-depth and specific analysis for each location, as it is not a uniform phenomenon. Although initially associated with a process typical of the inland areas of the Iberian Peninsula, it is now more widespread and affects highly populated regions with even positive growth, which present significant internal inequalities, with large cities and/or coastal areas attracting population to the detriment of peripheral and/or inland areas.

The dimensions it has acquired in the 21st century are so significant that the term "España vacía" (Empty Spain) has been coined[1]. This term is associated not only with depopulation but also with the problems derived from it, such as territorial inequalities and the lack of opportunities for present and future generations. This impact makes it necessary to involve pre-university students in its knowledge and awareness. To do this, it is necessary to go beyond theoretical content and enhance competencies related to information search and education in values, especially considering that the latest curricular regulations for pre-university education already include this competency-based teaching of depopulation. It is necessary to foster in students the concern to understand the problems related to the eco-social causes and consequences of depopulation, to generate respect for the environment and the population living and working in rural areas, and to awaken interest in providing possible solutions.

The territorial and cross-cutting aspects of depopulation allow for numerous opportunities to work with students on different geographic concepts, as well as to incorporate digital tools such as Geographic Information Technologies (GIT) into their analysis. This reinforces digital competencies and information processing skills, which are essential for understanding eco-social phenomena and fostering citizenship education.

Depopulation is therefore a complex phenomenon that requires learning both contents and competencies. Precisely, the new curricular regulations explicitly address this topic as fundamental knowledge, sometimes linked to specific competencies in geographic learning. This circumstance is the starting point of this work. In this context, the objective of the article is to justify the design of a didactic proposal for the elaboration of a territorial report on a depopulated area, which will be methodologically structured as a research project supported by geotechnologies that provide the necessary territorial information. In line with the principles of education for sustainability, the project concludes with the development of management proposals based on the Sustainable Development Goals (SDGs) of the 2030 Agenda.

Geotechnologies have proven to be highly effective in geographical learning, but they have barely been applied to the phenomenon of depopulation. In fact, so far, there are few studies that reflect on the didactic potential of depopulation in pre-university education. Some notable works include that of Velilla & Lagura (2019), in which they propose educational materials developed to be used in the Geography classroom, with students aged 14-18, to explain the depopulation in Spain using GIS. Others propose the design of educational materials to address the existing relationships between depopulation and different elements or phenomena such as landscape and cultural heritage (Guallart *et al.*, 2020) or climate change and rural development policies (de la Vega, 2019; Velilla & Guallart, 2024). At times, these works employ the use of GIS to reinforce geographical and cartographic competencies. Additionally, there are some projects like the one called "Chimeneas sin humo: la despoblación en Aragón" [*Smokeless chimneys: depopulation in Aragon*] developed by the Center for Studies on Depopulation and Rural Development Areas and the "Rolde de Estudios Aragoneses" [*Aragonese Studies Circle*] in 2003, which generated interactive didactic resources. Or the interuniversity project titled "GEOVACUI: citizen science and cooperation initiatives against depopulation in rural areas", which included workshops in the classroom with secondary school students[2]. The purpose of these workshops was to disseminate the project's results, raise awareness among younger populations about the topic, and encourage citizen participation in research

1 The concept of Empty Spain refers to the depopulated Spain that suffered a strong emigration in the 1960s. The term is consolidated in 2016, when the journalist Sergio del Molino published a book titled "Empty Spain", in which he made an analysis of the situation of these spaces of inland Spain.

2 https://www.ucm.es/geovacui/experiencias-eso-y-bachillerato

activities to promote scientific culture in society. The storymap created by Zúñiga-Antón *et al.* (2022) should also be highlighted as a GIS resource to better understand the phenomenon of depopulation in Spain, although it does not present a specific pedagogical function.

The work presented here provides an innovative didactic strategy based on proven active methodologies. Additionally, it adds value to proposals on depopulation, whether they use geotechnologies or not, and whether they systematize learning in the development of a research project or not. This is because the phenomenon of depopulation is conceived as a "supracurricular" object of study, which must be approached both conceptually and competently. This can lead to a focus on education for sustainability and in values, with a preponderance of digital competencies and skills in searching for and managing reliable and complex information.

After presenting a theoretical framework on depopulation and the didactic use of geotechnologies, the results of the design elements of the presented teaching strategy are shown. These are designed based on a systematization of learning, sought in the successive steps of the project, which are then discussed according to their curricular, pedagogical, and didactic interest. The article concludes with some reflections on the relevance of this proposal and the added value and opportunity cost it entails.

2. THEORETICAL FRAMEWORK

2.1. The Challenge of Depopulation

The European population is not growing at the same rate as during the 20th century, nor is it growing uniformly, causing imbalances between urban and rural areas, as well as between regions, accentuating differences (England & Azzopardi-Muscat, 2017). This is a demographic problem, but especially a territorial one, which has been prioritized on the European political agenda, as it is a common challenge for all low-density population territories in EU countries (Molina Ibáñez, 2019).

This phenomenon, known as depopulation, is highly complex and is considered characteristic of developed societies, as it entails an economic and social readjustment linked to progress. It results in numerous consequences such as population aging, declining fertility, migration flow dynamics, and significant economic impacts, with direct consequences on environmental sustainability, economic growth, and social well-being (Lasanta, Arnáez, Pascual, Ruiz-Flaño, Errea, & Lana-Renault, 2017).

The dimensions and magnitude of the problem in Spain have led it to be considered a national problem. The progressive decline in inhabitants in a large number of rural municipalities since the 1960s has caused unsustainable population densities in many rural areas for maintaining current living standards and even for the development of a strong and diversified productive fabric (Martínez-Arnáiz, Mínguez, Martín Vide, Ojeda Zújar & Ruiz Sinoga, 2020). The diversity of causes that originate depopulation and its derived consequences makes each territory unique (Molinero, 2019; Molinero & Alario, 2022).

In the last decade, there has been a growing sensitivity to depopulation, with repercussions in the academic field, generating discourses based on available statistical information and numerous reports and sectoral analyses related to depopulation in rural areas, from a geographical perspective and other disciplines such as sociology and economics. It has also sparked interest in society, through significant media coverage, but has also led to the emergence of numerous initiatives, projects, associations, and even political parties. In short, depopulation has become a challenge for policy management and design. This confers added interest for its study, while also presenting an opportunity for teaching, as it positions itself as an independent topic, of great current interest, that cuts across various didactic units that articulate curricula. Depopulation should not be approached as a purely demographic phenomenon or limited to rural areas.

This is a territorial phenomenon with economic, environmental, and social implications, as it relates to aspects of cultural and natural heritage conservation, land use, and exclusion, directly affecting rural inhabitants by reducing their opportunities. It is not a uniform phenomenon, as it does not present the same problems or severity everywhere, with some regions in decline, others showing some population stability, and others with certain economic activity. These correspond to the classification made by Professor Molinero, which distinguishes between deep rural (<5 inhab/km^2), stagnant rural (5-10 inhab/km^2), intermediate rural (10-25 inhab/km^2), and dynamic rural (>25 inhab/km^2) (Molinero, 2019).

This diversity of situations necessitates accurate characterization for subsequent diagnosis and intervention with measures to promote recovery and revitalization. Thus, depopulation discourses are nuanced, not solely based on demographic criteria, increasingly demonstrating that depopulated or "empty" Spain consists of resilient territories with potential (Sánchez-Zamora, Gallardo-Cobos & Delgado, 2016; Castrillo Romón, Khairullina, Lalana Soto & Pérez Eguíluz, 2023). Therefore, they should be considered both in their study and in the design of heterogeneous and specific measures, with an integrative perspective that considers the complementarity between urban/rural spaces as well as the diversity and potential of rural areas (Mínguez García, Martínez Arnáiz, Martín Vide, Ruiz Sinoga, Ojeda Zújar & Bárcena-Martín, 2022).

2.2. Geotechnologies for Teaching Geographic Phenomena

Geotechnologies are the tools, methods, and techniques that constitute a set of technologies aimed at obtaining and spatially analyzing geographic data, and making geographic information available (Buzai, 2004). Among them are Geographic Information Systems (GIS), remote sensors, global positioning systems, and digital globes (Baker *et al.*, 2015). They enable the acquisition of a series of fundamental knowledge and skills in geospatial matters (Lázaro y Torres, Izquierdo Álvarez & González González, 2016), thus being incorporated as a pedagogical resource to enhance learning through new didactic strategies. Globally, geotechnologies were not included in curricula, despite the demand from numerous authors (Bednarz & van der Schee, 2006; Buzo-Sánchez, Mínguez & Lárazo-Torres, 2022; among others). However, recently, some countries, like Spain following its latest educational law (LOMLOE, 2020), have incorporated them.

Among the geospatial skills, the value of visualization and territory-centered thinking (Hagevik, 2003), and the development of spatial critical thinking (Kim & Bednarz, 2013) stand out. All of these contribute to spatial thinking, which is fundamental for geographic learning (Martínez-Hernández, Stoffelen, & Piskorski, 2022), and spatial problem-solving (Huynh & Sharpe, 2013). For their acquisition, among the most common geotechnologies are GIS and cloud-based GIS. Many authors have pointed out their utility for teaching different subjects and at different academic levels (Fargher, 2018; Kerski & Baker, 2019; Buzo-Sánchez, Mínguez & Lárazo-Torres, 2022), as their educational implementation, as a resource and as a didactic methodology, allows the analysis of social realities at different scales (Zappettini, 2007).

At the same time, geotechnologies offer a broad and dynamic view of territorial issues associated with social, economic, and environmental problems, demonstrating the ability to interrelate them. This capacity constitutes the basis of education for sustainability or sustainable development, which is a UNESCO initiative currently seeking to implement the SDGs of the 2030 Agenda in education and has become a good reference framework for geographical education as a discipline focused on the interrelation between nature and society (Martínez-Hernández & Mínguez, 2023). According to numerous authors, this interrelation can be approached from an ecosocial perspective, considering human responsibility, from a local scale, in global sustainability (Crespo Castellanos, Martínez-Hernández, Mateo Girona & Rodríguez de Castro, 2023). Given the quantity and variety of mobilized factors, most of them of territorial aspect, geotechnologies can be a fundamental tool for improving measurement and observation (Demerit, 2009) and the search for solutions (Bailly & Gibson, 2004) with an ecosocial approach, as well as for transmitting social responsibility in territorial issues promoted by sustainability education, especially necessary in the teaching of complex geographical phenomena (Haubrich, Reinfried & Schleicher, 2007).

In the educational field, there are numerous didactic experiences that consider geotechnologies associated with geographical issues such as environmental education, landscape analysis and its components, cartographic design, geopositioning, and the management of various natural resources, among others (Lázaro y Torres *et al.*, 2016). In many of these experiences, these tools are integrated into methodologies related to Project-Based Learning (PBL). This methodology allows students to acquire a series of basic knowledge and skills in knowledge generation (Ruiz Hidalgo and Ortega-Sánchez, 2022), including those related to the use of technologies. Additionally, they help systematize learning in order to solve complex problems (Galeana, 2006), as is the case in education for sustainability. Depopulation emerges as a central case of complex territorial analysis that can be addressed from an ecosocial approach through PBL and with the support of geotechnologies.

 Estudios Geográficos, 86 (299), julio-diciembre 2025, 1206. ISSN: 0014-1496 | eISSN: 1988-8546. https://doi.org/10.3989/estgeogr.2025.1206

3. DESIGNING A DIDACTIC PROPOSAL

3.1. Selection of Geoviewers as Didactic Resources

The didactic proposal has been designed based on two institutional geoviewers. It has been considered important to ensure this condition of institutionalization to guarantee the reliability of the territorial information they contain, their official status, and universal access. Numerical data information comes from the SIDAMUN portal, while information based on temporal satellite images comes from the SIGNA portal.

These geoviewers are configured as support for territorial inquiries in both professional and citizen domains; however, their use as a didactic resource is possible when associated with a systematization of tasks (see the next section). Indeed, geoviewers are a common geotechnological resource in recent geography didactics, thanks to their intuitive interfaces, accessibility, and interactive graphic products that help develop spatial and digital competencies (Martínez-Hernández, Piskorski & Stoffelen, 2023).

Firstly, the Integrated Municipal Data System[3], known by its acronym SIDAMUN, is the spatial data visualization tool created and published by the General Secretariat for the Demographic Challenge, of the Ministry for the Ecological Transition and the Demographic Challenge of the Government of Spain. It offers highly detailed information on the territorial situation. This project aims to facilitate access to the most detailed information possible on the territorial situation for consultation by researchers, policymakers, and the general public. The data and indicators are provided at the municipal scale, and their visualization can be consulted at that scale and also at the provincial, regional, and national levels. The information comprising SIDAMUN is organized into six thematic blocks: physical environment, demographic, economic, services, housing and household, and environment. Additionally, it allows for personalized queries through the application of filters. Furthermore, for each administrative area, SIDAMUN offers the ranking of the 10 municipalities containing the highest and lowest values for each of the selected variables. Additionally, from SIDAMUN, access is provided to the Ministry's geoportal[4], which supplements relevant information for the demographic challenge with other agrarian themes such as water, food, environment, coast, etc.

On the other hand, the National Geographic Information System[5] (SignA) is the online GIS portal of the National Geographic Institute (IGN), aimed at integrating institutional geodata and services for management, analysis, and consultation purposes. Since its creation in 2010, it has been regularly updated with GIS and SDI updates. SignA allows users to navigate, query, and search for information online without the need to download any software. It is implemented according to norms and standards, making it fully interoperable with OGC services. Among its tools, the orthophoto comparator PNOA is of great interest for the designed proposal. It is a viewer that allows for consulting and comparing orthophotos corresponding to the National Aerial Orthophotography Plan from its inception in 2004 to the present day, as well as orthophotos from historical flights SIGPAC, OLISTAT, National, Interministerial, and American Series B in areas where digitization and orthorectification work has been carried out.

3.2. Grounded Task Design

The didactic proposal is designed from a maximalist approach so that it can be adapted to different educational levels, both in terms of didactic procedures and content. It can also be carried out individually or collectively, collaboratively or cooperatively, at the discretion of the teaching interest. Specifically, students are presented with a cartographic research project to draft a socioterritorial report comparing a municipality and a province representative of depopulated Spain with others from populated Spain. Prior to this, they would be provided with a list of possible depopulated and populated municipalities and provinces to choose from for a personalized case study. An alternative for higher levels is for students to freely choose locations based on a cursory interpretation of the population density map, associating areas of lower density with depopulated Spain.

The project is systematized into research questions, from a conceptualization of the phenomenon to options for sustainable management, through multidimensional characterization. Resolving the questions requires the

3 https://public.tableau.com/views/SistemaIntegradodeDatosMunicipales2023/Portada?:language=es-ES&:display_count=n&:origin=viz_share_link?:showVizHome=no
4 https://sig.mapama.gob.es/geoportal/
5 https://signa.ign.es/signa/

use of institutional geoviewers (see previous section) with the necessary information variables based on a systematic script (Table 1).

TABLE 1.
SCRIPT OF THE CARTOGRAPHIC RESEARCH PROJECT TO PREPARE THE REQUESTED REPORT

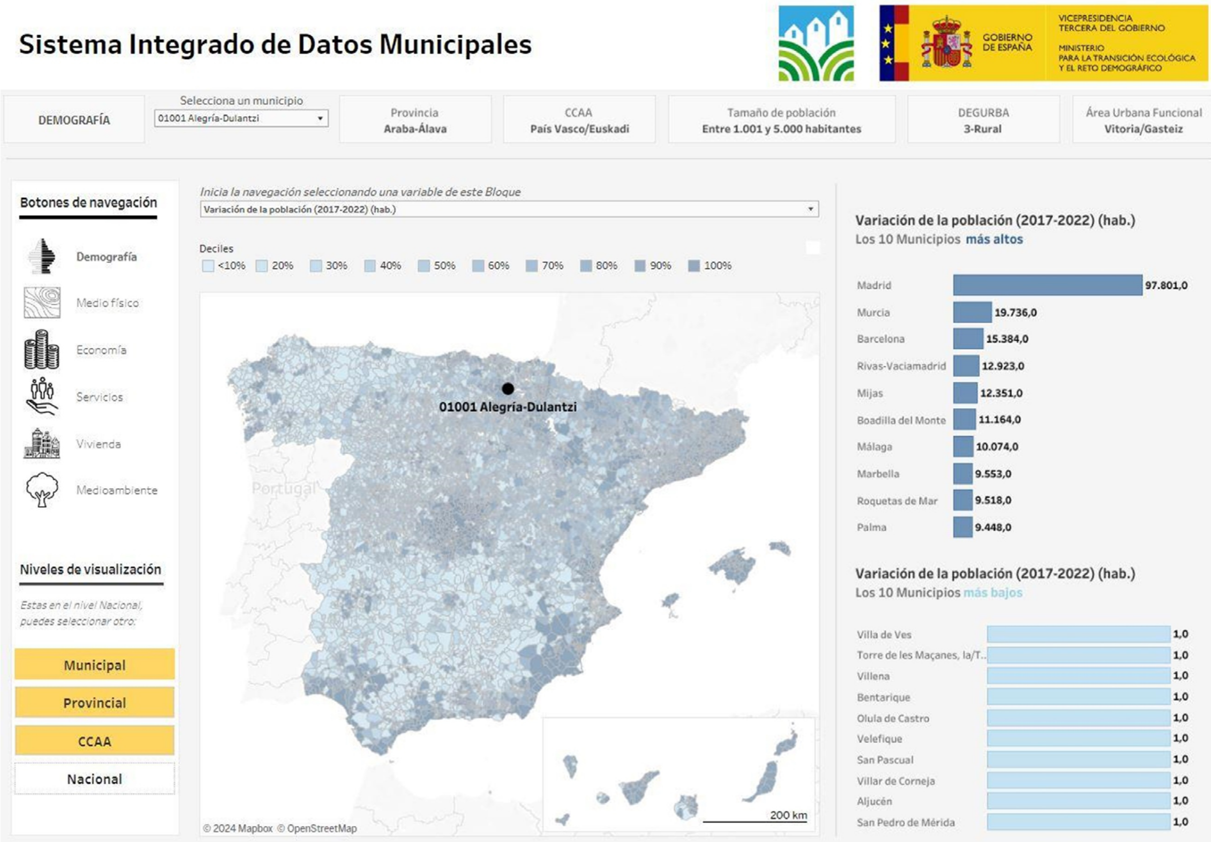
Question	Geoviewer	Scale	Variables
1. What is depopulation?	SIDAMUN ("Demography")	Provincial - Spain	• Population evolution • Natural increase rate • Net migration balance
2. What is its territorial distribution in Spain?	SIDAMUN ("Physical environment")	Provincial - Spain	• Population density
3. What are their cause-and-effect interactions? What differences exist compared to non-depopulated areas?	SIDAMUN and SIGNA	Municipal	Various
3.1. At the economic level	SIDAMUN ("Economy")		• Unemployment rate • % Affiliation to the agricultural regime • Gross average income per person
3.2. At the demographic level	SIDAMUN ("Demography" and "Housing")		• Average age • Aging index • Dependency ratio • Male-to-female ratio • % Single-person households
3.3. At the social level	SIDAMUN ("Services")		• Presence of health centers and hospitals • Presence of post offices • Presence of bank branches • % 100 Mbps coverage (internet) • Presence of kindergarten/primary education schools • Presence of secondary education centers
3.4. At the territorial cohesion level	SIDAMUN ("Services")		Time to nearest municipality with >50,000 inhabitants
3.5. At the landscape level	SIGNA (Tool "comparator": American flight orthophoto 1956-57 vs current satellite image.)	Local (approximate minimum scale 1:2,000 within the municipal level)	Land use changes
3.6. At the environmental level			Soil conservation status
4. How can it be managed within the framework of the Sustainable Development Goals (SDGs)?	-	-	-

Source: Own elaboration

The decreasing gradation of academic level, to address different cognitive capacities of spatial thinking (Catling, 1978), can be done by: (i) reducing the use of geoviewers (including only the layers that are considered most representative in each case, or giving more teaching support in their use); (ii) homogenizing the tasks of the entire group (for example, choosing the same case studies for everyone so that there is easier follow-up of the teacher's guide), or (iii) simplifying the contents of the requested report (for example, accompanying the inquiry questions with a possible answer guide).

Among the variables that can define depopulation are population evolution, natural growth, and migratory balance, all provided by the SIDAMUN geoviewer. Evolution data provides information about population loss or gain and its intensity, which can be relativized - made comparable between territories - through natural growth (difference between births and deaths), as a rate of natural mobility, and migratory balance (difference between emigrations and immigrations), as a rate of geographical mobility. Thus, a depopulated area will be defined by a significant population loss due to negative natural growth and migratory balance (Fig. 1).

Figure 1.
APPEARANCE OF THE SIDAMUN INTERFACE



Source: https://www.miteco.gob.es/es/reto-demografico/temas/analisis-cartografia.html

A good measure of geographic dispersion is population density, which relates the number of inhabitants to each square kilometer. Small densities, below approximately 5 inhab/km^2, indicate vast expanses of territory without population presence, thus corresponding to depopulated areas (Molinero, 2019). Therefore, the density variable provided by SIDAMUN will determine the territorial distribution of depopulation.

Depopulation is characterized by a series of interrelated and repetitive causes and effects in their condition as causes or effects, which can be analyzed according to their thematic aspect. The characteristics of the economic level are very important, as depopulation is associated with a low economic activity rate due to the low population present, mainly linked to rural utilization as the primary sector and more accessible for resource exploitation (Bandrés & Azón, 2021). Some variables that provide information on this economic characterization, covered by the SIDAMUN geoviewer, include the unemployment rate (high), the percentage of affiliation to the agricultural regime (high), and the average gross income per person (lower due to the lower profitability of the agricultural regime and higher unemployment presence).

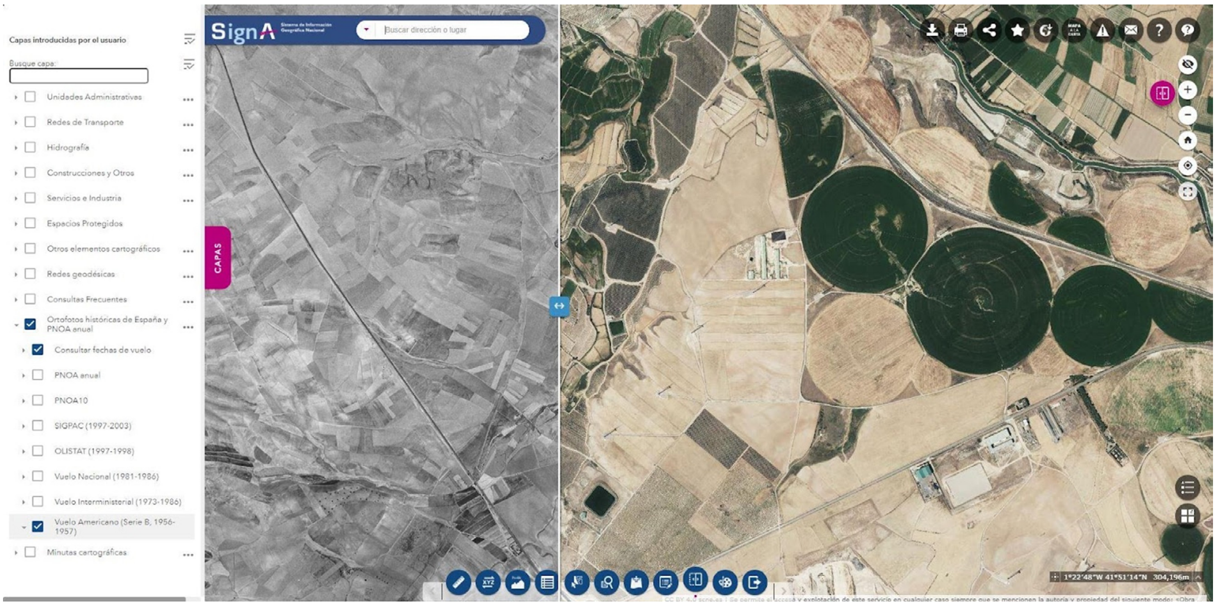
However, the most directly defining characteristics of depopulation are demographic, allowing for the profiling of the phenomenon. Depopulated areas do not regenerate demographically due to poor natural mobility and negative migratory balance (data proposed to characterize the phenomenon). Consequently, they have a high average-age rate, with a large part of the population being elderly and thus dependent. The female population is the most likely to migrate, as the agricultural economy is more heavily masculinized, resulting in a higher presence of men than women in these populations (Gobierno de España, 2021). Additionally, due to the high aging, residential loneliness is common. All this demographic characterization can be verified with variables such as average age, aging index, dependency rate, masculinity ratio, and percentage of single-person households, all available in SIDAMUN.

In relation to economic and demographic elements, depopulated areas are characterized by precarious and scarce social provisions, with less effective services covering fewer personnel in low population density areas. Some are particularly sensitive, such as healthcare centers, while others exacerbate the lack of opportunities in these areas, such as educational centers or internet coverage. There are also those that affect daily life, such as banking and postal services (Banco de España, 2021). Social variables such as the presence of health centers and hospitals, post offices, bank branches, basic education schools, secondary education centers, and the percentage of coverage of decent internet speed (100 Mbps) can be consulted in SIDAMUN in relation to this characterization of depopulated areas.

The economic, demographic, and social characteristics of depopulated areas occur in a poorly cohesive territorial framework, with large spatial gaps in infrastructure, services, and job opportunities, which are profitable in larger population centers and therefore concentrated in more populated and concentrated territories (Banco de España, 2021). SIDAMUN offers a variable on the time required to reach the nearest municipality with more than 50,000 inhabitants, which, conceived as a socioeconomic engine, could be used as an indicator of the territorial cohesion level of the study area.

Finally, depopulated areas can also be characterized by landscape issues, as they undergo significant changes in land use. Some historically agricultural land covers are being abandoned and environmentally deteriorated due to lack of conservation, resulting in different levels of degraded landscapes, with ruined infrastructure, abandoned crop plots, paths saturated by plant invasion, destroyed houses, etc. In areas with higher erodibility, an intensification of erosion evidence can be observed (broken ridges between crop terraces, subsidence of large soil volumes, formation of gullies and rills), while in other areas with higher soil and ecological consolidation, there may be evidence of better soil conservation, due to more effective vegetative colonization of former agricultural and residential uses, in density and size. This information, well corroborated in research on abandoned fields (Romero Díaz, Martínez Hernández & Belmonte Serrato, 2016), cannot be provided with SIDAMUN data due to its more visual nature. Therefore, a geoviewer providing satellite images and multitemporal ones is necessary to observe abandonment evidence over time and contrast the landscape and environmental consequences. SIGNA allows this exercise through its orthophoto comparison tool, so students can be asked to analyze, at a metric visualization scale optimal for land use photointerpretation, changes in land uses since available images and their consequences on soil conservation (Fig 2).

Figure 2.
APPEARANCE OF THE SIGNA INTERFACE



Source: https://signa.ign.es/signa/

4. DISCUSSION

The designed didactic proposal can be fundamentally discussed based on its curricular, pedagogical, and didactic interest. Beginning with a curricular perspective, depopulation is part of the most recent educational curricula in Spain for pre-university education, derived from the latest educational law (LOMLOE, 2020). Its presence is framed within the discipline of Geography, within the area of Natural, Social, and Cultural Environment Knowledge in Primary Education (RD 157/2022); Geography and History, in Secondary Education (ESO) (RD 217/2022); and Geography of Spain, in Baccalaureate (RD 243/2022). The associated learning is constituted in conceptual, competency, and value dimensions.

The conceptual dimension is present in all stages. In Primary Education, there is a basic content within the block of *Societies and Territory*, in the third cycle (10-12 years old), regarding the "Contrast between urban areas and rural depopulation." In ESO, it is discussed in the first cycle (12-14 years old) about "Depopulation and sustaining rural areas", in the *Challenges of the current world* block; and in the second cycle (14-16 years old), about the "Problem of rural depopulation," in the *Societies and territories* block. In Baccalaureate (16-18 years old), within the *Territorial planning in the ecosocial approach* block, "The demographic challenge: aging and rural depopulation" is included.

In the competency dimension, only in Baccalaureate there is a specified competency learning related to depopulation, through the critical explanation of Spain's territorial imbalances (specific competency 6). In the dimension of education in values, rural depopulation is already mentioned in ESO as one of the phenomena that need to be ethically questioned regarding their consequences, as well as a problem to address concerning the environmental quality of lived spaces, in the breakdown of specific competency 4 on landscape elements and their articulation in complex systems to be conserved and sustainably used. In Baccalaureate, depopulation is linked to one of Spain's demographic challenges, as part of specific competency 6 on the critical explanation of territorial imbalances and the awareness of solidarity and commitment to cohesion.

The research project of the didactic proposal covers the conceptual dimension of depopulation, especially with questions 1 and 2, questioning what the phenomenon consists of and what its territorial distribution is, which constitute theoretical knowledge. The competency dimension is covered with question 3, which puts on the table the interrelationship of causes and consequences in different dimensions of the phenomenon, about which critical reflection is required, and from which ethical issues also arise. However, the question that most develops the value dimension is question 4, by proposing management measures within the framework of the SDGs, ensuring solidarity, environmental quality, and territorial cohesion in the fight against depopulation.

The use of geotechnologies is also based on educational curricula since Geographic Information Technologies (GIT) appear at all stages. In Primary Education and in ESO, they are part of basic contents, in relation to the production of georeferenced data and their visual representation. In Baccalaureate, they are also included among specific competencies: competency 4 refers to applying them to locate geographical phenomena and argue scale definitions and categorizations.

From a pedagogical point of view, the didactic proposal as a whole, presented as a project-based learning methodology, specifically cartographic research and as an example of education in sustainability, fits perfectly with the specific competency 3 of the subject in ESO, which proposes the "development of research projects and the use of reliable sources" to identify causes and consequences of current changes and problems, within the framework of sustainable development. Even previously, in Primary Education, a specific competency is established (no. 3) on project creation, highlighting the application of computational thinking. It divides problems into successive parts to solve until reaching the final product, as this project is proposed by systematizing the final resolution into smaller parts with their own resolution guidelines. In Baccalaureate, the Geography subject does not include project work but does include the use of geotechnologies (specific competency 4), which require their own systematization of computational thinking and project-based learning.

Project-based learning (PBL) is a widely used and well-researched didactic methodology (Ruiz Hidalgo & Ortega-Sánchez, 2022). It can be defined as an active methodology aimed at learning about the process of completing a project, in which the teacher acts as a facilitator or guide, helping students to develop critical reasoning skills and acquire greater autonomy (Thomas, Mergendoller, & Michaelson, 1999). PBL has been shown to be very effective for learning complex geographical phenomena because, as Torres Enjuto, Aguado-Moralejo, & Ormaetxea Arenaza (2022, p. 22) relate, "instead of starting the learning process with exposure (...), it begins with observations, data interpretation, case study analysis, or solving a problem that the student must solve in an active way", which leads the student to build step by step, systematically, and in a simpler way, their knowledge about the phenomenon. The presented didactic proposal has been divided into phases precisely to enable this progress, guided and supported by geotechnologies, towards the final product of making proposals for depopulation management.

This task would not be viable or would not have academic success if the information were not previously systematized to be built gradually, from the defining variables of the phenomenon to the explanatory ones and finally those related to its implications. In this methodology, the systematization in project phases and the search for reliable information are fundamental. Therefore, the chosen structure and the institutional condition of the proposed geotechnologies are noteworthy, showing students the importance of official sources and critical thinking in information retrieval. It is an importance aligned with curricular competencies of pre-university education on computational thinking and information retrieval, configured as part of students' scientific literacy and fundamental in today's citizenship (Motoa Sabala, 2019).

Iranzo-García, Escribano Pizarro, Jardón Giner, Ruescas Orient, Fansa Saleh, & Arnal Aniorte (2022) successfully applied PBL to understand the depopulation of an inland area of Valencia and highlight that this methodology has served to involve students more and convey the phenomenon more clearly, resulting in greater awareness. Similar results could be expected from the proposed project in our proposal, with the addition of providing geotechnologies as support for its elaboration. Having therefore proposed a digital cartographic research project, it is also interesting to base the expected disciplinary learning outcomes on educational research on the didactic use of geotechnologies.

Firstly, proposing activities for visualizing layers of overlaid geographical information can facilitate the understanding of complex territorial realities. Martínez-Hernández, Yubero, Ferreiro-Calzada, & Mendoza-de Miguel (2021) demonstrate this for touristification phenomena, stating that geotechnologies generate interactive visual results that significantly represent the interrelation of factors, as occurs in the case of depopulation, with all its causes and consequences recorded in the script of Table 1. Without the systematization of PBL and the didactic strategy of GIT, understanding these phenomena becomes complicated; Velilla & Guallart (2024) empirically demonstrated this for depopulation topics and also for climate change and migrations.

In addition, the geoviewers used have a simple interface that does not require extensive prior technical knowledge. Henry & Semple (2012) believe that webGIS, like geoviewers, are no longer intimidating to students as they were in the past due to their technical complexity of use. SIDAMUN and SIGNA present a toolbar and conventional symbology of applications.

Some studies highlight the limitation of access to data when proposing didactic activities (Álvarez-Otero & Lázaro-Torres, 2017). The fact of resorting to institutional geoviewers, which function as repositories of official territorial information, hosted in the cloud, allows easy, direct, and reliable access to data and solves this problem. The advantage in terms of data storage provided by didactic activities with webGIS is one of the most prominent aspects in educational research (Lázaro y Torres *et al.*, 2016).

Geotechnologies applied in the understanding of complex territorial phenomena promote the development of digital competence and spatial thinking (Martínez-Hernández *et al.*, 2022), understood as the ability to solve spatial problems based on location data and their cartographic representation at an appropriate scale (Huynh & Sharpe, 2013). This is what is expected with the phenomenon of depopulation, which requires the location of a series of variables and their graphical expression through maps, for determined scales of study areas, as shown in Table 1.

The implementation of the 2030 Agenda for Sustainable Development by the UN in 2015 has given more weight to education in sustainability, which consists of learning the values, behaviors, and lifestyles necessary for a sustainable future and a positive transformation of society (Wals, 2009). Any subject is susceptible to incorporating aspects of training and awareness in sustainability, but precisely Geography, due to its holistic aspect and territorial approach, is one of the most-linked disciplines to education for sustainable development (Crespo & Rodríguez, 2020; Martínez-Hernández & Mínguez, 2023), and as such it was advocated by the International

Geographical Union (Haubrich *et al.*, 2007). Depopulation is a geographical phenomenon that fully fits these characteristics, as it constitutes a challenge for territorial cohesion and the fight against inequalities. So, it can be expected that, having incorporated a specific question about management within the framework of the Sustainable Development Goals (SDGs), students will acquire citizenship education in awareness and ethical commitment, avoiding that their learning is based on ideologized interpretations (Carretero Rodríguez, 2019).

The tasks of the didactic proposal based on photointerpretation also contribute to education in sustainability thanks to the direct observation of degradation evidence, visualized in their real forms, more significant than when they take the form of symbology (Lázaro y Torres & González González, 2014). Photointerpretation also favors a more realistic understanding of the environmental consequences and land uses of depopulation, transcending the intangibility of the data. For this additional reason to the specifics of webGIS, some authors emphasize the convenience of including photointerpretation tasks in geography teaching (Luque Revuelto, 2011).

Finally, there is a challenge surrounding the proposal related to the digital teaching competence (*DigCompEdu*) (Redecker, 2017). For its viability, the level of digital competence should be at least intermediate, and the teacher must have a good understanding of the foundations and characteristics of digital cartography. Geotechnologies based on geovisors, which are a type of webGIS, are not especially demanding in terms of technical knowledge when applied to the classroom (Kerski & Baker, 2019). However, in the Spanish context, where Geography teachers typically have a scientific background in History, it is not unusual for there to be limitations in handling in-depth geographical concepts and digital cartography tools (de Miguel, de Lázaro, Buzo, Reyes, Kiss, & Mineiro, 2023). The level of details provided in Table 1 is precisely intended to mitigate this risk.

5. CONCLUSIONS

Depopulation is a pressing phenomenon in the Spanish territorial reality. Its study is being approached from different perspectives due to its multiple dimensions and implications (demographic, social, economic, spatial, cultural, environmental...). Its territorial, research, and media importance have led to the inclusion of the phenomenon in the current educational curricula of pre-university education, as part of geographical learning. The aim is for the new generations to understand the phenomenon, not to stigmatize depopulated areas or those who inhabit them, and to acquire a sensitivity inherent in values education, within the framework of education for sustainability, leading them to awareness and mobilization against territorial inequalities. Addressing depopulation from an ecosocial approach reinforces the idea of human responsibility in the interaction with nature.

The multidimensionality of the phenomenon requires holistic learning, facilitated by geographical education, through various ecosocial, interconnected, and cross-cutting themes, and geographical thinking competencies. The novelty and relevance of the topic, at the curricular and social levels, make it essential to design didactic activities that facilitate its theoretical and competency-based learning and are effective in dealing with its complexity.

In this context, a didactic proposal on depopulation has been designed through a PBL methodology and the support of geotechnologies, which has been based on curricular, pedagogical, and didactic grounds. It can be concluded from this foundation that the pedagogical and didactic benefits already researched of PBL and the educational use of geotechnologies can be applicable in this case, thus improving the teaching of depopulation within the current curricular framework of basic contents of the topic, digital competencies, critical thinking, and autonomous work.

It is noteworthy, on the one hand, the ability of geotechnologies to cross georeferenced variables and allow a clearer conception of various interconnected territorial factors. On the other hand, the benefit of PBL in systematizing complex issues into compartmentalized steps that come together until the final result is achieved is remarkable. In relation to PBL, the importance of institutional information, created and configured for territorial consultations in the professional and citizen sphere, is equally notable. In this case, the geoinformation provided by the SIDAMUN and SIGNA geoviewers, which guarantees reliable data in a global context of post-truth, contributes to the scientific literacy of students and becomes a didactic resource of great potential.

However, the proposal has a significant limitation related to its non-implementation. This circumstance precludes the availability of empirical results that support the theoretical expectations that scientific literature and curriculum analysis lead us to have regarding expected learning outcomes. This is a pending task for later phases of research that could improve the proposal. At the level of learning assessment, the appropriateness of the students' responses to the report's questions can be assessed based on criteria of presence and depth tailored to the curriculum of each educational level.

The presented proposal thus becomes a pioneering example of a didactic strategy for comprehensive, integral, and competency-based teaching of the depopulation phenomenon, thanks to the methodological support of PBL and geotechnologies.

DECLARATION OF CONFLICT OF INTEREST

Authors declare no conflicts of interest.

FUNDING SOURCES

None.

AUTHORSHIP CONTRIBUTION STATEMENT

Carlos Martínez-Hernández: Formal analysis, Methodology, Project management, Resources, Validation, Visualization, Writing.

Carmen Mínguez: Conceptualization, Formal analysis, Methodology, Project management, Resources, Supervision, Writing.

REFERENCES

Álvarez-Otero, J. & Lázaro-Torres, M. L. (2017). Spatial Data Infrastructures and Geography Learning. *European Journal of Geography*, 8(3), 19-29. https://eurogeojournal.eu/index.php/egj/article/view/301

Bailly, A. & Gibson, L. J. (2004). *Applied Geography: A World Perspective*. Berlin, Germany: Springer Science and Business Media.

Baker, T. R., Battersby, S., Bednarz, S., Bodzin, A. M., Kolvoord, B., Moore, S., Sinton, D. & Uttal, D. (2015). A Research Agenda for Geospatial Technologies and Learning. *Journal of Geography,* 114(3), 118–130. https://doi.org/10. 1080/00221341.2014.950684

Banco de España (2021). *Informe anual del 2020*. Retrieved from https://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesAnuales/InformesAnuales/20/Fich/InfAnual_2020.pdf

Bandrés, E., & Azón, V. (2021). *La despoblación de la España interior*. Madrid, Spain: Funcas. Retrieved from https://www.funcas.es/wp-content/uploads/2021/02/La-despoblacion-de-la-Espa%C3%B1a-interior.pdf

Bednarz, S., & van der Schee, J. (2006). Europe and the United States: The Implementation of Geographic Information Systems in Secondary Education in two Contexts. *Journal of Technology, Pedagogy and Education*, 15(2), 191–205. https://doi.org/10.1080/14759390600769573

Buzai, G. D. (2004). Geografía y tecnologías digitales del siglo XXI: una aproximación a las nuevas visiones del mundo y sus impactos científico-tecnológicos. *Scripta Nova*, 8(170), 1. https://raco.cat/index.php/ScriptaNova/article/view/64014

Buzo-Sánchez, I. J.; Mínguez, C. & De Lázaro-Torres, M. L. (2022). Expert perspectives on GIS use in Spanish geographic education. *International Journal of Digital Earth*, 15(1), 1204-1218. https://doi.org/10.1080/17538947.2022.2096131

Carretero Rodríguez, M. (2019). De noticias falsas, reconquistas y demás. *Íber. Didáctica de las Ciencias Sociales. Geografía e Historia*, 96, 55-61.

Castrillo Romón, M. D. L. Á., Khairullina, E., Lalana Soto, J. L., & Pérez Eguíluz, V. (2023). *El potencial de las herramientas colaborativas en la investigación y la dinamización rurales*. Valladolid, Spain: Universidad de Valladolid, Instituto Universitario de Urbanística.

Catling, S. J. (1978). The child's spatial conception and geographic education. *Journal of Geography*, *77*(1), 24–28. https://doi.org/10.1080/00221347808980060

Crespo Castellanos, J.M.; Martínez-Hernández, C.; Mateo Girona, R.M. & Rodríguez de Castro, A. (2023). Landscape Education Two Decades after the European Landscape Convention—A Study with Trainee Teachers. *Education Sciences*, 13(12), 1188. https://doi.org/10.3390/educsci13121188

Crespo, J.M. & Rodríguez, A. (2020). La contribución de la educación geográfica para alcanzar los objetivos de desarrollo sostenible. In F. J. Hinojo, F. J. Sadio Ramos, J. A, López Núñez, J.M. Romero Rodriguez (Coords.), *Experiencias e investigaciones en contextos educativos* (pp. 376-385). Madrid, Spain: Dykinson.

De la Vega, A. G. (2019). Perspectivas de futuro en el aprendizaje del paisaje. *Didáctica Geográfica*, 20, 55-77. https://doi.org/10.21138/DG.441

De Miguel, R., de Lázaro, M. L., Buzo, I., Reyes, J., Kiss, D., & Mineiro, J. P. (2023). *Informe sobre las oportunidades de empleo de los Sistemas de Información Geográfica en el currículum escolar de enseñanza secundaria para crear itinerarios literarios por medio de Digital Maps Storytelling. Países analizados: España, Portugal, Hungría.* Comisión Europea. https://es.slideshare.net/isaacbuzo/oportunidades-para-el-curriculumpdf

Demerit, D. (2009). Geography and the promise of integrative environmental research. *Geoforum*, 40(2), 127-129. https://doi.org/10.1016/j.geoforum.2008.08.010

England, K., & Azzopardi-Muscat, N. (2017). Demographic trends and public health in Europe. *The European Journal of Public Health*, 27(suppl_4), 9-13. https://doi.org/10.1093/eurpub/ckx159

Fargher, M. (2018). WebGIS for Geography Education: Towards a GeoCapabilities Approach. *ISPRS International Journal of Geo-Information,* 7(3), 111. https://doi.org/10.3390/ijgi703011

Galeana, L. (2006). Aprendizaje basado en proyectos. *Revista Ceupromed*, 1(27), 1-17. http://ceupromed.ucol.mx/revista/PdfArt/1/27.pdf

Gobierno de España (2021). *Plan de Recuperación: 130 medidas frente al reto demográfico*. Retrieved from https://www.miteco.gob.es/es/reto-demografico/temas/plan_recuperacion_130_medidas_tcm30-524369.pdf (Accessed 7 August 2021)

Guallart, C., Velilla, J., Cuartero, N., Ferraz, M. F., Marín-Yaseli, M. L., Ojeda, A. O., & Rodrigo, B. (2020). Propuesta de recursos didácticos en línea para trabajar patrimonio, despoblación y territorio en Educación Secundaria Obligatoria. Paisaje, patrimonio cultural y despoblación en territorio mudéjar aragonés. *Cuadernos de geografía*, 104, 153-176. https://doi.org/10.7203/CGUV.104.16783

Hagevik, R. A. (2003). The Effects of Online Science Instruction Using Geographic Information Systems to Foster Inquiry Learning of Teachers and Middle School Science Students. PhD diss. http://www.lib.ncsu.edu/resolver/1840.16/4389 (Accessed 18 January 2022)

Haubrich, H., Reinfried, S., & Schleicher, Y. (2007). Lucerne Declaration on Geographical Education for Sustainable Development. *International Geographical Union***.** Retrieved from https://www.iau-hesd.net/sites/default/files/documents/lucernedeclaration.pdf

Henry, P., & Semple, H. (2012). Integrating online GIS into the K-12 curricula: Lessons from the development of a collaborative GIS in Michigan. *The Journal of Geography*, 111(1), 3–14. https://doi.org/10.1080/00221341.2011.549237

Huynh, N.T., & Sharpe, B. (2013). An assessment instrument to measure geospatial thinking expertise. *Journal of Geography*, 112(1), 3–17. http://dx.doi.org/10.1080/00221341.2012.682227

Iranzo-García, E., Escribano Pizarro, J. Jardón Giner, P., Ruescas Orient, A.B. Fansa Saleh, G. & Arnal Aniorte, V. (2022). Aprendizaje basado en Proyectos (AbP) y Aprendizaje-Servicio (ApS) en áreas rurales con espacios naturales protegidos: el proyecto 'GEODIDACT RINCÓN'. In: J.C. Cano Escribá (Dir.). In-Red 2022. VIII Congreso de Innovación Educativa y Docencia en Red (pp. 492-506). Valencia, Spain: Editorial Universitar Politècnica de València https://doi.org/10.4995/INRED2022.2022.15819

Kerski, J. J., & Baker, T. R. (2019). Infusing Educational Practice with Web-GIS. In R. De Miguel González, K. Donert, & K. Koutsopoulos (Eds.). *Geospatial Technologies in Geography Education* (pp. 3–19). EUROGEO Book Series: Key challenges in Geography. Suiza: Springer. https://doi.org/0.1007/978-3-030-17783-6_1

Kim, M., & Bednarz, R. (2013). Development of Critical Spatial Thinking Through GIS Learning. *Journal of Geography in Higher Education*, 37(3), 350–366. https://doi.org.10.1080/03098265.2013.769091

Lasanta, T., Arnáez, J., Pascual, N., Ruiz-Flaño, P., Errea, M. P., & Lana-Renault, N. (2017). Space–time process and drivers of land abandonment in Europe. *Catena*, 149, 810-823. https://doi.org/10.1016/j.catena.2016.02.024

Lázaro y Torres, M. L. de, & González González, M. J. (2014). La utilidad de los Sistemas de Información Geográfica para la enseñanza de la geografía. *Didáctica Geográfica*, 7, 106-122.

Lázaro y Torres, M. L. de, Izquierdo Álvarez, S., & González González, M. J. (2016). Geodatos y paisaje: de la nube al aula universitaria. *Boletín De La Asociación De Geógrafos Españoles*, 70. https://doi.org/10.21138/bage.2175

LOMLOE (2020). Ley Orgánica 3/2020, de 29 de diciembre, por la que se modifica la Ley Orgánica 2/2006, de 3 de mayo, de Educación. *Boletín Oficial del Estado*, 340, de 30/12/2020. https://www.boe.es/eli/es/lo/2020/12/29/3

Luque Revuelto, R. M. (2011). El uso de la cartografía y la imagen digital como recurso didáctico en la enseñanza secundaria. Algunas precisiones en torno a Google Earth. *Boletín De La Asociación De Geógrafos Españoles*, 55, 183-210. Retrieved from https://bage.age-geografia.es/ojs/index.php/bage/article/view/1318

Martínez-Arnáiz, M.; Mínguez García, M.C.; Martín Vide, J.; Ojeda Zújar, J., & Ruiz Sinoga, J. D. (2020). “Geovacui: Geografía y ciencia ciudadana ante el reto de la despoblación rural”. In E. Baraja & F. Molinero (Ed.) *Espacios rurales y retos demográficos: una mirada desde los territorios de la despoblación: ColoRural 2020, III Coloquio Internacional de Geografía Rural,* (pp-pp. 43-63). Valladolid, Spain: Asociación Española de Geografía.

Martínez-Hernández, C. & Mínguez, C. (2023). The Anthropocene and the sustainable development goals: key elements in geography higher education? *International Journal of Sustainability in Higher Education*, 24(7), 1648-1667. https://doi.org/10.1108/IJSHE-09-2022-0316

Martínez-Hernández, C., Piskorski, R., & Stoffelen, A. (2023). Designing Online Workshops for Teacher Trainees: Heritage Mapping with Web GIS Story Maps. *European Journal of Geography,* 14(3), 68-78. https://doi.org/10.48088/ejg.c.mar.14.3.068.078

Martínez-Hernández, C., Stoffelen, A., & Piskorski, R. (2022). Obtaining geographical competences through online cartography of familiar and unfamiliar urban heritage: lessons from student workshops. *Journal of Geography in Higher Education*, 48(1), 74–93. https://doi.org/10.1080/03098265.2022.2155935

Martínez-Hernández, C., Yubero, C., Ferreiro-Calzada, E., & Mendoza-de Miguel, S. (2021). Uso didáctico de SIG y Street View en el Grado de Turismo: aproximación a la gentrificación comercial en grandes destinos urbanos. *Investigaciones Geográficas*, 75, 61–85. https://doi.org/10.14198/INGEO2020.MYFM

Mínguez García, M.C., Martínez Arnáiz, M., Martín Vide, J., Ruiz Sinoga, J. D., Ojeda Zújar, J. & Bárcena-Martín, E. (2022). *GEOVACUI-2: CONCLUSIONES Y RECOMENDACIONES - Ni vacía ni vaciada: una España rural activa*. https://doi.org/10.5281/zenodo.7130861

Molina Ibáñez, M. (2019). Dimensión territorial de la despoblación. Aproximación al papel de las políticas públicas en un entorno europeo. In J. Farinós, J.F, Ojeda-Rivera y J.M. Trillo (eds). Geografías para un Estado posmoderno, (pp. 153-170). Madrid, Spain: Asociación Española de Geografía.

Molinero, F. (2019). El espacio rural de España: evolución, delimitación y clasificación. *Cuadernos Geográficos*, 58(3), 19-56. https://doi.org/10.30827/cuadgeo.v58i3.8643

Molinero, F. & Alario, M. (2022). *Una mirada geográfica a la España rural*. España: Revives.

Motoa Sabala. S.P. (2019). Pensamiento computacional. *Revista de Educación y Pensamiento*, 26, 107-111. http://educacionypensamiento.colegiohispano.edu.co/index.php/revistaeyp

RD 157/2022. Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria. *Boletín Oficial del Estado*, 52, de 02/03/2022. https://www.boe.es/eli/es/rd/2022/03/01/157/con

RD 217/2022. Real Decreto 217/2022, de 29 de marzo, por el que se establece la ordenación y las enseñanzas mínimas de la Educación Secundaria Obligatoria. *Boletín Oficial del Estado*, 76, de 30/03/2022. https://www.boe.es/eli/es/rd/2022/03/29/217/con

RD 243/2022. Real Decreto 243/2022, de 5 de abril, por el que se establecen la ordenación y las enseñanzas mínimas del Bachillerato. *Boletín Oficial del Estado,* 82, de 06/04/2022. https://www.boe.es/eli/es/rd/2022/04/05/243/con

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu*. Publications Office of the European Union. https://doi.org/10.2760/178382

Romero Díaz, A., Martínez Hernández, C., & Belmonte Serrato, F. (2016). Procesos de erosión en áreas abandonadas de la Región de Murcia. in: A. Romero Díaz (Coord.). *Abandono de cultivos en la Región de Murcia. Consecuencias ecogeomorfológicas* (pp. 85-110). Murcia, Spain: Servicio de Publicaciones de la Universidad de Murcia.

Ruiz Hidalgo, D., & Ortega-Sánchez, D. (2022). Project Based Learning: A Systematic Literature Review (2015-2022). *HUMAN REVIEW. International Humanities Review / Revista Internacional De Humanidades*, 14(6), 1–14. https://doi.org/10.37467/revhuman.v11.4181

Sánchez-Zamora, P., Gallardo-Cobos, R., & Delgado, F. C. (2016). La noción de resiliencia en el análisis de las dinámicas territoriales rurales: Una aproximación al concepto mediante un enfoque territorial. *Cuadernos de desarrollo rural*, 13(77), 93-116. https://doi.org/10.11144/Javeriana.cdr13-77.nrad

Thomas, J. W., Mergendoller, J. R., & Michaelson, A. (1999). *Project-based learning: A handbook for middle and high school teachers*. Novato, USA: The Buck Institute for Education.

Torres Enjuto, M. C., Aguado-Moralejo, I., & Ormaetxea Arenaza, O. (2022). Práctica de campo en la asignatura de Geografía Económica mediante aprendizaje basado en proyectos y en el lugar. *Didáctica Geográfica*, 23, 17-47. https://doi.org/10.21138/DG.632

Velilla, J. & Guallart, C. (2024). El desarrollo sostenible en las aulas de educación secundaria: cambio climático, migraciones y despoblación mediante la utilización de Web SIG. *South Florida Journal of Development*, 5(2), 531-545. https://doi.org/10.46932/sfjdv5n2-010

Velilla, J. & Lagura, M. M. (2019). El problema de la despoblación en España y su tratamiento didáctico. *Iber: Didáctica de las ciencias sociales, geografía e historia*, 96, 7-16.

Wals, A. (2009). *Review of contexts and structures for education for sustainable development.* Paris, France: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000184944

Zappettini, M. C. (2007). Enseñanza de la geografía e Informática: El uso del SIG en una experiencia pedagógica innovadora. *Geograficando*, 3(3), 189-203. https://www.memoria.fahce.unlp.edu.ar/art_revistas/pr.3674/pr.3674.pdf

Zúñiga-Antón, M., Guillén, J., Caudevilla, M., & Bentué-Martínez, C. (2022). *Mapa 174. Zonificación de los municipios españoles sujetos a desventajas demográficas graves y permanentes*. StoryMap. Retrieved from https://storymaps.arcgis.com/stories/9dd9b6e20cad403c95e87d4cc493c8fb