USING PHOTOGRAMMETRIC 3D MODELS AS LEARNING SOURCES IN ARCHAEOLOGY

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Abstract

During the last few years new technologies, as well as new software, have taken a really important relevance in research on archaeology. A great example is the case of 3D photogrammetry; this technique has shown its importance in archaeological research worldwide through software such as Agisoft Metashape.

This program allows the archaeologist to build 3D models of perishable elements, such as wood, bones, coins or pottery before being extracted from the archaeological site. Also, 3D modelling also allows reproducing of the strata that are being excavated and allow reproducing and immortalising every moment of an archaeological site. In the same way, the reproduction of ancient pottery, anthropological remains, or any other object is viable through photogrammetry. The combination of 3D modelling and the use of drones shows the way to ortophotographies and 3D models of the whole site, not just a part of it. This system, 3D modelling, allows transporting to the classroom the archaeological site such as archaeological material. This grants students with different capacities full access to a site and full contact with the ancient material.

In this paper, we argue the possibility of using 3D modelling methods in University teaching in different subjects such as archaeology o ceramology. For example, ancient pottery objects can be recreated and the student can work on them in a 3d environment, pieces can be moved, cut, transformed, drawn, etc. The using of 3D pottery models can be a new way to teach ceramology at the University. Also in combination with a 3D printer ancient objects can be created and every student can touch the ancient forms. We cannot underestimate the COVID-19 circumstances and the impossibility that this is supposed in the work with real ancient objects to the students. The use of 3D models and sharing models platforms such as Sketchfab favours the diffusion and learning of heritage through 3D models.

We are going to show 3D models based on Roman sites in the territory of Girona (Catalonia, Spain) to conduct our teaching speech to different examples that came from real and newest archaeological research of the zone. The use of drones, 3D models and other newer methods will be explained and also the relation with University teaching will be explained.

The innovation in teaching in archaeology is key and the need of using new tools that had already been used in research in teaching is a very important point in this paper. We aim to bond research innovations in archaeological methodology with the ones that need to be performed when teaching.

Keywords: Archaeology, 3D modelling, innovative teaching.

1 INTRODUCTION

In recent years, the world of archaeological research has begun to make increasing use of the new technologies that have emerged in the field of pure science. This is due to a drop in prices and new accessibility to such technology, which has allowed the incorporation of new techniques in a multitude of research projects.

These new methods are, for example, the use of drones, the use of Geographic Information Systems (GIS) software such as QGIS, or the use of 3D models made using photogrammetric techniques. Increasingly, the data obtained in an archaeological excavation are processed using the aforementioned techniques. As an example of the application of these programmes in archaeological research, we can mention the work of [1] where the findings of hundreds of bone fragments in the Roman villa of Vilauba (Girona, Catalonia) are georeferenced and drawn using QGIS. The novelty of this work lies in the use of the QGIS programme and its capacity to make plan drawings of micro-elements without losing detail of them, being a non-invasive technique, which does not affect either the excavation or the documented finds. Another example is the recent publication of the excavations carried out in the Greek city of Empúries (Girona, Catalonia), which shows a systematic use of drone flights and photogrammetric models in the creation of floor plans [2]. In the same way, the team in charge of the site has also

highlighted the use of new technologies to carry out reconstructions of the past of the site and its entire geographical area.

Similarly, other teams have already stressed the importance of the approach we propose, both in archaeology [3] and in the application of new technologies to teaching [4] [5].

As we have been able to appreciate, the importance of GIS in the world of research is growing and, in turn, increasingly present in high-impact publications; however, it is an importance that can also be reflected at the teaching level.

The widespread and systematic use of these programmes has generated a large amount of digitised material that is easy to share, easy to create and easy to access for students who are increasingly accustomed to and trained in the use of computer technologies. In this way, this text presents some of the options that photogrammetric models bring to university teaching, specifically to teaching in archaeology and related sciences. It will therefore consider how photogrammetric models can be used to represent in 3D material that is not accessible in classes with many students (ceramics, anthropological, numismatic, etc.); as well as a "transport" of the students themselves to a site recreated in 3D without leaving the classroom where the teaching is usually given.

In short, this text proposes the use of these new technologies to bring an increasingly digital student body closer to the world of archaeological and historical research, sciences that are traditionally conservative in their methodology. It will also show how photogrammetric models can be shared and how an archaeological explanation can be conveyed through these elements.

Firstly, the methodology and the different ways in which university professors have access to photogrammetric models will be presented, followed by an explanation of some of the possible applications of these technologies in university classrooms through practical examples.

2 METHODOLOGY

The methodology applied to teaching with photogrammetric models requires a good constructive base, being the creation or obtaining of the 3D models required to teach a specific subject.

The creation of a photogrammetric model has already been extensively explained in many works, therefore, this will not be a point to be developed in this work. In summary, several photographs of an object or a site are required, with a variable number of photographs, which are then processed through programs such as AgiSoft Metashape, and a 3D model is generated, which can be processed with another program such as Blender, for example.

If the teacher does not have the knowledge to create photogrammetric models, it is always possible to obtain them from websites or open-access digital repositories of 3D models. On this type of website, authors from all over the world share their photogrammetric models for free or sell them, making them available to teachers and educational institutions. An example of such repositories is the Sketchfab portal, which is open access. The importance of these repositories and the democratization of models have already been discussed in specialized publications [6].

The creative process of 3D models is the same as the technique used to reproduce any type of reality or object. Thus, the same method is used for a piece of pottery, such as an amphora or a vessel, or a part of a skeleton. On the other hand, it is also possible to reproduce larger elements such as archaeological sites. In this case, photogrammetry has a good complement, the flight of drones, which is used to take photographs of much larger spaces and then process them into large three-dimensional models.

It should also be noted that studies on the process of photogrammetry have been published on its methodology, specifically on how to teach it and how to apply it to teaching [7].

3 RESULTS

This section will show, with specific examples of a site (in this case a Roman villa), how its general plans could be shown using drone photography and processed from three-dimensional models. In this case, students could experiment and learn with these models (faithful to reality as every detail that can be found in the site is spatially represented) without having to leave the classroom, with all that this entails (possible poor accessibility to the site for people with walking difficulties, bad weather that prevents access to the site, differential access of students to the site for socio-economic reasons as this activity is understood by the institutions as something extracurricular, etc.). The students as a whole, therefore,

will be able to learn and familiarize themselves with basic archaeological concepts, such as stratigraphy, whose absorption of knowledge will come from the use of the models themselves, which are adaptable and moldable and help to perceive realities that only exist in the digital world.

Fig.1. Example of a mesh of a part of the Roman villa of Collet (Calonge i Sant Antoni). Source: University of Girona.

In the first example (Fig.1) we present the mesh of photogrammetry, at this stage of the process, even without texturing, some details of the relief of the site that cannot be seen in any other way can undoubtedly be seen. Students can thus access details of the sites and even edit or carry out teaching activities on the models themselves.

Again, by way of example, a photogrammetry edited using the Blender program is presented, showing the interior of two ceramic vessels, *dolia*, inserted in the ground. This perspective can only be obtained from the creation of digital models of the site, which can help students inexperienced in these matters to understand the stratigraphic relationships of the different elements of the site and, in addition, in this case, to understand the real volumetry of a *dolia in situ*, which would not be possible without this methodology. On the other hand, as indicated in the previous section, if necessary, these ceramic elements could be reproduced for educational and informative purposes so that they are accessible to a diverse student body (for example, they could be touched by students with visual difficulties, allowing the same access to information and education as the rest of the classroom).

Fig.2. Example of the section of the Roman villa of Collet, the same space that was represented in the mesh (Calonge i Sant Antoni). Source: University of Girona.

Continuing with the argumentative thread, the use of reproductions and 3D models of archaeological objects in the classroom is of great relevance in teaching. This particular topic, the recreation of archaeological objects for their study, has also been dealt with in scientific articles [8]; [5].

As an example, an unpublished work [9] has been chosen as a reference, where, by means of 3D models, it has been possible to calculate with great precision the capacity of a *dolia* that in reality is already partially destroyed. In this way, students can be taught the importance of these tools, not only for teaching purposes but also for practical ones. On the other hand, a student can interact with a digital 3D model; because these models can be moved with the computer, they can be cut, they can be drawn and they can even be printed with 3D printers reproducing the object exactly as it was. This allows us to recreate and reproduce moments often lost during archaeological excavation or affected by the passage of time. More delicate objects such as glass or bone can be recreated so that all students can have them at their fingertips.

Another argument in favor of the use of these models is undoubtedly the increase in online teaching. The vicissitudes of the COVID-19 pandemic that have affected university teaching worldwide have highlighted a number of problems in the methodology of archaeological teaching at the university, as online classes have meant that students have lost the ability to come into contact with archaeological sites and materials. The photogrammetric models can therefore be shared by the teaching staff and can be worked on in any space and place, through the programs presented here as an example, by their students.

4 CONCLUSIONS

The importance of the application of new technologies in the research and academic world has crossed borders when applied to the methodology of archaeological teaching at the university level. The implementation of the use of photogrammetry and new technologies in university teaching in archaeology is a necessary step towards the modernization and methodological adaptation of teaching to current trends. It is also a step towards the democratization of information, as well as towards the maximum integration of all students in a discipline, archaeology, which is sometimes restrictive.

This will bring the teacher closer to today's students, as in this way their digital language will be spoken, through the digitalization of teaching and their study and learning techniques, and at the same time, it will provide them with tools for a perfect archaeological record in the future that can be applied by these students.

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