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Research Article

Designing Online Workshops for Teacher Trainees: Heritage Mapping with Web GIS Story Maps

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Abstract: In a context of online and blended-learning education, widely applied during the COVID-19 pandemic and retained afterwards, geography education found great support in Geographic Information Systems (GIS). Already long before the pandemic, GIS were one of the most used research tools by geographers. Since a few years, educative curricula have increasingly started to include GIS. However, people without a background in geography such as future teachers may struggle to manage these technologies, both technically and in terms of the required spatial reasoning. The purpose of this paper is to reflect on the design characteristics of online workshops with teacher trainees that should allow to deal with these struggles. The workshops used web GIS story maps and focused on local and foreign urban heritage in Madrid and Krakow, cities that both host a UNESCO World Heritage Site. The teacher trainees had to create digital didactic routes to allow primary school pupils to become familiar with urban heritage processes. Fulfilling this task required the development of digital and didactic competencies, geographical reasoning, and critical thinking on familiar and unfamiliar urban heritage. In the Anthropocene epoch, accurate teaching projects like these workshops are needed to raise the spatial awareness of people, above all basic education teachers, who contribute to the making of future digital and global citizens. In conclusion, this paper could become a good-practice workshop design aimed at teacher trainees who at present show a lack of geographical and digital knowledge but will have to teach about this knowledge in the future.

Keywords: Digital cartography; Online education, GIS; Geography education; teachers in training.

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Highlights:

- Teacher trainees need to be educated in Geo-Information technologies.
- Design of a story map workshop to get geodigital, heritage and didactic competencies.
- Focus on a local and a foreign city to promote research and critical thinking.

1. Introduction

Online and blended-learning education has been globally retained as valid educational methods after becoming mainstream responses to the outbreak of the COVID-19 pandemic, from elementary education to universities, due to school closures and necessary social distance precautions (Ghazali, 2022). Although such educational models can enhance digital divides (Hughes, 2020) and reduce the enthusiasm of learners (Mahlangu, 2018), they have been a decent solution in times of forced online education. In this context, the teaching of geography has found great support in Geo-Information technologies (Yan et al., 2022). They comprise a range of technologies such as GIS (Geographic Information Systems), GPS (Global Positioning Systems), and web mapping, which seeks to accumulate geographical information for analysis within computer database systems (Gibson et al., 2010).

Already long before the pandemic, GIS were one of the most used research tools by geographers (Dixon & Whitehead, 2008). Geography has a long tradition in the study of society-nature relations (Maude, 2023). Spatial patterns of natural and human processes, and their interrelations, can be registered, explored and modelled using this kind of technology (Demeritt, 2009), also for qualitative research (Muenchow et al., 2019). Some examples provided by Demeritt (2009), Maude (2023) and Muenchow et al. (2019) are sustainable development, natural hazards, transport systems, migrations, landscapes, ecosystem services, tourism growth, global change, climate conditions, and land use cover studies.

The advances in research and the knowledge generated on society-nature relations and spatial technologies should be included in teaching (Castree, 2015). One of the main challenges of geography education is fostering certain skills, methodologies and competencies adapted to the advanced technological approaches of recent geography research (Meadows, 2020). Since a few years, basic educative curricula have followed suit and have frequently updated by the inclusion of GIS (Henry & Semple, 2012). The pandemic provided a further stimulus in this regard. However, people without a background in geography such as future teachers may struggle to manage GIS technologies, both technically and in terms of the required spatial reasoning to make most use of them (Collins & Mitchell, 2019). Any new disciplinary knowledge requires time to be transferred to a teaching practice (Senaratne et al., 2005). This is certainly the case for teacher training studies, which are eclectic to begin with.

It seems that students of teacher education programs would benefit from further exposure to didactic tools that are popular in geography, especially when they are compatible and even complementary with offsite education (Geraghty & Kerski, 2020; Martínez-Hernández et al., 2022). Consequently, the purpose of this paper is to reflect on the design characteristics of online workshops that should allow teacher trainees to make

use of GIS as a didactical instrument, despite their relative lack of technological and spatial reasoning expertise. We aim to focus on the didactic meaning of the intended learning outcomes, in terms of geographic reasoning skills (including geodigital competencies), heritage interpretation capabilities, and didactic transference ability. Doing so, this paper builds on a previously published paper in which an adaptation of the same workshop was used to assess whether digital and spatial competencies could be developed in online environments (Martínez-Hernández et al., 2022). Compared to that publication, the current paper focuses more on the design characteristics rather than on the actually achieved learning outcomes, and embeds the analysis of the design features into the literature on educational transposition. Practically, we present the design of an online workshop on web GIS story maps, applied to the topic of urban heritage. The concrete research objectives are: (i) to present and justify the structure of the workshop, (ii) to set up the didactic meaning of the intended learning outcomes, and (iii) to insert an evaluation system. All the objectives respond to a competency framework which will be developed. As such, the focus of this paper is not about the delivered works by the participants during the workshops, but on the logic of the design of the workshop itself.

According to scientific literature (see next section), web GIS are Geographical Information Systems which are available in a web format from data in the cloud (Kerski, 2021), so they are one of the most feasible GIS for teaching due to their simple interfaces and direct availability (Álvarez-Otero & Lázaro-Torres, 2017). Story maps combine digitized, dynamic maps with other story elements (i.e., title, text, legend, pop-ups and other visuals) and facilitate the creator to convey a message effectively (Giannakou & Klonari, 2019). Furthermore, urban heritage is a geographical study object with a long research tradition (Graham et al., 2000). It can be used as a key didactic concept to develop all kind of geographical learning (theoretical, methodological, and ethical). In our workshop, the story maps had to be designed for a domestic city and a foreign one, so that students were able to explore the heritage values in known and unknown urban fabrics, so as to improve their critical thinking.

2. Literature Review

Since 2020, much of the literature on geographic education has consisted of studies on how to adapt face-to-face classes to distance learning. Kidd and Murray (2020) summarized the evolution of experiences of educational agents during the COVID-19 outbreak: initial feeling of stress, uncertainty later, and finally facing the situation with technical solutions so as not to endanger teaching. Then teaching innovations appeared, although Bryson and Andres (2020) warned that their effectiveness could never be optimal due to the imposition of online teaching and the lack of time to plan it well and prepare materials. Schultz and DeMers (2020) called for a transition from what they called 'emergency remote learning' to further develop and prepare online learning experiences. When teaching ceases to be necessarily online, Blanford et al. (2022) argued that it should not simply return to a traditional learning system as developed before but should build on the experiences during the pandemic to move towards a learning practice that benefits from new technologies in geography teaching, which should be made compatible with face-to-face and hybrid education. If applied well, learning tools experimented with during the pandemic can complement face-to-face practices and optimize lessons time; a good example is the implementation of virtual field trips for the teaching of geography (Geraghty & Kerski, 2020).

Forced online learning experiences in geography can open the range of possibilities for working on spatial thinking and reasoning. One of the most effective learning strategies demonstrated in the development of spatial thinking and problem-solving skills, in this regard, is field trips (Ito & Igano, 2021). A key question that has inspired geographers for already a couple of decades is whether the benefits of field trips in geographic education are transferable to virtual contexts (Friess et al., 2016). The consensus is that the emotional benefits of sharing a group experience in the open air, outside one's usual environment do not seem to hold up (Hope, 2009). However, current digital mapping platforms (digital story maps are an example), which are now visibly more advanced than when this technology was still novel, can increasingly afford immersive and interactive virtual field trips (Leininger-Frézal & Sprenger, 2022), which encourage active learning and even feelings of emotion among students by discovering places they did not know previously or rediscovering those they did (Egiebor & Foster, 2019; Mead et al., 2019). Authors such as Martínez-Hernández and Alabadeljo-Albajadejo (2021) and Holgersen (2021) argued that field trips should make it possible to convert geographic theory into practical interactions in students' everyday spaces. Carver et al. (2004) understood early on that platforms such as web GIS present a great opportunity to face this challenge.

A basic conclusion of the literature on geographic education during the COVID pandemic is that virtual field trips, through digital story maps, may not be a complete substitute for face-to-face ones, but they can be a much-needed complement. From the beginning, virtual field trips have been highly recommended for students without a deep prior knowledge of geography or computer sciences (Carver et al., 2004; Henry & Semple, 2012; De Lázaro-Torres et al., 2017; West & Horswell, 2018). The main obstacles in the educational use of GIS are: the adequate technical knowledge of teachers, the investments needed in computer equipment and software, and the perception of students and teachers that GIS environments are difficult and inaccessible (Henry & Semple, 2012; Summerby-Murray, 2001). Web GIS can reduce the impact of these drawbacks due to its more flexible and simple interfaces, the possibility of using interactive tools and its limited investment costs (Carver et al., 2004). The main didactic advantage of web GIS is that they can facilitate students' spatial reasoning (Kim & Bednarz, 2013; Martínez-Hernández et al., 2022), even beyond specific geography studies, understanding web GIS as a spatial interaction tool and not as an object study (Carver et al., 2004; Henry & Semple, 2012). The recent simplification of its use (Mead et al., 2019; West & Horswell, 2018) allows exploratory and interactive tasks that require spatial thinking without technical difficulties (De Lázaro-Torres et al., 2017). The didactic use of digital cartographic viewers based on Spatial Data Infrastructures (SDI) has become widespread in the last decade (Álvarez-Otero & Lázaro-Torres, 2017), so access to data and platforms is no longer a problem. Henry and Semple (2012) summarize the key advantages of web GIS for developing geographic reasoning skills as: (i) the interface of current web GIS is not intimidating for non-expert students, (ii) it takes very little time to get familiar with its tools, only an hour or two; (iii) its use may be as a tool and not so much as an object of study; (iv) the data is pre-loaded in the cloud and always available; and (v) there is more technical training among teachers. Practically, the topic of heritage interpretation is a leading subject in geography education (Röll & Meyer, 2020), and heritage elements can be easily mappable. This topic could help trainee teachers to appreciate cultural and natural heritage in their teaching context, and it contributes to developing SDG Goal 11.4 ("Strengthen efforts to protect and safeguard the world's cultural and natural heritage").

This article presents the design of workshops on web GIS story maps applied to the identification of urban heritage by teachers in training. Martínez-Hernández et al. (2022) already demonstrated the workshops' learning effectiveness. In this paper we focus on design elements to reflect on the conditions that allow making most of online web-based GIS workshops, so that this effectiveness can be achieved. This way, the workshop is grounded according to the development of geographic reasoning skills (including geodigital competencies), heritage interpretation capabilities, and didactic transference ability. The workshop is in line with an active learning paradigm (Prince, 2004) and with an urgent situation of updating

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the geospatial skills of future teachers, adapted to current geographic research and the new educational curricula for basic and secondary education.

3. Materials & Methods

The workshop was grounded in a four-step systematization (Figure 1): (i) Target participants and task assignment, (ii) Workshop design, (iii) Didactic meaning of the intended learning outcomes, and (iv) Didactic basis for evaluation.

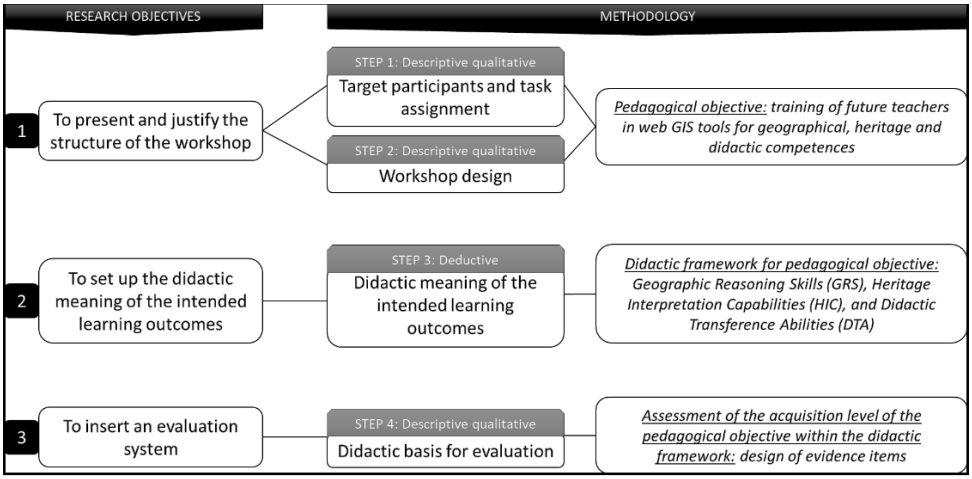

Figure 1. Methodological process according to the research objectives.

The first and second steps (first research objective) were developed in a descriptive qualitative way, according to the pedagogical objective of the workshop (obtaining generic geographical competencies), described in Martínez-Hernández et al. (2022). The third step (second research objective) followed a deductive methodology to connect the intended learning outcomes (Martínez-Hernández et al., 2022) to the didactic framework of the workshop's pedagogical goals. This framework consisted of: (i) Geographic reasoning skills (GRS), (ii) Heritage interpretation capabilities (HIC), and (iii) Didactic transference ability (DTA).

Geographical reasoning is a product of the new nature of geographic knowledge, which has moved from the knowledge "of" space (accumulation of geographical facts) to the knowledge "about" space (reasoning on spatial relations) (Eliot, 2000) in the new information technology society (Golledge, 2002). It is a way to refer to geospatial thinking, a subset of spatial thinking which needs territorial reasoning skills to be established (National Research Council, 2006). Geospatial reasoning involves problem-solving from data related to the Earth or its representation through maps (Huynh & Sharpe, 2013). Key concepts for this kind of reasoning are geographic space, visualization, scale, and representation (Bodzin et al., 2014). One potential method for enhancing geographical reasoning skills is the didactic use of GIS (Bodzin, 2011), which provides tools to overlay spatial variables and visually understand complex spatial relationships (Martínez-Hernández et al., 2021). Based on the brief review above, basic geographic reasoning skills (GRS) include:

- GRS.1. The identification of geographical spaces and territorial boundaries.
- GRS.2. The understanding of spatial data visualization.
- GRS.3. The capacity of working with geographic scales.
- GRS.4. The ability to create (GRS.4a), interact (GRS.4b) and interpret (GRS.4c) geographic representations (material or digital mapping competencies).

Heritage interpretation is an educational activity consisting of providing information on heritage values in heritage sites or objects (Silberman, 2012). The main purpose of the heritage interpretation skills is to understand the place, feel sensitized to the surroundings and be aware of the importance of the conservation of the landscape and human values of the heritage site or object (Nowacki, 2021). Öztemiz (2020) organized culture heritage literacy into four skills. These can be extended to all kind of heritage due to the human or cultural value inherent to any heritage element, irrespective of whether it applies to cultural or natural, or tangible or intangible, forms of heritage (Smith, 2006). In this way, the capabilities for the interpretation of heritage (HIC) can be synthetized as:

- HIC.1. Discovery and access: the construction of strategies to find information and data about heritage.
- HIC.2. Analyze and evaluate: the review of the research process, comparation, analysis and evaluation of information and data about heritage.
- HIC.3. Use and create: the use and creation of information about heritage professionally and ethically.
- HIC.4. Information sharing: the sharing of information gained about heritage, sharing the results of research, synthesizing new and old information and data to create new information and disseminating it in a variety of ways.

Didactic transference or transposition is the process through which some knowledge generated outside school is moved to school out of a social need of education and diffusion (Bosch & Gascon, 2006). According to the pioneering didactic transposition theory by Chevallard (1985), synthetized by Bosch and Gascon (2006), there are four steps to make transposition possible: (1) scholarly scientific knowledge, as it is produced

by scientists (2) knowledge to be taught officially, as prescribed by the curriculum; (3) knowledge as it is actually taught by teachers in the classroom; and (4) knowledge as it is actually learnt by students. For digital environments (for example, research and teaching through GIS), Mishra and Koehler (2006) proposed the TPACK model: they included technological knowledge for didactic transposition and highlighted the importance of pedagogical knowledge for the teaching action (step 3 in transposition theory). The result is managing "Technological, Pedagogical And Content Knowledge" (TPACK) to make didactic transference possible. Lomos et al. (2023) also highlighted the importance of the pedagogical use of ICT for teaching/learning, by applying their Four Balance Model. In this model, transference depends on ICT infrastructure, digital materials, adequate use, and teaching skills. Then, we can conclude that didactic transference ability refers to good pedagogical practices of teachers that should allow transforming the scientific and technological knowledge to be taught into high-quality taught knowledge (Atalar & Ergun, 2018). Moreira et al. (2023), in line with the transposition theory and the digital teaching environment models, summarized these good practices into six teaching competencies or didactic transference abilities (DTA), from a systematic literature review:

- DTA.1. Personal skills: respectful trait and being stimulating and positive.
- DTA.2. Didactic competency: ability to use different and active teaching methods, strategies, or techniques to support students' learning (DTA.2a); ability to structure and manage the course or lessons (DTA.2b); ability to implement a motivational and fair learning assessment (DTA.2c); ability to create a supportive classroom climate and manage the classroom effectively (DTA.2d); coaching and mentoring ability (DTA.2e); and possessing sound content knowledge (DTA.2f).
- DTA.3. Communicative competency: ability to give clear presentations and explanations (DTA.3a), and ability to produce an academically stimulating, challenging, and engaging discourse (DTA.3b).
- DTA.4. Digital competency: ability to choose the right environment and the appropriate tools for (collaborative) activities.
- DTA.5. Interpersonal competency: strong relationships with students.
- DTA.6. Cultural and ethical competency: following expected sociocultural norms.

Finally, the methodological fourth step (didactic basis for the evaluation of the workshop, that is, the third research objective) also took place in a descriptive qualitative way. The workshop's assignment statements partially provided by Martínez-Hernández et al. (2022), as evidence items of the acquisition level of the workshop learning outcomes, were connected to the three key concepts of the didactic framework of the workshop pedagogical goal (GRS, HIC and DTA), in a detailed description.

4. Results

4.1. Target students and task assignment

The target students for the workshop were teacher trainees. During their professional career as teachers, they will contribute to the making of future digital and global citizens of different youth cohorts. It is essential that they are able to provide high-quality teaching and adequate facilitation of spatial thinking in digital environments. Online workshops can provide an opportunity to prepare them for these tasks.

The assignment we prepared for this workshop was: to create two didactic pedestrian itineraries as ArcGIS Online StoryMaps for teaching own-selected heritage elements to 12 years old students, in one familiar local city and an unknown foreign one.

The stops had to be related to different heritage values (natural, religious, historical, cultural…) and their didactic interest had to be justified. Every stop had to follow the same structure: (i) Title and image, (ii) Description, (iii) Justification of the heritage value, (iv) Didactic justification, and (v) Timing. Students were assisted by mentors, who were expert in the didactical application of Geo-Information Technologies.

The workshop which is presented in this paper was designed for Madrid and Krakow, as local and foreign cities depending on the Spanish or Polish nationality of the students. This selection was based on the following shared circumstances: historic centers, European background, cultural and financial hubs, international tourism destinations, UNESCO World Heritage sites, and availability of large open geographical data.

4.2. Workshop design

The workshop was designed in an online format. The total duration was 10 hours and consisted of seven sections (Table 1). As Martínez-Hernández et al. (2022) pointed out, when describing the workshop before moving on to explore the learning results, "students and mentors were able to interact orally and share their screens through an open-access videoconference platform" (p. 7). The mentors were always online to solve any trouble, guide the process, and provide continuous educative and geographic discussion. They had to introduce the purpose and organization of the whole workshop in the first 10 minutes (section 1).

The first task for students was to fill a self-evaluation sheet, Likert scaled, on their knowledge about geographic (digital) reasoning skills and urban heritage interpretation capabilities, as well as their expectation on the learning and didactic utility of the workshop (Table 2). These evaluation domains were based on the three key concepts of the didactic framework of the workshop (GRS, HIC and DTA; see Methodology), which shaped the workshop's educative goals.

Before the students started with the assignment (sections 5 and 6; Table 1), they received two one-hour lectures (sections 3 and 4; Table 1). The first one was about the content (urban heritage) and the second one was about the technical tool (basics of web GIS).

Urban heritage was presented as the thematic axis for the geographic competencies the workshop aimed to develop. This way, students were formed to face heritage interpretation capabilities in the context of geography education: to invoke critical thinking at the role of heritage in urban spaces (HIC), under the framework of critical heritage studies (Smith, 2006). So, heritage is conceived as a selective (HIC.1) process of meaning (HIC.2) and values creation (HIC.3), not objective nor necessary material (HIC.3), which can be studied in spatial settings and shared through the concept of landscape biography (Kolen & Renes, 2015) (HIC.4).

The second lecture focused on conventional cartographic fundaments, as the basis for digital cartography, that could be mobilized for enhancing geographic reasoning skills. Students were taught about how cartography allows solving three main problems for the graphic representation of a spherical surface on a plane [GRS.4]: (i) to take a large space into a drawn little space (scale) [GRS.3], (ii) to take a spherical surface -Earth- into a plane -map- (projection and coordinates systems) [GRS.2]; and (iii) to take a three-dimensional space -reality- to a bi-dimensional space

(topography) [GRS.2]. Digital cartography was presented in terms of Geo-Information technologies. They are technologies which provide information related to spaces [GRS.1] and allow for its analysis [GRS.4]. Important ones are GPS (Global Positioning System), GIS (Geographical Information System) and Web GIS (cloud data). The workshop was based on the latter, thanks to its wide potential didactic use. Subsequently, we presented ArcGIS Online, as the currently most used web GIS portal. It is part of the well-known ESRI GIS software. StoryMaps are storytelling webpages from ArcGIS Online, which are structured by an interactive digital map or group of maps which can be combined with text, images and audio-visual content. These digital maps allowed students to create (GRS.4a), interact (GRS.4b), and interpret (GRS.4c) geographic representations.

Table 1. Structure of the workshop.

Section	Duration
1.- Presentation	10 minutes
2.- Self pre-evaluation	20 minutes
3.- Theoretical lecture I: urban heritage	1 hour
4.- Theoretical lecture II: web GIS	1 hour
5.- Practical lecture I: story maps for the local city	3,5 hours
6.- Practical lecture II: story maps for the foreign city	3,5 hours
7.- Self post-evaluation	30 minutes

Table 2. Self-evaluation items (adapted from Martínez-Hernández et al., 2022, p. 9).

Theme	Items	Evaluation domain
General questions	The competencies I will acquire in this workshop will help me become a better teacher	Didactic transference ability
	I feel motivated to participate in the workshop	Didactic transference ability (learning expectation)
	Working with web GIS (interactive digital cartography) is useful for didactical purposes	Didactic transference ability
	I feel motivated to use web GIS (interactive digital cartography) myself, also after the workshop	Didactic transference ability (learning expectation)
	Pedestrian urban mobility should get priority over other urban polluting and not healthy mobility forms	Geographic reasoning skills
	Didactic activities with interactive digital cartography (web GIS) are effective for dealing with unequal access to educational activities by students with different purchasing power	Didactic transference ability
	Participating in a workshop about the heritage of both a well-known city and an unknown one is effective for developing a feeling of European citizenship	Heritage interpretation capabilities
Case studies	I am motivated to design the local/foreign route during the workshop	Didactic transference ability (learning expectation)
	I am motivated for researching heritage elements in local/foreign city for designing the route during the workshop	Heritage interpretation capabilities
	On-site fieldwork would improve the quality of my local/foreign route	Geographic reasoning skills
	I know the local/foreign city well	Geographic reasoning skills
	Prior knowledge about the city is crucial to choose adequate heritage elements and design a good route	Geographic reasoning skills
Current knowledge and skills	My GIS skills are…	Geographic reasoning skills (digital competencies)
	My ability to work with web GIS (interactive digital cartography) for didactical purposes is…	Geographic reasoning skills (digital competencies)
	My general understanding of what heritage is, is…	Heritage interpretation capabilities
	My theoretical insights about heritage are…	Heritage interpretation capabilities
	My skills to identify and interpret urban heritage are…	Heritage interpretation capabilities

Finally, when students finished their assignment, they were asked to complete a post-evaluation sheet (section 7; Table 1), as a self-assessment process of initial didactic transference abilities. It consisted of the same items as the pre-evaluation sheet, to allow quantification of their improved competencies.

4.3. Didactic meaning of the intended learning outcomes

After the theoretical and practical classes, the participants were expected to be able to explore different heritage components, locate coherent urban elements, think about an appropriate didactical approach, track a realistic pedestrian route, and design a well-suited story map website. These tasks were needed to complete their assignment. Correct execution would imply the acquisition of the geography learning that the workshop aimed to achieve. Table 3 shows in what didactic way every task could lead to competency acquisition in relation with an intended type of geography and educational learning outcome, according to the didactic framework of the research.

Table 3. Didactic meaning of the intended learning outcomes from the workshop tasks.

Assignment	Task	Learning outcome	Competencies
To decide on the heritage values to highlight in the routes	To explore different heritage approaches	Heritage interpretation capabilities	HIC.1. Discovery and access HIC.2. Analyze and evaluate HIC.3. Use and create HIC.4. Information sharing
To select adequate stops for the routes	To locate coherent urban elements	Geographic reasoning skills	GRS.2. The understanding of spatial data visualization GRS.4a. The creation of digital geographic representation
To manage a well-justified educational utility of the stops	To think about an appropriate didactical approach	Didactic transference ability	DTA.2. Didactic competency DTA.3. Communicative competency DTA.4. Digital competency DAT.6. Cultural and ethical competency
To create suitable school routes	To track a realistic pedestrian route	Geographic reasoning skills	GRS.2. The understanding of spatial data visualization GRS.3. Working with scales GRS.4a. The creation of digital geographic representation
To present web GIS story maps of the routes	To design a well-suited story map website	Geographic reasoning skills	GRS.1. The identification of geographical spaces GRS.2. The understanding of spatial data visualization GRS.3. Working with scales GRS.4(a,b,c). The creation, interaction and interpretation of digital geographic representation

4.4. Didactic basis for evaluation

The evaluation sheets were formed by items which students had to fill to make a self-assessment of their prior and posterior knowledge and expectations (see Table 2). Items were the same for the pre- and post- evaluation sheet so that a longitudinal analysis was possible for students learning awareness, in terms of geographical reasoning skills, heritage interpretation capabilities and didactic transfer ability. These same types of intended learning outcomes were used by the mentors to evaluate the students' final story maps. Assignment statements that define these learning outcomes can be used as evidence items (Table 4), punctuating their presence/correction in a Likert scale.

5. Discussion

The existing literature on virtual field trips, web-based GIS and online story maps already shows that this type of didactic strategies can generate the development of geographical and digital skills (Kim & Bednarz, 2013; Álvarez-Otero & Lázaro-Torres, 2017; Martínez-Hernández et al., 2022), even if some of the advantages of real field trips are hard to reproduce in a digital format (Carver et al., 2004; Egiebor & Foster, 2019; Henry & Semple, 2012; Mead et al., 2019). The workshop led the clear acquisition of geographical competencies among the students involved (Martínez-Hernández et al., 2022).

It is important to note that our focus on urban heritage as a point of departure was a conscious one. Although other reported web-based GIS activities had other thematic focuses, such as tourism (Martínez-Hernández et al., 2021) or landscape (De Lázaro-Torres et al., 2017), urban heritage has previously been also used in didactic studies of geography (Delgado-Peña et al., 2017), due to its structuring role in the configuration of people's socio-spatial identities and urban space (Graham et al., 2000). To contribute to a critical heritage conception, which requires critical thinking skills (Nowacki, 2021), the workshop included a theoretical introduction lecture about the critical study of heritage (Smith, 2006) and the

creation of a story map in a well-known native city and in another foreign, unknown city. For instance, to select the heritage elements of the local city, students had to be didactically challenged not to settle for the traditional heritage they already knew about, but rather investigate other urban heritage values and even contemplate intangible heritage. It was important to opt for the study of cities that offer a good range of heritage values for the workshop implementation. Such is the case of the exemplification in the cities of Madrid and Krakow, as both hold World Heritage Sites and are conformed as great historical metropolises with great cultural and educational dynamism (Sánchez-Rivera, 2022; Pawlusiński & Kubal, 2018). Hence, picking a suitable thematic vector, which mediates between, on the one hand, the intended spatial reasoning and didactic learning objectives and, on the other hand, the online GIS platform, was important in the overall workshop design.

Table 4. External evaluation items for the story maps (adapted from Martínez-Hernández et al., 2022, p. 10).

Learning outcome	Competencies	Items
Geographical reasoning skills	GRS.2, GRS.4	The student places the chosen elements where they are actually located
	GRS.3	The student uses an adequate visualization scale
	GRS.1, GRS.2, GRS.3, GRS.4	The student elaborates a route sequence which is appropriate for the task's purposes (can be completed in real life in <5 hours, elements are located close to each other, …)
	GRS.1	The student adequately manages the timing for the configuration of the route
Heritage interpretation capabilities	HIC.1, HIC.2	The student selects the heritage elements for the route in such a way that it shows that the designed route has a clear concept and storyline
	HIC.4	The student links an adequate image/video to every heritage element
	HIC.3	The student writes an adequate description for every heritage element in the route reflecting on the heritage values that appear in the chosen heritage element
Didactic transference ability	DTA.2(a,f), DTA.3	The route is adapted to the cognitive capabilities of 12-years old students
	DTA.2(a,b,e,f), DTA.3	The route is structured in a clear learning and motivating sequence
	DTA.4	The story map is visually attractive
	DTA.2(a,b,f), DTA.3, DTA.6	The stops are clearly and rigorously explained

By focusing on the workshop's design in this paper, we looked at the reasons why a web-based GIS workshop can be useful for geographic education, in terms of HIC, GRS and DTA. First, web-based GIS can be useful for geographic education in terms of HIC. In this workshop, the assignment of identifying and selecting certain heritage values that were to be highlighted in the routes generated a learning outcome formed by heritage interpretation capabilities, such as those specified by Öztemiz (2020). We tested this through items on the coherence and level of critical reflection in the story map's heritage narrative and the selection of representative images or videos of heritage elements. Coherence of the selected heritage values and locations was a manifestation of the student's ability to discover, access, analyze and evaluate heritage values (HIC.1 and HIC.2). Creating a relevant and critical description of these values reflected their ability to use and create discourses around heritage (HIC.3). The audiovisual link was an expression of the ability to share heritage information (HIC.4). As reviewed by Röll and Meyer (2020), a good number of geographical didactic experiences manage to develop HIC.1, HIC.2, and to a certain extent HIC.4, but HIC.3 is compromised in Eurocentric heritage education, due to a lack of a global comparison approach. So, it is necessary to introduce didactic strategies of critical thinking and comparison activities. This is why our workshop design was able to foster a critical geographic-based heritage education.

Second, the design of a web-based GIS workshop can foster the GRS proposed by Bodzin et al. (2014). For this workshop, the adequacy of the stops in the story map was evaluated because it implied locating urban elements, for which it was necessary that the students in question understood how spatial data is visualized (GRS.2) and how geographic space is digitally represented (GRS.4). Knowing how to locate is a fundamental competency in the didactics of Geography, for which successful teaching experiences have been designed for decades, and which has incorporated new technologies (Paraskevas et al., 2010). The workshop also evaluated the adequacy of the visualization scale, that is, the ability to work with scales (GRS.3). It was necessary that the layout of a route gave contiguity to the stops. This aspect of the workshop seems to benefit from digital exercises over those on paper (Zaleshina & Zaleshin, 2017). This was because the digital platform offers the possibility of visually manipulating the scales on digital maps with different layers, which allows making the proportional representation of space immediately visible and therefore more understandable. Finally, the evaluation of the route and its presentation as a whole reflected the development of all the GRS. Creating a viable route as a pedestrian itinerary for children implied that the student was able to provide a good identification of the geographical spaces (GRS.1), with a realistic completion time and accessibility guarantees to children (for whom the route was designed). The use of itineraries on a map has been shown to be effective from a very early age in improving the understanding of geographic space and the way in which it is represented (Jerez-Carañana & Morales-Hernández, 2021). Presenting this route through a web GIS implied the creation, interaction and interpretation of the digital geographic representation (GRS.4). The created spatial data were driven to the digital platform of the story maps (GRS.2) and they had to be visualized at an adequate scale (GRS.3). They were also linked to interaction tools to access the heritage and didactic interpretation that had been carried out for these geographic data. One of the success factors of the educational use of story maps was the availability of a multitude of spatial data in the cloud, free of charge and with standardized information (Bartha & Kocsis, 2022).

The technical requirement to handle a GIS, previously unknown by not-geography-specialized students, is sometimes a restraint to the development of geographic skills (Summerby-Murray, 2001). This could also be the case for the target participants of our workshop, who were teachers in training. However, this risk was solved, as Henry and Semple (2012) pointed out, by using an attractive and non-intimidating web GIS

platform. The participants were able to master its basic features after just a one-hour lesson, thereby crucially understanding that GIS is a methodological tool and not the primary object of study. In fact, there are studies that show that the use of GIS for terrestrial exploration is effective for lifelong learning (Idrizi et al., 2021), implying that it can be valid as a didactic resource for inexperienced students. The accessible and interactive interface of current web GIS (West & Horswell, 2018; Kerski, 2021) and the inclusion in our workshop of an initial lecture on web GIS were expected to contribute to success (Martínez-Hernández et al., 2022).

Our workshop was designed to be worked on individually, to ensure personal geographical learning, with good results (Martínez-Hernández et al., 2022). Nevertheless, group work could be considered in the design, perhaps on some specific tasks, if cooperative learning and social skills are included (Le et al., 2018) and individual learning is not compromised. Group work has already been shown to be effective in GIS-based learning (Carver et al., 2004; Idrizi et al., 2021).

Third, the design of a web-based GIS workshop can also foster DTA. On the one hand, the workshop's evaluation method allowed a longitudinal study of the participants' prior and post-workshop knowledge, thereby giving indications about DTA acquisition. Our longitudinal study used a self-assessment method. This was adequate for teacher trainees because it promoted an identity feeling of being a professional teacher (Powell, 2000). Contrary to other evaluative methods, which are not so reflective, this process contributed to the participants' self-awareness regarding the workshop's didactic effectiveness, promoted attitudes of trust, and allowed participants to reflect on didactic transposition processes. This self-awareness is a prior phase to the development of didactic competency. It is widely used in all types of teaching practices with teachers in training (Cigala et al., 2011), due to its usefulness in preparing for the teaching profession (Powell, 2000), also in geography, both digital (Paraskevas et al., 2010) and off-line (Martínez-Hernández & Albaladejo-Albaladejo, 2021). The best moment for a self-assessment method is close after the didactic activity (Tejeiro et al., 2012), so that students can remember all their work and achievement better. This is why we timed this evaluation immediately at the end of the workshop.

On the other hand, the designed workshop tasks allowed the development of most of the DTA proposed by Moreira et al. (2023). Only those that exclusively depended on the personal skills of each teacher (DTA.1) and their interpersonal skills (DTA.5) were left out. The external evaluation items allowed to assess the resulting didactical approach. The DTA.4 (digital competency) showed to the extent that the story maps were visually attractive. A digital resource is preferable to other materials (the story map compared to a static map on paper) when it provides added pedagogical value (Lomos et al., 2023). In this case, the added value was to facilitate cartographic interpretation thanks to the possibility of an easy, visual, and attractive GIS interface (Zaleshina & Zaleshin, 2017). This added pedagogical value is one of the main success factors of web GIS for its didactic use (Carver et al., 2004; Henry & Semple, 2012; Martínez-Hernández et al., 2022). The rest of the evaluative items, that is, the adequacy of the adaptation of the route to the cognitive capacity of the 12-years-old students, a clear stops' sequencing of learning and motivation, and a clear and rigorous explanation of the stops, were a consequence of applying communicative (DTA.3) and properly didactic (DTA.2) skills. Communication skills were necessary to adapt the explanation of the contents (DTA.3a) and make them attractive (DTA.3b) based on the psycho-cognitive progressing capacity of the students. Evaluating this was possible by looking at the consistency of the route layout, its heritage narrative, its stimulating nature for the route's target audience, as well as the presence of clear and rigorous descriptions at each stop. In the literature there is a consensus on the importance of communicative competency for the teaching practice, since it enables knowledge to be adapted to the language required in each educational context (Neira-Piñeiro et al., 2018). Hand in hand with communicative competency, in the workshop design we observed the didactic competencies of both using appropriate learning strategies (DTA.2a), such as active learning for the implementation of the route, and maintaining a rigorous disciplinary discourse (DTA.2f), e.g., the heritage knowledge acquired needed to create the route. The ability to draw a coherent route, with well-explained stops according to the age of the students, fosters a potential active and disciplinary learning. Active learning is fundamental in the current teaching paradigm, more so than the traditionally valued passive reception of knowledge (Prince, 2004).

Determining whether the content sequencing is clear and the content itself is adequate also reflects the didactic competency on managing lessons (DTA.2b). The extent to which this sequence was also stimulating for the target audience reflects the didactic competency on coaching and mentoring (DTA.2e). Precisely this point stands out in the literature on the didactic experiences with web GIS: they are an extraordinary resource to stimulate students (Henry & Semple, 2012; Martínez-Hernández et al., 2021). In short, the balanced combination of theoretical (geographical space), technological (digital representation) and pedagogical (didactic route design) learning ensured effective didactic transfer based on the TPACK (Mishra & Koehler, 2006) and Four Balance models (Lomos et al., 2023) and the theory of didactic transposition (Bosch & Gascon, 2006). Finally, it should be noted that the workshop also contemplated cultural and ethical competency (DTA.6), as an attitudinal approach to describe the stops of the story maps. Critical heritage values were highlighted, adjusted to the theoretical lesson at the beginning of the workshop. Not forgetting an ethical approach when transmitting content is very important in the sustainable development paradigm that frames the current world through the 2030 Agenda for Sustainable Development (Leininger-Frézal & Sprenger, 2022; Martínez-Hernández & Mínguez, 2023), understanding that education is a fundamental means for global citizen formation, based on critical democratic thinking (De Arriba-Rivas & Ibáñez-Ruiz del Portal, 2023). Digital mapping experiences have been also successfully used to promote a global digital citizenship (Panek & Netek, 2019).

6. Conclusions

GIS have a large presence in current geographic research, and new educational curricula begin to reflect this presence. However, in teacher training there is a significant lack in the teaching of geodigital skills, necessary to didactically use GIS. Based on the scientific literature, designing and subsequently applying didactic practices on digital mapping can be an effective way of introducing these competencies in teacher training. Insights from the didactics of Geography can assist with designing adequate workshops to facilitate not just the acquisition of geographical reasoning skills but also to mobilize these skills for didactical purposes. In this paper, we selected a theme with a geographical focus -urban heritage- to design a workshop centered on digital mapping through a story maps application, using web GIS technology. The workshop's effectiveness was studied by Martínez-Hernández et al. (2022), but that paper did not analyze the workshop's pedagogical approach. This paper zoomed in on the key design features of the workshop, focusing on the didactic framework upon which these features were hinged.

Using a framework of competencies provided by the scientific literature, the workshop tasks were related to the acquisition of geographic reasoning skills (including geodigital competencies), heritage interpretation capabilities, and didactic transfer ability. Our evaluative model had been designed to determine to what extent participants would achieve this acquisition. We discussed how: (i) the search and justification of critical heritage values to create a story map corresponds to a designed task that brings HIC, based on the necessary critical thinking to explore urban heritage of known and unknown cities; (ii) the drawing of a route, the location of stops, and the display in a digital map environment are design strategies to develop GRS; (iii) the adaptation of the story map's content to the level of the target audience and its clear and attractive explanation

and sequencing require didactic transposition skills, in a virtual or hybrid teaching environment; and (iv) the improvement and generalization of web GIS and the availability of spatial data in the cloud may have alleviated the conventional obstacles to a good didactic use of GIS.

The workshop was targeted at students enrolled in a higher education teacher training program. We reflected on the importance of the design features that allowed making the most of online web-based GIS workshops. The main design component consisted of having a didactic basis framework, which we constructed based on GRS, HIC and DTA. All the working and evaluative tasks of the workshop had been linked to this framework of competencies, meaning that all individual design features were didactically grounded. Future adaptations or optimizations of the workshop should start with reflecting on the didactic framework that underpinned the workshop's design, before making practical changes to the design itself.

The study is limited by the specific didactic framework which has been used. For sure, other frameworks could be also suitable, or even mixed ones. This research is theoretical, and it complements a previous experimental investigation (Martínez-Hernández et al., 2022) using a concrete but small sample (n=15). That study lacked analysis of the pedagogical approach upon which the workshop was hinged, which has been solved in the present article. However, both studies still lack large-scale implementation. It is necessary to compare the theoretical postulates (this research) and the reported learning outcomes (previous study) in other, notably larger didactic experiences. In the Anthropocene, accurate teaching projects like this workshop are more needed, above all among primary and secondary teachers, who contribute to the making of future digital and global citizens. In conclusion, this paper could become a good-practice model for teacher trainees who present a lack of geographical and digital knowledge but will have to teach about it.

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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

Atalar, F.B., & Ergun, M. (2018). Evaluation of the knowledge of science teachers with didactic transposition theory. *Universal Journal of Educational Research, 6*(1), 201-210. https://doi.org/10.13189/ujer.2018.060130

Bartha, G., & Kocsis, S. (2022). Standardization of geographic data: the European INSPIRE Directive. *European Journal of Geography, 13*(2), 79-89. https://eurogeojournal.eu/index.php/egj/article/view/36

Blanford, J.I., Bowlick, F., Gidudu, A., Griffin, A.L., Kar, B., Kemp, K., de Róiste, M., de Sabbata, S., Sinton, D., Strobl, J., Tate, N., Toppen, F., & Unwin, D. (2022). Lockdown lessons: An international conversation on resilient GI science teaching. *Journal of Geography in Higher Education*, *46*(1), 7–19. https://doi.org/10.1080/03098265.2021.1986687

Bodzin, A. (2011). The implementation of a geospatial information technology (GIT)-supported land use change curriculum with urban middle school learners to promote spatial thinking. *Journal of Research in Science Teaching, 48*(3), 281–300. https://doi.org/10.1002/tea.20409

Bodzin, A.M., Fu, Q., Kulo, V., & Peffer, T. (2014), Examining the Effect of Enactment of a Geospatial Curriculum on Students' Geospatial Thinking and Reasoning. *Journal of Science Education Technology, 23,* 562–574. https://doi.org/10.1007/s10956-014-9488-6

Bosch, M., & Gascon, J. (2006). Twenty-Five Years of Didactic Transposition. *ICMI Bulletin, 58*, 51-65. https://edisciplinas.usp.br/pluginfile.php/226929/mod_folder/content/0/BoschGascon%202006.pdf?forcedownload=1

Bryson, J.R., & Andres, L. (2020). Covid-19 and rapid adoption and improvision of online teaching: Curating resources for extensive versus intensive online learning experiences. *Journal of Geography in Higher Education*, *44*(4), 608–623. https://doi.org/10.1080/03098265.2020.1807478

Carver, S., Evans, A., & Kingston, R. (2004). Developing and testing an online tool for teaching GIS concepts applied to spatial decision-making. *Journal of Geography in Higher Education*, *28*(3), 425–438. https://doi.org/10.1080/0309826042000286983

Castree, N. (2015). Geography and global change science: Relationships necessary, absent and possible. *Geographical Research*, *53*(1), 1-15. http://doi.org/10.1111/1745-5871.12100

Chevallard, Y. (1985). *La transposition didactique - Du savoir savant au savoir enseigne [Didactic transposition: From scholarly knowledge to taught knowledge]*. La Pensée sauvage.

Cigala, A., Venturelli, E., & Bassetti, M. (2019). Reflective practice: A method to improve teachers' well-being. A longitudinal training in early childhood education and care centers. *Frontiers in Psychology, 10*, 2574. https://doi.org/10.3389/fpsyg.2019.02574

Collins, L., & Mitchell, J. T. (2019). Teacher training in GIS: What is needed for long-term success? *International Research in Geographical and Environmental Education, 28*(2), 118-135. https://doi.org/10.1080/10382046.2018.1497119

De Arriba-Rivas, C., & Ibáñez-Ruiz del Portal, E. (2023). Teachers' insights from an ethics of care programme aimed at promoting global citizenship education in the classroom. *Teaching and Teacher Education, 126*, 104075. https://doi.org/10.1016/j.tate.2023.104075

De Lázaro Torres, M. L., De Miguel González, R., & Morales Yago, F. J. (2017). WebGIS and geospatial technologies for landscape education on personalized learning contexts. *ISPRS International Journal of Geo-Information*, *6*(11), 350. https://doi.org/10.3390/ijgi6110350

Delgado-Peña, J.J., Subires-Mancera, M.P., & Arias-García, J. (2017). Spatial Skills Development in Outdoor Education a Comparison Between Graduate Students at the Universities of Malaga (Spain) and Linkoping (Sweden). *European Journal of Geography*, 8(3), 41-66. https://eurogeojournal.eu/index.php/egj/article/view/303

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

Dixon, D.P., & Whitehead, M. (2008). Technological trajectories: old and new dialogues in geography and technology studies. *Social & Cultural Geography, 9*(6), 601-611. https://doi.org/10.1080/14649360802320560

Egiebor, E. E., & Foster, E. J. (2019). Students' perceptions of their engagement using GIS-storymaps. *The Journal of Geography*, *118*(2), 51–65. https://doi.org/10.1080/00221341.2018.1515975

Eliot, J. (2000). *The nature and measurement of spatial intelligence*. College Park.

Friess, D.A., Oliver, G.J.H., Quak, M.S.Y. & Lau, A.Y.A. (2016). Incorporating 'Virtual' and 'Real World' Field Trips into Introductory Geography Modules. *Journal of Geography in Higher Education, 40*(4), 546–564. https://doi.org/10.1080/03098265.2016.1174818

Geraghty, E., & Kerski, J. (2020). The impact of COVID-19 on geography, GIS, and education. *Journal of Research and Didactics in Geography*, *2*(9), 53-66. https://doi.org/10.4458/3617-06
Ghazali, F. (2022). Towards an optimal blended learning model during disrupted education periods. *Pegem Journal of Education and Instruction, 12*(3), 97–105. https://doi.org/10.47750/pegegog.12.03.11
Giannakou, O., & Klonari, A.I. (2019). Digital storytelling in education using webGIS. *European Journal of Geography, 10*(3), 154-172. https://eurogeojournal.eu/index.php/egj/article/view/190
Gibson, C., Brennan-Horley, C., & Warren, A. (2010). Geographic information technologies for cultural research: Cultural mapping and the prospects of colliding epistemologies. *Cultural Trends, 19*(4), 325-348. https://doi.org/10.1080/09548963.2010.515006
Golledge, R.G. (2002). Presidential Address: The Nature of Geographic Knowledge. *Annals of the Association of American Geographers*, *92*(1), 1–14. http://www.jstor.org/stable/1515264
Graham, B., Ashworth, G.J., & Tunbridge, J.E. (2000). *A geography of heritage. Power, culture and economy.* Routledge.
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
Holgersen, S. (2021). How to incorporate theory in (urban) field trips: The built environment as concrete abstraction. *Journal of Geography in Higher Education*, *45*(3), 361–379. https://doi.org/10.1080/03098265.2020.1833317
Hughes, C. (2020). *Some implications of COVID-19 for remote learning and the future of schooling*. IBE-UNESCO. https://bit.ly/2cFXDnm
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
Idrizi, B., Pashova, L., & Nikolli, P. (2021). Lifelong Training Program on QGIS Tools for Earth Observation Sciences in South-East Europe. *European Journal of Geography, 12*(3), 88-102. https://eurogeojournal.eu/index.php/egj/article/view/109
Ito, H., & Igano, C. (2021). International fieldwork as skills development: An exploratory study. *Journal of Geography in Higher Education*, *45*(3), 417–434. https://doi.org/10.1080/03098265.2020.1836481
Jerez-Carañana, M., & Morales-Hernández, A.J. (2021). Personal maps and school mapping: abilities of students in the first stage of primary education. *Educatio Siglo XXI*, *39*(2), 371–394. https://doi.org/10.6018/educatio.410771
Kerski, J.J. (2021). Innovative Instruction Using Field Surveys, Interactive Maps, Dashboards, and Infographics. *The Geography Teacher, 18*(1), 45–54. https://doi.org/10.1080/19338341.2020.1861051
Kidd, W., & Murray, J. (2020). The Covid-19 pandemic and its effects on teacher education in England: How teacher educators moved practicum learning online. *European Journal of Teacher Education*, *43*(4), 542–558. https://doi.org/10.1080/02619768.2020.1820480
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
Leininger-Frézal, C. & Sprenger, S. (2022). Virtual Field Trips in Binational Collaborative Teacher Training: Opportunities and Challenges in the Context of Education for Sustainable Development. *Sustainability, 14*, 12933. https://doi.org/10.3390/su141912933
Lomos, C., Luyten, J. W. H., & Tieck, S. (2023). Implementing ICT in classroom practice: What else matters besides the ICT infrastructure? *Large-Scale Assessments in Education, 11*(1), 1-28. https://doi.org/10.1186/s40536-022-00144-6
Mahlangu, V.P. (2018). *The Good, the Bad, and the Ugly of Distance Learning in Higher Education. Trends in E-Learning*. Intechopen. https://doi.org/10.5772/intechopen.75702
Martínez-Hernández, C., & Albaladejo-Albaladejo, S. (2021). Geohistorical, Didactic, and Linguistic Competencies Learning through a Bilingual (Spanish/English) Fieldtrip Project With Teachers in Training. *Tuning Journal for Higher Education, 9* (1), 65-102. https://doi.org/10.18543/tjhe-9(1)-2021pp65-102
Martínez-Hernández, C., Yubero, C., Ferreiro-Calzada, E., & Mendoza de Miguel, S. (2021). Didactic use of GIS and Street View for tourism degree students: Understanding commercial gentrification in large urban destinations. *Investigaciones Geográficas*, *75*, 61–85. https://doi.org/10.14198/INGEO2020.MYFM
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*. https://doi.org./10.1080/03098265.2022.2155935
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*, Ahead-of-Print. https://doi.org/10.1108/IJSHE-09-2022-0316
Maude, A. (2023). Using geography's conceptual ways of thinking to teach about sustainable development. *International Research in Geographical and Environmental Education, 32*(1), 4-19. https://doi.org/10.1080/10382046.2022.2079407
Mead, C., Buxner, S., Bruce, G., Taylor, W., Semken, S., & Anbar, A.D. (2019). Immersive, interactive virtual field trips promote science learning. *Journal of Geoscience Education*, *67*(2), 131–142. https://doi.org/10.1080/10899995.2019.1565285
Meadows, M.E. (2020). Geography education for sustainable development. *Geography and Sustainability*, *1*(1), 88-92. https://doi.org/10.1016/j.geosus.2020.02.001
Mishra, P., & Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x
Moreira, M., Arcas, B.R., Sánchez, T.G., García, R.B., Melero, M.R., Cunha, N.B., Viana, M.A., & Almeida, M. (2023). Teachers' pedagogical competences in higher education: A systematic literature review. *Journal of University Teaching & Learning Practice, 20*(1), 90-123. https://doi.org/10.53761/1.20.01.07
Muenchow, J., Schäfer, S., & Krüger, E. (2019). Reviewing qualitative GIS research—Toward a wider usage of open-source GIS and reproducible research practices. *Geography Compass, 13*(6), e12441. https://doi.org/10.1111/gec3.12441
National Research Council (2006). *Learning to think spatially: GIS as a support system in K-12 education*. National Academy Press.
Neira-Piñeiro, M.R., Sierra-Arizmendiarrieta, B., & Pérez-Ferra, M. (2018). Communicative competence in the degree in early childhood education and the degree in primary education teacher. A proposal of achievement criteria as a tool for its analysis and assessment. *Revista Complutense De Educación, 29*(3), 881-898. https://doi.org/10.5209/RCED.54145
Nowacki, M. (2021). Heritage Interpretation and Sustainable Development: A Systematic Literature Review. *Sustainability, 13*, 4383. https://doi.org/10.3390/su13084383

Öztemiz, S. (2020). Cultural heritage literacy: A survey of academics from humanities and social sciences. *Journal of Librarianship and Information Science, 52*(3), 818-831. https://doi.org/10.1177/0961000619872529
Panek, J., & Netek, R. (2019). Collaborative mapping and digital participation: A tool for local empowerment in developing countries. *Information, 10*, 255. https://doi.org/10.3390/info10080255
Paraskevas, A., Lambrinos, N., & Psillos, D. (2010). A study of blended didactic approach to teacher professional development in Geography. *European Journal of Geography, 1*(1), 46-60. https://eurogeojournal.eu/index.php/egj/article/view/15
Pawlusiński, R., & Kubal, M. (2018). A new take on an old structure? Creative and slow tourism in Krakow (Poland). *Journal of Tourism and Cultural Change, 16*(3), 265-285. https://doi.org/10.1080/14766825.2017.1330338
Prince, M. (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education*, *93*, 223-232. https://dx.doi.org/10.1002/j.2168-9830.2004.tb00809.x
Powell, L.A. (2000). Realising the value of self-assessment: The influence of the business excellence model on teacher professionalism. *European Journal of Teacher Education, 23*(1), 37-48. https://doi.org/10.1080/026197600411616
Röll, V., & Meyer, C. (2020). Young people's perceptions of world cultural heritage: Suggestions for a critical and reflexive world heritage education. *Sustainability, 12*(20), 1-18. https://doi.org/10.3390/su12208640
Sánchez-Rivera, J.A. (2022). World Heritage and teaching innovation for Teacher Training: the case of Madrid, "Landscape of Light". In C. Gonzálvez Maciá et al. (Eds.), *New educational challenges and interdisciplinary research* (pp. 439-452). Aula Magna-McGraw Hill.
Schultz, R. B., & DeMers, M. N. (2020). Transitioning from emergency remote learning to deep online learning experiences in geography education. *The Journal of Geography*, *119*(5), 142–146. https://doi.org/10.1080/00221341.2020.1813791
Senaratne, S., Kagioglou, M., Amaratunga, D., Baldry, D., Aouad, G., & Bowden, A. (2005). Research knowledge transfer into teaching in the built environment. *Engineering, Construction and Architectural Management, 12*(6), 587-600. https://doi.org/10.1108/09699980510634146
Silberman, N.A. (2012). Heritage interpretation and human rights: Documenting diversity, expressing identity, or establishing universal principles? *International Journal of Heritage Studies, 18*, 245–256. https://doi.org/10.1080/13527258.2012.643910
Smith, L. (2006). *The uses of heritage*. Routledge.
Summerby-Murray, R. (2001). Analysing heritage landscapes with historical GIS: Contributions from problem-based inquiry and constructivist pedagogy. *Journal of Geography in Higher Education*, *25*(1), 37–52. https://doi.org/10.1080/03098260020026624
Tejeiro, R.A., Gómez-Vallecillo, J.L., Romero, A.F., Pelegrina, M., Wallace, A., & Emberley, E. (2012). Summative self-assessment in higher education: Implications of its counting towards the final mark. *Electronic Journal of Research in Educational Psychology, 10*(2), 789-812. http://www.investigacion-psicopedagogica.org/revista/new/english/ContadorArticulo.php?707
West, H., & Horswell, M. (2018). GIS has changed! Exploring the potential of ArcGIS Online. *Teaching Geography*, *43*(1), 22–24. https://uwe-repository.worktribe.com/output/860980
Yan, Y., Cai, F., Feng, C., & Chen, Y. (2022). University students' perspectives on emergency online GIS learning amid the COVID-19 pandemic. *Transactions in GIS, 26*(6), 2651-2668. https://doi.org/10.1111/tgis.12977
Zaleshina, M., & Zaleshin, A. (2017). The brain as a multi-layered map. Scales and reference points for pattern recognition in neuroimaging. *European Journal of Geography, 8*(1), 6-31. https://eurogeojournal.eu/index.php/egj/article/view/278

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