Introduction

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Over recent decades, digital methods have increasingly pervaded every aspect of archaeological knowledge production, from data collection, analysis and interpretation to interaction with the public, as well as exchange between scholars (see e.g. Morgan 2019: 325; Huggett 2019). This development began in the 1960s and has since slowly moved into higher education (Perkins et al. 1992; Schütz-Pitan et al. 2018). University courses on 3D modelling, computer simulation, or serious games – to name just a few – which until a few years ago were considered niche, are gradually included in a growing number of undergraduate and postgraduate archaeology curricula. At the same time, as 3D and interactive technologies are becoming more and more affordable, a proliferation of digital tools, ranging from virtual and augmented reality applications and interactive displays to mobile apps, have been made available for the communication of the past in museums and via the internet. In light of these developments, this volume aims to encourage a productive debate on the potential and challenges of using digital methods for teaching and learning in archaeology.

Unfortunately, academic teaching in general is often thought of as the by-product of the researching scientist. It is not teaching but third party-funded projects that bring academic revenue for the researcher, the institute and the university, whereas good teaching is rarely rewarded (Wosnitza et al. 2014

summarise several studies showing the same attitudes). This leads to an undervaluation of good university-level teaching, which engages students and allows them to develop critical thinking, empathy and integrity. Nevertheless, we firmly believe that teaching is at the very core of universities as well as the archaeological discipline itself and that we need to re-evaluate the way we communicate our knowledge to our students. This holds especially true with the already-mentioned technological developments in the archaeological field. Being an archaeologist today incorporates much more than it did 20 years ago. Today, there is a need for well-educated digital-oriented archaeologists who know and understand the needs of modern-day fieldwork.

Universities and museums are by definition places of teaching and learning (Paletschek 2002; Walz 2016: 9). Outside of these institutions, too, the interest in spreading results was always present. By the 18th and 19th century, researchers such as Johann Joachim Winckelmann and Sir Austen Henry Layard were already not only researching but also disseminating their knowledge to the public in approachable ways (Layard 1851; 1853; Winckelmann 1760). They found a way to relate to the audience. In light of the digital developments outlined above, we therefore want to present methods and tools of today that improve digital teaching and learning in archaeology in- and outside academia.

Since 2016, the Ministry of Culture and Science of the German state of North Rhine Westphalia has been awarding annual fellowships for innovative ways of digital teaching at university level. The aim is to develop and test methods of digital teaching in various fields and in this way transform and strengthen the way we teach at the university. In 2017 the editor of this volume was able to obtain a fellowship which funded not only new technology for the Institute of Archaeology at the University of Cologne but also the organisation of a two-day international symposium on the given topic and its open-access publication, in which you are currently reading these lines.

The symposium was held at the University of Cologne (Germany) from 12 to 13 October 2018, with international scholars from Australia, Canada and Europe, and focused on teaching and learning archaeology with digital methods. In these two days, we had wonderful presentations and discussions of like-minded educators from universities as well as museums that have a shared interest in digital teaching and learning. The symposium was divided into five sessions: archaeogaming, learning in the museum, digital tools in the classroom, digital learning environments, and technical demonstrations. The last session offered participants in the symposium hands-on experience of some of the presented tools. This session did not translate well into a book, but, as the projects are described and published here in detail, we hope readers may get a glimpse into their practical applications. Therefore, the contributions to the volume at hand are divided into the first four sections of the symposium. As is always the case, some of them would have fitted more than one category but were kept in their assigned sessions.

The sessions have been constructed to mirror the variety of applications for the symposium and thus can show only a select view of the possibilities of digital teaching and learning in archaeology. We did not focus on how digitalisation may undermine the old clear-cut division between those who teach and those who are taught (although Remmy or Boom et al. in this volume do) and in this way help to develop a more participatory culture (as put forward by Giaccardi 2012). Citizen science is not just a buzzword but a successful practice (Smith 2014; or see e.g. DigVentures), academic teaching does not need to happen in a classroom and teaching through digital and social media is already part of archaeological education and outreach (MOOCs, Twitter, Skype a Scientist, and much more). Digitalisation and education should also play a role in postcolonial discourses and discourses of decolonisation, as exemplified by Cook's submission to this volume. However, our volume mostly presents techniques and methods of teaching and learning programmes of European, North American or Australian institutions. We express our hope, though, that a successor volume will focus on initiatives that have come to the fore, such as the decolonisation of archives (Cushman 2013) or, more recently, Felwine Sarr and Bénédicte Savoy's report to the French president, in which the sharing of digitised objects of cultural heritage plays a role (Sarr and Savoy 2018: 67). Certainly, the contributions to this volume touch upon topics of decolonialisation and postcolonialism; nevertheless, we do not pretend to cover the theme to its full extent. Digitalisation in archaeology also involves issues of 'democratisation' or at least the hope for that, especially in the realm of knowledge production. We are therefore delighted that a number of speakers focus on free and openly available software solutions (see e.g. Remmy, Rubio-Campillo and Boom et al. in this volume), which undermine established power structures and monetary barriers and thus level the playing field of digital teaching. In this regard, we are also happy to offer this volume as a freely available digital open-access version through the publisher's website.

The first part of this volume consists of chapters related to the relatively new term of archaeogaming (Reinhardt 2018: 2–4), which refers to the archaeology both in and of digital games. In many digital games, reconstructions of the past are created or archaeologists depicted and these representations have largely gone uncommented or are not influenced by historians and archaeologists, who therefore could not impact the kind of knowledge disseminated by these games. The importance of this issue has been recently underlined by Daniel Giere, who developed an empirical study of the influence that digital games have on historical narratives offered by players. He could conclude convincingly that games have an impact on how history is conceived and that game content is being learned and memorised as historical knowledge (Giere 2019). Later contributions in this volume will highlight how players engage with games on an emotional level and how this influences learning behaviour (see Hiriart and McKinney et al. in this volume). The archaeogaming section focuses more on

the aspects of how gameplay, game mechanics and representation in different games may further the teaching and learning of archaeology.

Erik Malcolm Champion explains how games can promote learning archaeology. He correctly points to the question of game mechanics and how these are typically used in computer games. He asks us to question what a digital archaeology game should consist of if it is to teach us something, and offers a way to achieve this goal, by proposing a framework within which teachers and students can find, relate, annotate and modify existing 3D models, while exploring the usage of these models with the help of suitable game mechanics.

The joint article by the VALUE Foundation (Boom et al.) shows that video games can be used to teach about the past in a critical, yet fun way, allowing for a deep level of personal and historical learning. Through four case studies, the authors show us how this happens in practice: they used video games to present complicated archaeological topics in the classroom, show us how to use video streaming to not only play but also discuss video games from an archaeological point of view, discuss how the software Twine creates interactive non-linear stories, and finally show us how the popular game Minecraft can help to engage with children and create a first contact with cultural heritage in a fun and creative way.

Xavier Rubio-Campillo gives a real-life example, as he directed the team that created a simulation game with archaeological content. This game allows the player to take the role of the leader of a hunter-gatherer group in different stages of human evolution and try to survive in different eras. He explains how the theme, lore, narrative and game mechanics enabled him to create a challenging and informative game that promotes the understanding of hominid evolution in the Sierra de Atapuerca in Spain.

The second part of this volume examines the topic of learning in the museum. Museums have a long-standing tradition of disseminating knowledge as one of their key functions (Walz 2016: 9). As institutions, they are also changing with the advent of new technologies and interests of the public (Walz 2016: 40–75). Archaeological parks and open-air museums are already an example of this (Walz 2016: 93–103). Nowadays, modern digital tools are being tested and employed to create interactive spaces, engage people of different ages, enhance the experience for impaired visitors and create spaces for polyvocality (Arrigoni & Galani 2019). Engaging with visitors is different from teaching in a classroom and the contributions in this section not only present a whole range of different ways of doing so but also discuss pitfalls and challenges.

Anna Riethus shows us how playing an audio app game during a museum visit can create an inclusive museum experience. Her development of the NMsee app game combines an interactive story with tactile exhibits within the permanent exhibition of the Neanderthal Museum. This innovative approach offers both seeing and visually impaired visitors an audio-tactile way to experience the past that is more immersive than before.

Stephan Quick offers a way to use digital media in an open-air archaeological park and how this aids in experiencing the Roman past. Virtual reconstructions at the exhibition reveal the monumentality of the site as it once was. The response to these elaborate visualisations is positive throughout all target groups.

Adolfo Muñoz and Ana Martí describe a project realised at the La Almoina Museum in Valencia, Spain, where they experimented with a prototype of an application where the visitors could experience the excavated remains of the Roman Republic in Valencia. With the help of the HoloLens, view-through augmented reality glasses, visitors are guided through the museum and can see overlays of reconstructions directly on the actual remains. Additional information is given by a virtual tour guide perceptively superimposed as a video inside the glasses.

Finally, Sebastian Hageneuer discusses how to present archaeological reconstructions to a broader audience and highlights examples of the past and the present. He also risks a look into the future and concludes that the correct communication of archaeological reconstructions is the key, especially in a museum environment. While most displays of virtual reconstructions aim for visually pleasing or impressing effects, the most important aspect of this form of scientific communication, the potential to inform, is often neglected.

Digital tools in the classroom is the third section of this volume and concerns itself with tools that assist us in teaching archaeology to children and adults in schools or universities. Here the volume ties back to the archaeogaming section and links it to gamification. Gamification describes the transfer of playable elements to tasks, which usually are not part of games. This means that rules are created that assign awards or penalties to certain actions; points may be gained, levels reached etc. (Oxford Dictionaries 2019), creating positive feedback for preferred behaviour, which leads to higher motivation. Gamification has been a buzzword for several years, because many studies took the view that gamification has the potential to improve learning, if well designed and used correctly (Dicheva et al. 2015). In this session, Michael Remmy and Juan Hiriart take advantage of these approaches.

The first contribution, though, produces a smooth transition from the last session on museums, as Katherine Cook focuses on higher education courses on public archaeology. She exposes problems involved in teaching archaeology in the global context of postcolonial legacies and neocolonial structures of oppression, challenging the ways in which we learn, teach and do archaeology today. She demands that we find ways to decolonise archaeology and asks what digital technologies can do to help. In two case studies, she explains how bringing together students, instructors, heritage professionals, descendant communities and the public promotes the transformation of the discipline of archaeology itself.

Michael Remmy presents his experience with the application of geocaching software at the university level, where he taught courses in collaboration

with the digital humanities (DH). Students of archaeology and DH jointly developed geocaching games that led the user through modern-day Cologne to teach them something about the rich Roman past of that city. The outcome was truly positive, as the students reported a higher motivation and gaining practical experiences.

Juan Hiriart developed a game for primary schools, where one plays the head of an Anglo-Saxon family and learns about cultural meanings and traditions, defining identities, roles and social interactions in post-Roman Britain. By assessing the knowledge of schoolchildren before and after playing the game, Hiriart was able to evaluate that the game was most successful when it was able to engage with the children empathetically. This leads to the conclusion that we need to teach the past in a more thoughtful way, especially in the classroom.

The last section examines digital learning environments and how these affect and help teaching and learning in archaeology. Learning environments may look very different from each other. While in some cases a whole countryside is used as a learning space (see Hölscher in this volume), in other cases purely digital environments (Holter and Schwesinger in this volume) or a mixture of digital and analogue entities (McKinney et al. in this volume) are created. By creating the right learning space, we can engage better with students and the general public. An important aspect here is the experience in itself, which facilitates the learning process.

David Frederik Hölscher showcases ways to base science outreach in archaeology upon educational principles. In his PhD project, visitors in northern Germany are offered GPS-guided cycling tours with ludic elements, inviting them to learn about the local landscape and its cultural history. This connection of outdoor learning, archaeological content and digital media might prove to be a powerful way to facilitate public engagement with heritage sites.

Erika Holter and Sebastian Schwesinger's approach is a completely different learning space, in which they simulate the sound distribution in open spaces in classical Athens. With the help of virtual reality, the user is able to listen to a public speaker in an open space from different points with varying options, like the volume of the surrounding crowd, the position of the speaker or his temper. This way, the user is not only able to see a reconstruction of a certain space but also experience its purpose.

The EMOTIVE Project (McKinney et al.) finally introduces a multi-component digital kit for use in formal and informal learning environments in order to foster prehistorical empathy among young people for cultural heritage. They also emphasise the importance of social interaction and dialogue in learning.

In the last 150 years, archaeology has experienced major transitions and the once-classical archaeology of the elite is now a worldwide profession, with dozens of disciplines and led by a common public interest in our past. The digital turn changes our way of practising archaeology and offers many possibilities

to address these issues. Although archaeological projects (gradually) adapt accordingly, with the exception of a few examples, teaching archaeology does this only very slowly and in isolated cases.

Overall, the symposium and the chapters in this volume show a clear trend towards a more playful and empathetic, but also more respectful way of teaching archaeology in the future. Either by play, practical experience or both, the authors of this volume put forward how we should think about knowledge transfer and how we should transform classical forms of teaching in our field.

Through different forms of gaming, the chapters by Champion, Boom et al., Rubio-Campillo, Remmy, Hiriart and Hölscher demonstrate clearly how to engage playfully with students, but also the public. Their results clearly show that learning and interest is raised by playful engagement. The works by Riethus and Cook, especially, focus on the inclusion of marginalised people into the creation of content for museums. This decolonisation of knowledge creation can be much aided by digital media, as has been shown by Arrigoni and Galani (2019). In addition, the division between 'audience' and 'specialist disseminating knowledge' is broken in several contributions by engaging the public and by creating digital spaces, in which the players can create their own content (e.g. Boom et al. or Holter and Schwesinger in this volume).

Several contributions in this publication show how emotional involvement may improve the engagement of pupils, students and the general public with archaeology (e.g. Boom et al., Hiriart, Remmy, McKinney et al. in this volume). It has recently been put forward how entrenched emotions such as excitement and enchantment are in archaeological practice (Perry 2019) and how archaeological narratives reflect personal attitudes as well as the zeitgeist (Hageneuer 2016; Miera 2019; Moser & Gamble 1997). Digital tools offer a multitude of ways to engage users emotionally by creating captivating narratives, interactive spaces and/or lively representations, and games are one of the most proliferative. This does not necessarily mean that we should start playing games with our students or visitors in the museum (although we can!) but it does exemplify that we cannot continue teaching archaeology in the same traditional way, which focuses on frontally disseminating knowledge created by experts, whether this happens in the classroom or the museum.

We therefore need to focus our teaching to a more specialised direction, as it is already partially done in special MA programmes in digital archaeology[1] or archaeoinformatics.[2] These new sub-disciplines train students in the usage of digital technologies designed to help in the field but also to develop methods for the future. Just as well, these methods aid in communicating archaeology

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[1] For example, at the University of York: [online] Department of Archaeology. Available at: https://www.york.ac.uk/study/postgraduate-taught/courses/msc-digital-Archaeology [Accessed 3 June 2019].

[2] For example, at the University of Cologne: [online] Institute of Archaeology. Available at: http://archaeoinformatik.uni-koeln.de [Accessed 3 July 2019].

to the public in a more relatable way. Comfortable in the digital space, the broader audience understands technologies and visualisations much better than it does scientific publications or traditional museum displays. It responds better to engagement than to passive reception. This volume demonstrates in many ways how we can engage in scientific communication with the public, in contrast to simply telling them what to believe. This holds especially true with a younger audience.

We strongly believe that as archaeologists it is our duty not only to discover the past but also to communicate it to everyone that makes our profession possible and in this way to foster a close relationship to our shared human history. With technologies like virtual or augmented reality, computer games, 3D visualisations or virtual environments, this is easier than ever before, when done responsibly and respectfully.

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