DHQ: Digital Humanities Quarterly
2020
Volume 14 Number 3

Inside the Trading Zone: Thinkering in a Digital History Lab

Andreas Fickers <andreas_dot_fickers_at_uni_dot_lu>, University of Luxembourg
Tim van der Heijden <tim_dot_vanderheijden_at_uni_dot_lu>, University of Luxembourg

Abstract

The goal of this article is to critically reflect on the practical and epistemological challenges of doing historical research in the digital age. The analysis is based on a case study of the Doctoral Training Unit (DTU) "Digital History and Hermeneutics", an interdisciplinary research and training programme that was established at the Luxembourg Centre for Contemporary and Digital History (C²DH) of the University of Luxembourg. The DTU is designed as interdisciplinary *trading zone* that applies the method of "thinkering" – the tinkering with technology combined with the critical reflection on the practice of doing digital history. Based on this case study, the article addresses the question of how to constitute an interdisciplinary trading zone in practice and how to situate this trading zone in physical working environments, like a Digital History Lab and shared office space.

1. Introduction

> It kind of starts off with a historical perspective. That is that people from different domains don't understand each other. There is quite a wall. Because when you have been studying a topic from a paradigm of your discipline for a long time, and others are dealing with similar things but in a totally different way, then there are certain blockages between them. And there has always been a curiosity to be the trader between those different domains. I think what we are doing here is to explore the digital tools to build bridges. [...] [However] people are not willing to come out of their comfort zone often. (interview, PhD 3, digital archaeologist)

1

With these words, a PhD student described the ambitions but also the challenges of the Doctoral Training Unit (DTU) "Digital History and Hermeneutics": a four-year interdisciplinary research and training programme that was established at the Luxembourg Centre for Contemporary and Digital History (C²DH) of the University of Luxembourg in March 2017. The DTU aims to provide an experimental space, in which different communities of practice and their epistemic cultures negotiate new forms of knowledge production and dissemination in the field of digital history.[1] The programme involves thirteen PhD students with different disciplinary backgrounds, varying from history, philosophy, linguistics, geography, archaeology, computer science and human-computer interaction. One of the central aims of the DTU as such is to form a "trading zone", a space for interactions and negotiations between these different knowledge domains, in order to explore how the emergence of digital research technologies and infrastructures has impacted the practices of doing historical research.

1.1 Research questions and argument

2

While the digital has increasingly provided a "common ground" between the humanities and the computer sciences during the last decades, this is not to say that connections are easily made – as the opening citation of this article indicates well. Using the case study of the DTU, we aim at discussing a number of critical questions that resonate with the topic of this special issue: How to build bridges between different knowledge domains in a specific research environment? How to stimulate interdisciplinary collaboration and to get scholars out of their disciplinary or

methodological comfort zones? What is at stake in such interdisciplinary trading zones? Who are the traders – and what is being traded? Investigating these questions is not only relevant for the field of digital history, but for the wider domain of digital humanities at large: many DH research projects involve collaboration across different disciplinary fields and domains. While much theoretical work is being done on interdisciplinarity in digital humanities (e.g. [Klein 2015], [Deegan and McCarthy 2012], [Stehr and Weingart 2000]), the questions of how to constitute an interdisciplinary trading zone in practice and how to situate this trading zone in physical working environments remain largely underexplored.

This article focuses on the DTU as a case study of an interdisciplinary trading zone and its situated research practices in digital history, the field that engages with digital tools and technologies in historical research practices. The shift from "digital history 1.0", which was basically about analysing digital sources with traditional historical research methods, to "digital history 2.0", which requires more advanced competences when "doing things with historical data" [Mussell 2013], made historians adopt digital tools, methods and concepts from other disciplines, like the computer sciences, and collaborate with computational experts for analysing large historical datasets. The aim of this article is to investigate the practical and epistemological negotiations of such digital historical research practices in an interdisciplinary setting. 3

Thereby, we explore how physical spaces of collaboration, specifically the Digital History Lab of the University of Luxembourg and the C²DH "open space", could play a role in the formation of trading zones and serve as platforms for interdisciplinary knowledge production and dissemination. It will be argued that physical spaces, like a common office and laboratory, as research and training environments can be conductive for interdisciplinary collaboration and exchange as well as for stimulating processes of "thinkering": the playful experimentation with digital tools and technologies for historical research. We argue that training infrastructures enabling hands-on collaboration are constructive for both the formation and transformation of interdisciplinary trading zones in the field of digital history.[2] Whether this twofold potential can be realized, however, is dependent on various factors, such as time investment, research profiles, and the willingness to cross disciplinary and discursive boundaries. Reflecting on these matters, this article provides insights that are beneficial for scholars, administrators, curriculum developers and heads of research units in the field of digital history and the wider domain of digital humanities. 4

1.2 Methodology

Our analysis draws on literature studies on "interdisciplinarity" [Klein 2015], "infrastructuring" [Star and Bowker 2006], "trading zones" [Collins et al. 2007] [Galison 1996] [Kemman 2019], and "communities of practice" [Wenger 1998], and is empirically based on an ethnographic study including the analysis of a series of self-reflexive training reports and semi-structured interviews, in which the PhD students of the DTU reflect on their research practices and experiences of the project's first year. The reports were written either individually or collectively after the various skills trainings, which were organized during the first year of the DTU as part of its "DH incubation phase".[3] In total, nine skills trainings were organized, which led to the production of thirty-nine reports in total.[4] The reports were analysed and coded on the basis of a number of predefined themes: digital history and hermeneutics, interdisciplinarity, thinkering, infrastructure, communities of practice, and spaces or places of collaboration. In addition, interviews were held with twelve of the PhD students of the DTU.[5] Candidates were interviewed once or twice for an average of one hour. All interviews were audio-recorded, fully transcribed and pseudo-anonymized on the basis of the researcher's disciplinary background, which they could formulate themselves.[6] Similar to the self-reflexive training reports, the interviews were analysed and coded on the basis of the aforementioned themes. 5

The article focuses on the DTU as object of study. The PhD students of the DTU have of course numerous interactions with the wider environment they operate in - e.g. with the C²DH staff, their supervisors, or invited experts from partnering institutions and the wider scientific community.[7] Inspired by laboratory studies in social studies of science [Knorr 1999] [Latour and Woolgar 1979], however, we decided to focus on the PhD students exclusively as a spatially bounded group of their own within which different communities of practice interact [Lave and Wenger 1991]. This helped us to form a "micro perspective" on interdisciplinary collaboration and negotiation practices in the field of digital history [Kemman 2019]. 6

The DTU is certainly not an exclusive example of a trading zone. Interdisciplinary settings in doctoral education have a long history[8], and many collaborative projects in digital humanities [Deegan and McCarthy 2012] and so-called "makerspaces" [Peppler et al. 2016] are inspired by the idea of collective "thinkering". The specificity of the DTU is its focus on digital history and its emphasis on the hermeneutic reflection on the practices of historical research in the digital age. 7

1.3 Overview article

The article is structured along three complementary perspectives on situated research practices and the Doctoral Training Unit as an interdisciplinary research and training programme. The first perspective, *sense of place*, investigates the spatial and organizational framework of the DTU, the Digital History Lab, and where and how they are situated in or related to the C²DH as one of the three interdisciplinary research centres of the University of Luxembourg. It also discusses the C²DH open space, which was designed as shared office for all thirteen PhD students of the DTU, to discuss the role of spaces and places of communication in interdisciplinary collaboration. 8

The second perspective explores the DTU as a *trading zone* in digital history. By zooming in on the research practices and various training activities that were organized within the DTU framework, it analyses how this DTU framework has been experienced in practice by the PhD students. We will identify and distinguish certain "boundary objects" [Gieryn 1983] [Star and Griesemer 1989] between the humanities and computer sciences as distinct communities of practice within the DTU as interdisciplinary trading zone. 9

The third part explores the DTU from the notion of *thinkering*, providing an epistemological and methodological reflection on the use of digital methods and tools in situated digital historical research practices. In the conclusion, finally, we reflect on some of the main opportunities and challenges of thinkering as pragmatic digital hermeneutics in an interdisciplinary trading zone like the DTU, and the role of the Digital History Lab and the C²DH open space as physical spaces and platforms of collaboration. 10

2. Sense of place

2.1 The DTU framework and training programme

The DTU is hosted by the Luxembourg Centre for Contemporary and Digital History (C²DH), which is one of the three Interdisciplinary Centres (IC) of the University of Luxembourg. Because of the interdisciplinary character of the DTU, the training unit was a great possibility to strengthen collaboration between researchers (mainly historians) working at the Centre and colleagues from other Centres or Faculties of the University. The DTU team consists not only of the thirteen PhD students, but also includes their supervisors, a coordinating post-doc, the Management Team, and the PI (principal investigator). The DTU is framed by a number of international partner institutions which agreed to support the project and to serve as a critical sounding board for DTU activities.[9] 11

Aims and objectives

The DTU departs from the constatation that there is growing gap or a-synchronicity between the fast development of digital research technologies and infrastructures, and their rather slow appropriation within historical research practices. Everyday we witness the emergence of new digital infrastructures, software and tools, be it for text mining, data visualization, GIS-analysis, virtual and augmented reality apps, et cetera. While these new possibilities are surrounded by a discourse of revolutionary potential for future research, their appropriation in teaching and research is slow and very limited in scale so far. (See for a discussion [Rosenzweig 2003], [Fickers 2012].) 12

Nevertheless, addressing the question *how* the digital turn does impact the practices of historical research has become more urgent than ever [Graham et al. 2016]. In the introduction to the volume *History in the Digital Age,* Toni Weller stated that "history as a field of enquiry is standing on the edge of a conceptual precipice. Historians need to be thinking about the radical impact of the digital turn in historiography and historical methodology in a critical and engaged manner" [Weller 2013, 1]. This is exactly the aim of the DTU: to critically reflect on the epistemological and 13

methodological implications of the digital turn in historical research practices. It thereby builds on the concept of “digital hermeneutics”, defined as the critical and self-reflexive use of digital tools and technologies for the development of new research questions, the testing of analytical assumptions and the production of sophisticated scientific interpretations. [10]

DTU skills trainings

But how to organize and realize such a training programme in an interdisciplinary and international setting? Based on the assumption that a PhD trajectory runs through several phases, the DTU was divided into three consequent phases: a DH incubation phase (first year), a DH problematization phase (second and third year), and a final phase of writing and defence (third and fourth year). In this article, we will only focus on the first phase, the DH incubation phase, which aimed to familiarize the interdisciplinary group of PhD students with a critical mass of digital methods and tools. For this purpose, nine specific skills trainings were organized within the DTU framework: Text Mining; Digital Source Criticism; Database Structures; Introduction to Programming with Python; Data Visualization; Tool Criticism; Algorithmic Critique; GIS-analysis, Mapping and Cartography; and Experimental Media Ethnography. The aim of the skills trainings in the DH incubation phase was to establish a common ground and shared experiences, and to encourage the PhD students to critically reflect on the use of digital tools and technologies in their own research practices. 14

2.2 Situated working environments: Digital History Lab and C²DH open space

Digital History Lab

The DTU training activities mostly took place in the Digital History Lab. Within the C²DH, the lab has been designed to serve as a space for experimentation and hands-on teaching. It is part of a larger Lab-infrastructure of the Faculty of Humanities, Education and Social Sciences (FHSE) of the University, bringing together five laboratories from different departments (the GIS-Lab, the Experimental Psychology Lab, the Media Lab, the Usability Lab, the Digital History Lab). As these Labs are all located on the first floor of the “Maison des Sciences Humaines” (House of the Humanities) (see Figure 1), they offer a fantastic infrastructure for doing hands-on and experimental research in a great variety of disciplines in the humanities and social sciences. Within this setting, the Digital History Lab is equipped with a multitude of scanning devices and digitization equipment. Designed as a “laboratory setting” for trainings, seminars, workshops, experiments and as infrastructure for the scanning of research materials and sources, the Digital History Lab has developed into a critical infrastructure for the Centre and a safe environment for playing with digital technologies. 15

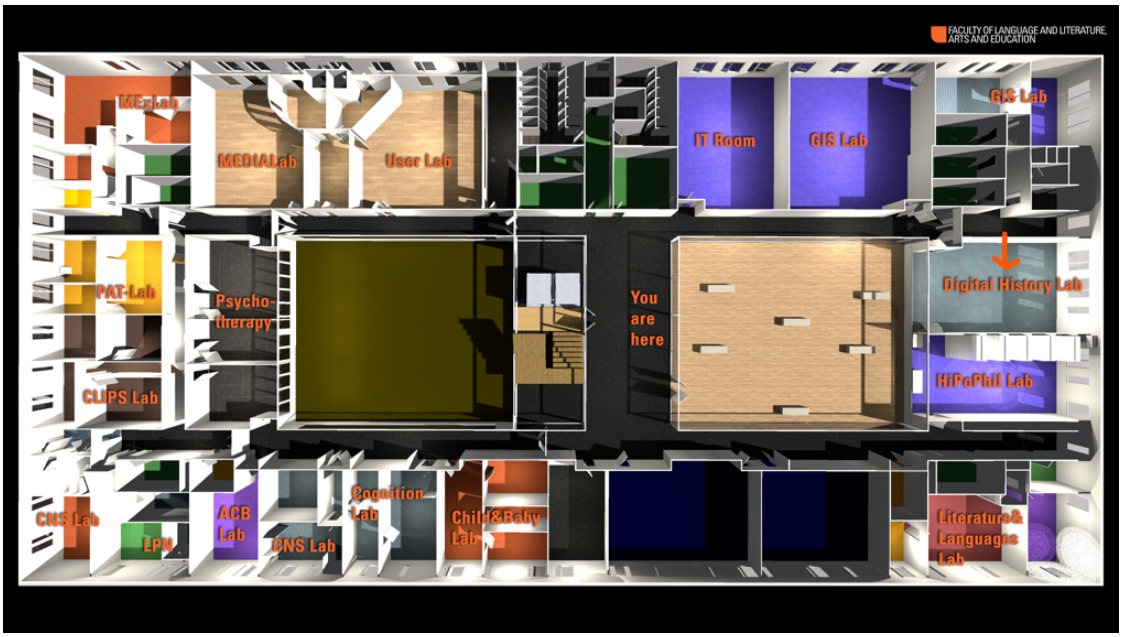

Figure 1. Floor map of the first floor of the “Maison des Sciences Humaines” (MSH) of the University of Luxembourg, including the Digital History Lab.

C²DH open space

In order to facilitate the communication and exchange between the thirteen PhD students of the DTU, they were all located together in an open office space of the C²DH. As a collective working space with single offices the open space created some challenges in terms of spatial arrangement, so we decided to group four desks into smaller units in order to create smaller physical and social neighbourhoods. As the open space has step by step been populated by other PhD students who have joined the C²DH since its creation in 2017, it now hosts some thirty PhD students in total and the room is no longer an exclusive space for DTU members. The open space includes a smaller seminar room, which is acoustically isolated from the rest of the open space. This seminar or project room can be used by the DTU students for group discussions or team meetings. Next to the open space, the Centre has installed a cosy "communication space" with sofas and coffee tables that serves as meeting space for informal exchanges, smaller public events (e.g. guest lectures) as well as space for the monthly "plenary sessions" of the C²DH in which C²DH staff is informed about ongoing activities, decisions of the Management Team or general University politics. 16

3. Inside the Trading Zone

The DTU has explicitly been designed as a "trading zone", as an experimental place for knowledge transfer and exchange between different communities of practice. In the case of the DTU, these include the knowledge domains of history, philosophy, linguistics, geography, archaeology, computer science and human-computer interaction. The concept of trading zone originates from history of science and sociology of knowledge, where it has been used to analyse how different communities of practice interact when working in an interdisciplinary setting [Collins et al. 2007] [Galison 1996]. Communities of practice can be defined as groups of people who collectively engage in shared learning activities and base their group identity on a shared craft, domain and practice [Lave and Wenger 1991] [Wenger 1998]. 17

Three aspects are particularly relevant for analysing the DTU as interdisciplinary trading zone: (1) the notion of *interdisciplinarity*, (2) the notion of a *common ground* or *common language* within interdisciplinary trading zones, and (3) the notion of *locality* or collaborative space to facilitate interactions between communities of practice. By zooming in on these three aspects of digital history trading zones, this part explores how the DTU framework has been experienced by the PhD students and which "boundary objects" we can identify between the distinct disciplinary traditions within the DTU. 18

3.1 Interdisciplinarity

Interdisciplinarity is at the very heart of the concept of trading zone: the transfer and exchange of concepts, methods, tools, techniques and skills between or across different disciplinary fields or domains. Digital history can be framed as an interdisciplinary field or domain of the wider discipline of history, as digital historians have been "incorporating" methods and tools from the domain of computer science [Kemman 2016]. In *Interdisciplining Digital Humanities*, Julie Thompson Klein distinguishes between "methodological interdisciplinarity" and "theoretical and critical interdisciplinarity" [Klein 2015]. While methodological interdisciplinarity is concerned with the *application* of digital technologies and their methods to humanities scholarship, theoretical interdisciplinarity concerns the epistemological reflection on the nature of these digital tools and technologies. The DTU explicitly deals with both methodological and theoretical forms of interdisciplinarity. 19

One of the advantages of interdisciplinarity is bringing together approaches and perspectives from different knowledge domains. As one of the PhD students states: we are all "coming from different [disciplifignary] backgrounds, [...] have different point[s] of view, [and so] see reality in different ways" (interview, PhD 1, computer scientist). A good illustration is one of the collaborations that was formed within the DTU framework, in which a digital humanist, linguist and digital heritage specialist worked together in reconstructing the historic landscape of Larochette Luxembourg for a joint article. Bringing in different perspectives and forms of expertise was very beneficial for them, as one of the collaborators explained: 20

> [W]e all went [to the area] and actually walked around the town of Larochette together. And [the linguist] said: "Look at the street signs, you can see that this is named after the field that stood here;

> and look, the church was here because this car park is called graveyard." While [the digital heritage specialist] said, "If you look at the property boundaries between the houses, you can see where the city wall used to be." While [the digital humanist] stated: "If you just take like three steps to the side here, your perspective totally changes." [...] Everybody was literally bringing their view of landscape into it. (interview, PhD 7, digital heritage specialist)

Opportunities of interdisciplinary collaboration

The possibility to learn from each other is seen as one of the main benefits and advantages of participating in the DTU. Participants engage in interdisciplinary collaboration because of a certain need for expertise from another field. A PhD student argues: "Everybody is an expert in a certain field. And if I need something or if I have questions, it's easy to approach people and ask them what to do." (interview, PhD 9, philosopher). Likewise, another PhD student states: 21

> I don't know anything about text mining [...] But I know a lot more about GIS than some others. We are all experts in our own fields, and this makes it nice [to be part of the DTU]. So if I have a question about text mining, there is someone [in the team that] I can ask. (interview, PhD 2, historian)

While humanities scholars can learn from computer scientists' expertise of specific digital methods and tools, computer scientists seem to be interested in collaborations with historians especially because they hope to develop specific *applications* for their models and algorithms. As a computer scientist in the group sums up: "the historian needs the expertise from the computer scientist, and the computer scientist needs an interesting application. And then they can collaborate" (interview, PhD 1, computer scientist). Some interdisciplinary collaborations go beyond the mere methodological exchange and applicability of data, but involve a debate about the epistemological underpinnings of disciplinary traditions and schools of thought. A computer scientist in the group states: 22

> I want to look at my data from the perspective of a historian. For example, to analyse how the language of people has changed throughout time. For this I can use the help of a historian: what kind of questions come to mind when they have this kind of data? (interview, PhD 8, computer scientist)

However, sharing or exchanging between methods and perspectives across different disciplinary traditions does not only provide new opportunities. It can also be challenging in practice.

Challenges of interdisciplinary collaboration

There has been much debate about the longstanding cultural-epistemic differences [Knorr 1999] between the humanities and computer sciences, and whether bringing computational techniques and quantitative methods like statistics to the domain of humanities can make the work of the historian more "valid" and "scientific" [Jockers 2013] [Graham et al. 2016]. Old questions concerning the validity, objectivity and evidentiary quality of history as a "social science" that characterized the epistemological debates during the classical period of historicism re-emerge in the digital age through tensions between close and distant (machine-based) reading, exemplary and representative, statistical and historical evidence. Although such dualistic conceptualizations have been challenged ever since the emergence of "computational humanities" in the second part of the twentieth century, the idea that historians produce "subjective interpretations" and scientists "objective facts" as forms of knowledge production still prevails today [Fickers 2013]. (See for a discussion on objectivity and subjectivity in scientific knowledge production also [Daston and Galison 2007].) 23

The DTU aims to overcome these dichotomies by utilizing the concept of digital hermeneutics. As a "hermeneutics of in-betweenness" it allows to address the tensions between quantitative and qualitative or empirical and hermeneutic approaches in a productive way [Fickers forthcoming]. In *Reading Machines*, Steven Ramsey similarly argued to "locate a hermeneutics at the boundary between mechanism and theory" in order to channel the "heightened objectivity made possible by the machine into the cultivation of those heightened subjectivities necessary for critical work" [Ramsey 2011, x]. The concept of digital hermeneutics invites us to critically reflect on how digital tools and infrastructures 24

produce new historical information by transforming “raw” data into “cooked” historical analyses and narratives [Frisch 2011]. (For a critique on the idea of data as “raw” or “neutral”, see also [Strasser and Edwards 2017].)

25 Despite of the ambition of the DTU to develop the concept of digital hermeneutics as a way to overcome the longstanding cultural and epistemic differences between the humanities and the computer sciences, they nevertheless play an important role in how the PhD students *think* about their communities of practice. The interviews show ample evidence of how the PhD students strongly locate themselves in disciplinary traditions and epistemic cultures. One of the PhD students, for instance, stated that “the real difference between the humanities and the hard sciences is that the humanities are a lot more subjective in many ways” (interview, PhD 7, digital heritage specialist) and that “[f]rom the humanities perspective, everything is about interpretation and perspective” (interview, PhD 6, digital humanist). Computational methods and techniques, on the other hand, like machine learning and big data algorithms, are perceived to enhance the objectivity of historical analyses. Reflecting on a recent collaboration with a digital historian, for instance, a computer scientist in the group argued that:

> ... if a person looks at the [historical] data and then says something, it’s subjective. It’s human interpretation. While you can [also] ask the same [historical] questions in an objective way using machine learning or any computer science algorithm. (interview, PhD 1, computer scientist)

26 Using scientific methods in humanities’ scholarship has been perceived to “prove the validity of your work” (interview, PhD 6, digital humanist) and to “strengthen the reproducibility” of the data analysis (interview, PhD 7, digital heritage specialist). Having a specific working environment or laboratory to do “scientific experiments” is seen as helpful in that regard: “On the third floor [...] they consider themselves scientists, because they have a lab. They do tests, and they use a scientific method” (interview, PhD 6, digital humanist).

27 Computer scientists may indeed use different methods and skills. In order to analyse historical data computationally, for instance, one needs to be able to build a database and work with it. According to a digital historian in the group this is actually one of the most important skills in digital history: “Simply because we [as historians] have always worked with source material. When we enhance that source material with meta-data, and add this meta-data to a database, we can see more patterns and may discover a lot more than just by looking at the material itself” (interview, PhD 4, digital historian). However, the same digital historian also warned that if you think like a computer scientist [too much], “you start seeing things in ones and zeros; whereas reality is often more complex. I think that this complexity is not always thought of in computer science” (interview, PhD 4, digital historian). Despite of the new opportunities offered by computer scientists, the “humanist way of thinking and knowledge” shouldn’t be sacrificed in interdisciplinary trading zones (interview, PhD 3, digital archaeologist). When being asked to reflect on the future of digital history, one of the digital humanists in the group argues:

> ... we have a discourse [at the moment] that technology is good, because it can help you if you already have a humanist mind. But if you don’t, it’s not going to help you develop one. You just base your entire career on these tools. [...] The most relevant skill [in interdisciplinary collaboration] remains the same that has always been, which is understanding: the humanities approach. (interview, PhD 6, digital humanist)

3.2 Common ground and language

28 A second characteristic of the DTU is the ambition to establish a certain common ground and, possibly, to share a common vocabulary and develop a new “interlanguage” [Collins et al. 2007]. After all, key terms and concepts often mean very different things to different scholars or communities of practice. Whereas historians speak about “sources”, for example, librarians or archivists talk about “documents” and computer scientists refer to “data”. Such terms and concepts can be described as “boundary objects” in the negotiation of new knowledge, characterized by a process of “heuristic groping” [Rheinberger 1997].

29 Whether a common language really emerges, however, depends on the *type* of trading zone. In their article “Trading Zones and Interactional Expertise”, Collins et al. differentiate between interlanguage, subversive, enforced and

fractionated trading zones [Collins et al. 2007] (Figure 2). The type of trading zone depends on whether a group is homogeneous or heterogeneous, and whether the "trading" or group dynamics is based on collaboration or coercion (involving power relations). As opposed to enforced trading zones, which are characterized by high heterogeneity and high coercion, interlanguage trading zones may only develop in groups with strong collaboration and high homogeneity. Subversive trading zones are characterized by a power imbalance between the involved collaborating parties or language communities, whereas fractionated trading zones show a high degree of collaboration and heterogeneity [Collins et al. 2007]. (See for a discussion of the four trading zones also [Klein 2015] and [Kemman 2019].)

Trading Zones	**Homogeneous**	**Heterogeneous**
Collaborative	Interlanguage	Fractionated
Coercive	Subversive	Enforced

Figure 2. The four types of trading zones according to [Collins et al. 2007].

Particularly relevant about this model is the temporal dimension involved in the development of interactional expertise, namely the possibility to "move between different kinds of trading zones over time" [Collins et al. 2007, 657]. Groups can change, for instance, from enforced trading zones (coercive-heterogeneous) to interlanguage trading zones (collaborative-homogeneous). The ambition to create a "specific environment for learning, practising and reflecting on digital history" [Fickers 2015, 2] combined with the high heterogeneity of the group given the PhD students' diverse disciplinary backgrounds, ages and nationalities, made the DTU an *enforced trading zone* in the beginning. This was especially the case for the DH incubation phase, in which the skills trainings were meant to establish a common ground among the PhD students. 30

In search of a common ground

The DH incubation phase, as enforced trading zone, partly succeeded in its aim to establish a common ground among the PhD students. The trainings, for instance, provided "an opportunity to learn something about computer science or philosophy" (interview, PhD 2, historian) or to deal with technical or practical problems, such as applying or evaluating Optical Character Recognition (OCR) to large bodies of textual sources for computational analysis: 31

> That is something that the training made me more aware of, I think. For example, when I was going through the frequency tables and texts that I used, I asked myself: when were they OCR'ed? [...] How good is the OCR? Which libraries applied it? And why have they done this? These are questions that I try to think about, although you cannot always answer them. (interview, PhD 5, historian)

Sometimes, the skills trainings were useful to better understand how researchers from other domains are dealing with specific digital tools and methods. For a computer scientist in the group, for instance, GIS-analysis was not "completely new", yet still participated in the training out of curiosity "to see how historians use GIS tools: what kind of questions they try to address and what kind of problems they try to solve" (report GIS-analysis, PhD 1, computer scientist). Likewise, for another PhD student in the group 32

> ... the most powerful thing [in the training] was to learn how different the problems are that people face in their everyday work and how they are being solved, because the entire purpose of an interdisciplinary group [like the DTU] is to be able to try [certain] methodologies from one field and apply them to another. (report, PhD 7, digital heritage specialist)

Occasionally, the skills trainings even fostered collaborations between the PhD students and so stimulated a transfer of knowledge and skills across disciplines. In relation to the skills training on programming with Python, for instance, a historian in the group wrote: 33

> For me, it was not always clear how to construct certain parts of the code, or to understand their meaning, but with help from [a digital historian] and [a computer scientist] they made this more insightful for me. […] I learned a lot about Python and that everything starts with being able to read and understand code; something that I am more skilled in now than before the workshop. (report, Programming with Python, PhD 5, historian)

Needless to say, the skills trainings also came with a significant time investment. While they were potentially interesting, one of the PhD students remarked that "the [main] goal is to finish my PhD; that's the most important thing" (interview, PhD 2, historian). More PhD students in the group were critical about the trainings, especially because not all of the digital tools, methods and skills were necessarily applicable to their individual PhD research projects – which indeed varied significantly in terms of topic, scale, type of data, method and approach. In fact, the trainings were mostly evaluated based on their applicability and usefulness for the PhD student's own research. It made one of the PhD students argue that the skills trainings had "to be elective, because they are not relevant for everyone. If you would just put everyone in the same room and make them study, make them learn, it's not productive I think. It's just a waste of time" (interview, PhD 10, linguist). The PhD student further explained: 34

> ... we all came from different backgrounds [...] by having one session on text mining, you cannot make a person capable of text mining just after one day. And the same goes about databases. I know that some [of the PhD students] have experience with SQL. I attended the training and all I came out with was just a general understanding of how databases work. [...] So, it was just an introduction. I think that those trainings, if they had the purpose of bringing everyone to the same level, they didn't do that. And they couldn't by definition, by the time frame, by the level. [...] because everyone has different projects. Not everyone is interested, and gets into the same level of, say, data visualization or programming. Some [of the PhD students] did not want to start programming. They said, [the training] is a waste of time. I'm not going to use it, so why do I need it? (interview, PhD 10, linguist)

Clearly, the DTU incubation phase did not serve everyone equally. The question whether the skills trainings should be compulsory or not, was extensively debated within the DTU Management Team as well as by the complete project team during evaluation meetings. Eventually, half-way the first year of the project it was decided to make the trainings no longer compulsory but optional, so the PhD students could choose which trainings were relevant to attend for themselves. The idea to establish a common ground among the PhD students by means of a series of skills trainings in digital humanities research practices, in other words, led to some form of resistance. The DH incubation phase was experienced as an enforced trading zone and, subsequently, led to a renegotiation of the DTU's training programme, framework and aims. 35

3.3 Locality and physical proximity

A third characteristic of a trading zone is *locality*. According to historian of science Peter Galison, locality is central to the definition of a trading zone, which he defines as "an arena in which radically different activities could be locally, but not globally, coordinated" [Galison 1996, 690]. Digital humanists, in contrast, often describe or qualify the recent intersection of the humanities and the computer sciences as a "generalizable global phenomenon" (see for a discussion [Kemman 2016]). While digital research infrastructures and online communication technologies have certainly fostered new forms of collaboration at a distance, our interest was to study the situated and local research practices. 36

The "open space" as local trading zone

For the design of the DTU, locality therefore played an important role. One of the project's distinguishing and grounding principles was to have one shared open office space instead of having team members work in different departments and locations. The concept of the open plan office, typically "a shared room occupied by more than four people, where desks are arranged in groups, and where there are few barriers between desks" [Irving 2016, 26], can be traced back to the 1920s [Baldry 1997]. After the 1960s, the open plan office became implemented more widely in workspace design (see for a brief history [Irving 2016, 26–8]). In academia, however, this development is relatively new. While individual 37

cellular offices remain the norm, there have been movements towards “more open work environments” since the early 2000s [Parkin et al. 2011]. This trend was pushed, among others, by new managerial and financial paradigms (promoting flexible use of space and cost efficiency [Baldry and Barnes 2012]) as well as “demands for more collaborative and interdisciplinary research” [Pinder et al. 2009, 5]. Research in the fields of social psychology and organizational studies shows that group interactions benefit indeed from close proximity: being physically near one another is constructive for (interdisciplinary) collaboration, communication and exchange (see, for instance [Kiesler and Cummings 2002], [Hinds and Kiesler 2002], [Olson et al. 2002, 114]).[11] With this theory in mind, all thirteen PhD students of the DTU gathered together in one shared office space, also called the C²DH open space (Figure 3).

Figure 3. Picture of the C²DH open space, designed as collaborative working environment for the DTU PhD students.

For some of the PhD students, being in the same department (C²DH) and being situated in one collaborative working space as a group stimulated exchanges within the team. A PhD student states: “I think it’s thanks to the open space that we collaborate. Thanks to the fact that we work in a similar department” (interview, PhD 1, computer scientist). Another PhD student emphasized the importance of physical proximity, which the C²DH open office provides as a working environment: “It’s important to be near each other. Yes, it creates an opportunity to do something [together]” (interview, PhD 3, digital archaeologist). Of course, “virtual” spaces or platforms of communication, like Skype, Facebook and Slack, also provide possibilities for collaboration and exchange: “You don’t have to be in the same [space in order to collaborate]. I mean, you can use Skype, use different [media], you can even call. [However] it’s easier when you are in the same space” (interview, PhD 2, historian). One of the downsides of communication via online platforms is that it comes with certain conventions, which could make it more difficult to approach someone else in the group: 38

> When I am here [in the open space] and the others are also here, it almost doesn’t involve any risks to just easily talk to people. Collaborations almost always start through chats, I think. Well, okay, you can send an official email as well, but in my experience starting off with official emails doesn’t work with people who already have enough interesting things to do. (interview, PhD 3, digital archaeologist)

Face-to-face communication and presence are mentioned as important characteristics of physical platforms of exchange. As one of the PhD students argued: “It would be impossible to get any collaboration done if we were working from home all the time. [...] I think it’s true that face-to-face is important, for initiating collaborations in the least” 39

(interview, PhD 6, digital humanist).

The "open space" as non-trading zone

40 While the C²DH open space provides presence, proximity and locality, it clearly came with some limitations as well. One of the main challenges of open plan offices in academia is to find a balance between "the promotion of communication and collaboration on the one hand and the provision of privacy on the other" [Parkin et al. 2011].

41 One of the issues at stake are noise and disturbance. Some of the PhD students prefer to have a quiet space as working environment, where they can concentrate and work on their own without disturbing others: "If I really have to concentrate on something, if I'm writing something, I prefer to have a space of my own. Because I also feel kind of self-conscious, like I'm disturbing the others if there's stuff I need to do" (interview, PhD 7, digital heritage specialist). More participants note that people in the open space "can't work really with all the chatting going on" (interview, PhD 3, digital archaeologist) and signal the fact that "people are wearing headphones all day just to prevent others from disrupting them from their own project" (interview, PhD 10, linguist). Some PhD students, on the other hand, prefer to have some background noise: "Most people don't like the open space because it's too loud. I [personally] don't like the open space, because it's too quiet" (interview, PhD 6, digital humanist). The examples make clear how difficult it is to meet the expectations of everyone when it comes to a common working environment.

42 Another factor limiting the trading zone-effect of the open space was the fact that ten out of the thirteen PhD students of the DTU have a second office in the research institute, department or internal research groups that their supervisor is affiliated to. The wide variety of disciplinary research affiliations created a certain administrative and institutional confusion for some of the PhD students, especially in the beginning of the project. For others, having a second office space was beneficial as it provided a solution to some of the aforementioned problems the PhD students experienced in the open space. It allowed them to divide between specific working environments in relation to types of work that for instance required more concentration:

> Well, I have the other office [at the Computer Science department] that I use sometimes. I go there once or twice a week, because my supervisor requires me to. That's why I separate [between] my "focus time" and "more easy time". (interview, PhD 10, linguist)

This last citation indicates how the supervisors played an important role in this issue as well. The spatial and institutional division of the PhD students was not very constructive for the building of a trading zone. Certainly, it didn't help the formation of a certain group identity with the project team. A historian in the group reflected about the second offices in terms of a "loss" for the DTU:

> We [have] already lost two people [*mentions names*]. And [two other PhD students] aren't here [in the open space] often. [...] Probably, because they have to be at their department. A lot of us have second offices. I also have one... (interview, PhD 2, historian)

43 A third reason why the open space didn't foster interactional expertise as expected might be related to the fact that the DTU missed a common research project in which all PhD students would have to participate. Collaborations between PhD students rather happened "bottom up" and at smaller scale based on shared (thematic) research interests or methodologies.[12] A computer scientist in the group argued:

> [In general] I would say a common environment helps [to stimulate group collaborations]. However, I don't think ours [the open space] is yet such an environment. [...] I expected the DTU to have a more common research [project], in which we would all collaborate. That way, I think, the common workplace would be really relevant. But this is somehow missing now. [...] Most of our exchanges happen in the seminars and in the skills trainings [...]. Most ideas started from those kinds of meetings. (interview, PhD 8, computer scientist)

44 To sum up, the actual exchanges and collaborations did not take place in the open space, but in some of the other venues for collaboration provided by the C²DH and the University. These include, among others, the PhD seminar room,

the University's Learning Centre, the C²DH lounge area, the kitchen next to the open space, the University canteen, and – in the case of the skills trainings and research seminars – the Digital History Lab. The social setting of these venues plays a crucial role in fostering internal exchanges; whether informally over lunch, during a coffee break, or in group activities. While the open space mainly functioned as shared office space, the "thinkering" happened in these other spaces.

4. Thinkering

From the start, the Digital History Lab was designed as a space for doing hands-on experiments with digital tools and technologies. By turning historians into experimenters who experience the "mangle of practice" [Pickering 1995] of "science in action" [Latour and Woolgar 1979] – such was the original idea – we would combine a pragmatic approach to a hermeneutic process of critical reflection. Such experimental settings of knowledge production have been coined as "collaborative thinking" [Corrigan 2012], "thinkering" [Huhtamo 2010], "heuristic groping" [Breidbach et al. 2010], or "bricolage" [Rheinberger 2015]. All these concepts build on the idea of a hands-on approach fostering "situated learning" [Lave and Wenger 1991] and "learning by doing" [Heering and Wittje 2011]. We finally decided to adopt the term "thinkering" as umbrella term for the hands-on philosophy of C²DH at large, merging the tinkering with technology with the critical reflection on the practice of doing digital history.[13] 45

4.1 Thinkering within the DTU framework

How has the DTU framework stimulated or facilitated such thinkering processes within the project group? Did the skills trainings and research seminars contribute to new forms of knowledge production in digital history research practices? 46

Building on the concepts of "digital hermeneutics" [Capurro 2010], the so-called "third wave" in DH scholarship [Berry 2012], and critical approaches to digital humanities [Berry and Fagerjord 2017, 136–162], it is increasingly important to understand how digital tools or technologies mediate, represent, structure and produce research results. Since, in the words of one of the PhD students, "we often use these tools without actually knowing how they work" (report Digital Source Criticism, group 1). There is thus an urgent need to open the "black box" and critically reflect on what the use of the digital tool or technology means for the historical research process in all its phases. Or as Jennifer Edmond wrote: "For historians to harness big data, the black boxes will need to become glass boxes" [Edmond 2016, 97] (cf. [Fickers 2012, 411–439]; [Bell 2006, 131]). 47

In order to enable this to happen, the DTU framework focused on (1) *the heuristic potential of thinkering*, which involves the methodological implementation of digital tools in historical research practices, and on (2) *thinkering as hermeneutic practice*, which involves a critical reflection on the meaning of using such tools and the epistemological consequences of the transformations from source to data to database for historical analysis. 48

4.2 The heuristic potential of thinkering

One of the most applied tools and methods in digital humanities is "distant reading": the analysis of large bodies of text-based data by means of computational techniques [Moretti 2013]. As one of the PhD students in the group explained: 49

> ...if I have a library of encrypted texts, it would be really time consuming to read all of [these texts] and see how people of this area think about a particular topic. I can [also] do that with an algorithm, if the books are digitized, in less than one hour. [...] if we can build this environment [within the DTU] between historians and computer scientists, a historian can use this tool for analysing a whole dataset of text for extracting what he has in mind. (interview, PhD 8, computer scientist)

Distant reading methods were explored specifically in the skills trainings on text mining and programming with Python, where participants experimented with text analysis tools, like Voyant [Rockwell and Sinclair 2016]. In one of the DTU research seminars, a historian in the group showed how applying distant reading techniques could be useful to find, analyse and visualize meaningful patterns in a digital corpus of historical texts: 50

> ... looking for specific words and when counting them over time, you really saw something happening. [...] because of the word frequencies, you could zoom in on certain things, for instance how they changed over time. And then it appeared that for all my [historical] journals something was happening in the same year. (interview, PhD 5, historian)

Likewise, in the skills training on data visualization, it was explored how network visualization tools like Palladio and Gephi could be used as heuristic instruments to “show new and to that point unknown connections in the data” (report Data Visualization, PhD 2, historian). Visualizing such connections “may help us see trends and patterns which may not be seen in, for example, a spreadsheet containing a lot of numerical data, or in an unstructured text” (report Data Visualization, PhD 10, linguist). It may even help “to find anomalies or even mistakes in data,” which were not visible before (report Data Visualization, PhD 8, computer scientist). 51

As one of the PhD students remarks in this regard, the shift from close reading as traditional approach in the humanities to distant reading with text mining “is all about ignoring specific features of individual texts of the corpus and focusing instead on identifying large-scale trends and patterns throughout the collection” (report Text Mining, PhD 10, linguist). Sometimes additional tools had to be used to remove certain elements in order to make the digitized map more useful for GIS-analysis (Figure 4): 52

> ... the georeferencing process requires a high level of accuracy to map physical space onto a map while maintaining the correct proportions. This meant editing via Photoshop to remove unnecessary whitespace, especially at the joints of the map where it folds. During my first georeferencing attempt, the software was unable to proportionally juxtapose the image of the map with the georeferenced data. By removing white space it increased the overall accuracy. (report GIS-analysis, PhD 6, digital humanist)

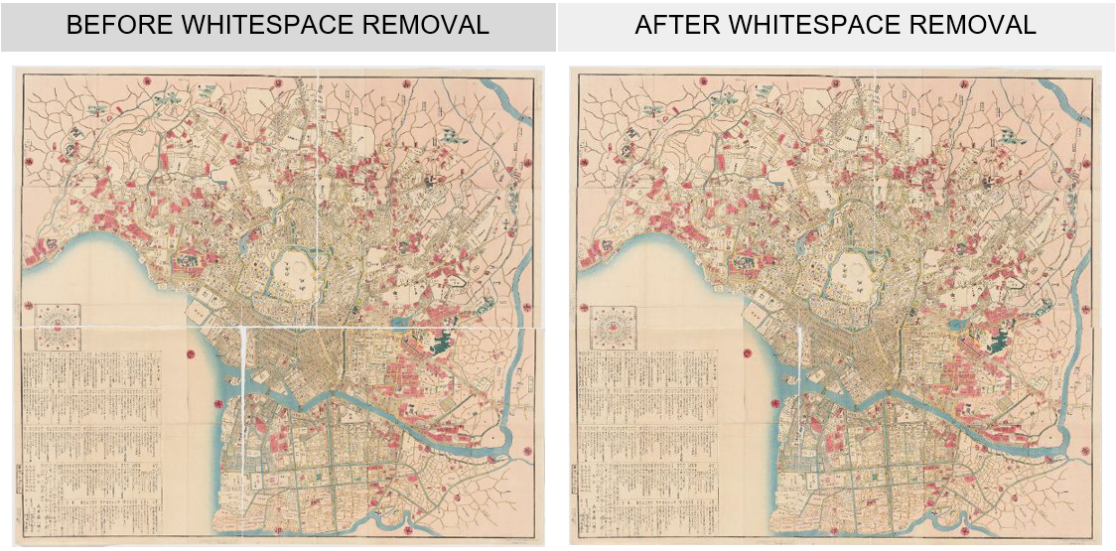

Figure 4. Image before and after whitespace removal. Image from GIS-analysis skills training report.

Before being “mined”, searched through, or visualized, data thus needs to be corrected, adjusted or (re)structured to make them suitable for computational analysis. In the skills training on Database Structures, participants learned how to structure big data into SQL databases and work with “queries” to search through and analyse specific datasets. However, the creation and implementation of database structures also came with certain challenges. As one of the participants wrote: “Although it seems easy at first, thinking about establishing a database from scratch is quite a complex feat. The need arises to think about the categories and relationships of the data that is to be put into the database” (report Database Structures, PhD 11, linguist). Thinking about databases and which categories and relationships to include is not just a technical, but also a conceptual exercise. For example, in an internal collaboration on gender in computer science conferences, thinking about data categories and relationships led to a problem of how to 53

cluster data in a database for making useful queries. Structuring data by means of an “ontology” and “entity relationship diagram” finally resulted in a graphical representation of the relations between certain data entities and their attributes (Figure 5). However, what exactly constitutes an “entity”, “relation” or “attribute” is subject to human interpretation and therefore not always self-evident:

> For example, first we were thinking about putting the “People” category [...] in the “Individuals” table, but then we saw this would work better as a separate table. We first created the diagram on paper, and also visualized/sketched our database tables to make the structure more clear and understandable for ourselves (report Database Structures, PhD 5, historian; PhD 4, digital historian; PhD 10, linguist)

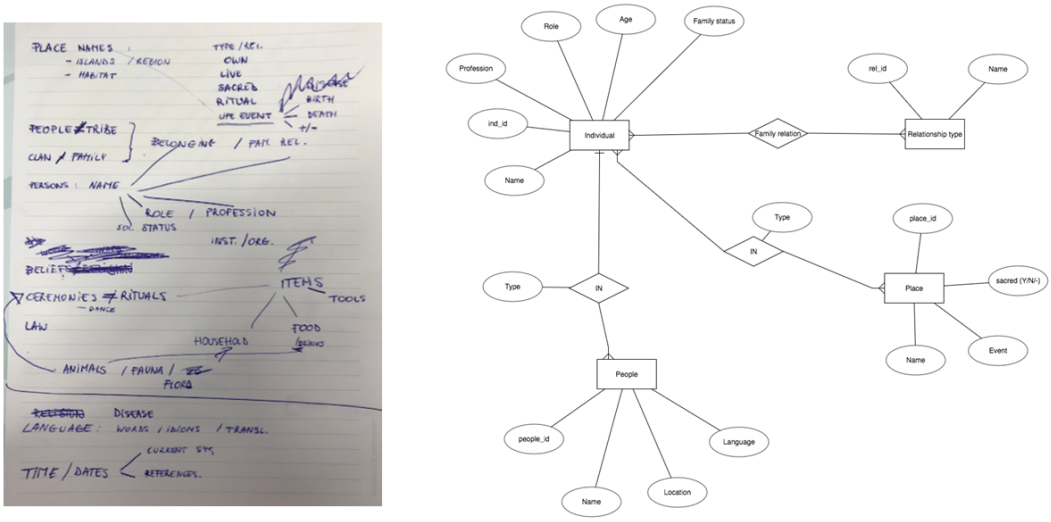

Figure 5. Database structures: from sketch to ontology. Image from database structures skills training report.

In short, by thinkering with digital methods and tools in the skills trainings and research seminars, the PhD students learned about how to work with database structures, text mining algorithms and data visualization techniques in order to analyse, visualize and interpret their historical sources and to discover certain meaningful patterns, relations or anomalies. However, as historians of science and technology have argued before, using a tool is “neither good, nor bad, nor neutral” [Kranzberg 1986, 544], but also shapes our practices and interpretative framework [Fickers 2014] [Latour 2007]. Consequently, structuring and representing data by means of databases and ontologies inevitably involves some form of transformation, translation and interpretation, which is necessary to reflect on as well. 54

4.3 Thinkering as hermeneutic practice

Applying digital methods and tools not only comes with methodological challenges and opportunities, but also implies certain epistemological consequences that need to be addressed by the historian or humanities scholar. 55

From source to data

Since most historians in the group are not dealing with born-digital sources but with retro-digitized sources, the skills training on digital source criticism explored the transformation process from a historical source to data by means of hands-on exercises. In the exercises, participants needed to digitize a historical source themselves – a historical text, analogue photo, audio recording, or 3D object. This made them conscious about the ontological shift in the digitization process and how this impacts their research practices. One of the participants realised “how actual pieces of reality are transformed from a historical type of knowledge to [a] quantified one during the process of digitisation, and how inanimate the data loss is” (report Digital Source Criticism, group 1, PhD 3, digital archaeologist). Another participant confessed: 56

> I became much more aware of the process that is behind all kinds of digitisation techniques: from scanning books, to digitising pictures, audio or 3D material. [...] Before the workshop I hadn't thought about if or how digitalisation altered my source material. (report Digital Source Criticism, group 1, PhD 5, historian)

57 Other participants reflected on the loss of certain physical and material qualities. Due to the transformation from material source to data, they argued, "it is not a physical object anymore [...] we can't touch, taste and smell the photo [...] weigh the picture or feel what kind of texture the paper is made of" (report Digital Source Criticism, group 1). Another report mentions the loss of "scale, colour, size, materiality, scent, sound, historical sensation and context, storage, preservation, restoration, price, accessibility, emotional / commercial / scientific value, whether it is personal or public property, which power relations can be involved, etc." (report Digital Source Criticism, group 4). Reflecting on what such loss of material qualities could mean for the historian in the hermeneutic research process, one of the PhD students states in the report:

> I found it surprising that when you manipulate sound on a computer and for example cut and paste different pieces of audio, it is almost impossible to trace if or when parts were changed. This creates problems for historical research as it is almost impossible to know what the original file was. (report Digital Source Criticism, group 1, PhD 5, historian)

58 On the other side, people noticed how the digitization process not only led to a potential loss of information, but could also enhance the possibilities for research and investigation: a digitized source "allows digital touch-ups, zooming, and other new functionalities" (report Digital Source Criticism, group 2). Digitization, in other words, makes the source more accessible and searchable: "Being able to zoom in, the background of the picture becomes somewhat clearer and shows us that there is a window in the back of the photograph. Although we manipulate the picture by zooming in to get a closer look, we don't lose the 'original' data file of the picture" (report Digital Source Criticism, group 1). However, as another report argues: "greater accessibility [...] would turn out to be useless if digitised sources lack the necessary metadata" (report Digital Source Criticism, group 2). It exemplifies the importance of source criticism as a key competence of doing history in the digital age.[14]

From data to database

59 In addition to the reflection on the transformation from source to data, the skills trainings also reflected on the epistemological consequences of the transformation from data to database. Especially the skills training on Database Structures discussed how the transformation from data to database could have an impact on the process of historical interpretation and understanding. One of the participants raised the question as follows:

> Databases represent data in a highly structured way. This means that we had to bring our raw data into a structured form. We did this by creating an ontology. [However] if the database is set up with the help of this ontology, it can be difficult to reconstruct the decisions that led to the creation of the ontology and the database. In this way, it could be the case, that some potentially valuable information is lost. (report Database Structures, PhD 9, philosopher)

60 It seems of crucial importance to reflect on and be critical about how database structures may impact research results, not only in terms of their indexical logic and semantic hierarchy, but also in terms of missing or corrupted information. Close reading is therefore necessary to complement – or possibly to contradict – certain results produced by distant reading methodologies. As some of the PhD students argue:

> Through close reading and entering provisional data into the dataset we noticed that some issues remained unresolved. Most problems relate to missing data, and sometimes it is very hard to define family relations when people do not have a name (i.e. three sisters, my father). One possible solution would be an added field called "other names" (i.e. father of person x). (report Database Structures, PhD 5, historian; PhD 4, digital historian; PhD 10, linguist)

The question of representation and the importance of being conscious about possible errors or mistakes hidden in the "raw data" played a crucial role in participants' reflections. Based on experiences with the data visualization tool Tableau, one of the historians in the group stated: 61

> With this experiment, I learned once again that it is very important to treat your data very securely, because only after doing these experiments and going back to my data files I noticed that I did not see certain faults that were still in the data files that I used. This constituted for example empty cells that were not supposed to be empty, countries or parts of a country that were not streamlined [such as] the use of "UK" when England is mentioned, but writing "UK Scotland" when the correspondent was from a Scottish city [...] Before starting to explore information visually it is [therefore] important that you double-check all your information at least twice or three times, otherwise you keep going back and forth between the data and the visualizations which can take up a lot of time — as was the case with the experiments I did (report Data Visualization, PhD 5, historian)

The various examples show that experimenting with digital methods and tools served both a heuristic and hermeneutic objective. In short, the DTU skills trainings and researchers seminars enabled PhD students to acquire both a practical and a conceptual "tool kit" fostering a more reflexive attitude in digital history research practices. 62

5. Conclusions

Digital history, as an interdisciplinary field, has brought both challenges and opportunities to situated research practices. While the DTU training programme has certainly contributed to the development of both a practical and conceptual tool kit among the PhD students involved, the question remains whether it has also contributed to the idea of the DTU as a digital history *trading zone*. To what extent have the skills trainings and research seminars stimulated interdisciplinary collaborations and contributed to the development of a common ground and interlanguage within the team? 63

5.1 Between formative and transformative trading zones

We can identify various tensions in both the formation and transformation of the DTU as a digital history trading zone. With *formation*, we mean the importance of institutional spaces (i.e. C²DH open office) and research infrastructures (i.e. Digital History Lab) in the establishment and development of the DTU as platform for interdisciplinary collaboration and thinkering. With *transformation*, we mean the impact of situated research and thinkering processes on new digital history research practices and the "interdisciplinary acculturation" [Horn 2013] (cf. Kemman 2019) among participating PhD students. Though "formative" and "transformative trading zones" are intrinsically related, it is helpful to distinguish between the different dynamics involved. 64

We have discussed how interdisciplinary exchange and collaboration comes with a significant time investment. Since the PhD students have to finish their individual PhD dissertations within three to four years, this puts a certain constraint or limitation on the amount of time that they can invest in interdisciplinary interactions. In other words, from the beginning of the DTU, there has been an ongoing tension between the individual PhD research on the one side and the collaborative aims of the DTU as interdisciplinary project on the other. The tensions between individual and collaborative work were to a certain degree mirrored and even reinforced by institutional tensions between the C²DH – as host institute of the DTU – and the other research institutes or departments that ten of the thirteen PhD students (and their supervisors) are affiliated to. The dynamics between the various institutional affiliations led to centrifugal forces, challenging the shared open space as initial trading zone for the project. 65

In addition to the tensions in the "formative trading zone", the perceived dichotomies between the humanities and the computer sciences as "subjective" versus "objective" forms of research make proof of disciplinary tensions in the "transformative trading zone". Although the DTU skills trainings were potentially helpful to establish a common ground and so stimulated interdisciplinary exchanges and connections among the PhD students, they also came with some form of interdisciplinary resistance. Not only on the side of the PhD students, but also on the side of the supervisors and instructors of the skills trainings. 66

Transforming the “formative trading zone” into a trading zone were “interlanguage” and real interactional expertise were happening proved basically to be a challenge of communication. In fact, the skills trainings have made discursive differences between disciplines explicit. It is through the collaborative work that the different epistemic traditions become visible and make people aware of the implicit traditions of their community of practice. By experiencing these differences and making them a topic of reflection, the “enforced trading zone” at the beginning of the DTU slowly but steadily changed into a “transformative trading zone” which was able to adapt to the specific needs and interests of the PhD students involved. Sometimes, even a new terminology or “interlanguage” appeared, bridging (discursive) disciplinary boundaries. In one of the self-reflexive reports on the skills training on GIS-analysis, for example, a participant describes an original historical map as a “non digital-born source”: 67

> Our task was to identify ground points both on the historical map and the digital map in order to match the former with the latter and “anchor” the historical map to the digital one. In this way, *a non digital-born source* such as an historical map can be not only digitalised but also enriched with other digital information and be suitable for analysis using digital tools. (report GIS-analysis, PhD 1, computer scientist, emphasis added)

5.2 Lessons learned

We can draw at least three concrete lessons learned. The first lesson is the meaning of spaces and places of collaboration and communication for interdisciplinary projects. When organizing an interdisciplinary doctoral training unit, most of the attention often goes to the creation of an interesting training programme or curriculum. Based on our reflections of the Digital History Lab and the C²DH open space as situated research and training environments, however, we found that the spatial dimension is just as important for establishing an interdisciplinary trading zone. A second lesson concerns the governance of this trading zone, in particular the disciplinary and institutional disparity resulting from the dynamics between the C²DH, as the host institution of the DTU, and the various disciplinary research institutes that the PhD students and their supervisors are affiliated to. Unlike some of the literature on interdisciplinarity in digital humanities, we learned that the value of bridging disciplinary gaps in a digital history project is actually not a given – even among the DTU team members. For this, perhaps, the supervisors could have played a more stimulating role in the centralization of the DTU as an interdisciplinary project. A third lesson is that the tension between the individual PhD research and the aims of the DTU as a collaborative project could be solved, at least partly, by designing common research projects within the DTU framework right from the beginning. Although some bottom-up and small scale collaborations already emerged in the first year, and new ones have been formed in the second year as well, the question is whether such internal group collaborations could have been stimulated more, or whether this would have created just another instrumentalization of interdisciplinary collaboration similar to the DH incubation phase. 68

In conclusion, we argue that the formation and transformation of interdisciplinary trading zones depends on various factors, including time investment, collaborative spaces and research infrastructures, communication skills, research profiles, and scholars willingness and ability to cross both spatial and disciplinary boundaries. Getting PhD students out of their disciplinary “comfort zone” and making them fit for an interdisciplinary “trading zone” thus comes with a lot of challenges. Instead of striving for a homogeneous and fully collaborative “interlanguage trading zone” - which possibly remains a theoretical option rather than a realistic possibility - we argue that digital history trading zones should actually embrace their own diversity, heterogeneity and hybridity [Zaagsma 2013]. Because, as Peter Weingart has argued, “interdisciplinarity is not the promise of ultimate unity, but of innovation and surprise by way of recombining of different parts of knowledge, no matter which” [Weingart 2000, 41]. The creative uncertainty that results from such engagement clearly fosters new questions and curiosity – which should be the aim and motivation of any scientific endeavour. 69

Acknowledgements

This research is supported by the Luxembourg National Research Fund (FNR) (10929115). The authors thank the editors of this special issue and the anonymous peer reviewers for their valuable feedback. They furthermore thank the PhD students of the Doctoral Training Unit who participated in this studies for their time and for sharing their experiences. 70

Notes

[1] The Doctoral Training Unit (DTU) “Digital History and Hermeneutics” (DHH) is funded by the Luxembourg National Research Fund (FNR) as part of their PRIDE project grant scheme. See the project’s website for more information: http://dhh.uni.lu.

[2] For the purpose of this article, we situate the field of digital history within the wider domain of digital humanities. Both constitute trading zones between the humanities and computer sciences as distinct communities of practice. While Patrik Svensson has offered some reflections on the field of digital humanities as a trading zone or “meeting place” in a more general sense (see, for instance [Svensson 2012], [Svensson 2016]), we conceptualize the DTU as a trading zone within digital history specifically.

[3] The DH incubation phase is inspired by the “Digital Scholarship Incubator” (DSI), offered by the Centre for Digital Research in the Humanities at the University of Nebraska-Lincoln.

[4] The reports were part of the skills training’s final assignment, for which the PhD students could obtain credits as part of their formal doctoral school training. The purpose of the reports was to critically reflect on the learning processes and outcomes of the skills trainings, for instance the challenges of working with a particular digital tool, like Tableau, QGIS or Voyant. Some of the reports were published on the blog of the DTU website (https://dhh.uni.lu/category/blog/) as well as on some of the PhD students’ personal blogs.

[5] The broad range of disciplinary backgrounds, but also the gender balance and geographical spread or national variety is exemplary for the composition of the DTU project team. We have seven male and six female PhD students, coming from Australia, Austria, Belgium, Czech Republic, Estonia, Germany, Italy, Iran, Luxembourg, the Netherlands, and the USA. At the start of the project, the age range of the PhD students was between 23 and 39 years old.

[6] The PhD students voluntarily participated in this research, and could withdraw their participation at any moment. All research has been approved by the Ethical Research Committee of the University of Luxembourg, and was evaluated on the basis of the most recent General Data Protection Regulation (GDPR).

[7] In the “DTU lecture series” which started in the project’s second year, for instance, international experts were invited to present new research methods and tools from their areas of research and discuss these with the PhD students. See for more information: https://dhh.uni.lu/category/activities/lecture-series/.

[8] See for instance the report of the Deutsche Forschungsgemeinschaft (DFG) “20 years of Research Training Groups. Matrix for New Doctoral Cultures: Innovative, Interactive, International”: https://www.dfg.de/download/pdf/dfg_im_profil/geschaeftsstelle/publikationen/20_jahre_graduiertenkolleg_en.pdf.

[9] For the list of project partners, see: https://dhh.uni.lu/partners/. The C²DH moreover stimulates the collaboration of scholars with experts from the public sector. In the case of the DTU, this particularly involves key players in the country’s digital cultural heritage field, such as the National Library, National Archives, Centre National de l’Audiovisuel, which are involved in large digitization projects in the framework of the “Digital Luxembourg” (Digital Lëtzebuerg) initiative and DARIAH-LU strategy.

[10] https://www.C²DH.uni.lu/events/digital-hermeneutics-history-theory-and-practice.

[11] Interestingly, a recent study in organizational behaviour science actually shows that the architecture of the open workspaces impacts human collaboration *negatively*: “rather than prompting increasingly vibrant face-to-face collaboration, open architecture appeared to trigger a natural human response to socially withdraw from officemates and interact instead over email and instant messaging” [Bernstein and Turban 2018].

[12] In 2018, so after the project’s first year, two internal collaborations have been successfully accomplished within the DTU framework. One is a project between a computer scientist and a digital historian, who collaborated to analyse the role of gender in computer science conferences by means of digital classification of research areas based on topic modelling. Another interdisciplinary publication within the DTU includes the collaboration between a digital humanist, digital heritage specialist and linguist, dealing with the 3D reconstruction of the historic landscape of Larochette Luxembourg in cultural heritage education by means of building a virtual reality application. See for publications of these collaborations respectively [Van Herck and Fiscarelli 2018] and [De Kramer et al. 2018]. For a list of all publications and other research output of the DTU project team, see: https://dhh.uni.lu/category/activities/publications/.

[13] The term “thinkering” also prominently figures in the menu of the C²DH website: https://www.C²DH.uni.lu/thinkering.

[14] For this reason, the C²DH has invested in developing an online teaching platform on digital source criticism called “Ranke 2”. See for more information: https://ranke2.uni.lu.

Works Cited

Arrigoni 2013 Arrigoni, G. “Innovation, Collaboration, Education: Histories and Perspectives on Living Labs”, *XCoAx2013 Computation, Communication, Aesthetics and X*. Bergamo, Italy (2013): 215–224.

Baldry 1997 Baldry, C. “The Social Construction of Office Space”, *International Labour Review*, 136.3 (1997): 366–378.

Baldry and Barnes 2012 Baldry, C. and Barnes, A. “The Open-plan Academy: Space, Control and the Undermining of Professional Identity”, *Work, Employment and Society*, 26.2 (2012): 228–245. https://doi.org/10.1177/0950017011432917.

Bell 2006 Bell, D. *Science, Technology and Culture*. Open University Press, Maidenhead (2006).

Bernstein and Turban 2018 Bernstein, E.S., Turban, S., “The impact of the ‘open’ workspace on human collaboration”. *Phil. Trans. R. Soc. B*, 373.1573 (2018): 20170239. https://doi.org/10.1098/rstb.2017.0239.

Berry 2012 Berry, D. M. *Understanding Digital Humanities*. Palgrave Macmillan, New York (2012).

Berry and Fagerjord 2017 Berry, D. M. and Fagerjord, A. *Digital Humanities: Knowledge and Critique in a Digital Age*. Polity Press, Cambridge, England; Malden, Massachusetts (2017).

Breidbach et al. 2010 Breidbach, O., Heering, P., Müller, M., and Weber, H. “Experimentelle Wissenschaftsgeschichte”. In O. Breidbach, P. Heering, M. Müller, H. Weber (eds), *Experimentelle Wissenschaftsgeschichte*. Fink, München (2010): 13–72.

Capurro 2010 Capurro, R. “Digital Hermeneutics: An Outline”, *AI and Society*, 25.1 (2010): 35–42. https://doi.org/10.1007/s00146-009-0255-9.

Collins et al. 2007 Collins, H., Evans, R. and Gorman, M. “Trading Zones and Interactional Expertise”, *Studies in History and Philosophy Part A*, 38 (2007): 657–666. https://doi.org/10.1016/j.shpsa.2007.09.003.

Corrigan 2012 Corrigan, K. “Collaborative Thinking: The Challenge of the Modern University”, *Arts and Humanities in Higher Education*, 11.3 (2012): 262–272. https://doi.org/10.1177/1474022212437336.

Daston and Galison 2007 Daston, L. and Galison, P. *Objectivity*. Zone Books, New York (2007).

De Kramer et al. 2018 De Kramer, M., Mersch, S. and C. Morse. “Reconstructing the Historic Landscape of Larochette, Luxembourg”. In M. Ioannides, E. Fink, R. Brumana, P. Patias, A. Doulamis, J. Martins, and M. Wallace (eds), *Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection*. Springer International Publishing (2018): 30–37.

Deegan and McCarthy 2012 Deegan, M. and McCarty, W. *Collaborative Research in the Digital Humanities*. Ashgate Pub., Farnham, Surrey, England; Burlington, VT (2012).

Edmond 2016 Edmond, J. “Will Historians Ever Have Big Data?” In B. Bozic, G. Mendel-Gleason, C. Debruyne, and D. O’Sullivan (eds), *Computational History and Data-Driven Humanities*. Springer International Publishing (2016): 91–105.

Fickers 2012 Fickers, A. “Towards a New Digital Historicism? Doing History in the Age of Abundance”, *VIEW Journal of European Television History and Culture*, 1.1 (2012): 19–26. http://doi.org/10.18146/2213-0969.2012.jethc004.

Fickers 2013 Fickers, A. “Veins filled with the Diluted Sap of Rationality: A Critical Reply to Rens Bod”, *BMGN - Low Countreis Historical Review*, 128.4 (2013): 155–163. http://doi.org/10.18352/bmgn-lchr.9347.

Fickers 2014 Fickers, A. “‘Neither Good, Nor Bad, Nor Neutral’: The Historical Dispositif of Communication Technologies”. In M. Schreiber, and C. Zimmermann (eds), *Journalism and Technological Change. Historical Perspectives, Contemporary Trends*. Campus, Frankfurt am Main, New York (2014): 30–52.

Fickers 2015 Fickers, A. “FNR PRIDE Application Doctoral Training Unit Research and Training Program: ‘DTU Digital History and Hermeneutics’”, University of Luxembourg (2015).

Fickers forthcoming Fickers, A. “Hermeneutics of In-Betweenness: Digital Public History as Hybrid Practice”. In S. Noiret, and G. Zaagsma (eds), *Handbook of Digital Public History*. De Gryter (forthcoming).

Frisch 2011 Frisch, M. “From ‘A Shared Authority’ to the Digital Kitchen, and Back”. In B. Adair, B. Filene, and L. Koloski

(eds), *Letting Go?: Sharing Historical Authority in a User-Generated World*. Pew Center for Arts and Heritage, Philadelphia (2011): 126–137.

Galison 1996 Galison, P. “Computer Simulations and the Trading Zone”. In P. Galison and D. J. Stump (eds) *The Disunity of Science: Boundaries, Contexts, and Power*. Stanford University Press, Stanford (1996): 118–157.

Gieryn 1983 Gieryn, T. F. “Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists”, *American Sociological Review*, 48.6 (1983): 781–795. https://doi.org/10.2307/2095325.

Gitelman 2013 Gitelman, L. (ed), *“Raw Data” is an Oxymoron*. MIT Press, Cambridge, Mass. (2013).

Graham et al. 2016 Graham, S., Milligan, I. and Weingart, S. *Exploring Big Historical Data: The Historian’s Macroscope*. Imperial College Press, London (2016).

Heering and Wittje 2011 Heering, P. and Wittje, R. (eds). *Learning by Doing: Experiments and Instruments in the History of Science Teaching*. Franz Steiner Verlag, Stuttgart (2011).

Hinds and Kiesler 2002 Hinds, P. and Kiesler, S. (eds). *Distributed Work*. MIT Press, Cambridge, Mass. (2002).

Horn 2013 Horn, S. A. “Interdisciplinary Engagement as an Acculturation Process: The Case of Japanese Studies”, *Social Science Japan Journal*. 16.2 (2013): 251–277. https://doi.org/10.1093/ssjj/jyt014.

Huhtamo 2010 Huhtamo, E. “Thinkering with Media: On The Art of Paul DeMarinis”. In I. Beirer, S. Himmelsbach, and C. Seiffairth (eds), *Paul DeMarinis: Buried in Noise*. Kehrer Verlag, Heidelberg and Berlin (2010): 33–46.

Irving 2016 Irving, G. *Collaboration in open-plan offices*. PhD thesis. The University of Queensland (2016).

Jockers 2013 Jockers, M. L. *Macroanalysis: Digital Methods and Literary History*. University of Illinois Press, Urbana, IL (2013).

Kemman 2016 Kemman, M. “Trading Zones of Digital History”. DH2016, Kraków, Poland, 11-16 July, 2016. http://dh2016.adho.org/abstracts/140.

Kemman 2017 Kemman, M. “Interdisciplinary Ignorance”. The Ends of the Humanities, Belval, Luxembourg, 10-13 September, 2017. https://www.maxkemman.nl/2017/09/abstract-interdisciplinary-ignorance/.

Kemman 2019 Kemman, M. *Trading Zones of Digital History*. Ph.D. thesis, University of Luxembourg (2019).

Kiesler and Cummings 2002 Kiesler, S. and Cummings, J. N. “What Do We Know about Proximity and Distance in Work Groups?” In P. Hinds and S. Kiesler (eds), *Distributed Work*. MIT Press, Cambridge, Mass. (2002): 57–80.

Klein 2015 Klein, J. T. *Interdisciplining Digital Humanities: Boundary Work in an Emerging Field*. University of Michigan Press, Ann Arbor (2015).

Knorr 1999 Knorr Cetina, K. *Epistemic Cultures: How the Sciences Make Knowledge*. Harvard University Press, Cambridge Mass. (1999).

Kranzberg 1986 Kranzberg, M. “Technology and History: ‘Kranzberg’s Law’s”, *Technology and Culture*, 27.3 (1986): 544–560.

Latour 2007 Latour, B. *Reassembling the Social. An Introduction to Actor-Network-Theory*. Oxford University Press, Oxford (2007).

Latour and Woolgar 1979 Latour, B. and Woolgar, S. *Laboratory Life: The Social Construction of Scientific Facts*. Sage Publications, Beverly Hills, California (1979).

Lave and Wenger 1991 Lave, J. and Wenger, E. *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press, Cambridge, England (1991).

Moretti 2013 Moretti, F. *Distant Reading*. Verso, New York (2013).

Mussell 2013 Mussell, J. “Doing and Making: History as Digital Practice” In: T. Weller (ed), *History in the Digital Age*. Routledge, London; New York. (2013): 79–94.

Olson et al. 2002 Olson, J.S., et al. “The (Currently) Unique Advantages of Collocated Work” In: Hinds, P., Kiesler, S. (eds), *Distributed Work*. MIT Press, Cambridge, Mass. (2002): 113–136.

Parkin et al. 2011 Parkin, J.K., et al. “Balancing collaboration and privacy in academic workspaces”, *Facilities* 29.1 (2011): 31–49. https://doi.org/10.1108/02632771111101313.

Peppler et al. 2016 Peppler, K.A. et al. *Makeology: Makerspaces as Learning Environments*. Routledge, New York (2016).

Pickering 1995 Pickering, A. *The Mangle of Practice: Time, Agency, and Science*. University of Chicago Press, Chicago (1995).

Pinder et al. 2009 Pinder, J. et al. *The Case for New Academic Workspace*. Loughborough University, Loughborough (2009).

Ramsey 2011 Ramsey, S. *Reading Machines: Towards an Algorithmic Criticism*. University of Illinois Press, Urbana, Ill. (2011).

Rheinberger 1997 Rheinberger, H. J. *Toward a History of Epistemic Things*. Stanford University Press, Stanford (1997).

Rheinberger 2015 Rheinberger, H. J. *Die Farben des Tastens: Hans-Jörg Rheinberger im Gespräch mit Alexandru Bulucz*. Frankfurt am Main (2015).

Rockwell and Sinclair 2016 Rockwell, G. and Sinclair, S. *Hermeneutica: Computer-assisted Interpretation in the Humanities*. MIT Press, Cambridge, Mass (2016).

Rosenzweig 2003 Rosenzweig, R. “Scarcity or Abundance? Preserving the Past in a Digital Era”, *The American Historical Review*, 108.3 (2003): 735–762.

Star and Bowker 2006 Star, S. L. and Bowker, G. C. “How to Infrastructure”, In Lievrouw, L.A. and Livingstone, S. (eds), *Handbook of New Media: Social Shaping and Consequences of ICTs*. SAGE, London (2006): 230–245. https://doi.org/10.4135/9781848608245.

Star and Griesemer 1989 Star, S. L. and Griesemer, J. R. “Institutional Ecology, ‘Translations’ and Boundary Objects: Amateurs and Professionals in Berkeley’s Museum of Vertebrate Zoology, 1907-39”, *Social Studies of Science*, 19.3 (1989): 387–420.

Stehr and Weingart 2000 Stehr, N. and Weingart, P. (eds). *Practising Interdisciplinarity*. University of Toronto Press, Toronto (2000).

Strasser and Edwards 2017 Strasser, B.J. and Edwards, P.N. “Big Data is the Answer... But What Is The Question?”, *Osiris*, 32.1 (2017): 328–345. https://doi.org/10.1086/694223.

Svensson 2012 Svensson, P. “The Digital Humanities as a Humanities Project”, *Arts and Humanities in Higher Education* 11.1.2, 42–60 (2012). https://doi.org/10.1177/1474022211427367.

Svensson 2016 Svensson, P. *Big Digital Humanities: Imagining a Meeting Place for the Humanities and the Digital*. University of Michigan Press, Ann Arbor (2016). https://doi.org/10.2307/j.ctv65sx0t.1.

Van Herck and Fiscarelli 2018 Van Herck S. and Fiscarelli A. M. “Mind the Gap Gender and Computer Science Conferences”. In D. Kreps, C. Ess, L. Leenen, and K. Kimppa (eds), *This Changes Everything – ICT and Climate Change: What Can We Do?*. HCC13 2018. IFIP Advances in Information and Communication Technology. Springer International Publishing (2018): 232–249.

Weingart 2000 Weingart, P. “Interdisciplinarity: The Paradoxical Discourse”. In N. Stehr and P. Weingart (eds), *Practising Interdisciplinarity*. University of Toronto Press, Toronto (2000): 25–41.

Weller 2013 Weller, T. “Introduction: History in the Digital Age”. In T. Weller (ed), *History in the Digital Age*. Routledge, London; New York (2013): 1–20.

Wenger 1998 Wenger, E. *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press, Cambridge (1998).

Zaagsma 2013 Zaagsma, G. “On Digital History”, *BMGN - Low Countries Historical Review*, 128.4 (2013): 3–29. https://doi.org/10.18352/bmgn-lchr.9344.