VETTONIA PROJECT: A VIRTUAL ENVIRONMENT FOR THE EDUCATIONAL DISSEMINATION OF THE IRON AGE

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ABSTRACT:

The VETTONIA project aims to disseminate the rich heritage from the Iron Age of the western Iberian Peninsula and the archaeological investigations carried out on this topic in recent years. The project utilizes new technologies such as virtual tours, 3D models, and impressions to create interactive and stimulating ways to access the results of the most recent archaeological research. Using these resources, lectures and seminars are being given in various forums with diverse types of audiences to present the virtual tours and the rest of the dissemination initiatives. In addition, the project presents its different initiatives during the annual archaeological interventions developed in the *oppidum* of Ulaca (Solosancho, Ávila, Spain), with good reception by the attending public. The VETTONIA project represents a pioneering dissemination experience that takes advantage of the educational opportunities offered by new technologies. In the future, tools such as virtual tours to archaeological sites may prove essential in classroom teaching at different levels and could promote sustainable tourism in fragile natural environments such as those that constitute the major settlements of the Late Iron Age (ca. 400–50 BC).

1. INTRODUCTION

The Nara Document on Authenticity, which was adopted by the International Council on Monuments and Sites in 1994 (ICOMOS, 1994), emphasizes the importance of understanding the cultural values and meanings associated with a cultural heritage site in order to properly conserve and manage it. These values can be both tangible, concerning the physical properties of the site, and intangible, linked to the cultural practices and traditions of the site. The International Charter of Restoration, adopted by ICOMOS in 2000 (Krakow), also highlights the importance of understanding the values of a cultural heritage site for its proper restoration and conservation, in order to ensure that it does not lose its cultural significance and sense of social identity (ICOMOS, 2000). As a rule, heritage sites are fragile, and their values can be modified over time due to different factors caused by changes in the site itself or in the surrounding context, leading to disaffection in the community that uses or interacts with the site. To avoid these facts, local communities, if involved, can help to build support for the conservation and restoration of cultural heritage sites, which is essential for their long-term preservation and management.

There are numerous actions and strategies that can be used to involve and engage society in the management and conservation of cultural heritage (e.g., Brown and Hay-Edie 2013). Some of the key strategies include: i) Education and outreach: This can include organizing educational events, workshops, and lectures on cultural heritage management and conservation, as well as developing educational materials and resources such as brochures, websites, and social media campaigns, to raise awareness of cultural heritage, and research work being carried out (if ongoing). ii) Community involvement: Involving local communities in the management and conservation of cultural heritage can be a powerful way to engage people and build support for these efforts. This can be focused on involving community members in decision-making processes, asking for their input and feedback on conservation projects, and providing opportunities for them to volunteer or get involved in hands-on conservation work. iii) Partnerships and collaboration: Building partnerships with other organizations, institutions, and individuals can help to leverage resources and expertise, and can also help to raise awareness about cultural heritage conservation efforts. All this includes partnering with local businesses, community groups, and government agencies, as well as working with international organizations and NGOs. iv) Advocacy and lobbying: Working to raise awareness about the importance of cultural heritage and the need for its conservation can contribute to build support for these efforts. This can include engaging in

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advocacy and lobbying efforts to influence policy and decision-making at the local, national, and international levels. v) And funding and resource development: Sustaining cultural heritage conservation efforts often requires significant resources (including funding). Developing strategies for fundraising and seeking out grants and other sources of financial support can be an important aspect of involving and engaging society in these efforts.

Within this context, the main objective of the VETTONIA project: a virtual environment for the dissemination of the Iron Age, financed by the Spanish Foundation for Science and Technology (FECYT), is the dissemination: i) of the rich heritage bequeathed to us by the Vetton communities; ii) of the research carried out in this field in recent years; with the aim of involving and engaging society in the management and conservation of archaeological heritage. In this sense, there are several challenges associated with the dissemination of archaeological heritage, such as: i) Physical accessibility: Numerous archaeological sites are located in remote or hard-to-reach locations, which can make it difficult for the general public to visit and experience these sites first-hand (Grima 2017). This can be particularly problematic for people with disabilities or mobility issues. ii) Context: When archaeological artifacts are displayed in museums, they are taken out of their original context, making difficult its understanding without background knowledge or additional information. This can make it challenging for people to appreciate the full significance of these objects. iii) Interpretation: Interpreting and explaining the meaning and significance of archaeological artifacts and sites can be a complex and nuanced process and can be complex for those who are not trained in archaeology or history.

To address these challenges, with a very limited financial budget, different strategies have been developed to make archaeological heritage more accessible and understandable to the general public. Thanks to geomatics, educational resources and materials have been developed (virtual tours, 3D models, 3D prints, virtual reconstructions…) with the aim of providing interpretation and context of sites and museum artifacts, while ensuring that they are well conserved and preserved. In addition, it has sought to involve local communities and stakeholders in the management and dissemination of archaeological heritage, as they have a strong connection to these sites and have contributed valuable ideas and perspectives.

In summary, this research presents the work developed in the VETTONIA project, which takes advantage of new technologies as attractive tools to bring heritage and archaeological studies closer to society. Thus, the objective is to transmit the results of the research to the global society and avoid historical knowledge remaining solely in the scientific field, as well as to promote an appreciation of archaeology and heritage among the general public (Kajda et al., 2018). In this way, this work aspires to encourage respect for our archaeological heritage, which is under considerable threat from, among other factors, looters and the illicit trade in cultural property or climate change and large forest fires. It also wishes to raise awareness of how important it is to preserve this heritage for future generations. In this sense we, as archaeologists, need more understanding about the relationship between knowledge production and public benefits (Fredheim & Watson, 2023: 61). The transfer of archaeological sites to archive reports and museum archives means, in some way, a disruption and creates problems for many audiences. New ways of archaeological communication imply making explicit the benefits of our work.

2. CONTEXTUALISATION OF THE WORK

Vettones were one of the most remarkable *populi* in Celtic Iberia. Texts addressing these populations from classical Greek and Roman authors described them as groups occupying the territory of the current provinces of Ávila and Salamanca, as well as parts of Zamora, Cáceres, and Toledo. Throughout the Late Iron Age (ca. 400–50 BC) the first cities or *oppida* arose in this area of the western Iberian Peninsula. In order to provide sustenance for their hundreds or thousands of inhabitants, these settlements held dominion over a vast territory and were typically established in strategic locations featuring significant natural defenses. Even so, settlements were reinforced by powerful walls, bands of upright stones (*chevaux-de-frise*), and ditches (Álvarez-Sanchís, 1999; Rodríguez-Hernández, 2019). The most famous *oppida* in the province of Ávila are: Ulaca, Las Cogotas, La Mesa de Miranda, and El Raso (Figure 1).

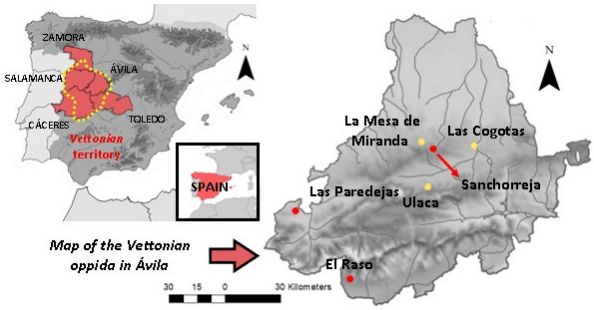

Figure 1. Location of the main Iron Age sites in the province of Ávila (Central Spain).

This work has focused on spreading the archaeological sites of Ulaca, La Mesa de Miranda and Las Cogotas (yellow dots in Figure 1) and the investigations carried out in recent years on these *oppida*.

3. VIRTUAL ENVIRONMENT FOR THE EDUCATIONAL DISSEMINATION OF THE IRON AGE

Virtual tours are digital tools that create an immersive experience of exploring different locations or spaces within a particular environment. These tours are created by stitching together a series of 360° panoramic images using specialized software, resulting in a comprehensive visualization of the space. Users can access these virtual tours from any device with internet access, providing a similar experience to physically being present at the location. Moreover, these virtual tools can incorporate additional information to enhance the user's understanding of the showcased environment (Maté-González et al., 2022). The following subsections outline the steps involved in the development of virtual tours.

3.1. Workflow for the Creation of the Virtual Tours.

The virtual tour platforms developed in this project rely on 360° images to create an immersive experience without incurring high costs. These images are presented on the platform in spherical projection and have their own coordinate system. By using this system, it is possible to place buttons (known as hotspots) at specific coordinates within a panorama and associate them with multi-source and multidisciplinary information using the angles θ and φ (Figure 2).

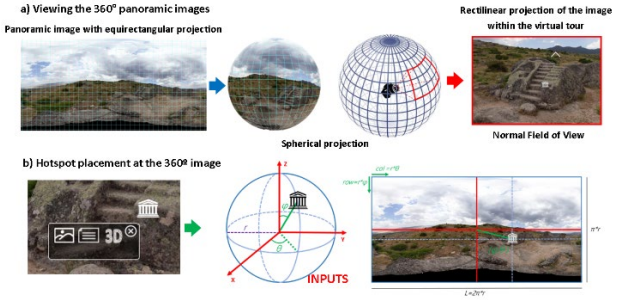

Figure 2. Workflow for the creation of the Virtual Tours. (a) Visualization of the panoramas that integrate the virtual visit. (b) Positioning of the information in the panoramas.

3.2. Panoramic Images

After carefully examining different methods for capturing panoramic images, it was decided to use a reflex camera with a fisheye lens to take seven images at 60° intervals, as well as an overhead shot. This approach, as opposed to using 360° cameras, offers greater control over parameters such as ISO, exposure, and white balance, resulting in higher quality images. The Nikon D5600 reflex camera with a 10.5mm 1: 2.8G fisheye Nikkor lens was used for this project, capable of producing 24 MPx resolution images. To achieve precise angular positioning, a photographic tripod and Manfrotto 303SPH panoramic head were requried. Before taking the photographs, the camera and lens must be calibrated on the anterior patella to align the entrance pupil with the axis of rotation and eliminate parallax. Additionally, internal camera parameters, such as aperture, exposure time, and ISO, need to be configured, along with the option to activate HDR mode. Once photographs are taken using the shooting protocol, they are processed in Hugin open-source software (http://hugin.sourceforge.net/) using the workflow outlined in Figure 3. This process includes key-point extraction and matching, distortion parameter optimization, and multi-band blending to fuse images from a radiometric perspective. Finally, the panoramic photo is generated by projecting the images into the spherical coordinate system (in .tif format).

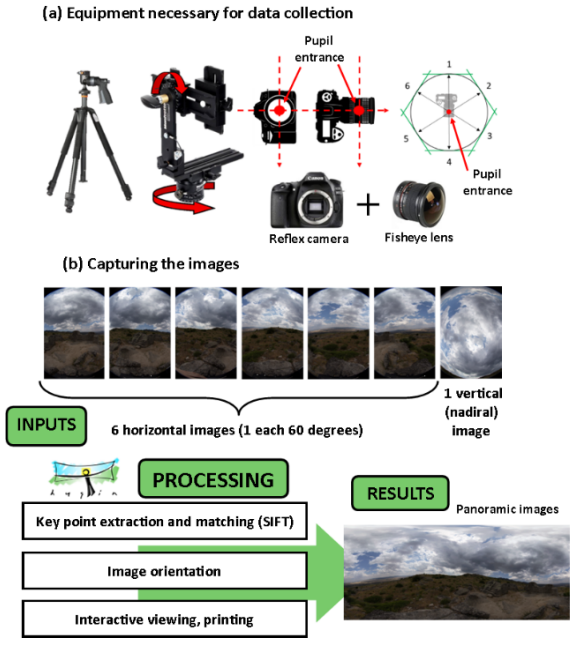

Figure 3. Protocol for data collection and processing of photographs to obtain panoramic images.

In this way, panoramic images were generated in the three *oppida* showing: (i) their main monuments; (ii) the locations where information panels are placed; (iii) the most representative parts of the archaeological sites due to their landscape interest; (iv) intermediate transition locations among the above scenarios; (v) and finally, several panoramic images of places of interest where archaeological excavations have been carried out (some of them showing the work dynamics of the entire archaeological team in the excavation), and in other locations where archaeological objects were found and that are currently in museums.

3.3. Information Required (Textual, 2D and 3D) for Understanding the Archaeological Sites and an Explanation of the Research Carried Out and the Results Obtained

A crucial aspect of this type of undertaking is the accurate collation, consistency, and uniformity of data to facilitate comprehension of the site being analysed. However, in these scenarios, the data: (a) often come from diverse origins; (b) is typically scattered across multiple locations (depending on its source, relevance, and historical significance); (c) or is presented in different forms and structures (heterogeneous data). Therefore, the process of gathering and compiling information is frequently a complex task that requires comprehensive and extensive research. It is also important to recognize that obtaining the required information may not always be possible, and it is advisable to establish search criteria and preliminary objectives to estimate the resources necessary for this phase of the investigation.
In addition, geomatics allows accessing other types of information for a better understanding of archaeological sites. One of these products is point clouds that provide a figurative and detailed visualization of archaeological sites, monuments and archaeological artifacts, which is of great help for their analysis and understanding, thanks to a detailed and precise exploration of these elements from different perspectives and angles.

3.3.1 Obtaining 3D Documentation: At present, there are several techniques and methodologies to obtain 3D point clouds, each of which has its own advantages and disadvantages. For this project, depending on the element to be documented in 3D, as well as the level of precision and detail required, a different technique or methodology was selected.

3.3.1.1. 3D Documentation of the Archaeological Sites and the Most Representative Monuments.

For the 3D documentation of the *oppida* and its principal monuments, photogrammetric techniques have been used through the use of drones. Drone photogrammetry is a technique increasingly used to document monuments and archaeological sites in 3D. Camera-equipped drones can capture a large number of aerial images from different angles, making it possible to create a detailed 3D point cloud of the object or area of interest.

For extensive 3D documentation of archaeological sites, a DJI Matrice 300 RTK Drone with a DJI Zenmuse P1 camera has been used (Figure 4). The different data collections have been planned following an intelligent oblique photogrammetric data collection protocol. This type of configuration allows data collection to be carried out automatically based on the established configuration and the size of the study area. It is an optimized data collection, since only photographs of the area of the study are taken, avoiding obtaining information outside the borders. During the flight and depending on its location, the DJI Zenmuse P1 camera performs camera movements at different inclinations to achieve vertical and oblique photography. To capture the photographs in

an oblique position, an angle of 45º was established. Regarding the overlap among images, this was 80% frontal (with respect to the flight direction) and 70% lateral (the oblique photographs had the same overlap).

On the other hand, for the 3D documentation of the monuments, commercial drones have been used, which allow to be handled in a much more practical way. In this case, a DJI Mavic 2 Pro was used to capture the images of the different flights carried out over the monuments of the archaeological site, following an oblique/convergent photographic protocol. Photographs were taken ensuring an adequate overlap among images (around 80–90%) and performing different passes varying the pitch angle of the drone by 10–15° and maintaining a constant distance to the monuments. For this task, a series of photographs were taken in a single flight following a circular sequence (360°), with the point of view of each image towards the center of the monument, flying in a circular way at three heights above the ground (15 m with a camera tilt of 60°, 30 m with a camera tilt of 45°, and 60 m with a camera tilt of 30°).

Once the different flights were made, images were processed with photogrammetric reconstruction software. After considering all the existing programs, the open-source tool GRAPHOS was selected. Thanks to this software, the different dense point clouds of the *oppida* and their main monuments were generated (stored in .laz format).

Figure 4. Drone DJI Matrice 300 RTK with a DJI Zenmuse P1 camera.

3.3.1.2. 3D Documentation of Archaeological Artifacts.

This type of urban nucleus could house several hundred or thousands of people, dedicated mainly to economic activities associated with agriculture and livestock. The importance of the latter is evident as seen through the presence of more than 400 sculptures of bulls and pigs across the west sector of the Iberian Central Meseta. These stone figures, popularly known as “verracos” (boars), are an important icon in the modern-day cultural heritage of these areas.
Taking this circumstance into account, different archaeological artifacts characteristic of this culture have been chosen to be documented (several "verracos", ceramics, or brooches). Some of them are in the Museo Provincial de Ávila and others are in the possession of the research team as they are still under study.

For the documentation of this type of artifacts, laser techniques have been implemented. To be more specific, different Artec 3D brand scanners (Arctec Leo and Artec Space Spider) have been used. These machines are portable, self-contained scanners that combine a high-resolution 3D camera, as well as an integrated color camera, to capture images and data in real time as it moves across an object or scene. With both devices it is possible to get a 3D point cloud. For small parts where high resolution was needed an Artec Space Spider was used, while large parts (such as “verracos”) were scanned with the Artec Leo (Figure 5).

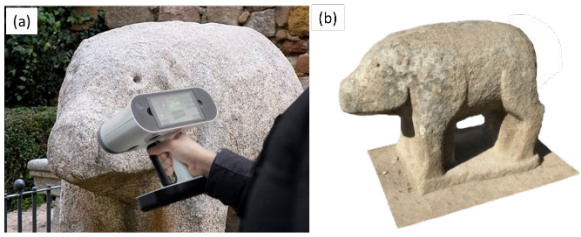

Figure 5. (a) Data collection with the Artec Leo scanner of the "verraco" located in the Plaza de Adolfo Suarez (Ávila, Castilla y León), coming from the Cogotas *oppidum*.

3.3.1.3. Visualization of the Point Clouds in the Virtual Platform.

All the generated point clouds have been included in the virtual tours to improve the visitor experience. To accomplish this, the open-source Potree® library (http://potree.org/) was utilized (Figure 6). This library employs WebGL technology to swiftly render large point clouds while also enabling metric operations like linear measurements, area and volume calculations that may be beneficial to professionals. The integration of this engine with the virtual tours was achieved by incorporating an HTML page that embeds the 3D point cloud. The viewer also provides several JavaScript functions that facilitate the acquisition of point coordinates, linear measurements, or area values for specific locations.

Figure 6. Point cloud of Cogotas *oppidum* visualized in Potree®

3.3.2 Obtaining Textual and 2D Documentation: Regarding the textual and 2D information to be displayed on the platform, it is related to the historical/archaeological aspects of the sites themselves and the work carried out in recent years by the research team. The information collected was enhanced with photographic documentation of significant elements in and around the *oppida*. Following this, all of the information was meticulously standardized and homogenized into various formats, including texts and explanatory sheets. Moreover, the Culture Territorial Service of the Junta de Castilla y León contributed all

of the informative posters present at the sites to augment the visitors' understanding and interest in the *oppida*.

3.4. Architecture of the Virtual Platforms

The sources of information previously identified were combined to create a single virtual environment using panoramic images as the primary visual element. To achieve this, the low-cost software Pano2VR® (https://ggnome.com/pano2vr/) was utilized, and the virtual environment was programmed using web-based languages including HTML, CSS, and JavaScript.
HTML and CSS were used to design the content and graphical user interface (GUI) of the platform, consisting of a header and body. The header displayed information related to the entities involved, while the body projected the panoramas, information, site map, and navigation menu. The information was displayed using hotspots, which are HTML entities that contain a JavaScript function that displays an image file when clicked by the user.
The navigation menu included several JavaScript functions that enabled users to change the point of view by rotating the panorama, as well as zoom functions and icons to open and close the map and access PDF files containing general information such as a historical or geological guide. The PDF files were rendered using an iframe entity in the HTML language.
To integrate the different sources of information and 3D point clouds into the 360° images, a Graphical User Interface (GUI) was created with several menus, toolbars, and hotspots. The GUI also included a map and a menu specifically designed to enhance the user experience.
One notable programmed function of the GUI allowed the panorama to rotate automatically after a few seconds of user inactivity. This feature provided a continuous view at a constant rate of the landscape present in the panorama, thus enhancing the user's viewing experience.
The result of the virtual tours of the *oppida* can be consulted in the following link (URLs may not be available at the present moment):

URL Ulaca: https://tidop.usal.es/Ulaca/
URL Cogotas: https://tidop.usal.es/Cogotas/
URL Mesa de Miranda: https://tidop.usal.es/Miranda/

3.5. 3New Possibilities of Virtual Tours for the Interpretation and Contextualization of Archaeological Artifacts and Sites (Both at the Site Itself and Museums)

The main challenge of virtual tours is the difficulty of transmitting certain experiences and attributes that can be observed on an actual trip to an archaeological site. These experiences include easy/difficult access, size, landscape, weather conditions, smells and sounds of the natural environment. Additionally, there are several other challenges to creating a virtual tour, such as integrating data from different fields, creating an attractive platform design, selecting appropriate formats, correcting imbalances, and detecting and debugging systematic failures.
However, virtual tours can overcome these limitations by providing access to sites and artifacts that are otherwise difficult or impossible to visit, such as those located in remote or politically unstable areas (Kyrlitsias et al., 2020). They can also be designed to be more accessible for people with disabilities, providing a way for everyone to experience these important cultural heritage sites.
These digital tools also offer rich contextualization for archaeological artifacts and sites, placing them within their historical and cultural contexts. Virtual tours provide exciting opportunities to enrich museum visits and enhance the experience of visiting archaeological sites, particularly for non-experts.
In museums, virtual tours can provide additional multimedia content that contextualizes archaeological artifacts, placing them within their historical and cultural contexts. This can include videos, images, and text that give additional information about the artifacts and the people who created and used them. For example, virtual tours can show how the artifact was used in daily life, its significance in a particular culture or society, or the techniques used to create it.
Virtual tours can also be used to enhance the experience of visiting archaeological sites, where it can be difficult for non-experts to understand the significance of what they are seeing. These virtual tools can provide rich contextualization, helping visitors gain a deeper understanding and appreciation of these cultural heritage resources. This can include information on the site's history, the people who lived there, and the social, economic, and cultural contexts in which they lived. Virtual tours can also highlight important features of the site, such as architectural details or natural features, that may be difficult to see or understand on site.
Access to visits can be facilitated both in museums and at sites by placing QR codes that give access to the exact panorama of the virtual visit where the context of the site is explained (Figure 7).

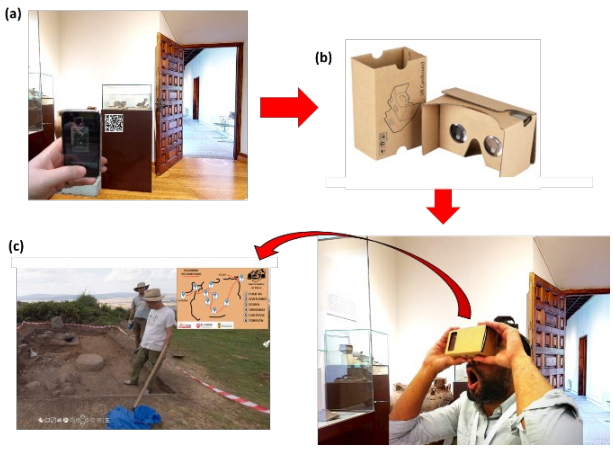

Figure 7. (a) Image showing a QR code on one of the museum visits. (b) If immersive glasses are available, the user can use them to obtain a more realistic experience. Otherwise, the simple mobile can be used for the experience. (c) The user can visualize the context where the archaeological artifact found at the site appeared thanks to the virtual platform.

Another benefit of virtual tours is their flexibility. Visitors can choose to focus on particular aspects of the site or artifact that interest them and can move through the tour at their own pace. This can help visitors engage with the content in a more active and participatory way, allowing them to gain a deeper understanding of the processes and techniques involved in creating ancient artifacts.

4. DISSEMINATION ACTIVITIES AIMED AT DIFFERENT TYPES OF AUDIENCES USING GEOMATICS AS A BASIS

Dissemination activities using geomatics as a basis can be a powerful tool for engaging a wide range of audiences in learning about a variety of topics.

4.1. The Role of 3D Printing

Geomatics refers to the collection, analysis, and presentation of spatial data, including Geographic Information Systems (GIS), remote sensing, and surveying. When combined with 3D printing, geomatics can provide a unique and immersive experience for different types of audiences. 3D printing is a technology that makes it possible to create physical objects from three-dimensional digital models. In the field of archaeology, this technology has become a valuable tool for the creation of replicas of objects and items found in museums, archaeological sites, landscapes, buildings and other locations (Figure 8). These physical models can provide a tactile and visual experience for different types of audiences, allowing them to better understand the spatial relationships and scale of different features. In addition, the ability to manipulate the replica by rotating or disassembling it enables a better understanding of its structure and functioning. For example, a 3D printed model of a historical building can help visitors to understand the architectural details and construction techniques used in its creation.
Another advantage of 3D replicas is that they allow the original model to be preserved. By creating a replica, the wear and tear that can occur when handling the original object is avoided.

Figure 8. Image of the monument and its 3D printed replica.

Dissemination activities using geomatics and 3D printing can be tailored to different types of audiences, including students, educators, researchers, and the general public. For students and educators, these activities can provide a hands-on learning experience that allows them to explore complex spatial concepts in a tangible way. For researchers, geomatics and 3D printing can be used to create high-quality replica of 3D data, allowing for more precise and accurate analysis.
For the general public, geomatics and 3D printing can be used to create engaging and interactive exhibits that showcase important cultural heritage resources, such as historical buildings and archaeological sites. Visitors can explore these exhibits in a tactile and visual way, gaining a deeper understanding and appreciation of these important resources.
Among the dissemination activities carried out within this project, different 3D printed models of buildings and archaeological artifacts were used. These models have been very useful to better explain the importance of these pre-Roman elements in the centre of the Iberian Peninsula. These models have been especially useful for people with reduced mobility and vision problems.

4.2. Talks and Seminars Explaining the Research Methodologies, the Main Findings, and the Results Obtained in the Different Projects Carried Out in Recent Years

Talks and seminars explaining research methodologies, main findings, and results obtained in recent projects are important for several reasons. Firstly, they provide an opportunity for researchers to share their work with the academic and scientific community, as well as with the general public (Figure 9). This helps to disseminate knowledge and promote the advancement of research in the field.

Figure 9. Talk held in Solosancho (Ávila, Castilla y León, Spain) during the XVI *Luna Celta* festival (2022).

These activities also provide a platform for discussion and debate among researchers, allowing them to exchange ideas, collaborate on future research projects, and identify new areas for investigation. This can lead to the development of new research questions and hypotheses, which can be further explored in future studies.
In addition, talks and seminars can help to raise awareness about the importance of research in different fields, and highlight the contributions that research can make to society. They can also help to build public support for research funding, which is critical for the continuation of scientific work.
Finally, talks and seminars can provide an opportunity for researchers to receive feedback on their work, which can help to improve the quality of their research and refine their research methodologies. This feedback can come from other researchers, as well as from members of the public who may have a different perspective on the research topic.
The use of geomatic techniques/tools together with virtual visits and 3D printed models has helped to offer a visual representation of the archaeological investigations carried out, allowing to show the location and spatial relationships among the different elements of the archaeological site record (either monuments or artifacts). This has enabled to explain the research questions and

methodologies and to illustrate the results obtained from the data analysis (Rodríguez-Hernández et al., 2023).

4.3. Explanations in the Context of the Excavation Works

Dissemination activities during the excavation of archaeological sites are important for diverse reasons. First and foremost, they can help to raise public awareness about the importance of archaeology and the significance of the site being excavated. This can be particularly important for sites that are not well-known or are located in remote areas, as it can help to generate interest and support for the project.

Dissemination activities can also contribute to foster a sense of community engagement and participation in the excavation process. By involving local communities, stakeholders, and associations in the project, archaeologists can help to build a sense of ownership and responsibility for the site and its preservation. This can be particularly significant in cases where the site is at risk of damage or destruction due to natural or human factors.

Another important benefit of dissemination activities during excavation is the opportunity to share research findings and methodologies with other scholars and researchers in the field. This aspect means a tool to stimulate further research and collaboration, leading to a greater understanding of the site and its significance.

Finally, dissemination activities during excavation can also help to generate financial and institutional support for the project. By demonstrating the importance of the site and the research being carried out, archaeologists can attract funding and resources from government agencies, private organizations, and academic institutions.

In summary, dissemination activities during excavation are essential for raising public awareness, fostering community engagement, sharing research findings, and attracting financial and institutional support for the project.

In the framework of the VETTONIA project, in addition to the *in situ* explanations about the archaeological excavation works, the 3D printed models, together with different panels created *ad hoc*, have been useful to enrich the explanations of the investigations carried out in recent years (Figure 10).

Figure 10. Image of the activities carried out on the open day in the middle of the 2022 excavation campaign in the "Torreon" of the Ulaca *oppidum* (Solosancho, Ávila).

5. ANALYSIS OF THE RESULTS OBTAINED

The main results of the VETTONIA project are the following:

a) The three virtual tours of the *oppida* of Ulaca, La Mesa de Miranda, and Las Cogotas. These virtual platforms contain numerous historical-archaeological and environmental information on these archaeological sites and their immediate surroundings. 3D models of the sites, their main monuments, and some of the most outstanding artifacts that appeared in the most recent excavations stand out. Likewise, information on the history of the investigations has been incorporated into the virtual visits, placing special emphasis on the latest work carried out.

b) 3D printed models of some of the most prominent buildings present at the three sites, as well as the most characteristic artifacts discovered in recent excavations. These models are extremely helpful in facilitating the understanding and interaction of people with different types of disabilities.

c) Lectures and seminars given in various forums with diverse types of audiences: in different educational institutions (institutes or universities), in the municipalities where the analyzed settlements are located, as well as in specialized conferences and congresses. In these talks, the virtual tours and the rest of the dissemination initiatives have been presented and, in the case of the lectures in institutes or universities, an evaluation of these tools has been carried out by the students through a series of surveys.

d) Explanations in the framework of the excavation works carried out in Ulaca: in the framework of the annual interventions developed in this *oppidum*, the different initiatives carried out within the VETTONIA project have been presented with a good reception by the attending public.

6. CONCLUSIONS

The results obtained during the development of the VETTONIA project ensure the fulfillment of its main objective: the dissemination of the rich heritage from the Iron Age of the western Iberian Peninsula and of the archaeological investigations carried out on this topic in recent years. It is a pioneering dissemination experience that takes advantage of the educational opportunities offered by new technologies such as virtual tours, 3D models, and impressions. Thus, this project makes it easier for different types of audiences (researchers, students, teachers, and the general public) to access the results of the most recent archaeological research in an interactive and stimulating way.

In the future, tools such as virtual visits to archaeological sites may prove essential in classroom teaching at different levels, as has already been verified during the confinement caused by the COVID-19 pandemic. In addition, this type of virtual platform has undergone great development in recent times due to the pandemic context and has become a first-rate tool when it comes to trying to attract visitors to different cultural heritage assets. In this way, they can promote sustainable tourism in fragile natural environments such as those that comprise the *oppida* of the Iron Age.

The generation of new knowledge leads to new research questions, these questions produce evidence gathering and recording data. From here analysis and synthesis are elaborated and so public dissemination can be enforced and finally we get new archaeological knowledge but, at the same time, also new knowledge on social attitudes and values of different publics (Thomas 2019). The VETTONIA project is inspiring people through new methodologies and creating increased pride and sense of place for local people and visitors.

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