



Universität Regensburg

Qualitative Analyse und Modellierung des wissenschaftlichen Arbeitens

– Qualitative Analysis and Modelling of Scholarly Work –

Masterarbeit im Fach Digital Humanities am Lehrstuhl für
Informationswissenschaft

Vorgelegt von: Michael Markus Achmann

Adresse: [REDACTED]

E-Mail (Universität): michael-markus.achmann@stud.uni-regensburg.de

E-Mail (privat): [REDACTED]

Matrikelnummer: [REDACTED]

Erstgutachter: Prof. Dr. Bernd Ludwig

Zweitgutachter: Prof. Dr. Christian Wolff

Betreuer: Florin Schwappach, M. Sc.

Laufendes Semester: Wintersemester 2019 / 2020

Abgegeben am: 18.02.2020

Contents

| | | |
|----------|--|-----------|
| 1 | Introduction | 5 |
| 2 | Related Work | 8 |
| 2.1 | Investigating Scholarly Work | 8 |
| 2.1.1 | Scholarly Work in Early Transition | 8 |
| 2.1.2 | Scholarly Work in a Digital Environment | 10 |
| 2.2 | Personal Information Management | 13 |
| 2.2.1 | The Vision – Memex | 14 |
| 2.2.2 | Document Classification | 15 |
| 2.2.3 | Prototypes | 16 |
| 2.2.4 | Note-Taking & Information Scraps | 18 |
| 2.3 | Digital Assistance for Scholarly Work | 22 |
| 3 | Activity Analysis of the Scholarly Workflow | 24 |
| 3.1 | A1 — Establishing the Research Interest | 28 |
| 3.2 | A2 — Choosing the Method & Methodology | 28 |
| 3.3 | A3 — Defining the Research Question(s) | 28 |
| 3.4 | B _n A — Research Activities for Empirical Experiments | 30 |
| 3.4.1 | B1A Planning the Experiment | 31 |
| 3.4.2 | B2A Preregistration | 31 |
| 3.4.3 | B3A Experiment Administration | 31 |
| 3.4.4 | B4A Data Analysis | 31 |
| 3.5 | B _n B — Activities for Mathematical Quantitative Research | 31 |
| 3.5.1 | B1B — Preparing Data | 32 |
| 3.5.2 | B2B — Creating & Validating the Model | 32 |
| 3.5.3 | B3B — Using the Model | 32 |
| 3.6 | B _n C — Activity for Qualitative Methods | 33 |
| 3.6.1 | B1C — Data Collection | 33 |
| 3.6.2 | B2C — Data Analysis | 33 |
| 3.7 | B _n D — Activities for Qualitative Hermeneutics | 33 |
| 3.8 | B _n R — Reading Activities | 34 |
| 3.8.1 | B1R — Finding Literature / Sources / Related work | 34 |
| 3.8.2 | B2R — Reading Literature / Sources / Related Work | 36 |
| 3.9 | C — Writing | 38 |
| 3.9.1 | C1 — Outline Design | 38 |
| 3.9.2 | C2 — Writing | 40 |
| 3.10 | D — End of Project | 42 |
| 3.10.1 | D1 — Publication / Delivery | 42 |
| 3.10.2 | D2 — Archival | 43 |
| 3.10.3 | D3 — Deletion | 44 |
| 3.11 | U — Universal Activities | 44 |
| 3.11.1 | U1 — Note-Taking | 45 |
| 3.11.2 | U2 — Bibliographic Management | 52 |
| 3.11.3 | U3 — File Management | 57 |
| 3.11.4 | U4 — Annotation | 60 |
| 3.12 | Summary | 62 |

| | | |
|----------|--|------------|
| 4 | Towards a Digital Assistant for Scholarly Research | 64 |
| 4.1 | Assistance Needs in the Scholarly Workflow | 64 |
| 4.2 | Concurrent Task Tree Model for a Digital Assistant | 68 |
| 4.3 | Summary | 72 |
| 5 | Eyetrack Reader – A prototype | 74 |
| 5.1 | Eyetrack-Reader v1 – Reading & Gaze Tracking | 75 |
| 5.1.1 | Setup | 75 |
| 5.1.2 | Participants | 77 |
| 5.1.3 | Intermediate Result | 82 |
| 5.2 | Eyetrack-Reader v2 – Translation Assistance for Excerpts . . . | 88 |
| 5.2.1 | Setup | 88 |
| 5.2.2 | Results | 92 |
| 5.2.3 | Qualitative Feedback | 98 |
| 5.3 | Final Assessment | 100 |
| 6 | Final Discussion | 101 |
| A | References | 104 |
| B | Interview Framework | 113 |
| C | Concurrent Task Trees – Notation | 116 |
| D | Additional Plots | 117 |
| E | Interview Transcripts | 118 |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| | █ [Redacted] | |
| F | Questionnaires | 278 |
| G | Digital Appendix | 288 |

Zusammenfassung

Diese Masterarbeit bietet einen Überblick der bestehenden Literatur zum Stand der Digitalisierung des geisteswissenschaftlichen Arbeitens und den Stellenwert des Exzerpierens und Notierens während der Forschung. Die Erkenntnisse aus der Literatur werden durch eine Interviewreihe, ausgewertet auf Basis der Grounded Theory, bestätigt. Basierend auf elf Interviews mit Promovierenden und Masterstudierenden wird ein informelles Aktivitätsmodell des (geistes)wissenschaftlichen Arbeitens erstellt. Unter Miteinbeziehung des Forschungsstands auf dem Gebiet des *Personal Information Management* wird anschließend ein *Concurrent Task Tree* Modell für digitale Assistenz im Rahmen geisteswissenschaftlicher Forschung vorgestellt. Basierend darauf wurde ein Prototyp zur Evaluierung einer stillen Ausführungs- und Übersetzungsassistenz entwickelt, der im Labor getestet wurde. Die Nutzung des Prototypen führte entgegen der Erwartung zu keiner Effizienzsteigerung beim Zusammenfassen einer Textquelle. Gleichzeitig konnte aber bestätigt werden, dass die Nutzung eines Eye-Trackers und einer Webcam die Verortung von Papiernotizen im digitalen Quelltext ermöglicht. Bei der Auswertung der Interviews wurden zudem zwei Typen der Literaturverwaltung beobachtet, die den Stellenwert von Exzerpten unterstreichen und die zukünftige Entwicklung von Literaturverwaltungssoftware für Geisteswissenschaftler beeinflussen sollten.

Abstract

This Master thesis starts with an overview of related work about the state of digitization in the humanities, and the status of excerpt creation and note-taking during research. The literature's findings are confirmed by a series of interviews. The interviews with eleven PhD and Master students are analysed, guided by grounded theory, and an informal activity model of the scholarly research is created. Incorporating the current state of research in Personal Information Management, a concurrent task tree model for digital assistance of scholarly work is developed, based on the informal activity model. Subsequently, a prototype based on the prior task model is developed and used to evaluate proposed silent execution assistance and translation assistance in a laboratory setting. The expectation of an increase in efficiency using the digital prototype when summarizing a text source was not met. However, the experiment showed that, using an eye-tracker and webcam, it is possible to find a right anchor for paper notes in a digital text. Further, while analysing the interviews, two types of literature management types were found, emphasizing once more the importance of excerpts. This finding should guide feature development of literature management systems for the humanist.

1 Introduction

While the importance of note-taking and excerpt production for scholarly research has been shown (Case, 1986, 1991; Cevolini, 2018; Palmer & Neumann, 2002) and transcends the interviews presented in this thesis, the digital humanities have hardly been concerned with this research activity, when developing tools for the digital workbench. While annotations have been investigated throughout different disciplines, no useful note-taking tool for the digital humanist has been developed (Bradley & Vetch, 2007; Brush et al., 2001; Marshall, 1997).¹ Finally, there is another argument for concentrating on excerpts: Andorfer (2015) argues for viewing notes as research data, with two implications: On the one hand, there might be a case for publishing them, similar to, e.g. psychology, moving towards publishing all data to overcome the replication crisis, and, second, the case for archival (Puhl et al., 2015). Therefore I carried out a case study, interviewing graduate students in order to elicit their research workflow, while paying particular attention to their annotation and excerpt practices, as a basis for a digital assistant supporting scholarly research.

What are Excerpts? According to Cevolini (2018), the term ‘exzerpieren’, to excerpt, derives from the Latin term ‘ex capere’, to pick from different trees or to pick flowers. This metaphor gives a first expression of what it means to excerpt or to create an excerpt. While practised since antiquity and throughout the Middle Ages, the invention of the printing press and the next obsession for knowledge, led to a change of the excerpt’s function. Early excerpt production was seen as personal training through imitation, and to improve learning. Writing and reading were secondary behind oral knowledge management. The excerpts were instead seen as a cache in preparation for sophisticated speeches and conversations. Between the 16th and 17th century, everything changed. An external memory function replaced the memory support (cache) function of the excerpts: scholars learnt to forget and use external tools (excerpts) to overcome ephemeral human memory. While early excerpts had a fixed order, derived from the original document, the document structure started to change in this time period as well: In order to find information in the excerpts, scholars either created keyword registers or started the production of systematic notes. To ease collocation of the externalised

¹There exist plenty of annotation tools for linguists. The methodology this thesis is mostly concerned about is, however, the hermeneutics. An annotation tool for linguists does not necessarily fit historians needs. For this reason, I will emphasise a difference between the term ‘annotation’ and ‘excerpt’ (or note), see *Annotation* on page 60.

memory, excerpts moved from bounded notebooks to slips of paper. This shift eventually ended in the invention of slip boxes.

While excerpt creation was part of the scholarly debates of the 17th century, the theoretical investigations ended in the 18th century. Finally, Cevolini sees Vannevar's Memex as a technological successor of the millennium-old technique of writing excerpts for information and knowledge management.² Finally, Cevolini spans the arc from the analogue to the digital world: He sees the modern web's basis, *Enquire* by Tim Berners-Lee (1980), as a kind of digital slip box. Similarly, he sees bibliographic management software like *Zotero* or *Citavi* as contemporary slip boxes. Finally, the one flaw of digital systems it addressed: Low cost of memory accumulates unrulable amounts of information. This takes us back to my thesis: Excerpts' modern relevance is to externally store information about the books, texts, sources we read for our scholarly work. Creating these memory slips is not an end in itself anymore. Today their content matters. Without a meaningful indexing system, however, these excerpts are not worth much. I do not entirely share Cevolini assessment of bibliographic management software representing modern slip boxes: While they certainly offer this function, my interviews validate impressions from the literature: Hardly anyone uses the knowledge management functions of this software. Mainly, people report being overwhelmed by the software's complexity and not wanting to spend time on training.

Overcomplexity and the fear of having to invest time to learn how to use a tool has also in the literature (Collins et al., 2012; Dowling & Wilson, 2017; Wiklund & Voog, 2013; Wiklund et al., 2017) been reported as an obstacle. Thus, inverting these findings, simplicity and ease of use are of the utmost importance when developing software for the humanities. I will, therefore, suggest the development of an intelligent digital assistant for scholarly work. Knowledge-based systems, the basis of an intelligent digital assistant, have a long history (Mainzer, 2016, ch. 4), the latest improvements in machine learning and devices like *Amazon's Alexa* and *Google Home*, helped digital assistance to become mainstream. For scholarly work, though, I will suggest a mostly invisible digital assistant, not (necessarily) relying on voice interaction. An essential difference between existing software is the assistant's ability to adapt to users' preference in writing and reading: Both activities may take place in the digital or analogue world. While truly ubiquitous computing may yet be decades away (West, 2011), some technologies and sensors necessary to bridge the gap between digital and analogue, already exist. Eye-tracking

²He adds, however, that the question whether it is the evolution of the slip box or a different type of knowledge management is debated, referring to (Cevolini, 2016).

is one of those already existing and working. Data from this device allows, for example, to capture what a user is reading at the moment, offering the possibility to link, e.g. notes to what a person is looking at (A. A. Khan, 2019). If those notes are taken by hand, technology to naturalistically capture the data in real-time may be available in the close future (Schwappach & Burghardt, 2019). Finally, SAP's Inscribe (SAP Design, 2018) shows how digitised handwriting might well become a new modality for human-computer interaction.

All in all, I suggest an invisible digital assistant bridging the analogue and digital world, fighting fragmentation of information between different modalities, and between different documents within a modality (Boardman & Sasse, 2004; Jervis, 2014; Mizrachi & Bates, 2013). This assistant mostly helps managing personal information, creating an accessible slip box for the scholarly work, with the possibility to aid writing by offering the right information at the right time.

After presenting related work from the digital humanities, library studies, information science, and psychology, I will follow Ludwig's (2015) guide for a plan based human-computer interaction for multi-modal assistance system by first acquiring knowledge for the assistance system. The knowledge acquisition through interviews is the major part of this thesis. First of all, interviews were conducted and analysed using grounded theory. These expert conversations resulted in an activity model, representing the workflow of scholarly research. Then, for the minor part of this thesis, I will concentrate on the requirements of qualitative research employing the hermeneutic methodology. Guided by the activities model, a task analysis for reading, note-taking and writing will be presented. It will be formalised using the Concurrent Task Tree notation. Finally, a prototype for a specific module within the task will be presented. The prototype was evaluated in a laboratory study, and the results will be presented at the end of this thesis.

2 Related Work

The present thesis is structured in two parts: first, scholarly work is investigated in chapter 3 using semi-structured interviews. They are going to be analysed using grounded theory to create an informal activity model of scholarly work. Furthermore, problems and user dissatisfaction with particular steps in the academic work are identified in chapter 4 and lay the foundation for part two: the creation of a task model for a digital research assistant helping overcome particular problems elicited from the interviewees. Thereafter, a prototype evaluating silent execution assistance and translation assistance will be presented in chapter 5. The prototype is going to focus on personal information management, particularly note-taking and literature management, within the research process, as the literature and interviewees univocally identified this activity as one of the most important activities throughout the paper or thesis production process. Hence, relevant related work from different fields is going to be presented in this chapter:

1. First of all, literature from different disciplines concerned with scholarly research will be presented. The older works, and the first ones to be presented, are rather concerned with document organisation in the academic setting, while already capturing transformation processes due to the spread of personal computers. The motivation of the second group of literature, more contemporary works, shines a light on the status of digitisation in the humanities and the elicits requirements for tools and services of the digital humanist.
2. Thereafter, the term ‘personal information management’ is introduced. Different threads of research will be presented, concerned with document classification and note-taking.
3. Finally, digital assistants for scholarly research will be presented.

2.1 Investigating Scholarly Work

2.1.1 Scholarly Work in Early Transition

While conducting research in the field of information science, Case (1986) investigated primarily scholarly settings. He builds upon some of Soper’s (1976) findings when examining scholar’s organization of written information. His exploratory study of scholarly work was conducted partly to help the software industry to develop computer systems to aid scholarly work. He interviewed 60 university professors from 32 different departments about their information collection and organisation habits. While different disciplines call for different data collection methods, they “include reading, talking with

colleagues, listening to lectures, viewing files and television, experimenting, conducting surveys, analysing archival data, examining artefacts, participant-observation and so on” (Case, 1986, p. 99). He identifies note-taking as an important part of research: “In taking notes, the scholar screens large amounts of material, selecting only those elements that are relevant to his or her interests. More importantly, the scholar transforms what is read – condensing it, making inferences and drawing conclusions.” (Case, 1986, p. 99).

In another study Case (1991) examined the scholarly work of historians. Interviewing 20 American historians, he investigated their use of information for research. Since this study dates back to the early 1990s, the dawn of the personal computer, their use was inquired as well. Interestingly most respondents used the machines to some extent, mostly for word processing. However, some historians also reported using computers for statistical analysis and bibliography management. For note-taking Case observed the beginning of a change in habits: Some historians started to transcribe their handwritten notes digitally, thereby adding further information, one respondent had already reported the use of a laptop. Thus, the first digitisation in the field of history was observed about 30 years ago. The writing process, as described by Case, is non-linear with the outline evolving and a back-and-forth between sorting notes, writing and reorganising the outline.

In more contemporary work, Brockman et al. (2001) investigated scholarly work in the light of technological advances. They conducted semi-structured interviews with 33 researchers and extensive case studies with five people out of this population. While the authors tried to capture a great picture of how research is conducted, the sections about writing and file organisation are of special interest in this thesis. Brockman et al. state the core of scholarly research to be the interpretation and structuring of different pieces of information, citation paths, primary sources, notes and more. One way this synthesis works is by arranging different items, such as physical notes and annotated copies collected throughout the research process. Some researchers also reported the use of file cards and bibliographic management software, one with more than 20,000 entries. Dependent on the field of research, specialised software was used. The authors, however, are not reporting many details about them. Every researcher interviewed for the study used a word processor for writing their scholarly works.

Interestingly, few interviewees reported the creation of an outline before writing started. Instead, texts are evolving. In the final stages of writing, the last amendments were done, and notes taken by hand or on pc to keep

track of what still needed to be done. Also, when writing, they referred to other papers they have written in order to extract information, like quotes and literature. For archival one extraordinarily creative way was reported: one scholar kept his archive on a rewritable CD.

All in all, Brockman et al. found the word processor to be the primary digital tool employed by humanist researchers. Using computers for their scientific writing seemed to improve the situation for the interviewees already, as they could still relate to time in which they used typewriters for writing texts, which did not offer natural correction. While few exceptions reported the use of bibliographic management systems, or file cards, and some using specialised software for OCR, most researchers appear to store their research data within notes and text files saved on their computers. For the notes, the authors of the studies did not go into too much detail, whether they were handwritten or digital; since they emphasised handwritten notes as part of the final synthesis, it seems likely that they mostly referred to handwritten notes.

2.1.2 Scholarly Work in a Digital Environment

Research practices of scholars in humanist disciplines and their changes due to the advent of digital tools have been under scrutiny from different perspectives over the last two decades. Motivations for this research are mostly between evaluating needs of humanists for digital tools and assessing existing tools.

Toms (2008), for example, evaluated the needs of humanist researchers for digital tools utilizing an online survey. She analysed 169 replies, rendering a set of recommendations for a ‘humanities workbench’. While the majority in her population was younger than 45 years of age, two-thirds of the respondents had PhDs, and most respondents came from Canada. In contrast to subjects in the study of Brockman et al. (2001), at least 50% of participants of the study that also taught courses, lectured digital methods in their classes. All in all, her research concludes following recommendations: The workbench needs meta tags to support information relevant to humanists (other than, e.g. title, authors), appropriate scanning and browsing tools for text exploration, better support for downloading and storing digital text. Further, “[a] note-taking feature that would allow researchers to compile, edit and save their reflections on the text; notes could be viewed either co-located on a single page or as annotations on the actual text, or as a composite” and a standardised, sophisticated text analysis tool.

One catalyst for assessing needs of humanist researchers is the DARIAH project (Andorfer, 2015; Blanke & Hedges, 2013; Puhl et al., 2015). Andorfer

conducted interviews with 15 humanist researchers at the Wilhelm August library, eliciting the software they use, workflows and research data. Mostly the respondents reported the use of text processors, especially Microsoft Word, for their research. For the typical workflow, bibliographic management, note-taking and writing crystallised as the essential activities. While one-half of the participants reported the use of specialised software, like Zotero or Citavi, for literature management and document organisation, the other half relied on the operating system's filesystem.

Moreover, Andorfer found, that researchers in the humanities and cultural studies have problems in applying the concept of raw research data to notes and excerpts. This is, he assumes, due to the compositions of scientific publications in the field: By citing properly, indicating sources and explaining the selection of sources and cited material within the papers, humanist papers are verifiable by design. Thus, publishing excerpts, notes, transcripts, bibliographies or any other original work related to projects, is not a common practice in the fields observed. While the interviewees expressed wariness for how publicised raw data might be used, especially showing interest in being quoted if their material was used for publications, the status quo was that researchers only shared their material, like bibliographies, on a personal level.

Blanke and Hedges (2013) conducted their research in humanist practices for similar reasons. They, however, started with a more theoretical perspective on the humanist's work: based on the concept of 'scholarly primitives' (Unsworth, 2000) research processes were analysed to understand how it could be assisted by digital means. They describe their "resulting model [as] a loosely-coupled composite of components, which may be regarded as a 'production line' in which the primary sources [...] are processed through to research outputs that can be shared and discussed" (Blanke & Hedges, 2013, p. 655). Thus, they used the primitives as a basis, supplemented by additional ones grounded in empirical research, to fit their needs. The result was a workflow model along a sequence of activities assigned to primitives, which served as a framework for developing digital services for humanist research. For Blanke and Hedges the final set of primitives proved generic enough to apply to research in general, while structuring the research process sufficiently.

The scholarly primitives, based on a concept by Unsworth (2000), have been applied by several researchers in digital humanities and library science (e.g. Anderson et al., 2010; Benardou et al., 2010; Palmer, 2009). Palmer reduced them to five activities associated with a total of twenty primitives. These activities are: 1. Searching 2. Collecting 3. Reading 4. writing 5. Col-

laboration 6. Cross-cutting Primitives. The last is a collection of single primitives which do not fit in any of the activities. While they use the activities and primitives in order to organise research and develop recommendations for bibliographic, collection and other services for intervention within these categories.

Aware of their work, Benardou et al. (2010) created an empirical model of scholarly work, following the cultural-historical activity theory. Through the means of interviews, they tried to elicit information about activities, procedures, and types of information objects from their interviewees. Their open-ended questions included topics such as starting point, annotation, data management and organisation, terminology, work saving, and more. They conclude their work with finding that scholarly work is not just about information seeking, but also about the curation of information and using annotation to augment information objects semantically; finally, through writing and publicising, turning them into knowledge objects.

Another study viewed digital tools from the learning angle. Dowling and Wilson (2017) are interested in digital research and doctoral education. After conceptualising doctoral research and rendering a list of digital affordances paired to six components they identified, they conducted a qualitative study with five focus groups and a total of 25 PhD students. The authors were struck by the interviewees' resistance against digital tools beyond emails, word processing and other staples. They found time to be the main factor for their hesitation: ease of use and convenience were valued more highly, than a tool's potential usefulness, as the students' priority was completion. Thus, they did not want to spend time learning to use a new tool, for the fear that it interferes with their goal to complete their thesis – known software was preferred as it is dependable.

Finally, Antonijević's (2015) ethnographic study *Amongst Digital Humanists: An Ethnographic Study of Digital Knowledge Production* needs to be mentioned. She investigated digital scholarship on the micro, meso and macro level. For a better understanding of the complexity of digital knowledge production on the micro-level ethnographic methods and interviews allowed for a detailed understanding of the workflow of academics. Her analysis of the workflow of digital scholars served as an inspiration for the activities analysis presented in chapter 3 of this thesis. Also, Antonijević stresses the importance of annotation and note-taking for the research process, while mentioning the 'fusion' of pen and paper practices for this activity. Similarly, also Palmer and Neumann (2002) see note-taking as one of the most important activities for the humanist researcher: "Notes fix the intellectual work of reading in a

primitive form for future development. As scholars begin to compose more formal written works, they are not just documenting their ideas. The act of writing is formative.”.

All in all, different digital humanities projects were started in the last decade, some of them developing models or ontologies for humanist work in order to create appropriate tools. Some have already been introduced in this chapter, for a more thorough review of projects and corresponding models see Hughes et al. (2015), they created an overview while investigating digital methods in the humanities.

In summary, the presented literature shows: 1. A tradition of interviews to elicit activities of the scholarly work and as a basis for software development in the digital humanities. 2. Model creation, loosely based on scholarly primitives, to be a typical step in the creation of tools for the humanities. 3. Notes are one of the most important activities reported by humanist scholars throughout the literature. 4. In contrast to the last sentence, no tools were created for note-taking in the humanities³

2.2 Personal Information Management

After exploring research about scholarly research, and motivating a research interest for note-taking in the humanities, I will introduce literature relevant in the field of Personal Information Management (PIM). When analysing the interviews, it will transpire, how the organisation of documents – analogue and digital ones – is at the centre of working with literature and excerpts for scholarly text production. First a definition of PIM is offered, after that note-taking within PIM research, and document classification will be explored. Prototypes, created to improve PIM, will be presented, and notes will be viewed from the angle of information scraps.

Crystal’s (2008) dissertation offers an extensive introduction PIM. For a definition of the term, he points, among others, to Barreau’s definition:

“A personal information management system (PIM) is an information system developed by or created for an individual for personal use in a work environment. It includes a person’s methods and rules for acquiring the information which becomes part of the system, the mechanisms for organising and storing the information,

³When expanding the focus from excerpts or notes to include annotations. There has been some research. From a theoretical exploration of the TEI document structure and their ability towards the annotation of a note variorum. However, these works did not end in any tool for the humanist scholar conducting a qualitative study following hermeneutic methodology. See (Bradley & Vetch, 2007; Brush et al., 2001; Marshall, 1997).

the rules and procedures for maintaining the system, the mechanisms for retrieval, and the procedures for producing the various outputs required.” – (Barreau, 1995, p. 327)

Guided by this definition Jones (2007) suggests three groups of “essential PIM activities”, “derive[d] from a basic assumption – namely, that *PIM activities help to establish, use, and maintain a mapping between information and need.*” (p. 464). These activities are: Finding & refinding activities, keeping activities, and meta-level activities.

This thesis is mainly concerned with the meta-level activities involved in scholarly work. These activities focus on the organisation and management of information within the personal information space. I present a model of scholarly work in the subsequent chapters of this thesis and develop suggestions for a strategy of digital assistance for the research process, concentrating on note-taking. The prototype described in the second part of this work explores the possibility of automatically digitising and classifying handwritten notes. Hence I present related work from two threads of research within PIM: 1. document management, and 2. note taking (& information scraps).

2.2.1 The Vision – Memex

First, about note-taking: The literature points univocally to Bush’s (1945) ‘memex’ idea as early written documentation of a machine supported memory device. Similarly, as has been noted in the introduction, Cevolini (2018) sees in the memex the modern slip box. Bush imagined his apparatus to store all “books, records, and communications”. The device works mechanically – though this is due to the essay’s age – in order to be consulted at “top speed and flexibility”. The memex being an extension to human memory is based on association: information may be added by purchased microfilm, supplemented by “longhand notes, photographs, memoranda, all sorts of things” (Bush, 1945, ch. 6).

The ‘essential feature’, as Bush put it, of the memex is the ability to link items together. It is thus creating trails which may be followed in any direction. This envisioned feature is why the memex is an inspiration for researchers to this day. Today, there is the internet with platforms like Wikipedia, an encyclopedia possibly larger than Bush ever envisioned, the bulk of our communication is digital, we store photos and videos digitally, and handwriting recognition produces acceptable results. The core concept of the web is hyperlinked documents. Nevertheless, these links or the network of links

are not precisely the trails, envisioned for the memex, as the trails appear to be more complex, meaningful, connections between items.

One exceptional take on trying to create a memex is Gemmell et al.'s (2006) 'MyLifeBits'. It is described as a database structure encapsulating Bell's (2001) personal digital document archive and improving it is accessibility through diverse search and retrieval mechanisms. While this is an extreme example – Bell digitised every bit of his life, from emails to home videos, a personal assistant was working for years on this endeavour (Bell & Gemmell, 2007) – with too high a cost for consumer applications, some components described by the authors are today part of leading products: some photo apps (e.g. by *Google* or the *iOS* default app) use different information for categorising photos. They make use of the *GPS* coordinates, thus enable search by location and offer even more automatic systematisation. They showcase how memex's trails may be realised in real-world applications. This triggers a series of questions: 1. Is there a case for additional metadata location when retrieving documents? 2. If so, what about notes?

2.2.2 Document Classification

Researchers dedicated plenty of work towards document classification. In order to identify characters important for refinding or filing a document (metadata) experiments and research were conducted in different settings. Mizrachi and Bates (2013) identify two strands of research: the one starting with Malone's (1983) exploration of desks in office environments and another string beginning with Soper's (1976) investigation of personal collections in an academic setting. Latter has already been reported on page 8.

Malone interviewed people from several fields, including research scientists, to understand how they organise their desks, including shelves and filing cabinets. One finding of his study is the individual difference in organising: he divided his interviewees roughly into two groups: neat and messy. Furthermore, he identified a function of desk organisation beyond finding: "people sometimes intentionally look at their desktops to find what else needs to be done, a primary reason for placing tasks on the desktop in the first place is so that intentional search does not have to be relied upon." (Malone, 1983, pp. 106-107) Finally, the classification of documents was identified as a possibly tricky task, resulting – on the physical desk – in multiple loosely classified piles. Concluding his findings, Malone suggests, among other measures, to implement automatic classification, and to remind capabilities to computer systems for the 'electronic office'.

Kwaśnik (1989, 1991) investigated document classification in the office environment. Both studies were conducted with faculty members from different disciplines. The later one highlights how context plays an essential role in the classification of personal documents. She also notes that patterns of document classification apply across subjects, thus suggesting generalizability of interaction between documents properties and context during classification, albeit the small number of cases (eight) investigated.

2.2.3 Prototypes

In the decades since preceding authors started the research interest in PIM, plenty of prototypes have been developed and evaluated, automating document classification or improving search and refinding. One of the earliest projects is ‘Lifestreams’ (Freeman & Fertig, 1995). This prototype disbanded the folder hierarchy common to most computer storage systems to date and introduced a chronologically ordered stream of documents. It subsumed different common applications and offered the possibility to refine the search, thus creating specific substreams. While the authors envisioned a future without “the rigid storage system – a left-over artefact from early computer operating systems” (p. 44) history proofed them wrong.

Similarly, Ringel et al. (2003) created another prototype ordering files chronologically, linking the files not only to dates but rather life events. These landmarks were drawn from public or private events. A user study resulted in statistically significant time savings for searches enriched with landmarks.

Several prototypes were developed, taking more factors than just time into account. They use tags or associations between different objects or additional meta information. Karger et al.’s (2005) ‘Haystack’ explores the use of a *RDF*-based data model for personal information management. While trying to develop a system as flexible as possible, to allow users the greatest possible freedom in organising their information and associations. Combined with a *GUI*, the system allows the creation, search and management of collections. Cutrell et al. (2006) present a similar system, less complex ‘Phlat’, their prototype, allows browsing through documents by using several filters and tags. Chau et al. (2008) introduce ‘Feldspar’, a tool for searching by association. The application takes users step by step through different filtering options, thus creating a “association graph” (p. 1003). Their tool allows users to chain non-specific requirements together in order to find the documents they were looking for.

Évéquoz and Lalanne (2009) investigate PIM from a slightly different angle. They explore different facets important for refinding documents while

trying to stay naturalistic, hence trying to accommodate for changes in personal document management. Their study found three facets being important: the temporal, social and thematic facet. Expanding the Windows Desktop Search database, they created their prototype ‘WotanEye’. Further, they discovered that there are common patterns when changes in PIM strategies occur and, most importantly, that people are not aware of their PIM strategies and even asked the researchers for advice.

Finally, I would like to mention *docear*, an application for organising thoughts and literature for scholarly research around the concept of mind maps, while integrating reference management based on *JabRef* (Beel et al., 2011). The application automatically extracts metadata from PDF documents, adds them to the reference management database, and automatically links full-text documents to references in PDF documents. Also, the software monitors notes added to PDF documents by the user, extracting them and displaying them in the mind map view.⁴

All in all, this application offers silent execution assistance when adding PDF documents, as metadata is added automatically (similarly pertinent reference managers offer such a function). However, *docear* still forces its users into a specific organisational style, mind maps, in which information is filed. Hence it shows that extraction of notes from PDF documents is possible and that literature may to some degree be organised automatically. At the same time, the application still relies on the user to add files to the system and make the connections herself. While not strictly fitting to the prototypes presented in this section, *docear* similarly introduces an improved file management interface.

This short overview of different types of prototypes shows the research interest, especially between 2003 and 2009, trying to improve personal information management. While *Apple* introduced the ‘smart folders’, tags for folders and files and *Microsoft’s Windows* now also prominently features a search field in its taskbar, search by association or the extension of documents via metadata or graphs has not gone mainstream so far. While not all papers reported proper evaluations, the prototypes in combination with research on document classification, still, make a case for associating documents with factors like time and thematic information. Thus there is also a good reason for collecting data from multiple sources in order to create the right associations between document and recallable objects in the human

⁴At the time of this writing, the software did not run properly on my system. Thus, note extraction could not be verified, the last update, according to the changelog, took place in 2015. For an overview of functions, see <http://www.docear.org/>

mind. Capturing additional data, as suggested by PIM research, may also be essential for creating a personal knowledge graph (Balog & Kenter, 2019), eventually to be used by a digital assistant for scholarly research. *Docear* appears to be the application closest to such a concept.

2.2.4 Note-Taking & Information Scraps

First, a quick look at the definition of the term ‘note’. The Oxford English Dictionary offers different meanings: One of them describes critical annotations or a comment added to the text of some sort. The first use of this meaning can be attributed to a text from 1532. Another meaning, 15a., is: “A brief written observation, record, or abstract of facts, esp. one intended to aid the memory [...]” (Oxford English Dictionary, n.d.-c), this one dating back to 1548. Moreover, Yeo (2014) shows how notes have not just been part of our vocabulary long time, but moreover part of scientific research, similar to excerpt production (Cevolini, 2018). Nevertheless, notes may well have eluded information science’s research until recently, while psychologists have created the foundations of note-taking research:

Psychologists have been investigating note-taking in an academic setting in plenty of studies (Hartley & Davies, 1978). Most of these concentrated on note-taking during lectures. Di Vesta and Gray (1972) introduce two hypotheses of how note-taking has an effect on learning: 1. external-storage 2. encoding. The first hypothesis suggests the possibility that reviewing notes improves learning. The other credits the processing of information while taking a note. While further research proofed the first hypothesis, there are mixed results for the second one (Kiewra, 1989; Mueller & Oppenheimer, 2014). With the advent of portable computers, i.e. notebooks, note-taking can nowadays also be distinguished between the digitally or analogous: Mueller and Oppenheimer (2014) conducted several studies about longhand note-taking versus laptop use. There are two essential classes of how notes may be taken for their research. Note-taking may be generative: information may be summarised or paraphrased. The contrasting nongenerative notes are, in their example, verbatim notes. Their results suggest that notes taken on laptops are prone to become verbatim notes, resulting in worse learning performance, when subjects were allowed to review their notes. While the authors advise that not the note-taking medium itself, thus not paper vs digital, were the reason for performance differences, they suggest that the ease of digital writing might be the reason for subjects to take more verbatim notes, which resulted in the worse performance. Finally, they suggest caution about laptop use in classrooms.

As mentioned, the summarised psychologists' research investigated learning and note-taking. While learning has been tested in an academic setting, it is a different object of investigation than taking notes in the process of scholarly research, i.e. taking notes while reading. This, however, is the scope of the present thesis. Therefore the following takeaways from psychologists, and especially Mueller and Oppenheimer's, studies may be taken with a grain of salt: 1. Taking notes is a way to store information externally for later review. The process of note-taking itself might be helpful for retention as well, 2. There are two ways of taking notes: generative and nongenerative, and 3. longhand note-taking performs better than digital note-taking.

Plenty of literature dealing with note-taking references the term 'memory prosthesis', coined by Lamming et al. (1994). Once more, the idea of the memory prosthesis is inspired by Bush's memex. The memory prosthesis is the implementation of the memex: it uses different technology modules working together to sense the environment and automatically capture data, supplemented by manual data input. For retrieval, it is supposed to offer just the information needed and all in all the memory prosthesis is to be easy to use. Thus, while the psychologists are primarily concerned with learning and secondarily with external storage functionality and its aid in learning, the perspective from the memory prosthesis's research group concentrated on the external storage function primarily, and an extension of notes by sensor data in order to aid retrieval.

More recently Kalnikaité and Whittaker (2007) created a digital note-taking application for a PDA. It allows taking temporally co-indexed handwritten notes. The authors tested it against taking notes with pen and paper, and against the use of a digital voice recorder. They found prosthetic memory, in the form of their application, to be more reliable, especially for longer retention periods. Following their experiments, there is one outstanding design implication: the efficiency of the device or system for taking notes as prosthetic memories. Their prototype integrated paper affordances in a digital device while allowing for accuracy through the additional temporally indexing. Finally, they conclude, that prosthetic memory is not a substitute for organic memory, but rather the synergy of organic and prosthetic memory result in recall. Along this line, they also found organic memory to be the precursor to find synthetic memory. Thus, cues within prosthetic memory are important to trigger a user's memory (Kalnikaité & Whittaker, 2008). This finding is quite interesting in light of digital assistance: An intelligent system

would have to help overcome human oblivion. This will be addressed by the filter and consulting assistance in chapter 4.

Another take on note and note-taking is M. S. Bernstein et al.'s (2008, 2007) investigation of 'information scraps'. They are defined as follows: "An information scrap is an information item that falls outside all PIM tools designed to manage it" (M. Bernstein et al., 2008, p. 24:3). Examples by the authors of such scraps are todos on a post-it note, photos taken of a whiteboard, information sent to oneself by email or a transcript saved in a text file. By analysis of their study, they found five uses information scraps may offer: 1. Temporary storage, 2. cognitive support, 3. archiving, 4. reminding, 5. unusual information types. Further, they created a guideline of the following needs and design affordances needed for organising information scraps: 1. Lightweight capture, 2. flexible contents and representation, 3. flexible use and organisation, 4. visibility and reminding, 5. mobility and availability

In contrast to information scraps, there are excerpts. As seen in the introduction of this thesis, excerpts have a long-lasting history and importance in science. A literature search for further information about this specific document type only resulted in a few hits: an observation already made decades ago by Ehlich (1981). He carves out several attributes that define a (good) excerpt: An excerpt is always processing the primary text it refers to. While there are similarities to text reproduction, an excerpt is more than just a copy of a primary text's content: it reduces the complexity of the original text and thus stays highly relevant for scholarly work, even though today's technology allows copying a primary text at low cost. Ehlich presents four hypotheses: 1. For a set of students excerpt production is available, 2. for a set of students excerpt production is not available, 3. conveying excerpt production to the latter group is difficult or impossible 4. it is rather difficult to specify how the excerpt producer determines what of the primary text is important, and what is not. While he does not statistically proof these hypotheses, they still guide his exploration of the text type towards the final argument for university didactics: There is a need to properly teach and explore excerpts, since they are an important tool of hermeneutic research.

Creating excerpts is not just about condensing text quantitatively. Moreover, to write an excerpt, the reader needs to understand the arguments and weight within the primary text, to apply them to the excerpt as well. Thus, creating an excerpt depends on the creation of a mental reconstruction of the arguments of the primary text. Therefore he sees excerpt production as a cultural technology. The prior statement allows deducing an

interdependence between understanding a primary text and creating a proper excerpt: Writing an excerpt is actively researching in the humanities. All in all, excerpts, as will be shown in chapter 3, are often referred to as notes, while having characteristics of a ‘normal’ document. Therefore they do not fall out of PIM tools and thus do not fit M. S. Bernstein et al.’s definition of information scraps.

Finally, A. A. Khan (2019) presents in a recent paper an exciting research project about gaze-assisted note-taking: Her set-up includes an eye-tracker, thermal camera, a webcam and a microphone. Participants read their own literature in a laboratory setting, without anyone in the room, and make their annotations of the primary document by speech, while audio, video, thermal images and eye-tracking data are recorded. The project aims towards training a machine learning model which enables users to automatically annotate texts through gaze and spoken words, thus creating a hand free audio note-taking system. In order to collect ground truth material, participants reviewed the recorded audio and screen recording, with an overlay of gaze data, and were asked to highlight the text referred to by the audio note.

In summary, note-taking is a century-old practise in science and research. It has been investigated in the last century mainly by psychologists in learning settings, examining its external-storage and encoding functions. In recent years note-taking and prototypes for note-taking applications have also been studied in the fields of information science and human-computer interaction. The findings of Kalnikaitė and Whittaker are an essential basis for the prototype to be introduced in the second part of this thesis. They show how prosthetic memory helps retaining memory over more extended periods of time. As research projects usually take between weeks (class assignments) up to years (dissertations) or even a life-time, retention of long periods of time may well be at the centre of note-taking in scholarly projects. Kalnikaitė and Whittaker also show how notes may be seen as cues for organic memory. Thus it might be postulated that their content is not even that important. However, as they go on and report declining abilities to refinding information even with notes after about one month, they also outline how important organic memory is for finding the notes themselves. Therefore a concept like semantic notes (Drăgan et al., 2011) may well be worth a more thorough investigation within the concept of a digital research assistant: as has been shown earlier in this section, there is a case for landmarks in document refinding. Thus a system, aware of the researcher’s physicals desk’s state, as well as the state of the digital desktop she is working on and the

content of notes, may well add context information, necessary to improve refinding, aiding the organic memory to find the prosthetic memory's items. A. A. Khan shows one concept of context data, gaze data, to aid annotating text documents. The analysis in chapter 3 will show, that note-taking during reading is a practice reported by almost every interviewee. Therefore excerpts of text documents are at the centre of attention of this thesis. My prototype will also use gaze data for text annotation, the notes, however, will be taken with pen and paper. This decision is based on the reported mediums for notes by participants of the interviews and the findings by Lamming et al. of positive effects on learning by longhand notes and paper's affordances reported by Kalnikaité and Whittaker. M. S. Bernstein et al.'s information scraps suggest the possibility of a significant differentiation. As mentioned above, I propose two types of notes following his definition: One type of notes may well be viewed as documents in personal information management; they are the excerpts or notes about literature. These may be more or less structured, but they are managed well: they live as pages in a notepad, notebook or a pile, they may be single documents containing smaller units of notes or many documents living in the same digital folder, but they do have a specific location because refinding them within a research project is vital. And then there are notes which are information scraps: todo lists or temporary generative notes, taken in a thought process. This differentiation and note-taking practices throughout the research process will be analysed in the first part of this thesis, following its results, a prototype for note-taking and retrieval will be tested in part two.

2.3 Digital Assistance for Scholarly Work

One interface staple for digital assistants are Chatbots to offer help and support. Thus, OKI (Resch & Yankova, 2019), short for Open Knowledge Interface, uses the *Telegram* environment in order to help students with their academic assignments. The concept behind the conversational chatbot is to encourage students to work continuously and goal-oriented on their work, rather than binge writing shortly before the deadline. In order to support its users, it offers the creation of a project and the following features within a project: Projects management, reminders and context-sensitive hints search terms (to aid search in databases), scheduled background literature search, the view of abstracts, bibliography and project template management. Most impressive about this work would be an evaluation of the reminder and hints feature. Unfortunately, the authors are not going into much detail about how

they work and what context the feature works with. All in all, the work reported by Resch and Yankova appears to be in an early phase. User trials were conducted; however, no evaluation reported.

Another personal assistant was developed by Ivanov and Orozova (2018). Their system assists bat researchers' fieldwork. Their assistant is part of an android application, becoming intelligent through the belief-desire-model, where the belief stands for what the system knows about the world, plans are the recipes for how to achieve a certain state and different kinds which may be triggered by goals of different kinds. All in all, the belief-desire-model allows for intelligence by constantly adjusting the goals to user interaction. The authors see their work in the specialised field of bat research as a basis for future systems in any subject requiring fieldwork.

In summary, this chapter introduced the following concepts from the literature: 1. Scholarly research has been under scrutiny by different disciplines for similar reasons: Using interviews and similar qualitative methods, the scholarly workflow and activities were examined in order to learn more about computer use, document classification and digital requirements of humanists. Thus, interviews are a common method to gather knowledge about activities and workflows in the digital humanities and neighbouring disciplines. 2. There is a clear path from the millennium-old cultural technology of excerpt production to this thesis's concept for digital assistance for research revolving around notes. It starts with the invention of slip boxes centuries ago, leads to the conception of Bush's memex further to the invention of the modern web by Berners-Lee, as a stepping-stone for semantic data, and ends with systems like MyLifeBits and many of the presented prototypes: They show how, using existing technology, we may capture a great amount of data surrounding our lives. The question, however, is how to sort and filter the flood of information for spotting relevant information. This would be a major task for a digital assistant. For the limited scope of research, notes and excerpts promise access to the most relevant information for a system to use in order to aid research. 3. At the same time, research shows, how additional metadata, especially in the form of landmarks, help to find relevant documents. 4. Excerpts and notes by humanists may be seen as raw research data, saving and archiving it may be inherently important. 5. Humanists do not use many digital tools. One reason is the fear of losing time: They fear the cost of learning how to use a tool and weigh it against the benefit a tool promises. 6. Excerpts and notes have been considered important when tools in the digital humanities were created, yet no tool concerned with this activity was developed.

3 Activity Analysis of the Scholarly Workflow

Before a digital assistant for scholarly research can be outlined, the scholarly workflow needs to be understood thoroughly. Following the literature in digital humanities, I carried out an interview series in order to elicit typical activities and workflows while doing research, in the humanities and neighbouring disciplines. Emphasis was put on file management and note-taking, as I postulate that a research assistant should aid refinding of information, thus notes, and other documents.

The breakdown of all processes involved in scholarly work in this chapter prepares the task-analysis in the next chapter. At the end of this chapter, an activity model will have been drawn, grounded in interviews conducted with 11 students. Concentrating on note-taking as one of the most important activities for humanists (Case, 1986, 1991; Cevolini, 2018; Palmer & Neumann, 2002), the analysis of excerpt production and related activities is more thorough than for other activities. Modelling adheres to Stachowiak's (1973) concept of models. According to him, a model is made up of three attributes: 1. Projection: A model is always the projection of something, artificial or natural. 2. Abbreviation: A model does not capture all attributes of the original object; instead, those attributes relevant to the model's user. 3. Pragmatism: A model replaces the original for a specific user (human or artificial model user), within a specific timeframe for a specific purpose (Stachowiak, 1973, pp. 131–133). Thus, the analysis took place with the focus on excerpts and data management in mind, and the aim of the analysis has never been to create a universal model of scholarly work.

I carried out a case study exploring the workflow of 12 graduate students to learn more about scholarly work. Throughout one month, ten semi-structured interviews⁵ were conducted, with an additional two pilot-interviews. A short questionnaire⁶ supplemented the interviews about demographic data, the personal study path and software usage.

Three conversations were recorded through Skype; the rest were audio-recorded with a voice recorder or smartphone app. While the Skype colloquies took place in the home of both parties, the face-to-face conversations were typically recorded at the University of Regensburg – either in the office of the interviewee or a random quiet location on campus – with two sessions taking place at my home. Each meeting took about one hour, with variance due to some participants being more loquacious than others. Depending on the

⁵Framework see Appendix B

⁶see Appendix F

location, the interviews were supplemented by ethnographic elements: some interviewees asked me to look at their computer screen when talking about software and file management or held their notes into the webcam in Skype sessions.

The participants were recruited through social media posts and word-of-mouth. The resulting convenience sample was deemed appropriate for the exploratory fashion of this study. It consisted of five PhD students and seven master students. While students of the humanities were the primary target, some participants from neighbouring disciplines were recruited as well: Four subjects were history students, two at the PhD level, two at master level. Two interviewees were students of Eastern European studies in the master level the other participants were: one PhD student of Slavic linguistics, one PhD student of macroeconomics, one PhD student of work and social psychology, one master student of political science, one master student of philosophy and one student of teaching in the subjects of biology and chemistry. Ten participants were female, two male and all interviewees were born between 1989 and 1996. While only looking for Master or PhD students to ensure a right (and comparable) level of skill and routine with scholarly work, the student of teaching was recruited without satisfying the requirement of holding a first degree (due to the “Lehramtsstudium” without a bachelor degree). Throughout the interview, it transpired that students of this particular track have no experience in research, as their training is structured differently. Thus this interview was deemed unusable. While never planning to create a general model of scholarly work, the non-humanists were recruited in order to survey, whether excerpt writing and bibliographic management might be generalizable research activities.

All interviews were transcribed by hand. Most dialectal words and pronunciations were *translated* to High German. Ellipses were transcribed. In rare cases, the intentions were added in square brackets to make sure for statements to be understood from the transcriptions. After that, the transcriptions were coded using grounded theory as proposed by Corbin & Strauss (2008, 1990). The first iteration of open coding was applied, according to their instructions. Through several iterations, codes were condensed and finally a transition from conceptual codes, grouping similar themes and giving them speaking names, towards the exploration of activities, was made. The software *MAXQDA* (VERBI Software, 2019) was used for creating the transcription and coding them.

Moreover, with later iterations coding became more adapted towards classifying activities and exploring concepts, attributes, values and relations

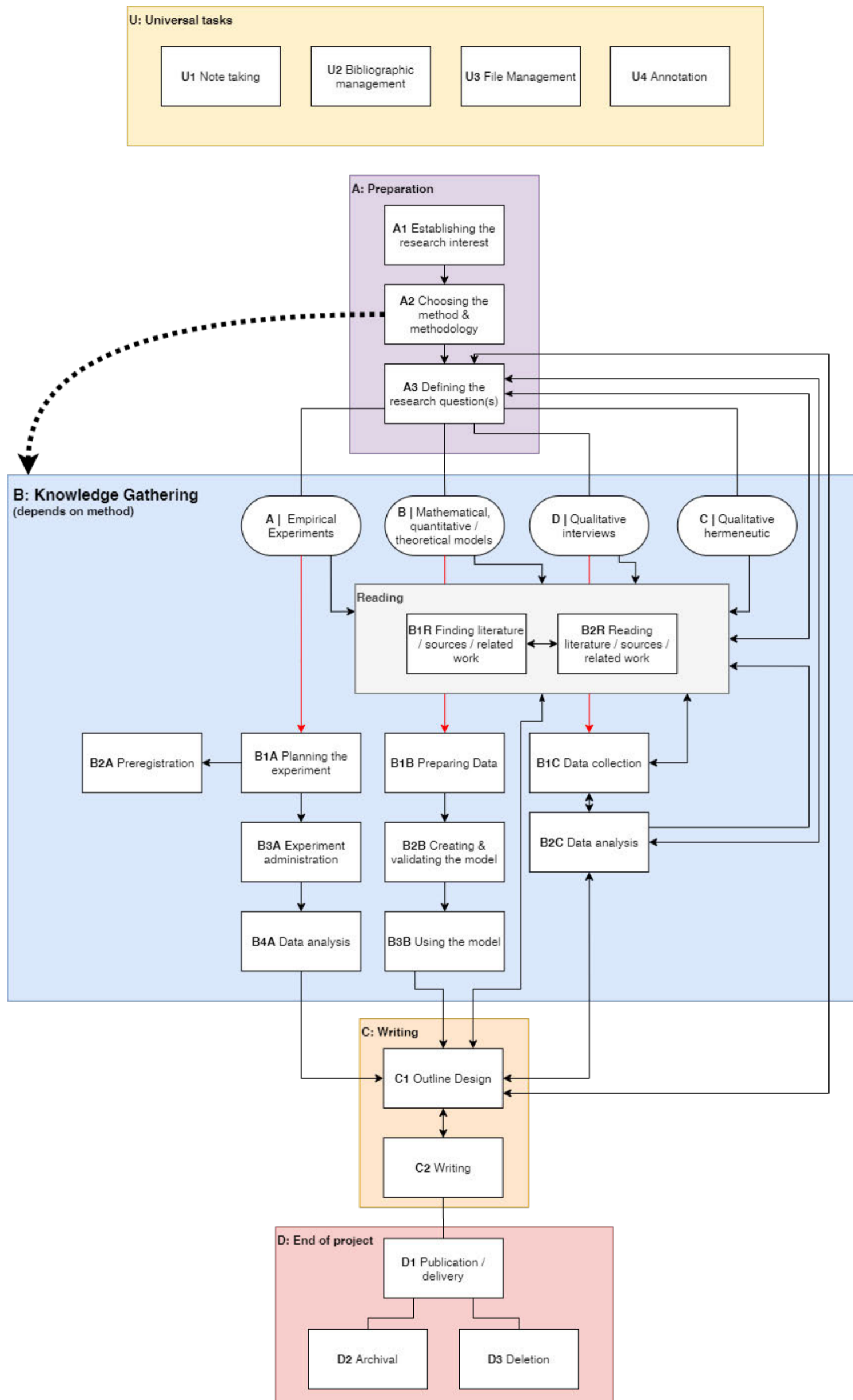
(Milton, 2007). In the same fashion, sections with participants complaining about procedures, requesting improved tools or reporting about problems and errors throughout research projects were coded as well. These labels will be used in chapter 4 to establish needs for assistance and to prioritise activities to be supported by a digital research assistant.

The interviews focused primarily on an adapted set of scholarly activities: 1. Method Selection 2. Note-Taking 3. Writing 4. Archiving. In comparison to related work, there are two shortcomings in my interviews: publication has not been explored as thoroughly as desirable, and collaboration has not been touched at all. While the literature covers especially collaboration as an essential activity in scholarly research, I missed this activity when creating the outline for the interviews. Publishing has been touched in only a few interviews, due to most respondents not having published any paper yet.⁷

The interviews concentrated on eliciting how each activity is done, which smaller steps they include, what tools researchers use, what problems occur, and how participants would like to improve processes. Interviewees were asked to think about their last major research project while answering the questions. Most participants were able to quickly put themselves in the position of writing their last thesis or their last seminal paper, while others thought about their ongoing dissertation or master thesis. The focus on these events helped to gain insight into the research process; special attention was paid to elicit negative experiences, problems and dissatisfaction with processes and tools.

⁷This applies mostly to master students, but also one PhD student, who was about to finish her doctorate reported not having published any paper.

Informal Flow-Diagram of Scholarly Activities



An informal flow-diagram of the activities found while analysing eleven interviews with PhD and master students. Each activity is explained thoroughly in its own chapter. Arrows display temporal relations. Especially the humanist students have been found to iteratively start different activities again and again, thus for their track most activities are connected to most other connectivities, because they reported jumping from the one task to the other, back and forth. The dotted arrow from *A2* to *B* signals the influence, the decision in activity *A2* has on the selection of a track of activities in the group *B* – *Knowledge Gathering*. While the knowledge gathering activities for the method & methodology tracks *BnA* and *BnB* run successively, reading may take place synchronously. For these two tracks, however, going back from e.g. *B4A* – *Data Analysis* to *A3* – *Defining the Research Question* is not possible anymore. Not being able to distinctively displaying these temporal relations is a shortcoming of this diagram.

3.1 A1 — Establishing the Research Interest

The very first step in the scholarly workflow is establishing the research interest. This activity seems to be strongly dependent on the level of expertise and studies. Interviewees report having chosen topics related to classes, course literature and lecturer's interests in their time as undergraduates. Those enrolled in a master's programme report to still develop a first draft for their paper's research interest affected by a combination of the topics of attended seminars and the research interest of their supervisors – no matter whether they are preparing a seminal paper or their thesis. The PhD students' research interest was in one case set by employment in a research project. In another case, it evolved from a master's thesis. The activity of establishing a research interest is in the case of hermeneutic studies closely linked to the activities *B1R Finding Literature / Sources / Related Work* activity and *A3 – Defining the Research Question(s)*. Since being aware of a rough research interest appears to be the most basic principle in order to make decisions about further scholarly work, this activity is modelled as the first activity of every research workflow.

3.2 A2 — Choosing the Method & Methodology

This activity modelled as an essential activity at the beginning of every research project. While the reflection upon used methods and methodology differed between the interview partners, every single research project relies on choosing a certain method and methodology. For some interviewees, though, this choice happened rather unconsciously, due to typical practices in the subject, while for others, methods were chosen specifically to fit the object of scholarly observation. The participants with humanist backgrounds reported on the use of qualitative methods paired with hermeneutics or grounded theory, while quantitative methods were mentioned as a possibility by a student of political science. The students of psychology and economics reported the use of quantitative methods: experimental empiricism and the use of mathematical models. Since the choice of method and methodology depends on the research interest while dictating the workflow of the whole project, it is modelled as the subsequent activity to *establishing the research interest*.

3.3 A3 — Defining the Research Question(s)

Specifying one or multiple research questions was reported most directly by the student of psychology. As a practitioner of quantitative experimental

empiricism, she specifies the research question at the very beginning of every project. Together with the experimental settings, these pieces of information are uploaded to a cloud platform and preregistered as proof for reviewers that the experimental design and hypothesis were not amended to fit the empirical data. The student of economics did not mention “Forschungsfrage” a single time throughout the interview, with one exception when referring to read papers. The students employing qualitative methods did – in some cases – not mention “Forschungsfrage” directly.

The student of Slavic linguistics reported finding the topic for her latest paper while working with the corpus of her PhD project and recognizing a language anomaly not noted before:

“[Ich] schreibe [...] gerade einen Artikel, der ist dann hoffentlich bald fertig, da war ich gerade auf Feldforschung mit einer Kollegin in Polen und wir haben festgestellt, dass fast alle Probandinnen gesagt haben „und dann hab’ ich mich verheiratet“. Und das war so eine Konstruktion, die ist einfach super herausgestochen, und dann haben wir zu zweit überlegt und noch in mehrere Interviews hineingehört, dass es eben viele Konstruktionen gibt, die im Deutschen eigentlich nicht reflektivisch gebildet werden, und im Polnischen schon. Und dass das, dieses reflexive, aus dem Polnischen ins Deutsche übernommen wird, oder eben auch anders rum, und das ist uns halt einfach aufgefallen und dann haben wir uns gedacht, da müssen wir mal genauer hinschauen wie oft das vorkommt, unter welchen Umständen und warum vielleicht. Und das wird dann unser nächster Artikel sein.” (singuläre-Elena, Pos. 17)

The students of history used the term the most amongst the humanists. The hermeneutic researchers reported narrowing their research interest down to particular topics recursively. While for the student of psychology this activity necessarily terminates before an experiment begins, the humanists tend to rerun this activity multiple times, throughout their project, only necessarily terminating when *D – End of Project* is initiated. Most respondents report running through this activity at the beginning of their projects, creating preliminary research questions, like this history student:

“[...] daraus resultier[t] dann meistens auch aus dem Prozess ein vorläufiger Titel und eine vorläufige Forschungsfrage. Und parallel natürlich auch zu diesen Überlegungen mache ich es zumindest so, dass ich schon ein bisschen recherchiere drüber, aber erstmal ob es

überhaupt etwas gibt dazu. Also das ist ja eigentlich immer das wichtigste, ich habe auch schon mal Themen gehabt, wo ich dann gemerkt habe, da gibt es einfach kein Material dazu.” (bartloser-Edwin, Pos. 2)

Others reported amending the research questions until the end of their writing process, like these two students of Eastern European studies:

“Weswegen ich auch echt, also ich hab’ auch zwischenzeitlich manchmal gedacht, „boah wie unwissenschaftlich bist du eigentlich, du hast nicht mal’ ne richtige Forschungsfrage“, weil ich so bisher immer vorgegangen bin. Wenn ich das Ding fertig geschrieben hab’, dann kann ich in die Einleitung reinschreiben, auf welche Frage ich die Antwort gegeben habe. Und so war’s bei meiner Masterarbeit tatsächlich auch.” (unerwartete-Sina, Pos. 79)

“Das habe ich im hinteren Drittel der Arbeit gemerkt, dass mein Fokus sich ein bisschen verschoben hat und ich sehr wenig über, ich dachte es geht darum, dass der Krieg mehr hinterfragt wird, das wurde er aber nicht. Das hat sich dann im Nachhinein geändert, das habe ich dann noch angepasst. Und zwar wirklich innerhalb der letzten vier Wochen.” (visuelle-Leana, Pos. 26)

Ultimately this activity seems to be part of every project throughout the fields covered by present interviews. While the psychology student was the only one to mention it as a proper, self-contained, activity, the other interviewees mentioned each a process of narrowing down their research interest to a specific question (or set of questions) they want to answer in their research. For the hermeneutics, this activity might be a latent one, yet it is an important one since many activities will be based on the definition of a research question. For the economics, the respondent did not mention this activity explicitly. However, she mentioned research questions being part of papers. Thus it should be valid to assume that this activity exists in the field of economics.

3.4 BnA — Research Activities for Empirical Experiments

The following activities were only reported by one interviewee: the student of psychology. This is one of three observed specialized groups of activities for collecting and accumulating data. All of them may run parallel to reading activities.

3.4.1 B1A Planning the Experiment

As the psychology student conducts experiments, planning them is a particular activity of experimental empiricism. Planning the experiment has been reported as depending heavily on the research question(s). Different types of experiments can be used to detect different habits and examine different events (kulanter-Peter, Pos. 6). During the planning process pen & paper is used for note-taking and writing todo lists. Parallel to notes and lists, the outline for a manuscript is created and used for thinking – as the respondent reports to be thinking and writing at the same time (kulanter-Peter, Pos. 80, 82).

3.4.2 B2A Preregistration

Following the ‘replication crisis’ in the field, measures were taken to improve the quality of scholarly publications. Nowadays, hypotheses, methods and planned analyses are submitted through a tool (*Open Science Framework*) before data collection starts. While the information is yet only visible to the owner, a timestamp has been added. Once the paper about the experiment using the preregistered data is submitted, reviewers obtain access to the timestamped vault. Thus they can verify that proper methods were used, rather than hypotheses or methods chosen to fit the outcome of an experiment (kulanter-Peter, Pos. 16). This activity is obligatory before *B3A* and follows *B1A*.

3.4.3 B3A Experiment Administration

In this stage, the experiment planned in *B1A* is conducted and data collected. The respondent reported the use of questionnaires for data collection (kulanter-Peter, Pos. 4).

3.4.4 B4A Data Analysis

Collected data is analysed descriptively and statistically with regard to the hypothesis (kulanter-Peter, Pos. 4).

3.5 BnB — Activities for Mathematical Quantitative Research

The student of economics with a specialization in macroeconomics reported the use of theoretical models in her research. She uses the following activity when dealing with aggregated data. Like the prior experiment activities, this

track is also modelled as a parallel activity to other means of data collection (*reading*), due to the lack of information about the chronology.

3.5.1 B1B — Preparing Data

The respondent reported ‘giant aggregated macro databases’ (pleitee-Betty, Pos. 68) as her data sources. Before using the data she transforms and saves the data sets using *FORTRAN*, *Matlab*, *Stata* or *R*. Due to the use of scripts for data transformation, the process is easily reproducible. Therefore, it is not the transformed data sets that are of great importance, but the scripts. In some cases, they include commands to download data sets from their sources automatically; this is relevant in cases with regularly (e. g. monthly, quarterly) changing data sets.

3.5.2 B2B — Creating & Validating the Model

For this activity, the interviewee reported modelling the current situation as a theoretical model for the first step. The model serves the purpose of simulating policy changes:

“Also du baust quasi ein Modell, versuchst das irgendwie in Computersprache zu übersetzen, und versuchst eben dann das zu simulieren. Du simulierst quasi erstmal die Ist-Situation, dann simulierst du mögliche Maßnahmen, dass du sagst, keine Ahnung, du erhöhst das Renteneintrittsalter oder senkst das oder so. Guckst also ok, was würde das ausmachen. In unserem Modell, was hat das für Auswirkungen?” (pleitee-Betty, Pos. 4)

Once the model is fully created, historical data is used to evaluate the model. The models are mostly based on models of existing research and minimally modified to serve the new purpose.

3.5.3 B3B — Using the Model

Once the model is evaluated, it is used for solving the actual research questions. Explaining the idea behind theoretical models, the student gives an example: The aim of the research might be maximizing welfare in a system. To archive this end, the distribution of consumer goods and leisure needs to be optimized. The model offers the possibility to find the optimal distribution using math, while incorporating a multitude of parameters, like tax yield and others (pleitee-Betty, Pos. 10).

3.6 BnC — Activity for Qualitative Methods

The student of Slavic linguistics reported the use of interviews and qualitative methods of analysis. She described the workflow of her scholarly work to be non-linear due to the use of grounded theory. She reports reading literature simultaneously to collecting data for a corpus. Because of the non-linear character of her research *A3* is not finally completed before activities of type *B* – *Knowledge Gathering* (singuläre-Elena, Pos. 93) or activities of type *C* – *Writing* (singuläre-Elena, Pos. 43) start.

3.6.1 B1C — Data Collection

The respondent carried out fieldwork in Poland and collected audio recordings of interviews. The interviews are in the process of being transcribed (singuläre-Elena, Pos. 21). Audio files and transcriptions are saved on the university cloud with backups on external hard-drives (singuläre-Elena, Pos. 43, 45).

3.6.2 B2C — Data Analysis

Ideally, the audio recordings should be transcribed as the written form offers searchability. For the latest research project, however, the files were not readily transcribed yet, hence *Audacity* and *Excel* were used for recognizing patterns within the interviews (singuläre-Elena, Pos. 23, 43). The *Excel*-sheet included an identifier for the subject, manual timestamps, and colour coding for the classification of specific pattern types. The student uses several data sheets within *Excel* for the analysis process; each sheet collects different types of information paired with notes to herself. Sheets are also used for the process of translating and glossing; both activities are required for publications (singuläre-Elena, Pos. 29, 31). All in all, research in her field uses inductive methods (singuläre-Elena, Pos. 39), inspired by grounded theory (singuläre-Elena, Pos. 93).

3.7 BnD — Activities for Qualitative Hermeneutics

Students from the following fields reported the use of hermeneutics: history, Eastern European studies, philosophy and political science. Their information gathering solely relies on reading texts. Hence no specialized track of activities was modelled for their research methodology. Students of history reported the possibility to use pictures or objects as sources for research. However, none of them reported using these in their research.

3.8 BnR — Reading Activities

Reading activities are introduced as a group of specialized activities within the group of information gathering activities. All respondents, no matter the subject, reported doing some kind of reading. As mentioned in the introduction of this activity track above: Reading activities run simultaneously to other activity-tracks. The terminology of what is being read changes through the subjects: The student of psychology reports constantly reading papers about methods (kulanter-Peter, Pos. 6) and reading-related work leading to the research questions and hypotheses of the project (kulanter-Peter, Pos. 4). Similarly, the student of economics reads papers for a literature review section of her project (pleitee-Betty, Pos. 50). The student of Slavic linguistics uses the term source and literature synonymously (pleitee-Betty, Pos. 50), while students of history differentiate these terms (erdbeerfarbener-Charlie, Pos. 6; runzelige-Giulia, Pos. 4; bartloser-Edwin, Pos. 4) and introduce a difference between primary and secondary literature (erdbeerfarbener-Charlie, Pos. 14; lautmalerischer-Elmedin, Pos. 10). The latter terminology has also been observed in the interviews with students of philosophy and Eastern European studies (e. g. unerwartete-Sina, Pos. 6; mobiler-Nino, Pos. 8).

3.8.1 B1R — Finding Literature / Sources / Related work

Due to the multitude of terms used referring to the sources for information gathering, the title for this activity is rather bulky. While students use different classification for their textual sources and while they serve divergent ends, every report of scholarly research shares the activity of identifying suitable sources. The finding activity may be initiated in different stages (see above). However, it is an essential activity before reading the literature: logically, without any sources, there is nothing to be read in the first place. The reading and finding activity, then, may be invoked in a loop: Read literature refers to more sources. Hence the sources are looked up and read, possibly offering more references to look up and so on.

The respondents reported the use of similar methods for finding literature through different disciplines. Most of the students reported consulting the library catalogue and *Google*, *Google Scholar* or *Google Books* at the beginning of their search (e. g. runzelige-Giulia, Pos. 34; erdbeerfarbener-Charlie, Pos. 14), as a student of political science explains:

“[...] mein erster Schritt ist meistens, dass ich dann in Katalog schaue, also von der Uni Wien, was es da gibt. Dann hoffe ich,

dass ich was finde erstmal. Natürlich der zweite Schritt ist bei mir Google Recherche.” (prominenter-Kimi, Pos. 26)

The order of consultation varies between individuals, a student of history, for example, reports a different order of literature search, after having read *Wikipedia* articles relevant for his research project:

“Und das ist Schritt eins, erstmal eine ganz basale Google-Suche. Und Punkt zwei ist dann schon auch so der Regensburger Katalog, dass ich mal schaue, was gibt es für Monografien dafür, dazu, für für Sammelwerke, was kann man sich auch aus dem Magazin holen [...]” (bartloser-Edwin, Pos. 8)

The student of psychology, on the other hand, did not report any use of the library catalogue at all, her first address when searching literature is *Google Scholar*, after that meta-analyses. The same goes for the student of economics – throughout the interview, it turned out, that she hardly uses any books for her research, the literature she needs is usually found through *Google Scholar* as well.

All in all, most interviewees use one of the *Google* products, those employing hermeneutic methods retrieve their literature also through library catalogues, and most respondents reported the use of snowball procedures. They identify in a first cycle, possibly interesting literature, that leads them to more sources, each cycle narrowing the focus further until key literature is identified. The use of non-specialized search engines like *Google* or *Google Scholar* have also been reported in the literature (Chen, 2019; Collins et al., 2012). As one student of Eastern European studies explains:

“Und da ist es halt dann so, also ich mach’ das dann immer so, dass ich erstmal meine, also mir ein Haufen Literatur raussuche, also je nachdem wie viel es halt gibt, zu allem möglichen [...]” (unerwartete-Sina, Pos. 2)

Besides, students report receiving literature suggestions by their advisors (bartloser-Edwin, Pos. 2), using literature they encountered in earlier stages of their studies (visuelle-Leana, Pos. 24). Historians’ sources are not only available through the internet or libraries, but they are also stored at archives. Hence they, depending on their field of research, also spend time looking through archives or their catalogues in order to find their sources (erdbeerfarbener-Charlie, Pos. 6; lautmalerischer-Elmedin, Pos. 14; runzelige-Giulia, Pos. 6,8,10; bartloser-Edwin, Pos. 2).

The practices described in this activity are part of information seeking processes. These have been thoroughly researched in the field of information science and library studies. One famous model concerned with these processes was developed by Kuhlthau (1991, 1994). The search for literature activity presented here may be classified as stages 3 ‘Exploration’, 4 ‘Formulation’ and 5 ‘Collection’ in Kuhlthau’s model. The descriptions of the students using hermeneutics reports fit well into the model’s stages of refinement throughout the search process, while the model explains the ongoing invocation of search activities throughout the work on a research project. This thesis, however, tries to capture the activities of scholarly research in total. After that, it concentrates on note-taking and reading. Thus, it should be noted that plenty of literature exists exploring this very activity in much more detail, while this activity model merely scratches the surface.

3.8.2 B2R — Reading Literature / Sources / Related Work

Due to the multitude of types of reading sources, there is no single answer to how and where reading takes place for everyone. As mentioned above, dependent on the subject, texts may be classified as primary or secondary literature, they may be archival material simply referred to as ‘source’, and respondents report reading different kinds of literature:

- Monographs (runzelige-Giulia, Pos. 6; prominenter-Kimi, Pos. 22; erdbeerfarbener-Charlie, Pos. 20; bartloser-Edwin, Pos. 16)
- Miscellanies (kulanter-Peter, Pos. 75; prominenter-Kimi, Pos. 22)
- Journals (and papers) (pleitee-Betty, Pos. 81; kulanter-Peter, Pos. 26; runzelige-Giulia, Pos. 36)
- Working papers (pleitee-Betty, Pos. 14)
- Textbooks (visuelle-Leana, Pos. 80)
- Archived newspapers (visuelle-Leana, Pos. 6; runzelige-Giulia, Pos. 6; bartloser-Edwin, Pos. 2)
- Belles-lettres (‘schöne Literatur’) (visuelle-Leana, Pos. 16)
- Dissertations (erdbeerfarbener-Charlie, Pos. 42; bartloser-Edwin, Pos. 16)

Besides, text may be read from books, printouts or digitally. While every respondent reported to use digital documents in their research, preferences

diverged whether to read on-screen or paper. Many respondents appreciate the immediate availability of digital material. However, they prefer paper for reading, a student of Eastern European studies explains:

“Ja, also es gibt schon einige Aufsätze auch, die digitalisiert sind, was natürlich praktisch ist, weil man das dann nur runterladen muss und dann kann man das direkt lesen und so, muss nicht extra in die Bibliothek gehen und das ausleihen und so. Und, also ich arbeite schon tatsächlich am liebsten mit Papierbüchern, weil ich das zum Lesen angenehmer finde.” (unerwartete-Sina, Pos. 59)

The same student, however, reports dissatisfaction with printing out digital texts for working with them:

“Deswegen, aber ich versuche halt auch immer nicht so viel auszudrucken, weil sonst habe ich so einen Papierzettelwust und komme irgendwie nicht mehr so richtig zurecht. Wenn ich dann gerade keinen Tacker zur Hand habe, dann fliegt mir das alles auseinander und dann fehlt die Hälfte der Seiten.” (unerwartete-Sina, Pos. 59)

Finally, she hopes to find a ‘healthy equilibrium’ between reading digitally and on paper and aims to organize her printouts more tidily in the future. While this student’s case of missing order marks an extreme, she is not the only one to print digital texts for reading (and annotation): explanations vary between simple non-explanatory statements like “Ich bin aber ein Mensch, der’s gedruckt braucht [...]” (runzelige-Giulia, Pos. 36), a dislike of working the whole day in front of a screen (lautmalerischer-Elmedin, Pos. 20) and grounded arguments for printouts due to unique affordances (Norman, 2013) of paper for annotation: a history student reports how she used glue and notes, thus extending the available space, another one uses sticky-notes for the same purpose (erdbeerfarbener-Charlie, Pos. 32; lautmalerischer-Elmedin, Pos. 20). One historian speculates whether humanists might simply be bibliophiles and thus prefer reading books over digital texts (bartloser-Edwin_Nachtrag, Pos. 1).

Other reasons for digital copies or digitized archival objects are that they save money (travel expenses) and time (lautmalerischer-Elmedin, Pos. 14), in these cases they may or may not be printed afterwards, dependant on personal preferences.

In some situations students prefer reading digitally: In one case digitized Ottoman newspapers offered a unique possibility to improve readability of Arabic script: The student used a feature of his document reader to invert colour of b/w scans, thus creating a better contrast for him to translate the newspaper from Turkish (visuelle-Leana, Pos. 24). The student of Slavic linguistics reports preferring reading digitally, since she dislikes printing for ecological reasons, thus she requested a particular type of computer when starting work at the university: it is possible to turn the notebook into a tablet. She uses her finger for annotation work and emulates her paper reading practices on-screen (singuläre-Elena, Pos. 49). The students of economics and the student of psychology reported mainly reading digitally (pleitee-Betty, Pos. 26; kulanter-Peter, Pos. 40). In all instances of digital reading the use of *Adobe Acrobat Reader* was reported, with only one exception: the Ottoman newspaper documents were not available in *PDF* format. Thus a different software was used.

While reading, two of the universal activities are invoked by most interviewees: *U1 Taking Notes* and *U4 Annotation*. (e. g. erdbeerfarbener-Charlie, Pos. 52; lautmalerischer-Elmedin, Pos. 36; kulanter-Peter, Pos. 40; unerwartete-Sina, Pos. 6)

3.9 C — Writing

The group of writing activities consists of two elements: *C1 Outline Design* and *C2 Writing*. The students of psychology and economics reported a rather streamlined structure for their paper. Therefore they are mostly able to create an outline for their writing and after that fill the sections with content. For the other interviewees, the writing activities alternate with other activities, mostly reading activities. Nevertheless, for the hermeneutics track, it is possible to jump from *C2 writing*, to *A3 Defining the Research Question* and vice versa; they tend to create their work iteratively, starting with the *A Preparation* activities, going via *BnR Reading* to *C Writing* and after that back to any single activity within any group, if necessary.

3.9.1 C1 — Outline Design

The student of psychology reported the most standardized design. She was able to state different sections compulsory for papers in her discipline and thereafter explained the steps necessary to fill them with content (kulanter-Peter, Pos. 4). The outline design happens within her manuscripts, which iteratively is filled with information (kulanter-Peter, Pos. 82). The student

of economics reported a similar structure, predefined by the standard of her field. She also reported to constantly update the outline, starting with a rough skeleton, filled with more and more information. She states that the design process is not self-contained, rather linked to the writing process. The student of linguistics is already working on chapters for her dissertation, although she just created the first iteration of an outline (singuläre-Elena, Pos. 43, 63). She mentions a few items on her outline compulsory in the field, like sections for theory, method and descriptive analysis. The literature in her field inspires this structure (singuläre-Elena, Pos. 63).

Finally, there are the students of the hermeneutics track. Most participants reported their outline design between two extremes: One student was somewhat well organized; he started right at the beginning of his master thesis with an outline. It was created as part of a – as he put it – extremely short exposé of three pages. In this early stage of his work, the outline was rather simple. Nevertheless, the exposé directed his first steps while working on his thesis, and he reported only one alteration of his original outline: the focus of his thesis changed slightly. Hence he needed to adjust the title of his conclusion section (visuelle-Leana, Pos. 26). On the other extreme, another master's student of the same subject (Eastern European studies), also prepared an outline as a part of her exposé. However, she reports her final work massively diverging from the first outline, initially approved by her adviser (unerwartete-Sina, Pos. 79).

While students of the other tracks reported to some extent outlines influenced by standards of their fields, none of the hermeneutics students mentioned such a thing. Asked about typical compositions of papers in the field of literary studies, one respondent answered:

“Äh, ne, das ist total offen eigentlich. Also in der Literaturwissenschaft allgemein. Es gibt halt oft auch gar nicht so einen richtigen Theorieteil” (unerwartete-Sina, Pos. 77)

Once more, this marks one extreme. Another student uses a generic approach for her assignments:

“Genau und die Gliederung ist eigentlich meistens, also in folgendem Schema: Eine Einleitung, ein Hauptteil, der besteht dann aus Theorie und Analyse und dann eben ein Schlussteil, eben das Fazit von der ganzen Sache.” (mobiler-Nino, Pos. 8)

All in all, every student reported the use of an outline. Outlines by users of hermeneutic methodologies live through different stages, from a slightly

rough version at the beginning of research projects to more detailed versions throughout the writing process until the very end. Outlines are used to sort thoughts (unerwartete-Sina, Pos. 79) and are created at different times. For one interviewee, the outline unfolds itself through reading secondary literature about her project's topic. Thus she starts reading literature before thinking about the structure of her paper (erdbeerfarbener-Charlie, Pos. 36), while others create the outline at the beginning of a project and chose their reading according to their outline (visuelle-Leana, Pos. 26). In the end, this activity is an important stepping stone towards the writing activity, even though it may be initiated or revisited throughout different stages within a project.

3.9.2 C2 — Writing

Writing is another activity reported by every participant. In this activity, products from preceding activities come together; pieces of information are funnelled into one written text. While the process from information collection to outlining differs across the different methodologies, this step marks the final consolidation of all possible paths through the prior workflow. The writing process needs to be completed before the *End of Project (D)* activities can be started, while all interviewees report an interaction between the writing and outlining activities. Also, there is an interdependence between the *Universal activities (U)* and the writing activity, as some of them (like *U1 Note taking* and *U4 Annotation*) convey information from the *B Data Collection* activities into the (possibly chronologically later) writing activity, when the information is needed. Similarly, the *U2 Bibliographic management* activity is needed, information stored earlier in the project is retrieved during writing for citing or for refinding information about sources to help the retrieval of notes.

All students use a computer when writing, most people use *Word* or an open-source alternative like *Libre Office* as a word processor, with one exception using \LaTeX .

The student of psychology needs her notes, a *Word* and a *Excel* file, while writing her (final) draft. Since her writing is in English, she uses the add-in *Grammarly*. She manages her quotations and literature section of her document with *EndNote* (kulanter-Peter, Pos. 26). While she is one of the few students making use of citation management software throughout the writing process, she is rather dissatisfied by the application:

“[W]obei ich sagen muss, dass also EndNote ist halt schon so [...] mittelgut. Man muss das ganze Literaturverzeichnis definitiv nochmal überarbeiten. Im Text zitiert es ziemlich gut, aber

ich würde sagen das Literaturverzeichnis, wenn man nicht alles tausendmal nochmal checkt, oder halt quasi jede Quelle, die man in EndNote rein zieht, wenn man zum Beispiel die Quelle von Google Scholar in EndNote rein zieht, dann sind das sehr oft Fehler, dass da irgendwie eine Seitenzahl fehlt, oder dass das Journal nicht ausgeschrieben ist, oder irgendwas. Man muss das definitiv nochmal nachchecken.” (kulanter-Peter, Pos. 26)

The student of economics reported the least about her writing process because it seemingly is not that important for her research process. She starts writing while working on other activities, gathering information. Throughout this process, she keeps adding information to a rough skeleton (outline) which becomes her draft. She uses L^AT_EX’s built-in comment functionality for note-taking and *BibTeX* for citations (pleitee-Betty, Pos. 38, 52).

The interviewee using qualitative interviews uses *Word* for writing and saves the chapters of her dissertation in one file each. The files are seen as drafts, with each edit, a timestamp is manually added to the file. She is the only person who reported the use of the university’s cloud storage for fear of losing data, thus creating back-ups on the university’s infrastructure (singuläre-Elena, Pos. 43). She mentioned the use of *Citavi* but did not mention using the add-in for this citation-manager.

All but one hermeneutics students reported starting the writing process at some point where they feel like not being able to keep thoughts, read literature and notes together in their head anymore (runzelige-Giulia, Pos. 90). Others ended up with a ‘mountain of notes’ (unerwartete-Sina, Pos. 6) that needs to be compiled into the continuous text; hence starting the writing activity while going through data collection. The exception makes one student of Eastern European studies: he reported a rather late start of the writing process. He classified his notes as rather elaborate. Thus when compiling his text, it became – as he stated – the final text, not a draft, with very few corrections being made once he finished writing (visuelle-Leana, Pos. 68). Producing text has a reassuring effect on some interviewees since even a few lines cure the impatience when the reading process takes to long and thus creates the fear of not being able to write (runzelige-Giulia, Pos. 90).

Word was the only word processor mentioned throughout the hermeneutics interviews (although data from the questionnaire suggests the use of open-source alternatives). One participant considered the use of L^AT_EX for her dissertation at the beginning of her project – due to peer pressure. However, she feared the cost of training and decided for *Word*, which she used throughout her prior studies, thus getting to know every vital function the software

offers (lautmalerischer-Elmedin, Pos. 70). The same interviewee and an additional one, both researchers of history, mentioned problems with larger *Word* documents. Both explained how they carefully avoided creating documents larger than 50-60 pages (lautmalerischer-Elmedin, Pos. 70; erdbeerfarbener-Charlie, Pos. 48).

On the one hand, this might be an indicator of how peers influence the use (and selection) of software. On the other hand, it is an excellent example of the creative software use in the scholarly practice: for her dissertation the history student creates *Word* files per chapter as a workaround for the self-imposed file size limitation, solving at the same time a layout problem. Making use of a *PDF-Creator*, she merges all documents, happy that small changes within a chapter will not influence layout decisions made in subsequent chapters of her dissertation (lautmalerischer-Elmedin, Pos. 70). While some participants use citation management software like *Citavi* or *Zotero* (e. g. visuelle-Leana, Pos. 64), some keep manually track of their quotes and add citation information by hand (e. g. lautmalerischer-Elmedin, Pos. 40).

3.10 D — End of Project

Eventually, every project comes to an end. The end of the project has been modelled to start with the activity *Publication / Delivery*, which leads to the two following activities *Archival* and *Deletion*. The activities of this category are the only ones strictly chronological between all methodologies reported. However, this is not surprising due to the nature of an end.

3.10.1 D1 — Publication / Delivery

The student of psychology reported most enthusiastically about her publication process. In her discipline, open data is the most important. Thus, when submitting a paper, she also gives access to all her data, including the preregistration of her hypotheses on *Open Data Framework*, to the reviewers. Once a paper has been accepted, all data is published as well. She tries to publish as much as possible in open access papers, as she dislikes the price policies of publishers (kulanter-Peter, Pos. 104, 114). One of the history students did not publish any paper throughout working on her dissertation, thus only preparing the delivery of her thesis (lautmalerischer-Elmedin, Pos. 98). The student for Slavic linguistics works on a monograph for her dissertation, while trying to submit smaller papers at the same time (singuläre-Elena, Pos. 11), though she did not give more details about the publication process. The eco-

nomics student tries to archive three publications throughout her PhD course. Her dissertation will consist of the three papers published as one monograph. However, she criticises the peer review system of her field: submissions take years to be published. Thus doctorates are usually granted before all papers have been published (pleitee-Betty, Pos. 18). Master students did not talk at all about publishing papers and did not mention anything about the process of delivering their exam papers or theses.

Eventually, more detailed interviews about publications would be necessary for a more detailed description of this activity. Thus there are two possibilities for submission or delivery: Completed manuscripts may either be printed or submitted digitally. Publication or delivery is the end-goal for a project. Future work may build upon the work from the project; maybe a finished project even morphs into a new project. However, for this model, I propose that after the publication or delivery, the activities *Archival* and *Deletion* are triggered.

3.10.2 D2 — Archival

Some interviewees reported keeping all their digital project data (prominenter-Kimi, Pos. 47-50, 81; runzelige-Giulia, Pos. 112; visuelle-Leana, Pos. 82; pleitee-Betty, Pos. 76). Few people also report ‘cleaning’ their data and only keeping important folders, especially deleting seminal papers from undergraduate studies, while keeping the literature and sources (erdbeerfarbener-Charlie, Pos. 80-82). Others go as far as also archiving physical notes. Since the cost of storage is a different one, physical space, one student goes to the length of storing her notes in her parent’s basement (prominenter-Kimi, Pos. 81). In the digital realm, however, she only archives the final version of her theses and papers (unerwartete-Sina, Pos. 97). One student praises the use of *Zotero* for simplifying the transition between projects: Looking into folders of past projects helps to find literature for new projects. Mobiler-Nino describes a physical folder for keeping all notes while archiving digital notes on *Google Drive* (Pos. 104; 120). One person just archives his finished works, arguing that all important thoughts have been incorporated in the finished piece. Thus nothing else needs to be archived (bartloser-Edwin, Pos. 70). Only one person reported a sophisticated archival process: Kulanter-Peter has a thorough system of folders (see *U3 – File Management*), once a paper is published, she adds the final *PDF* to the right position in her file system.

Once the material is archived, the interviewees report mixed success with refinding the material. Due to her neat system of document classification, the student of psychology can quickly find the necessary documents when re-

ceiving questions about her publications (kulanter-Peter, Pos. 104). Visuelle-Leane and lautmalerischer-Elmeding report the same success (visuelle-Leana, Pos. 84). Prominente-Kimi sometimes comes back to old projects in order to find inspiration for new ones. He also claims his neat system for being able to quickly find what he was looking for, even after years (prominenter-Kimi, Pos. 74-78). Due to her notes being stored at a different location, one of the Eastern European studies students has only been looking into the *PDFs* of her past assignments when looking for archived information. She reports using the search function, “weil ich hab’ dann auch keine Lust meine ganzen Hausarbeiten nochmal zu lesen” (unerwartete-Sina, Pos. 83). The history student saving her documents on flash drives reports mixed results when trying to re-find archived information. Data is fragmented on different drives, knowing on which one to look is tough (runzelige-Giulia, Pos. 116).

3.10.3 D3 — Deletion

Deletion as the counterpart of archival brings hardly surprising insights. It describes either the physical act of throwing away documents containing notes or other information or deleting digital documents. Once more, interviewees make a difference between physical notes and digital documents: Pleitee-Betty, for instance, tries to keep as few things as possible, thus tossing paper notes as soon as they served their purpose (pleitee-Betty, Pos. 72). For the digital realm, she described the contrary, keeping all files. However, the reaction of two interviewees when mentioning the option to delete documents stands out: sheer bewilderment, how can one dare to delete documents? (singuläre-Elena, Pos. 119; kulanter-Peter, Pos. 104). Other participants were less passionate while sharing the same strategy (unerwartete-Sina, Pos. 99; visuelle-Leana, Pos. 82; lautmalerischer-Elmedin, Pos. 100)

Certain types of documents have a half-life themselves, e.g. todo-lists are thrown to trash, once they served their purpose. Thus they inherently do not survive until the *Deletion* activity starts (e.g. erdbeerfarbener-Charlie, Pos. 54).

3.11 U — Universal Activities

Most steps in the scholarly workflow identified as activities have fixed relations to other activities like activity B following activity A, once activity A has been finished or activity D starting in parallel to the already running activity C. Or, in a more precise example, before collecting information, a methodology

needs to be chosen, and while reading in the information gathering process, the outline may continuously be amended to fit the latest information.

A few activities, however, were defined as *universal activities* – they may be initiated at every stage throughout a research project and were observed as such in every interview, no matter the interviewee’s subject. This is in contrast to activities running synchronously in the research projects by students employing hermeneutical methodologies. While there might be a case for these activities, like reading and outline creation, to be part of the universal activities as they are not executed explicitly synchronously, rather alternately, *universal activities* are distinctive in that **every** interviewee reported the actions described by the universal activities to be initiated within another activity – as a subactivity. Reading and writing are self-contained activities, taking notes, as an example for a *universal activity*, is not initiated by itself – it is always initiated by either of them, as no one is taking notes for the sake of taking notes: *universal activities* are no ends in themselves.

3.11.1 U1 — Note-Taking

Due to the importance of notes and excerpts, as has been shown in chapter 2, the note-taking activity is the most important *universal activity* and one of the most complex activities described in this thesis. It may be initiated at almost any stage throughout a scholarly project and creates time capsules for pieces of information. Since there are different types of notes, however, not all of them serve the same purposes. Before exploring these, let us take a look at the different types of notes. The types of notes mentioned by the participants are:

- Notes of conversations
- Notes of translations
- Notes of lectures
- Notes for thinking
- Notes to self
- Notes about literature (Excerpts)
- To-do lists
- Mind maps
- Timelines

Whether reported types of notes fit in M. S. Bernstein et al.'s definition of information scraps depends on the personal information management strategy. Except for excerpts most other forms of notes may be considered information scraps: todo-lists written down on scrap paper (e.g. pleitee-Betty, Pos. 28), notes for thinking (kulanter-Peter, Pos. 82) or code comments (pleitee-Betty, Pos. 86) are prone to fall out of standard information management tools. Then again, todo-lists exist as textfiles in project folders (pleitee-Betty, Pos. 26) and may purposefully be filed in paper form (kulanter-Peter, Pos. 80).

Excerpts, however, are a particular type of notes: They are text documents, digital or physical, filed in purposeful locations, centrally or within a project organization. If they fall out of PIM tools, it marks a problem for students, because plenty of work rests on finding the proper excerpts for the writing process. When written digitally, the excerpts are in most cases filed in a proper folder hierarchy. There are different units of notes. Some save their notes on a per-file basis. Others create a catch-all file which includes excerpts for different literature. In the paper world, a spectrum between catch-all writing pads (mobiler-Nino, Pos. 72; prominenter-Kimi, Pos. 40) and sophisticated physical folder structures (lautmalerischer-Elmedin, Pos. 52) have been reported.

While different types of notes come with different purposes, my interviews emphasized excerpt production. Thus, the interviewees explained their reasons for creating excerpts or notes about literature more elaborately. While the term 'excerpts' was mostly used by students of history and describes notes very close to the content of literature read, I would argue, that excerpts and notes about literature are of the same category. The next paragraph shows different note-taking practices initiated during the reading activity. While there are some differences to be observed, the procedures are overall quite similar – no matter the label. The name used for referring to excerpts might be influenced by 1. a department's education of the basics of scholarly work, 2. self-reflection on scholarly work and methodology. One person, for example, put it quite honestly:

“Der Zweck für Notizen ist für mich, weil man eine Hausarbeit leider immer belegen muss, und deswegen sollte man irgendwie das halt, ich glaube echt so das wichtigste, dass ich halt weiß wo was ist, damit ich's belegen kann mit irgendwelchen Fakten nachher. Das ist eigentlich der Hauptzweck für mich.” (prominenter-Kimi, Pos. 56)

He further reports pairing his own thoughts together with the content of the literature he is dealing with. Thus his notes already become his own work, making the writing process easier, since he already created the proper reference to the source of specific thoughts, while forming sentences in his own words. While he describes transforming the content and arguments in his own words, which fits Ehlich's observation of partial paraphrases in excerpts, the quote shows that this student did not understand the overall importance of excerpt production, nor that he was producing an excerpt. The motivations behind notes about literature and excerpts are equivalent enough to impute to students not using the term 'excerpt', that what they want to do is to create an excerpt.

With this assumption in mind, we can look at some more examples for excerpt production: One person reports annotating her own thoughts in notes with text markers in order to distinguish between content copied from the source and her own work. Reading and note-taking take place at the same time and notes are a combination between summarizing the text and supplemented by own thoughts (unerwartete-Sina, Pos. 6). Similarly, a student of philosophy sees the purpose of notes to be able to answer a question through her notes without having to reread a whole text and for a quick overview of a text's content (mobiler-Nino, Pos. 78). She uses margin-notes as well as excerpts for her notes during the reading process. While the margin notes are a short summary of a text block or information about the arguments in the text, the notes on a separate paper are more detailed and include own thoughts about the own arguments, as well as possible links to other arguments or texts (mobiler-Nino, Pos. 72). One history student was able to put the purpose of notes in one simple German word: 'Ergebnissicherung'. So, her purpose is to save her progress, especially of reading sources and literature (lautmalerischer-Elmedin, Pos. 62). She also reports an interesting expansion of excerpts: using post-it notes printouts of sources and documents are physically expanded, in order to add written information (lautmalerischer-Elmedin, Pos. 20). Another history student reports a different practice about her notes: she uses the two terms 'transcript' and 'excerpt'. The first word was used when referring to notes taken at an archive, where she selectively copied texts from the source into a *Word* document. She did not add any additional information or original thoughts, instead created a copy of relevant text parts of source documents not lendable from the archive (runzelige-Giulia, Pos. 12-16).

For the second term, excerpt, she mostly referred to secondary-literature. Here too, she describes selectively copying parts of the original texts in a

separate file, sometimes also making notes about the structure of a text (runzelige-Giulia, Pos. 42). However, she also makes notes about books and links between them, using *Citavi*'s comment function (runzelige-Giulia, Pos. 66). Similarly the student of Slavic linguistics uses *Citavi*'s comment function for similar purposes, she takes notes about methods and related work to the comment field of literature entries (singuläre-Elena, Pos. 55) thus fragmenting notes between literature management software and her dissertation's folder structure (singuläre-Elena, Pos. 93). Writing excerpts may be complemented by annotations; this process is described in more detail in *U4 Annotation*. In addition to creating an excerpt consisting of a source's summary, one interviewee also reports making use of *Word*'s comment function in order to add more information of the note-to-self-kind; the comment function helps to mark her own thought, their content is meta-information about links between notes and sources (erdbeerfarbener-Charlie, Pos. 26). Overall every interviewee reported creating summaries of sources or taking notes explicitly linked to some kind of text (additional interview passages overlapping previously presented information: bartloser-Edwin, Pos. 60; kulanter-Peter, Pos. 26) and no single person reported taking these types of notes at any other time but when reading the text. While the content of excerpts may be slightly different for the student of economy, she also takes notes while reading, hers appear more structured, since papers of the field are more structured as well (pleitee-Betty, Pos. 46). Finally, the student of psychology reported copying her notes, after having read a paper, from a *Word* document she created for the paper, to her literature management *Excel* sheet, arguing it helps her find a paper employing *Excel*'s search function (kulanter-Peter, Pos. 26).

Some students reported the use of todo-lists (singuläre-Elena, Pos. 79; pleitee-Betty, Pos. 26; kulanter-Peter, Pos. 80; erdbeerfarbener-Charlie, Pos. 54). They carry reminding functionality and may be created to live for a specific time-frame, e.g. a week, and allows the user to structure and plan workload for this time (erdbeerfarbener-Charlie, Pos. 58; pleitee-Betty, Pos. 26;). These todo-lists are ephemeral, and once the jobs are done, the sheet is moved to the trash bin (erdbeerfarbener-Charlie, Pos. 54; pleitee-Betty, Pos. 28). One person also reported a cross-over type of todo-list and note for thinking: She also uses the todo-lists for planning her workload but also explains how arrows connect steps on the list to signalize a sequence since some items need to be done before others are available (singuläre-Elena, Pos. 85). While one person reported the need of having a paper todo-list for the satisfaction of striking an activity out when done (kulanter-

Peter, Pos. 80), another person reports using a plain editor file (pleitee-Betty, Pos. 26).

The other types of notes have only been reported by a few people each. Timelines may be a historian's tool for structuring research findings (bartloser-Edwin, Pos. 60), one historian reported ordering her sources with an *Excel* sheet, publishing years being the important column for ordering the sheet (lautmalerischer-Elmedin, Pos. 42). While the latter example is not explicitly a note, rather part of the literature management activity, it may be seen as a kind of timeline as well: The *Excel* sheet helps to structure thoughts and research. For lecture notes, one interviewee reports taking notes to listen more carefully (visuelle-Leana, Pos. 54). Students of Eastern European studies also reported notes of translations. One person uses the page's margin for these types of notes. She finds them helpful for refinding certain positions in the original text since she is quicker in skimming German keywords rather than the Russian text (unerwartete-Sina, Pos. 33). Visuelle-Leana dealt with Osman texts written with Arabic script. Thus his notes for translation consisted of a table in a *Word* document, one column was filled with a transcription of the original script, the other column with the translation (visuelle-Leana, Pos. 34). Notes to self may well be hybrids of other note-types. One person, for example, uses them to remind herself of the thoughts she has during the research process. Thus the notes are work assignments to herself and reminders at the same time (lautmalerischer-Elmedin, Pos. 62). Other interviewees report taking notes for similar reasons (erdbbeerfarbener-Charlie, Pos. 50), others add these notes to the manuscripts:

“Also ich, wenn ich dann irgendwie sehe, ok, da brauche ich noch eine Information, dann markiere ich mir das in meinem Text so, irgendwie, „warum ist das so und so?“oder „hier brauche ich noch einen Beleg für diese These“, oder irgendwas, und dann, dann suche ich gezielt danach, also ich gehe dann meine Bücher durch und schaue gezielt, ob ich auf meine, auf das was dann quasi da fehlt, auf diesen Platz halt, ob ich darauf eine Antwort finde. Und manchmal stoße ich halt auch zufällig dann auf irgendwas” (unerwartete-Sina, Pos. 8)

Digital vs Analogue One of the most interesting question for this thesis is how notes are taken: digitally or analogous? This question cannot be answered definitely since most interviewees reported the use of multiple mediums for writing their notes. Most people use a notepad or just any type of

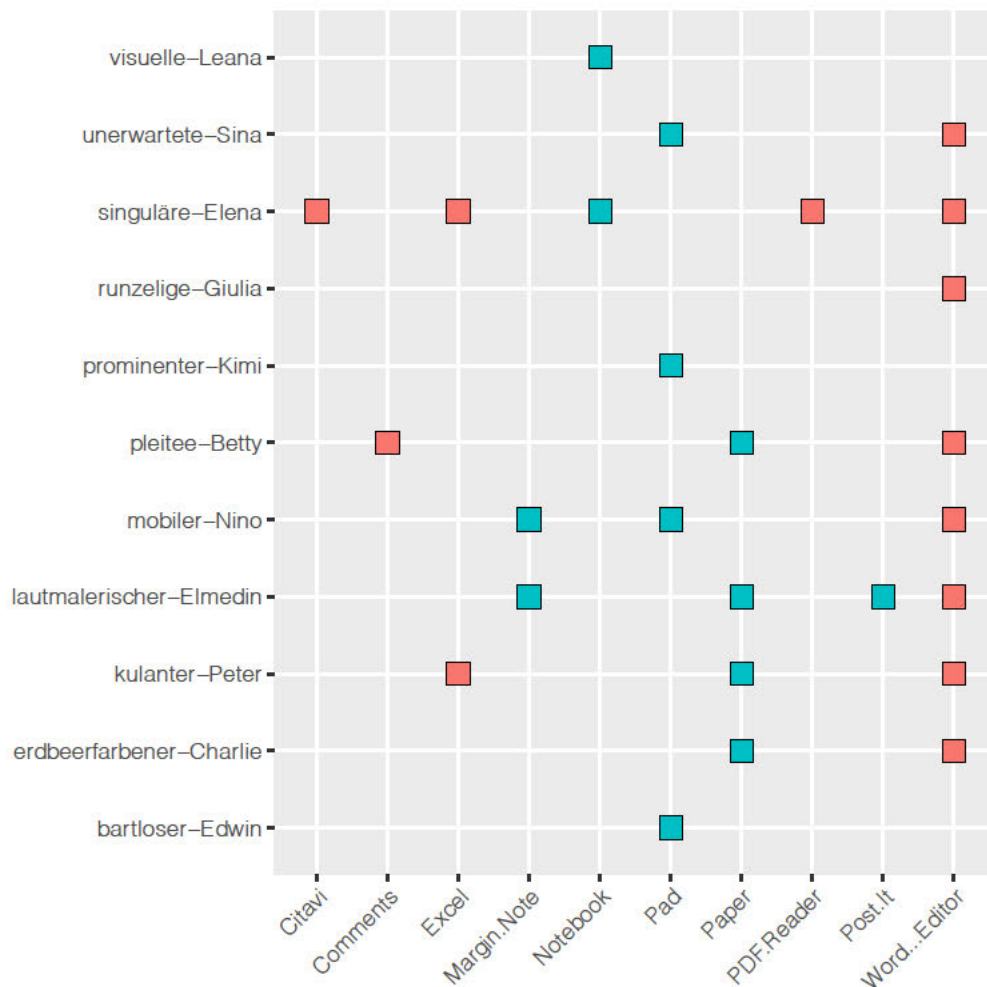


Figure 1: Mediums & software used for note-taking, red squares denote digital means, blue ones analogue.

paper for writing their notes, few mentioned writing on the margins books or copies, and one person reported the use of post-its. As for digital notes, *Word* documents or plain text-editors were reported the most often. Two people are using *Excel* for organizing their thoughts; one person uses code comments and another one *Citavi* for writing down notes. All in all, few people go either digital or stay analogue – three respondents only use notebooks or notepads against one person reporting note-taking with *Word*.⁸ Overall this result is

⁸To be precise: kulanter-Peter (Pos. 80) only uses paper for todo-lists and sketching while designing experiments. The same applied to pleite-Betty's (Pos. 86) todo-lists. These two examples are in contrast to the note-taking of all other interviewees who use paper. They report analogue methods for at least one or more types of notes. For this thesis, though, these two students are also seen as users of both worlds. The subsequent chapters introduce the concept of digital assistance; at its core, there is the possibility of a system's awareness of its environment. Thus, written information on the desk is important, even if it is 'just a todo-list' – it is possibly another source of information important for the systems' assistance strategy.

no surprise, with earlier research hinting at an almost equal divide between physical and digital information scraps within-subjects, and only a few all-digitals. (M. Bernstein et al., 2008; Boardman & Sasse, 2004; Jervis, 2014).

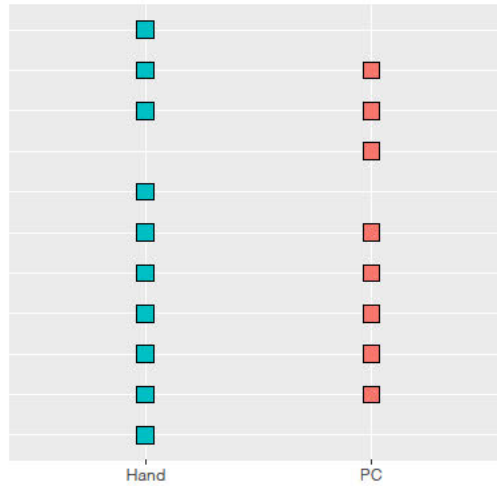


Figure 2: Analogue vs. digital. Use reported by the interviewees.

All in all, subjects reported two ways of dealing with notes: Some types of notes have the character of documents, others of information scraps. Excerpts and notes about literature are the closest to documents captured by PIM tools: they are systematically created and organized. Usually, these excerpts include references to the pages of the primary text (e.g. unerwartete-Sina, Pos. 22; visuelle-Leana, Pos. 50; lautmalerischer-Elmedin, Pos. 28; bartloser-Edwin, Pos. 2). The level of detail of the summaries depends on personal preferences, some interviewees report to only write down key terms (e.g. prominenter-Kimi, Pos. 64) and paraphrases of the text combined with chains of argumentation as well as own thoughts and associations (e.g. lautmalerischer-Elmedin, Pos. 30). Special formatting or annotations are used to mark differences between own ideas and content taken from the source (e.g. runzelige-Giulia, Pos. 82). No matter, whether the transcripts are written or typed, they usually contain a reference to the original document, for instance, formatted similarly to citation (e.g. erdbeerfarbener-Charlie, Pos. 44). While a minority reported the use of strongly organised tools like *Citavi* or annotating *PDFs*, most interviewees went for text documents or notepads and notebooks when working on their projects. The way of organisation varies between subjects, while one person reports neatly creating excerpts in a notebook divided into different chapters after purchasing it (visuelle-Leana, Pos. 50, 52), others use scrap paper to take their notes about literature (mobiler-Nino, Pos. 92). Nevertheless, also the later student

reported putting the pieces of paper with notes into a physical folder (without order), which is used throughout the project (mobiler-Nino, Pos. 104), thus organizing excerpts neatly. Finally, there exists a problem of fragmentation: Some interviewees report to use digital and analogue techniques when reading and creating their notes about literature, others a fragmentation in the same world between different documents. This observation is coherent with the literature. (Boardman & Sasse, 2004; Jervis, 2014; Mizrachi & Bates, 2013).

3.11.2 U2 — Bibliographic Management

While each participant has reported some kind of bibliographic management, some reported to use specialized software for this activity, while others create their own system, relying on non-specialized software like *Excel*. All in all seven out of the eleven interviewees use specialised software, most of them *Citavi*. Since the University of Regensburg’s library offers classes for this specific software and most interviewees were enrolled at this university, drawing a conclusion from reported software use to software quality is dangerous; a thorough look at the different motivations behind the choice is required.

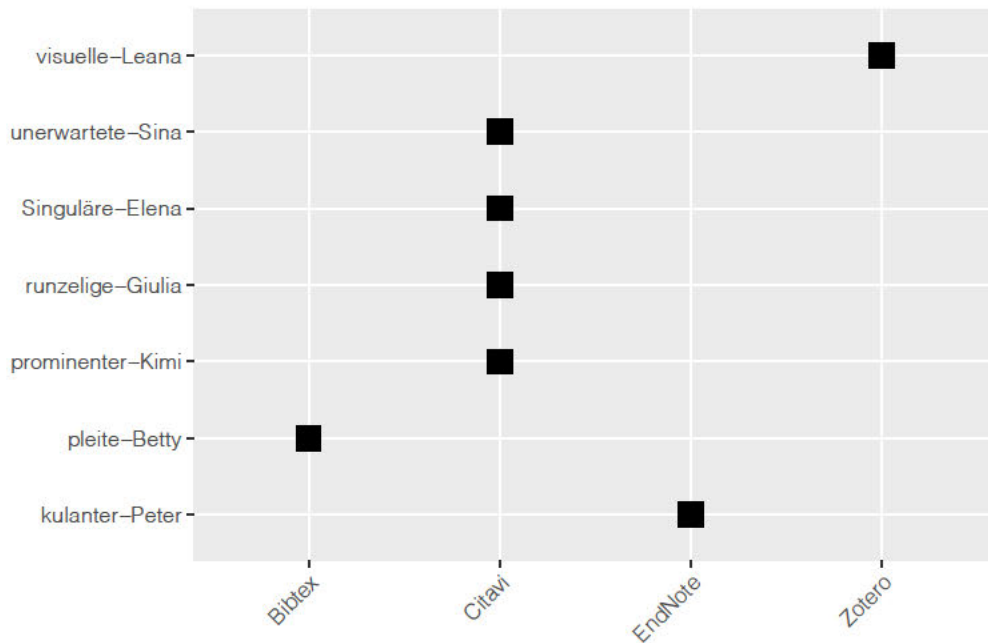


Figure 3: Reported software use for literature management.

The bibliographic management is modelled as a universal activity, since it is initiated at different stages throughout the research process, for different purposes. These consist of storing information about sources and literature, retrieving information about sources and literature and tracking citations. Different strategies have been observed for bibliographic management:

Specialized Software The first strategy solely relies on specialized software for all functions of this activity. The student of Slavic linguistics, for example, uses different functions of *Citavi* to manage her literature: besides creating a bibliographic entry for her sources and later citation, she organizes the literature with the software's tag and category system. She adds notes to the comment field of the entries. While being dissatisfied with the first sorting strategies she applied, she now seems to have found a good mean between too fine categorization and useful categorization (singuläre-Elena, Pos. 51-55). Prominenter-Kimi just started using *Citavi* after working on projects with similar research questions. He uses it to organize his literature by adding tags and keeping track of what has already been read, while not being particularly interested in *Citavi*'s *Word* add-in (prominenter-Kimi, Pos. 44).

Specialized Software-Manual Hybrid The first hybrid solution makes use of software for one set of functions while employing a manual strategy for other functions or using software and manual methods parallelly: One of the history students uses *Citavi* similar to singuläre-Elena. She reports a collection of about 200 entries for her master thesis's project and uses the software's knowledge-management-section to keep track of reading literature and organizing what needs to be read or what has been read (runzelige-Giulia, Pos. 100). However, she does not use its *Word* add-in when writing, she manually creates her citing when writing excerpts and uses these within her manuscript (runzelige-Giulia, Pos. 94). A student of Eastern European studies described an utterly different hybrid. He employs two methods for keeping track of his literature: When laying hands on new sources for the first time, he manually creates a – as he puts it – sparing entry in *Zotero*. The entries in the software are ordered by folders, one per project. After that, he takes his physical notebook and creates a very detailed entry about the book with plenty of information like the page number, language, format and other notes about the look of the book and other seemingly essential attributes (visuelle-Leana, Pos. 22-24). Eventually, *Zotero*'s *Word* add-in is used to support citation when writing and automatically create a literature section. He reported minor problems with the formatting and limitations of the software, which were corrected manually (visuelle-Leana, Pos. 40, 64). Visuelle-Leana is a fringe case, since he could also be classified into *Excel*-Manual Hybrid, as he uses an *Excel* sheet for organizing his sources as well. Sheets categorize the type of source, and

then the colour is added to code the status of the item (physical, digital copy, not yet available) (visuelle-Leana, Pos. 36). The student of economics uses *BibTeX* for the citation management within her manuscripts; however, she copies the entries manually from *Google Scholar* into her bib-file. She keeps track of her literature by organizing papers in a project-centric folder-hierarchy (pleitee-Betty, Pos. 38).

Manual This strategy does not rely on any type of software for organizing literature and citations. For this strategy, different extremes in the degree of structure have been observed – even within subjects. This claim applies to interviewees with two different organizational strategies: One of the interviewees uses one *Word* document within projects for her notes about literature, formatting the manually created bibliographic entry for each source as title, thus enabling *Word*'s built-in navigational functions to browse through her document for finding bibliographic entries (unerwartete-Sina, Pos. 89). Since these documents only live within projects, she does not have an overall list of literature, claiming her good memory for authors and titles to be sufficient and the possibility to search within manuscripts of old projects for refinding information about past read literature (unerwartete-Sina, Pos. 95). One of the history students uses the same strategy while making sure that the titles within her *Word* document are already in the right scheme for copying and pasting the references from the – as she calls it – excerpt into the manuscript (erdbeerfarbener-Charlie, Pos. 44). Another history student takes his notes on paper, adding the title and author for refinding the literature (bartloser-Edwin, Pos. 9). These notes, however, are purged once the project has been completed. He also would look up his old manuscripts on the search for information about an already read source (bartloser-Edwin, Pos. 70). The student of philosophy does not systematically keep track of her literature either. However, she keeps her paper notes about literature archived for future reference (mobiler-Nino, Pos. 25, 103-106).

Excel-Manual Hybrid This strategy was only reported by one student of history, who makes a difference between sources and literature. For her, this grounds a vital difference for bibliographic management, even though she deals with historical travel guides, which are nothing else but book. She does not keep any record of her literature, but uses an *Excel* sheet for organizing her sources. This sheet includes a simple array of information (author, title, year, publisher, location) for each

source and *Excel*'s built-in sorting functions are used. Now at the end of her dissertation, she reports frustration since she does not have an overview of literature existing as scans, printed or copied.

Further, there is no overview of the literature borrowed in the past. Her solution for this problem was eventually to start acquiring as many books as (financially) possible, to have them in her physical book shelf. Eventually, her system of painstakingly creating excerpts and filing them in physical folders appears to be necessary for the management of her literature and sources. These are ordered by topic according to chapters of her dissertation (lautmalerischer-Elmedin, Pos. 38-56).

Specialized Software-*Excel* Hybrid Students using this strategy, use *Excel* for keeping track and organizing their literature while using specialized software to aid citing in the manuscripts. The student of psychology has reported the most sophisticated use of this method. She has a perpetual *Excel* document, which links different types of information together. She reports creating a new row in the sheet each time she downloads a paper. The entry consists of bibliographic information, like author, title, and year of publication, however, she also adds her notes about literature, after reading the paper, to the entry, to be able to find the entry when using *Excel*'s search function, due to keywords included in her notes.

Further, she saves the *PDF* versions of each paper to her Dropbox, adding the link to the file to her *Excel* entry as well. However, for citation management within her manuscripts, she uses *EndNote* and is only partly satisfied with its functionality. She describes problems with the automatic generation of the literature section for her papers, having to fix formatting errors created by the software again and again (kulanter-Peter, Pos. 26). Pleitee-Betty tried a similar approach for one project complementing her *BibTeX* practices described above: Other than meta-information about papers look up, she also added a grading system for the relevance of the literature. Nonetheless, she abandoned the system (pleitee-Betty, Pos. 42).

All in all, looking at these strategies, two major approaches can be identified: For those who manually store or retrieve information about literature or sources, the notes about literature are in the centre of attention. They are ordered by references to literature and thereby offer a prototype for citing while writing and at the same time as they serve as an overview of reading

literature (compare Type A in figure 4). On the other hand, there are users of specialized software or *Excel*. They organize their literature by tagging it and adding meta information, they improve findability and like the possibility to mark whether literature has already been read, or is supposed to be read. While there is still personal differences within this type – some organize their literature on a per-project basis, others maintain a permanent collection – the bibliographic entry in whatever kind of system, is at the centre of their literature management (compare Type B in figure 4). While only explicitly reported by kulanter-Peter, this approach allows attaching (mainly digital) books and papers directly to the entry, as well as the ability to link notes to the entry (as has been reported by several interviewees, see above).

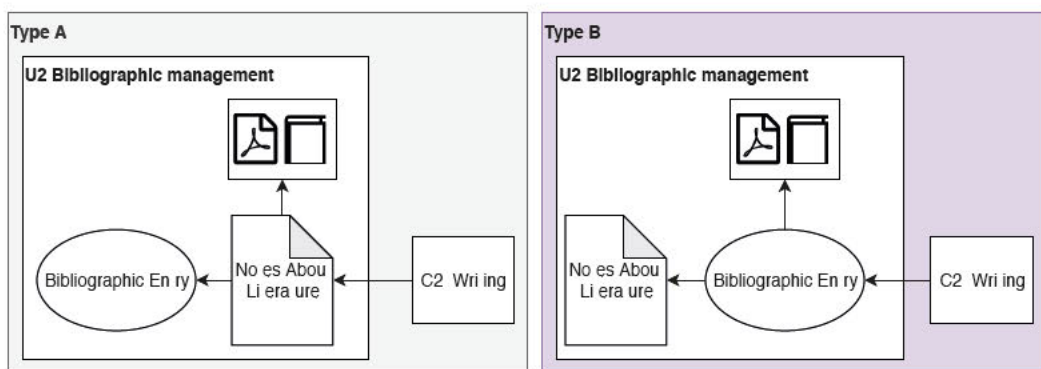


Figure 4: Two approaches of bibliographic management. Example here: *U2 – Bibliographic Management* invoked by *C2 – Writing* for retrieving information.

The storing function of this activity is mostly invoked parallel to *B1R – Finding literature / sources / related work* or (*B2R – Reading literature / sources / related work*). Whether a bibliographic entry is created during the finding or reading process appears to be a personal choice. Creating a bibliographic entry may be taken literally, when talking about type-B, for users of a type-A approach, the creation of a bibliographic entry takes place implicitly when they create a section within their notes, referring to the specific source.

The retrieving function is generally used in parallel to *C – Writing* activities. It may be invoked during both, *C1 – Outline Design* and *C2 – Writing*. While it may appear more obvious for the later one, also the outline design relies on bibliographic management: Some interviewees report linking specific literature to sections of the outline explicitly (runzelige-Giulia, Pos. 76) or implicitly (prominenter-Kimi, Pos. 16)⁹.

⁹Implicitly because prominenter-Kimi does not directly link bibliographic entries to the outline, the link occurs through concatenation: He collects and prepares all relevant literature before sketching the outline. Thus, he looks for literature, screens it for relevance,

Finally, tracking citations appears only to be used parallel to the writing activity.

3.11.3 U3 — File Management

File management may from the perspective of information science, and especially personal information management, well be the most interesting activity to be investigated. Hence, the activity is where my research links to authors like Barreau, Malone, Soper and Kwaśnik and their research introduced in the related works section. Since interviews, in general, took place in common areas or via Skype, most interviewees were not observed in their offices or workplaces. Therefore, with few exceptions, file management was elicited throughout the interviewees, with few students also showing their computers in order to make clear, how things are organized. Four strategies have emerged from the interviews:

Structured Projects Folders For users applying this organizational strategy, files are saved project-centric. For each project, a folder is created with subfolders for further classification of documents. A history student reported an elaborate version of project folders. She has two folders, a physical one and a digital one. For the digital version, there is a subfolder for excerpts. Contained documents have telling names which allow alphabetical sorting, thus rapid access. The paper excerpts are filed into a folder, which is ordered by the chapters of her dissertation (lautmalerischer-Elmedin, Pos. 38).

While she is an exception with analogue folders, prominenter-Kimi follows a similar strategy for his digital documents. He creates project folders in *Google Drive* and within them subfolders for documents types, like literature and summaries (prominenter-Kimi, Pos. 42). Pleitee-Betty reports the same structure for her local filesystem (Pos. 38).

Visuelle-Leana describes a similar system, although he uses *OneDrive* to organize his documents. He points out that the order within his project folder, especially the subfolder for sources, is critical since he used an additional *Excel* sheet with colour-coding for organizing his sources (visuelle-Leana, Pos. 36).

While the degree of structure among interviewees once more appears to be a continuum, the accounts prior suggest that an overall well-

makes notes about literature, categorizes the notes and finally creates the first draft for an outline whose sections are linked to his notes about literature, which are linked to bibliographic entries.

organized personal information management may positively influence the structure of project folders. One student's account, though, is an excellent reminder to be cautious about preliminary conclusions: While she shows some folders which are mostly unstructured, her project folders for her dissertation stands out. Also, she is the only participant reporting shared folders, thus relying in parts on a shared naming and folder scheme. Her personal dissertation folder includes subfolders per chapter and a literature folder, sorted along the attribute read-unread. The files are named in the same, telling, scheme. All documents are backed-up on her University's cloud storage. Her notes are saved in either *Citavi* or her project folder structure (singuläre-Elena, Pos. 43, 93).

Centralized Folders plus Project Folders Users following this filing scheme use central folders for specific document types while creating folders per project for other document types; mostly that is Centralized literature folders and optionally central folders for notes about literature, while all other documents are classified on a per-project basis.

erdbeerfarbener-Charlie maintains an everlasting literature folder, containing each excerpt she ever created. It includes a *Word* document which serves as an index for excerpts: Since she also creates a folder for each project which may include their own literature folders, this index is necessary. It includes bibliographic information, the location of the excerpts and meta-information about the excerpts. The project folders include more subfolders for digital copies of sources and literature, while the manuscript itself lives at the project folder root (erdbeerfarbener-Charlie, Pos. 76-78). Her dissertation's manuscript is split into single documents per chapter (erdbeerfarbener-Charlie, Pos. 48).

The student of psychology reported the most sophisticated file structure. She saves her files in Dropbox and describes plenty of subfolders for her dissertation project. Subfolders include literature, presentations, administration, teaching, publications and experiments. Inside the literature folder, there are more subfolders classifying documents either by importance ('to-read'-folder) or topic. The naming of the *PDF* documents within the literature folder always follows the same scheme. Her self-assessment is that she spends too much time on classifying and structuring her files, paired with the indexing strategies described for the activity *U2 Bibliography Management*. However, she claims always to find everything, immediately (kulanter-Peter, Pos. 44-48). While she

described her dissertation folder as a project folder, I still classify her behaviour in this hybrid category, since her strategy first classifies per type, after that per project, though every folder is part of one large project, namely her dissertation.

Catch-All Spring Cleaner The term spring cleaner has been coined by Whittaker and Sidner (1996) when researching E-Mail management behaviour. However, it also appears that students show this kind of behaviour when filing their documents for research projects. One student of philosophy uses *Google Docs* for her digital notes. The document stays at the root of *Google Drive*, from time to time, she cleans the root and files documents for re-findability into different folders. She reports not to use the *Drive*'s search function at all.

Similarly, unerwartete-Sina started with a catch-all project folder. Throughout her research, the number of documents increased, thus triggering a clean-up action. During the spring cleaning, she created subfolders, classifying literature about the importance of reading it and the states read – unread. Documents received telling names. There was however no universal scheme, somewhat random concatenation of author names and attributes, like “Briefe Gorki Original”, have been used.

All in all, the interviewee was not very happy with her strategy; however, she did not have the desire to change her habit. She does not see much value in literature scans since she can always go back to the library and scan the books once more, should the document get lost. Her notes though, are essential for her, as they are not replaceable. Thus she created from time to time an e-mail draft attaching her notes (unerwartete-Sina, Pos. ‘63-96).

Catch-All-Structured Hybrid Project Folders One of the more fragmented structures was reported by one of the history students. On the one hand, she describes the use of (multiple) flash drives as her primary data storage strategy. On the other hand, she also stores *PDFs* with *Citavi*'s attachment function. While she tries to organize her document more systematically for her current project, a master thesis, she describes it as a struggle, leading to a project folder partly structured, partly catch-all. She also tries to attach documents to *Citavi*; this, however, works “so halb gut” (runzelige-Giulia, Pos. 54) and just for certain publication types. Documents containing excerpts have telling names to improve finding them again (runzelige-Giulia, Pos. 50).

All in all, I would like to emphasize two findings from these reports: 1. Almost all interviewees reported two categories of dimensions used for classification of documents: Project & type. The difference between the strategies described above is the order of the categories, due to the hierarchical file structure of common filesystem, also emulated by the cloud services used by students, they need to decide whether to first classify by project or by type. Hence, structured project folders mean, users classify first by project, then each project folder contains similar subfolders, categorizing by document type. Centralized folders, on the other hand, show a reverse strategy: Documents are first classified by type, after that within the central folder, other attributes may categorize them. 2. While catch-all strategies were reported, not a single interviewee uses the search for refinding documents.

Finally, a few words about backups: between the interviewees, there is a considerable variety of backup-strategies. Most fundamentally there is the difference between those, who create backups – and those who do not. While the Cloud users mostly relied on the cloud, without a second backup, the local file savers reported the following strategies: Some people use external hard drives or flash drives for copies of their project folders or upload them periodically to cloud storage (lautmalerischer-Elmedin, Pos. 66; runzelige-Giulia, Pos. 118; singuläre-Elena, Pos. 43). Two people keep hard copies of their most valuable documents (lautmalerischer-Elmedin, Pos. 66; erdbeerfarbener-Charlie, Pos. 28) and one person attaches valuable documents to a draft e-mail in her account (unerwartete-Sina, Pos. 69). All in all the backup strategies may be influenced by skill, with students trying to find the easiest and quickest solution available within their skill-set of working with computers, like the e-mail-draft-solution being a substitution for not knowing how to use cloud-based services. Similarly, there might be interdependence between the degree of structure in document management and backup strategies; however the interviews do not offer enough proof for grounding these speculations; further research eliciting more information about backup-strategies, computer skills and document classification would be necessary.

3.11.4 U4 — Annotation

Annotation of documents and notes has been reported throughout all disciplines present in the set of interviews. Once more, annotation is modelled as a universal activity. It complements – runs in parallel to – *Reading* and *U1 – Note Taking* activities. While the term annotation, according to the Oxford

English Dictionary (n.d.-a), describes “[t]he action of annotating¹⁰ or making notes”, annotation is defined more narrowly in the context of this activity. Here it describes adding any kind of notes *to the original document*. Thus it is a different activity than *U1 – Note Taking*; as seen above, notes created by that activity, are written *in a different document*. Annotations include written notes, highlighting and any other kind of markings deliberately left by the reader on as document in order to add some kind of information¹¹. The discrimination between these two types is important to capture the ways students take notes about literature thoroughly – and its fragmentation. Also, it owes to technical implications: While digital notes from the *U2* activity are saved in documents on the hard drive, thus are manageable by standard software delivered with the operating system, annotations on digital documents require software capable of adding a layer to another document. For *PDFs*, which appear to be the major document format for digital literature and sources reported by the interviewees, there exist different applications offering different ways for annotation. *Adobe’s Acrobat Reader*, for example, allows to add comments, highlight text, add freehand drawings and more annotations to a document. Other software, like *Microsoft Word*, allows for comments, as reported by one student, and allows almost limitless annotations due to all the formatting tools available. These applications emulate the analogue ability to add a margin note, use a marker or underline a sentence.

Some interviewees reported adding symbols, arrows or keywords next to specific lines of their physical reading texts while assuring that they only do this if they are reading in either their own books or copies. Margin notes vary between single keywords to short notes for linking to other ideas or literature (bartloser-Edwin, Pos. 48; erdbeerfarbener-Charlie, Pos. 34). The philosophy student was by chance interviewed just after using *Acrobat Reader* for the first time for reading a text relevant for her research. She uses colourful bookmarks in her physical books for refinding essential pages. On the pages she adds arrows to link information together, complemented by margin notes for definitions and short summaries of paragraphs. The margin notes are deliberately added to either the left or right margin, denoting whether

¹⁰circularly the verb ‘annotating’ is defined as ‘[t]o add notes to, furnish with notes (a literary work or author)’ (Oxford English Dictionary, n.d.-b).

¹¹A simple example to illustrate the difference: the coffee stains left by a mug while reading do not deliberately carry information, while an arrow connecting two paragraphs, or an exclamation mark next to a specific line, may well remind the reader of a thought. Of course one could argue that even the coffee stain contains information, maybe the reader is only drinking coffee in the morning, maybe the student was annoyed by the coffee stain, both scenarios may well serve as a cue for remembering a thought – thus ending in the same outcome as the arrow. For the sake of abstraction, however, I narrow annotations to deliberate actions.

they are about the content of the paragraph or something else. While the software version of notes was satisfactory for taking her notes, she missed the ability to add symbols by hand (mobiler-Nino, Pos. 80-90). Lautmalerscher-Elmedin adds another dimension to her physical source material: Using post-its, she expands the surface and adds another layer of information (Pos. 20). The history student working with the ‘transcriptions’ of source material from the archive, uses formatting and colour-coding for annotating within these transcripts. When reading books, she underlines relevant sections (runzelige-Giulia, Pos. 82, 86, 42). Unerwarte-Sina reported annotating especially for her own notes, to differentiate between her own thoughts and the ideas from the literature. For physical notes, she uses markers, for *Word* files the digital equivalent (unerwartete-Sina, Pos. 6). However, she dislikes annotating texts, and digitally she only uses Acrobat’s highlight feature if a mouse is available, physically she sometimes adds margin-notes (unerwartete-Sina, Pos. 71).

Similarly, the psychology student, while reading all-digital, neatly colour codes her notes in *Word*. This is one of only a few instances where students reported to define colours for coding and sticking with their definitions (kulanter-Peter, Pos. 54). While also reading digitally and using highlighting and comment functions, pleitee-Betty did not go into more detail about her habits (Pos. 36). Singuläre-Elena’s use of annotations varies from the other accounts, due to her methodology: She uses colours within *Excel* sheets for classification, adding a legend for the colour codes to the files (singuläre-Elena, Pos. 27). On the other hand, she reports the use of *Citavi*’s marking tools for *PDF* documents. While being happy with her notebook’s ability to turn into a tablet, thus being able to mark texts with the fingertip, she expresses dissatisfaction with her annotations, as ‘it becomes too colourful’ (singuläre-Elena, Pos. 53). She also reported another type of digital annotation: for her team’s project, interviews were transcribed and now are annotated using specialized software (singuläre-Elena, Pos. 27).

3.12 Summary

All in all, I presented the analysis of eleven interviews with graduate students. They showed differences between the humanities and the neighbouring disciplines to be only observed within the knowledge gathering activities. Here, economics, psychology and linguistics supplement the humanities staple of looking up literature and reading by adding additional data sources, like experiments or mathematical models. For humanists employing hermeneutics,

reading is in the centre of attention. Reading may take place on the computer screen or paper, while accompanied in all worlds by annotations and notes.

Additionally, most methodologies, but the hermeneutics, allow for a stringent successive workflow, outlines for papers and thesis are somewhat fixed by a subjects typical structure. Hermeneutics students struggled with such a structure, their outlines and even research questions develop over time. In summary, the workflow in the hermeneutics track is shaped by synchronous and recursive activities, while the results of each activity build the foundation for the next one.

Moreover, the interviews once more showed the importance of excerpt production. When shining a light on notes and literature management, a possible explanation for some students' struggle with reference management systems all together was found: The two types of literature management show once more the importance of notes for many humanists. At the same time, they indicate an essential difference between how literature management tools are organised, and how humanists organise notes and literature. Excerpts may be the gateway to bibliographic entries and literature. Thus they are the centre of attention of many interviewees. The differentiation between annotation and note-taking may well be an artificial one since the activities show signs of interdependence. Similarly, different types of file management have been observed, though the difference in this activity is not as big as in bibliography management.

Finally, these findings will guide the development of a task model and subsequent implementation of a prototype. I argue, that note-taking has been overlooked by digital humanities research, while it is a crucial activity in the workflow, influencing other activities as well. Thus, for the digital assistant proposed in the next chapter, excerpt production will be in the centre of attention. Further, when developing such a tool, the findings of different file organisational and bibliographic management types should be considered.

4 Towards a Digital Assistant for Scholarly Research

The previous chapter of this thesis explored scholarly work through interviews, analysed using grounded theory. This analysis resulted in a list of activities for a research project’s workflow. In this chapter, I will introduce, based on the prior findings, an outline for an intelligent digital assistant.

Since the subject of digital humanities motivates this thesis, I will reduce the complexity of the task model by concentrating on the qualitative methods and hermeneutic methodology. Further, I will as pointed out before, primarily focus on excerpt production and related activities, due to the motivation of creating a prototype exploring this application. Using Wandke’s taxonomy (Ludwig, 2015; Wandke, 2005) of needs for assistance, I will first classify problems and ideas for improving the workflow, reported by the interviewees. After that, I will propose a task model used as a basis for the prototype implemented in the next chapter.

Dix et al. (2004) introduce three general concepts of task analysis: 1. Task decomposition, 2. knowledge-based techniques and 3. entity-relation-based analysis. My task analysis, inspired by Diaper’s (2004) introduction to the topic, will be a task decomposition based on the informal activity list, elicited and grounded in interviews in the last chapter. The activity model shows – at least for humanities students – the concurrency of plenty of activities. Reading, note-taking, writing, and more, take place simultaneously, while few activities have a fixed hierarchy. Therefore, the result will be notated using Concurrent Task Trees (Paternò, 2000). This helps to overcome the problem of other notation schemes, which only allow sequential tasks. Thus, the chosen notation is a good fit for the non-sequential workflow reported by humanist researchers.

4.1 Assistance Needs in the Scholarly Workflow

Now, first about assistance needs. Interviewees were asked a couple of questions about problems that occurred when working on a research project. The answers were a bit of a surprise since numerous interviewees reported problems and mistakes from a different angle than expected: They saw themselves as the source of error, rather than a system or software, e.g.:

“Und... da bin ich manchmal ein bisschen chaotisch. Und das ist tatsächlich auch was, was ich tatsächlich auch an mir noch

| | |
|--|---|
| Motiv- und Zielbildung | |
| Schaffung eines optimalen Aktivierungsniveaus | Aktivierungsassistentz |
| Verstärkung eines Motivs | Coach-Assistentz |
| Hemmung eines Motivs | Warn-Assistentz |
| Anregung eines Zielwechsels | Orientierungsassistentz |
| Informationsaufnahme | |
| Bereitstellung von Signalen | Anzeigefunktion |
| Signalverstärkung | Verstärkungsassistentz |
| Erzeugung von Redundanz | Wiederholungsassistentz |
| Transformation von Signalen in andere Modalitäten | Präsentationsassistentz |
| Integration von Information, Berücksichtigung der aktuellen Situation | |
| Bereitstellung von Erklärungen | Beschriftungen, Anleitungen, Hilfetexte |
| Bereitstellung externer Bezugssysteme | Übersetzungsassistentz |
| Erklärung von Systemausgaben | Erklärungsassistentz |
| Entscheidung über Auswahl einer Aktion | |
| Information über alle Optionen | Angebotsassistentz |
| Information über ausgewählte Optionen | Filterassistentz |
| Vorschlag einer Option | Beraterassistentz |
| Vorschlag und Ausführung, wenn der Nutzer zustimmt | Delegationsassistentz |
| Vorschlag und Ausführung, wenn der Nutzer nicht widerspricht | Übernahmeassistentz |
| Ausführung mit Information an den Nutzer | Informierende Ausführungsassistentz |
| Ausführung ohne Information an den Nutzer | Stille Ausführungsassistentz |
| Aktionsausführung: Wie soll die Aktion durchgeführt werden? | |
| Verstärken von Aktionen | <i>Power-Assistentz</i> |
| Verkürzen einer Aktionsfolge | <i>Short cut-Assistentz</i> |
| Alternative Modalitäten bereitstellen | Eingabeassistentz |
| Effektkontrolle | |
| Auswirkungen wahrnehmbar machen | Rückmeldungsassistentz |
| Grad der Zielerreichung bewerten | Kritikassistentz |

Figure 5: Taxonomy for assistance, taken from (Ludwig, 2015, S. 15), after (Wandke, 2005).

verbessern möchte, dass ich einfach ein bisschen disziplinierter einfach meine Sachen ablege. [...]” (unerwartete-Sina, Pos. 59)

This quote shows on the one hand, that many students understood the question to be referring to themselves, thus criticised themselves for being too unorganized, rather than blaming existing tools not to work with their way of working. On the other hand, this sentence expresses one of the most crucial assistance needs elicited from the interviewees: Silent execution assistance (*Stille Ausführungsassistentz*). I suggest, that for activities involving information management the silent execution assistance is needed to capture invisibly (meta) data necessary to automatically classify documents and save them in a data structure maintaining the relationship between documents. Further, silent assistance may help the user overcome fragmentation between the worlds and between files: It captures hand-written notes and physical reading as well as their digital clones. This type of assistance denotes an invisible back-end, which shows its purpose once the users starts writing her manuscript: Warning assistance (*Warn-Assistentz*), filter assistance (*Filter-assistentz*), consulting assistance (*Beraterassistentz*), and translation assist-

ance (*Übersetzungsassistentz*) guide the user from conceptualizing an outline through text production towards publication for any given research project. Based on the knowledge obtained through excerpts and bibliographic management, a digital assistant may, for instance, always monitor the manuscript and check for topics and similarity between text source, excerpt and the newly produced manuscript, thus warning the user if she runs the risk of plagiarising unconsciously.

Similarly, the filter assistance may, by knowing the state of the user and the manuscript, assist in filtering when a user searches for bibliographic entries or notes. Through the relation between these entities, users are further assisted in finding excerpts belonging to sources and vice versa. The consulting assistance might offer literature recommendations from external and internal sources: The knowledge about the state of the users (and thus the manuscript), may be used to find literature related to the content automatically. Literature from the personal library might be preferred, offering the user access to excerpts existing in the database directly. Similarly, relevant external databases may be queried for potential matches. Finally, the translation assistance may aid rereading source texts, by displaying notes in the relative location of the document and linking notes with texts and notes with notes, thus enabling browsing through related documents similar to hypertext documents. To enable this, the assistant extracts smaller information units from digitally or analogously created notes and documents and links them to all data available about the state of the user. Thus a whole page of paper notes may later be found attached to the source document, each piece of information at the right anchor.

The silent execution assistance is grounded in the interviewees' criticism of the lack of usability of existing tools (mostly bibliographic management tools), in combination with the report of failed attempts to stick to specific software and neatly enter necessary data into the management tools. All in all, every tool needs data in order to aid the user's workflow. Some users are not disciplined enough, or do not want to be disciplined enough, to always enter the necessary data; others were not successful in finding a proper classification system (lautmalerischer-Elmedin, Pos. 42; singuläre-Elena, Pos. 53, 93; erdbeerfarbener-Charlie, Pos. 60; runzelige-Giulia, Pos. 124; unerwartete-Sina, Pos. 59; pleitee-Betty, Pos. 88). Even the best-organized participant in my study reports discontent with overcomplexity of the existing solution. Thus she uses a makeshift excel-sheet solution at the core of her information management (kulanter-Peter, Pos. 92).

Therefore, I suggest, data collection and classification needs to be automated – the humanist does not want to be bothered by adding bibliographic entries or creating structured data – and we should not force her to be. Participants in my interview series reported several problems and errors which happen during research and have happened in the past. I propose a digital assistant, offering prior assistance strategies, helps to overcome those problems and errors. Some interviewees already mentioned the need for a tool which links all documents together (kulanter-Peter, Pos. 60) or offer searchability for notes and the possibility to create hyperlinks (prominenter-Kimi, Pos. 40, 66). Further, they hope for a system which helps them organize excerpts (lautmalerischer-Elmedin, Pos. 52) and some are unhappy with archiving paper notes about literature in physical folders since they do not tend to ever come back to those notes while sticking to paper due to its affordances for creativity (mobiler-Nino, Pos. 108). Also, not being able to recall authors, sources or notes, or not being able to find them, was reported by most interviewees, mostly as the downside of not structuring their files neatly enough (pleitee-Betty, Pos. 58; mobiler-Nino, Pos. 108; runzelige-Giulia, Pos. 44, 124; unerwartete-Sina, Pos. 59; pleitee-Betty, Pos. 88; erdbeerfarbener-Charlie, Pos. 68).

Similarly, some respondents already experienced episodes throughout research, in which they were not able to differentiate their own thoughts from their reading any more (prominenter-Kimi, Pos. 84; visuelle-Leana, Pos. 72). For one person, this problem turned into fear of unconsciously plagiarising (erdbeerfarbener-Charlie, Pos. 64). Most of the times, these problems could be repaired by trawling through excerpts and literature, until the sources were identified and ideas could be attributed to the right source. This search, however, may be rather time-consuming and assumes that the student knows an idea or concept is not their own. As mentioned above, this is not always the case.

All in all, I suggest that a digital assistant could, offering warning assistance and filter assistance help overcome these problems in a more time-efficient manner while helping humanists to sleep well without the fear of unconsciously having plagiarised. While no problems related to the *B1R Finding Literature* activity were reported, a statement by the psychology student guided the proposal of the consulting assistance: She would like to have a tool, that integrates with *Google Scholar* since she always uses it for finding her literature. She suggested that the integration of *Google Scholar* would dissolve other problems, like knowing what has been read, but not added to the literature management system (kulanter-Peter, Pos. 84). Thus,

why should a digital assistant for scholarly research just monitor the literature search, and not offer recommendations itself? It appears that users would benefit from such integration, and an intelligent recommending system might well be an argument for such an assistants' use in itself.

4.2 Concurrent Task Tree Model for a Digital Assistant



Figure 6: Overall view of the Concurrent Task Tree model for a digital research assistant. While illegible, it shows the complexity, even of a rather abstract concept as presented here. The original images is available in the digitally, see Appendix G for information for the file structure of the digital appendix.

With the requirements and wishes just presented in mind, I created an abstract task model for a scholarly digital assistant, as outlined above. As the overall task tree is too large to display properly on a page, I will successively present the most important subtrees, one after another. Figure 7 explains task allocations, for temporal relationships see Appendix C, Figure 26.



Figure 7: Task allocations as defined by Paternò (2000). The program executes application tasks silently on its own – thus silent execution assistance has completely been model as application tasks. The human executes user tasks; Interaction tasks are performed by the user interacting with the system. Warning assistance, as well as automated suggestions and recommendations, were modelled as interaction tasks, since they, for the warning assistance, should wait for confirmation by the user, for suggestions and recommendations they wait for user interaction to be activated.

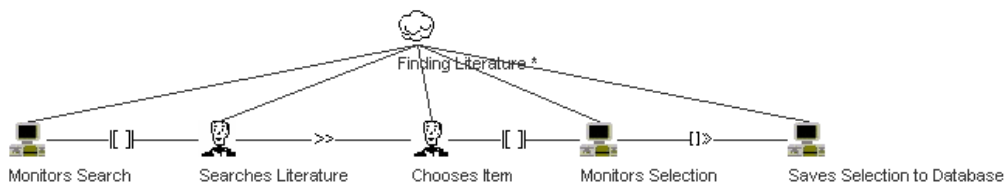


Figure 8: The Finding Literature Subtree.

Finding Literature Starting chronologically, the Research Interest is first established by the user, after that the method and methodology chosen. Then, the concurrency begins. On this level, the user task ‘Defining the research Question’ runs parallel with information exchange to the abstract tasks ‘Knowledge Gathering’ and ‘Writing’, while they enable, with information passing, the abstract ‘End of Project’ task. The first abstract task presented is ‘Knowledge Gathering’, here the iterative abstract task ‘Finding Literature’ runs concurrently with information exchange to the iterative abstract task ‘Literature Reading’. Figure 8 shows the ‘Finding Literature’ subtree. While the user searches for literature, the application monitors the search concurrently and obtains information about the search. Once search terminates, the user chooses an item, which once more is monitored by the application. When the application registered a selection, it enables with information passing a task which saves the selection to the database. Thus, the application silently monitors the user’s behaviour and automatically processes all available data about the selected literature and saves the dataset.

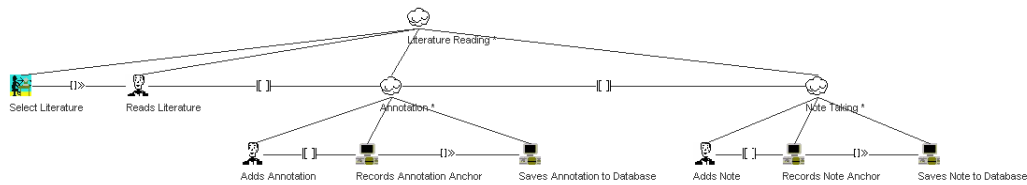


Figure 9: The Literature Reading Subtree.

Literature Reading First of all, the user selects in an interaction task the literature to be read. Within this task, the abstract, select literature task has not been modelled in all detail. In a later abstract task, the reading task, one possibility of running ahead of selection will be presented in the form of assistance to display recommendations. Similarly, this task may not necessarily be an interactive task: if a digital assistant is to work with physical literature as well, the book may be selected without interacting with a computer at all. For simplicity’s sake, I am going to concentrate on digital reading, as will be implemented for evaluation in the next chapter.

Once a selection was made, the next tasks are enabled with information exchange: The user reads concurrently to the recursive, abstract, tasks ‘Annotation’ and ‘Note-Taking’. In the annotation task, the user adds an annotation to the text, while concurrently, with information exchange, the application records the anchor for the annotation. Information exchange is one-sided: The application tracks the user’s annotations. After that, the

‘Saves Annotation to Database’ task is enabled, it receives all necessary information (e.g. type, content, anchor) and saves it to the database. Then, the task starts again, waiting for user annotations. Concurrently, the abstract ‘Note-Taking’ task monitors in an equivalent fashion notes. Since more than one text are usually read for scholarly projects, ‘Literature Reading’ is an iterative task, once reading of the one text finished, reading of another text can start.

Manuscript Writing The task ‘Writing’ was modelled concurrently with information exchange to ‘Knowledge Gathering’ and ‘Defining the Research Question’. It has two concurrent, information exchanging, abstract subtasks: ‘Outline Design’ and ‘Manuscript Writing’. The first one has, due to the objective of this task model, not been explored further. Instead, I concentrated on ‘Manuscript Writing’. It has four subtasks running concurrently, exchanging information: 1. ‘Looking for Literature in Personal Library’, 2. ‘Looking for Notes’, 3. ‘Writes (User)’, 4. and ‘Writing Assistance’. Except for the user task, all are abstract and iterative tasks.

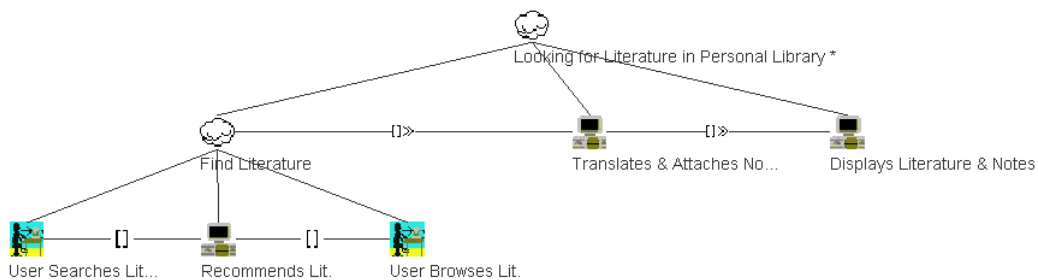


Figure 10: The Looking for Literature in Personal Library Subtree.

Looking for Literature in Personal Library This task starts at the abstract task ‘Find Literature’. Its branches offer the choice between the interaction tasks ‘User searches Literature’ and ‘User browses Literature’ and the application task ‘Recommends Literature’. The literature referred to here, is the literature already in the database of the assistant and known by the user. Once a selection was made, the next application tasks are enabled with information passing: First ‘Translates & Attaches Notes’, here the application retrieves automatically notes and excerpts written by the user, belonging to the selected literature. This is at the heart of the prototype presented in the next chapter. Translation means: The granular information is retrieved from the database and displayed meaningful for the user next to or within the literature. The concept behind this translation is grounded in the PIM

research about landmarks and refinding. Since it has been shown, that refinding document is aided by displaying landmarks and context information, the hypothesis for linking notes to text anchors is, that the notes act as a landmark, decreasing refinding time for relevant passages. The final task in this subtree is ‘Display Literature & Notes’, thus, displaying literature and notes in one view.

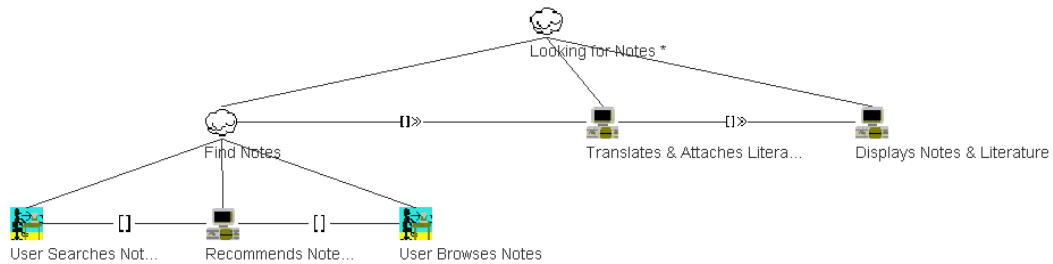


Figure 11: The Looking for Notes Subtree.

Looking for Notes This task works the same as ‘Looking for Literature in Personal Library’. While the latter allows search and selection by literature, this one allows browsing and searching by notes and excerpts.



Figure 12: The Writing Assistance Subtree.

Writing Assistance This an abstract task, containing two consecutive (with information exchange) subtasks: ‘Silent Assistance’ and ‘Warning & Informing Assistance’. The silent assistance consists of for subtasks of independent order: 1. Checks for Plagiarism 2. Looks up Literature in personal Library 3. Looks up Notes 4. Looks up Literature Recommendations. These applications monitor the current state of the manuscript and check the text against relevant databases. The information gathered is passed into the optional ‘Warning & Informing Assistance’s’ subtasks. This task is only activated if relevant information was found. While warning assistance is a category taken from Wandke’s assistance definition, the information assistance should better be called presentation assistance or display function. The tasks consist of four optional interaction subtasks, once more in an independent order: 1. Warning for Plagiarism 2. Suggests Literature from Personal

Library 3. Suggests Notes 4. Recommends Literature. While the warning should happen automatically, it still is interactive, since the user should have to confirm, before continuing to write. Suggestions and Recommendations, however, should not be interrupting. Thus, the digital assistant should offer some kind of interface for interaction. Only, then, if the user asks for a recommendation or is looking for notes and literature, should the suggestions be displayed. The interface might, for example, be a classical GUI, a chatbot, a voice interface, or a gesture interface. While the warning & information task is optional, each of its children is optional as well – if warnings, suggestions and recommendations are independent of another.

End of Project The last task to last be enabled (with information passing), is ‘End of Project’. It has three subtasks: The user’s ‘Publication / Delivery’ task, which enables the optional interactive ‘Deletion’ task, and finally enables the application ‘Archival’ task. The first two tasks do not need any comment; their names are telling. The archival task should be an application task: all data, except for what the user chose to delete, should stay in the database and be available for the next research projects. By archiving information throughout all projects, the digital assistant becomes the slip box outlined in the introduction of this thesis. Once archival is done, the root task ‘Scholarly Work’ is terminated, the researcher and system ready for the next research project.

4.3 Summary

This chapter showed, what kind of assistance needs exist in the scholarly workflow, and how a digital assistant might answer them. Further, a concurrent task tree model was presented, as the foundation for a prototype to be presented in the next chapter. The task model focused primarily on reading literature and writing a manuscript. Thus the present model is, while following Stachowiak’s definition of a model, truncated in order to fit this thesis’s need. If a digital assistant for scholarly research were to be implemented, the leaves of this task model would have to be evaluated further, and with each iteration, tasks would have to be modelled in more detail.

Also, one might argue that the present model forgot about literature management after this activity’s importance in combination with excerpt production has been emphasized prior. While literature management was not directly modelled as its own task, it pervades many (abstract) tasks in the proposed model: literature management is taken care of invisibly by the di-

gital assistant, helping to find the right information during the writing task through a bibliographic database which was created silently while the user searched for literature. By offering the ability to find literature through notes and notes through literature, it answers the problem of the two bibliographic management types presented in chapter 3. Thus, I believe, a digital assistant, as proposed by the task model, may well be the solution for the shortcoming of contemporary literature management software. Similarly, file management, while analysed extensively, is not represented in the model. Here I suggest, not to interfere with the users' habit. Let them save the files in their fashion. However, the assistant should either create a copy of the files at a specific location or monitor the file location in order to have an up-to-date reference in the database. If the assistant is useful enough, the users might at some point abandon their file management, as the file's location on the operating system's file system does not matter any more, since the assistant helps them locate their files. Additionally, the proposed assistant offers warnings against plagiarism and promises to work without specialised training, since most work is done automatically, minimizing the user interaction mostly to assist in the writing process.

In the next chapter, I will report the evaluation of a prototype developed following this task model. The prototype will assess, whether it is possible to monitor reading and note-taking in order to gain the necessary information to translate notes and display them at the right anchor of a text document, using contemporary technology.

5 Eyetrack Reader – A prototype

I developed a prototype and evaluated it in an experiment in order to assess silent assistance translation assistance, as suggested in the task model in the last chapter. The experiment tested the following hypotheses:

H1 Translation assistance for notes and literature allows for more efficient writing in scholarly research.

H1.1 Users testing a prototype which links notes to their context spend less time looking for text passages or notes.

H2 Silent assistance linking hand-written notes to the right anchor of a digital document is possible.

H2.1 Eye-Tracking captures adequate data to infer a specific anchor within the text at a given time.

H2.2 A Webcam captures adequate data to allow for the selection of meaningful units within notes written at a given time.

H2.3 Merging information from the gaze data and webcam stream make linking units of notes to units of text possible.

H2.4 The resulting link is correct.

The two evaluated assistance types would help to fight fragmentation between worlds and between documents, improve order and aid research by improving refinding of information through searchability and structure of excerpts. To test the hypotheses subjects were invited to participate in two consecutive experimental sessions. In the first session, they were asked to read a text, while an eye-tracker and a webcam were recording gaze points and paper notes they were taking. These data logs were used to prepare a fake translation assistant module for the second session, where subjects were asked to write a summary of the text they read in the first session. A test group was allowed to use a digital prototype, linking notes to text anchors, while the control group used their original paper notes. While the preparation of the digital prototype and user feedback answers **H2**, eye-track data will be used to assess **H1**: The gaze log allows measuring interaction time, answering hypothesis **H1.1**. Efficiency in the context of this hypothesis is measured by the amount of time spent searching for information in the primary text or excerpts, thus the less time is spent searching for information, the higher the relative amount of time spent writing the summary – the more efficient the summary production. All analysis, unless otherwise noted, was conducted

using *R* (R Core Team, 2018) and the following packages: `ggplot2` (Wickham, 2016), `tidyr` (Wickham & Henry, 2018), `dplyr` (Wickham et al., 2019), `openxlsx` (Walker, 2018) and `jsonlite` (Ooms, 2014).

5.1 Eyetrack-Reader v1 – Reading & Gaze Tracking

5.1.1 Setup

In the first session, all subjects were asked to read the same short text (about nine pages, German) on a screen. The text was displayed in ‘Eyetrack-Reader’, a custom made *HTML* & *JavaScript* application emulating the look of a *PDF*-reader rendering of digital documents (see Figure 13). The only options available to users were to scroll through the document, zoom in and out in order to adjust text size for readability and use a drop-down menu in order to jump between pages. Using the *CSS* framework *paper-CSS* (Kawamura, n.d.), the prototype’s layout was crafted by hand. The source *PDF*’s, “Digitale Dividende–Bedingungsloses Grundeinkommen” (Kind & Ehrenberg-Silies, 2016), content was copied into the *HTML* file and split into individual DIN-A4 pages. Each paragraph was carefully recreated, adding indents, bullet lists and headings to imitate the original as good as possible. There was one difference, however, the typeface ‘Linux Libertine’ was used rather than ‘Minion Pro’ in the original document. This decision was made for licencing reasons, ‘Libertine’ is available freely, while ‘Minion’ is licensed by Adobe. Both are serif fonts and ‘Libertine’ is used in the ACM’s *L^AT_EX*-Templates¹², thus a fitting candidate, since the ACM’s use makes it a ‘typical’ font for publications. After the layout was created, each element (e. g. `<p>`, `<h1>`, ``) was assigned an ID of the scheme `p<page#>p<paragraph#>`, hence finding the paragraph manually was possible and at the same time unique IDs were generated for programmatic use. For the overall style, layout and to ease handling browser-based *JavaScript*, the staples *bootstrap* (‘bootstrap’, n.d.) and *jQuery* (‘jquery’, n.d.) were used.

Throughout the experiment, gaze data was logged while the webcam and screen were captured as well. The webcam was directed at the desk in front of the reader’s screen. The view-angle was evaluated and marked on the desk with tape. The *JavaScript* application guided subjects through a questionnaire and eye-track calibration before they were able to enter the document view. Once the actual reader was entered, the full-screen mode was enforced programmatically (and through visual warnings and an overlay blocking the view of the text, in case the user exited full screen). After several tests for

¹²Available at <https://www.acm.org/publications/proceedings-template>

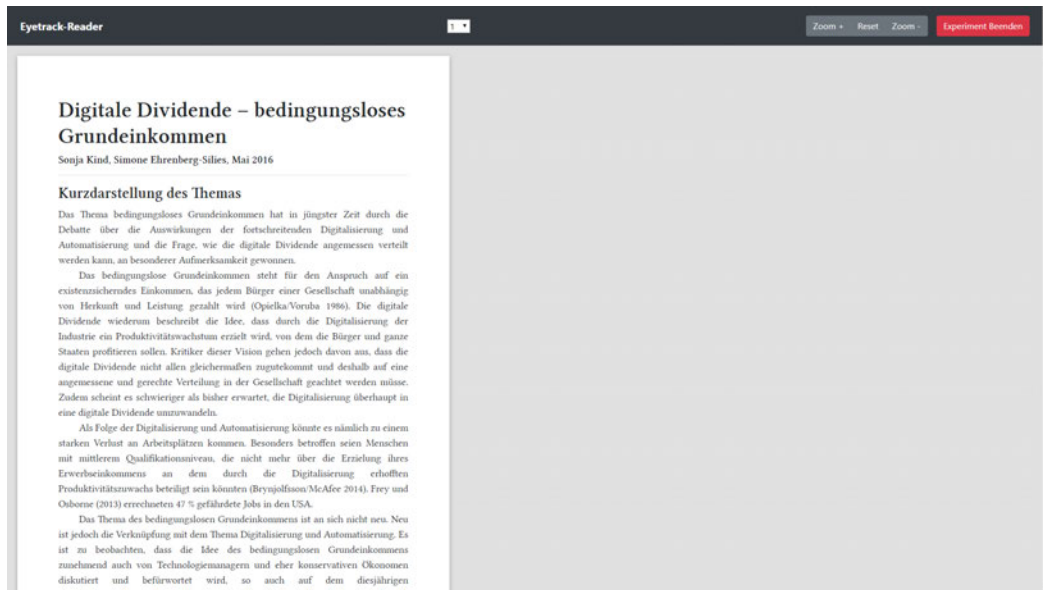


Figure 13: Screenshot of the Application in the state of the first experiment

calculating the viewport’s size and location on the screen reliably, the decision to enforce full screen was made: *JavaScript* offers an easy option to translate coordinates into an element, the method `elementFromPoint(x,y)` returns the element at specified coordinates **relative to the viewport**. Since it was vital for the experiment, to be able to trace gaze data to elements within the web page, this method was a perfect fit. Also, other thinkable solutions to trace gaze back to elements would rely on relative coordinates, unless the laboratory setup could reliably be reproduced, or more data points would have to be collected, like exact window sizes and positions on the screen — all in all, full-screen mode allowed to circumvent unnecessary complexity elegantly.

Using *gaze-client.js* (Bazo, n.d.-a) and patterns from Bazo’s (n.d.-b) *StarGazer*, the application listened to events via *web sockets*. During the experiment a *web socket* server ran on each machine, broadcasting gaze data from the eye tracker. The setup captured a maximum of approximately 30 Hz. This rate may only be 10% of the theoretical maximum offered by the hardware, however, the capturing rate was, as will be explained in more detail within this chapter, sufficient for my experiment. The video streams were captured directly through the web browser with the help of the open-source *RecordRTC* (M. Khan, n.d.) module. Media stream data was stored in 1000ms blobs in memory, while gaze data was also stored in memory. Since no reliable source about *Firefox*’s memory limitations was found, and trust in users is low, all data streams were asynchronously saved into *indexedDB* as well.¹³

¹³using *Dexie.js indexedDB* wrapper (Fahlander, n.d.)

While pilot experiments and stress-tests attested the memory reliability for the experiment, the second set of data, stored in a different location (while memory is ephemeral, *indexedDB* is persistent between sessions) served as a fail-safe. If the subjects were to close, although told otherwise and warned by the browser, the window or reload the page, all collected data would have been recoverable. The same applies to any other unexpected event, deleting memory. For each blob, or in other words, for each second of the video, a timestamp was saved. Gaze log, pseudonym and timestamp arrays were merged in a dictionary. At the end of the experiment, the dictionary was downloaded in the *JSON*-format. Video timestamps were, of course, also logged to the persistent database.

Subjects were asked to answer a short questionnaire, implemented using *Surveyjs* ('SurveyJS: Free Online Survey and Quiz Tools', n.d.), about demographic information and note-taking as well as reading habits. After that, they entered the document reader's screen, and all data streams started. Their task was to read the text and take notes. The only additional piece of information given to the participants was that they would use the notes in the next session. Otherwise, no limitations about time or amount of notes were set, and the specific task for the second session was not disclosed either. While this decision may have increased the workload of participants – as they did not know what to expect, they had to decide quantity and quality of notes to take, without knowing all necessary parameters. It was a deliberate shortcoming of the assignment. Giving instructions with too many details might have been problematic in the context of scholarly work: As has been shown above, while there are certain similarities between subjects and between students of their research process, there is still a vast difference in details. One example of those is terminology. A more detailed task description might have included terminology confusing to single participants. Thus, the least information task description strategy is grounded in fear of priming subjects by using the wrong terminology for their style of note-taking while reading. By giving the most general task description, I expect to have elicited the most natural behaviour of note-taking possible within the laboratory setting of my experiment.

5.1.2 Participants

Participants for the experiment have primarily been recruited through the class 'Übung Digitalisierung & digitale Gesellschaft IV'. In contrast to the interviewees, participants for this evaluative experiment were either students enrolled for a bachelor's or a master's degree. The participation in the exper-

iment was, for ethical reasons, voluntary for members of the seminar. In the end, only 12 people signed up for one of the two available time slots to join. Thus, a few days before the set date, recruitment was opened to students outside the class in order to fill as many places available at the laboratory (eleven seats and two sessions → 22 places in total). After advertising the experiment in a lecture and using a university forum, an additional seven people signed up. In the end, 19 volunteers were recruited, 16 people showed up (two people cancelled the day of the experiment, one no-show). Out of these, 7 (43.75%) were bachelor students, the rest (56.35%) master students. For more details about the subjects studied by the participants, see Table 1.

| Subject (or combination) | Degree | n |
|---|----------|---|
| Public History | Master | 6 |
| Digital Humanities | Master | 2 |
| Allgemeine und Vergleichende Medienwissenschaft | Master | 1 |
| Medieninformatik, Informationswissenschaft | Bachelor | 2 |
| Medieninformatik, Medienwissenschaft | Bachelor | 2 |
| Informationswissenschaft, Medieninformatik, FKN | Bachelor | 1 |
| Medieninformatik, Philosophie | Bachelor | 1 |
| Medieninformatik, Politikwissenschaft, Geschichte | Bachelor | 1 |

Table 1: Overview of subjects participants were enrolled for.

Participants were born between 1959 and 2001, and the median is 1995. 56.25% (9) of the volunteers reported their gender to be female, 37.5% (6) male and 6.25% (1) androgynous. In order to assess, of what importance reading is for the subject's university studies, their assignments and how they read their literature and take their notes three matrices for Likert scale questions were added. The first section elicited agreement for the following set of questions:¹⁴

1. Während meines Studiums lese ich viele Texte (Reading for studies)
2. Für meine Studienarbeiten¹⁵ muss ich viele Texte lesen (Reading texts for my assignments)
3. Gelesene Texte wiederzufinden fällt mir leicht (Text refinding)
4. Beim Lesen von Texten mache ich mir viele Notizen (Note-taking while reading)
5. Für meine Studienarbeiten fertige ich viel Texte an (Writing for assignments)

¹⁴Short names used in boxplots in parenthesis.

¹⁵Studienarbeiten: Projekte, Hausarbeiten, Abschlussarbeiten oder ähnliches.

6. Lesen ist ein essentieller Bestandteil meines Studiums (Reading for studies control)
7. Notizen wiederzufinden fällt mir leicht (Note refinding)

The median for all reading questions lies at ‘trifft zu’, with participants answering these questions within the span ‘trifft zu’ and ‘teils teils’¹⁶. Thus it is safe to say that reading is part of every subject, for most even essential. While refinding notes seems for most people to be an easy task (median at ‘trifft eher zu’, the span between ‘teils teils’ and ‘trifft zu’) finding texts which have already been read produced a wider variance of results, while the median is also at ‘trifft eher zu’. The least agreement was surprisingly found for question 4. *note taking while reading*: the median lies between ‘teils-teils’ and ‘trifft eher nicht zu’. Since the question was ‘beim Lesen von Texten mache ich **viele** Notizen’, it should not be deduced, that less agreement for this question can be inverted to subjects not taking notes while reading. As this was the only question with such a wide span of answers, I tested the difference in means when grouping the survey data by degree. After testing for normal distribution (Shapiro-Wilk-Test, $W = 0.919$, $p = 0.161$) and homogeneity of variance (Levene’s Test, $F = 3.17$, $p = 0.096$), the requirements for a t-test were fulfilled. The t-test shows a significant difference in means between the groups of bachelor students and master students ($t = 2.68$, $p = 0.020$), the effect size is large: $d = \frac{mean_1 - mean_2}{(sd_1^2 + sd_2^2)/2} = 1.36$ (Cohen, 1992).

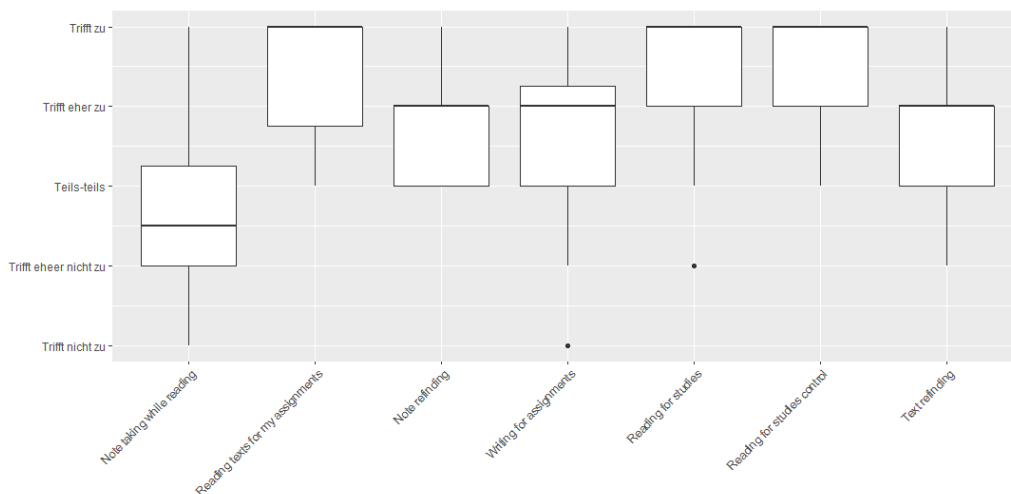


Figure 14: Boxplots for the questions regarding reading and notes in the context of studies and assignments.

When asked more generally about note-taking, participants’ responses spanned between often and occasionally, the median lies at occasionally.

¹⁶The scale has not been translated to prevent distortion by translation.

When asked about how those notes are taken, a majority of students (68.75%) reports to often use paper, with three outliers at often, occasionally and rarely. Taking notes on computers appears not as popular among the subjects: a majority takes between rarely and occasionally notes on pcs, the median lies at occasionally with the upper quartile ranging to often.

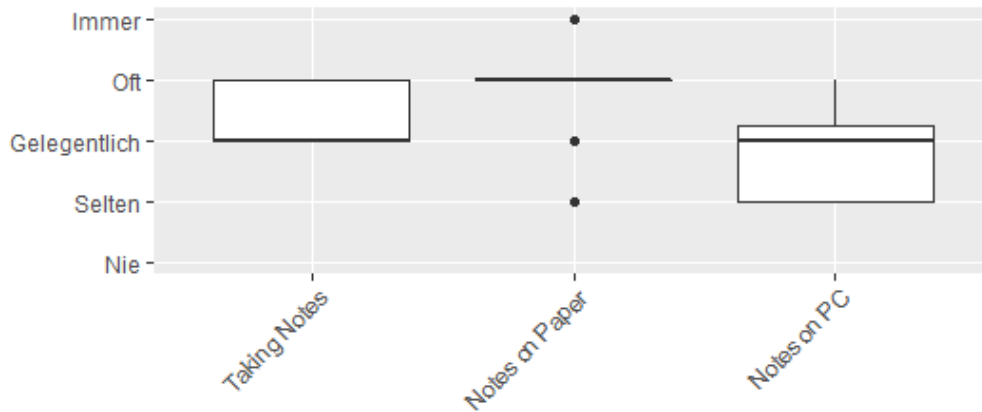


Figure 15: Boxplots about note-taking in general and whether notes are taken on paper or on PC.

The final group of Likert questions prompted how students read their literature — three out of five questions aimed at digital ways of reading, and two at analogue ones. The digital options offered were reading on PC, tablet and e-reader. Responses for the last item were quite definite. No one uses an e-reader. Tablet reading is spread more heterogeneously among the subjects: While a majority never reads on a tablet (with the median at never), the upper quartile ranges to occasionally, with the last quartile ranging to often. Finally reading on a PC appears to be the most popular digital way of reading: While ranging from rarely to always, the majority of subjects reads between often and occasionally on the pc, with one outlier reporting never. Interestingly the result is precisely the same for another item: Reading from printed pages. Finally, the majority of participants reports reading occasionally or often in books, with responses ranging from rarely to always.

Lastly, the volunteers were asked about the use of citation management software. If they answered positively, the name of the software they use was prompted additionally. 56.25% (9) people do not use any specialized software, 12.5% (2) did not answer the question, and 31.25% (5) do use a citation tool. Out of the five software users, three opted for Citavi, one for Zotero and one for citethisforme. All participants were German natives.

All in all, the purpose of the survey was to get to know the population of my study better and to evaluate whether it is a fitting one for evaluating

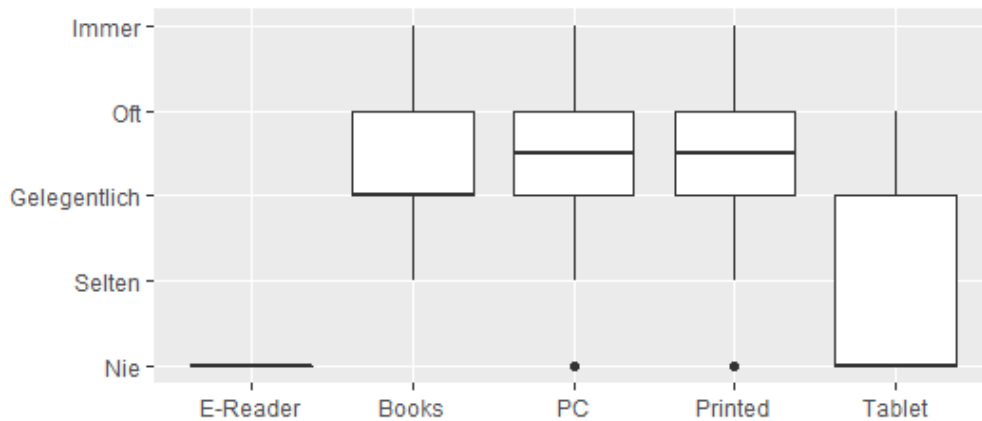


Figure 16: Boxplots for the questions regarding how texts are read.

a prototype for scholarly work focusing on excerpt production. First of all, the population is rather young – as was to be expected when recruiting students. However, it is safe to assume, that the majority of the participants are ‘digital natives’ (Prensky, 2001), as such they are more likely to adopt new digital strategies for their scholarly work (plus, as students, they are yet in the progress of developing their own system for this type of work). Thus, using a young test group to evaluate an explorative prototype seems appropriate. Furthermore, answers to the Likert scale questions show, that the multimodality of the implemented prototype, digital reading, analogue writing, fits the habit of students taking part in the study: Most participants read texts for their studies and see reading as an essential part of their studies.

Further, the majority needs to read for assignments, and most participants read between occasionally and always on a computer screen while taking paper is the most popular option for taking notes, with only two people using this method occasionally or rarely, while most take notes on paper often. The primary issue about the population is that the group of bachelor students reported significantly less affinity to note-taking while reading. While the aspired degree is the independent variable, I suspect the field of study to be a latent variable determining the affinity to note-taking. However, the dataset does not allow to empirically validate this suspicion: Students seeking a bachelor of arts degree may choose among a multitude of subject combinations. Thus, the combinations of my population are heterogeneous, no matter the small sample size. Grouping seven people in five groups does not allow for an accurate statement about variance. With this in mind, special care was taken when splitting the population into two groups for the second experiment to control this difference in population. Finally, this difference between the

groups may well be improving the validity of the results of this experiment: less proficient note-takers might gain the most from an assistance system.

5.1.3 Intermediate Result

Subjects spent between 15:21 mins and 38:04 mins for the reading and note-taking task. Once the subjects were done, they stopped the experiment by clicking a button on the screen, thereby the data streams were closed and data downloaded from memory to the hard drive. The volunteers were allowed to leave after that, while notes have been collected. In order to analyse the artefacts, all notes have been digitized. All work on and with the notes has been carried out on copies of the notes. Thereby the originals were preserved for the second experiment. The subjects wrote between one and four DIN A4 pages of notes. Since the look of longhand is heterogeneous, each word within each note has been counted by hand to obtain a uniform parameter for comparing notes. Abbreviations were counted as a word, numbers carrying content as well.¹⁷ Participants wrote between 39 and 315 words, on average 175.06, the median is 180.5. Out of the 16 notes, three were not readable. While counting words, an interesting discovery was made: every single note included some style of arrows. These were, however, used in different fashions, some were supposedly marking thoughts or conclusions, while others were used for structuring text. After this first look, two groups have been created. One group was assigned to test the digital prototype of Eyetrack-Reader's second iteration, displaying notes on the screen (more details in a moment). This required the notes to be transcribed and, using the different data streams, analysed along the timeline in order to connect each line (better: each word) of the notes to the corresponding paragraph of the source text read by all participants. Group membership was assigned through different parameters. First, all non-readable notes were assigned to the control group; without transcription, the prototype would not have worked. Afterwards, attention was paid to gaze logs. Two logs failed, clearly visible by looking at the file size of less than 500 KB, while the rest of the log files consisted of several MB of data. A visual inspection by plotting the number of gaze points against time in seconds confirmed this assumption, see Figure 17. By counting the total amount of gaze points logged and dividing it by time, an average value of recorded gaze points per second was calculated to check further on quality. Between the logs, a minimum of 1133 (politischer-Dorian) and a maximum of 43881 (szenische-Lilith) data points have been collected.

¹⁷Numbers carrying content were, e.g. amounts of money offered by basic income, numbers **not** carrying content were page numbers.

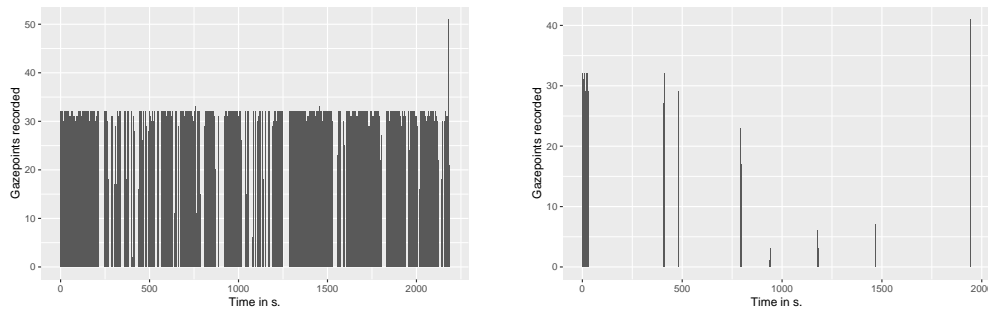


Figure 17: The left-hand example shows a proper log, a large number of gaze points logged. The right-hand example shows a failed gaze log. The x-axis shows the time in seconds. The y-axis displays the number of data points recorded per second.

The maximum of gaze points per second was 25.03 (lauterer-Jannik) and the minimum 0.58 (politischer-Dorian), with a mean of 14.60 and median of 17.15 data points per second. The – in comparison – low average of $8.42 \frac{\text{gaze points}}{\text{s}}$ (unvollendete-Helin) proved sufficient to allow tracing notes back to the position of the text they were related to, thus all but the two logs mentioned above allowed further processing. Since eye-tracker calibration failed multiple times for bewegliche-Zumra, the dataset was not considered for transcription either. This left eleven subjects eligible for testing the digital prototype. Group membership for the subjects was finally determined by looking at the number of words, answers of the Likert questions, gender, year of birth and degree. I tried to find the best combination as close as possible to the composition of the original population. The main focus was the number of words in notes. The total mean of the whole group was 175.06 words, 174, 5 for the digital group and 175, 63 for the analogue one. Due to uneven numbers, the proportion of degrees could not exactly be represented, same for age. While the means of the Likert questions within the newly created groups deviated in most cases by less than 0.1 from the original population, students reporting higher affinity of working with texts in their studies and for their assignments were slightly overrepresented in the analogue test group, and refinding texts with ease was under-represented in the digital group.¹⁸

Once group assignment was done, a small *Python* ('The Python Tutorial — Python 3.7.3 documentation', n.d.) script was created within *Jupyter* (Kluyver et al., 2016) using *Pandas* (McKinney, 2010) that expanded the log data with two columns (`video_m`, `video_s`) and filled these columns with seconds and minutes of the video file corresponding to the entry. Matching time was easily possible because when recording the video stream, timestamps

¹⁸Deviations: 1. Reading for studies: 0.375 2. Reading for studies control: 0.25 3. Reading texts for my assignments: 0.125 4. Text refinding: 0.37

| Average | Total | pseudonym | seconds |
|-------------|-------|------------------------|---------|
| 19.29 | 32964 | agressiver Atakan | 1709.23 |
| 15.43 | 28229 | alkoholhaltiger-Tammo | 1830.07 |
| 18.18 | 31264 | anregungsreicher Tiago | 1719.62 |
| 7.73 | 7127 | bewegliche-Zumra | 922.48 |
| 22.17 | 28181 | brave-Summer | 1271.01 |
| 15.02 | 29501 | erinnerlicher-William2 | 1963.60 |
| 8.75 | 17563 | interner-Quirin | 2007.93 |
| 18.10 | 26558 | konstitutive-Nahla | 1467.47 |
| 25.03 | 37836 | lauterer-Jannik | 1511.62 |
| 17.15 | 39528 | mutmaßlicher-Hasan | 2304.84 |
| 0.58 | 1133 | politischer-Dorian | 1945.43 |
| 12.11 | 24515 | religiöse-Zazou | 2025.10 |
| 20.10 | 43881 | szenische-Lilith | 2182.60 |
| 17.80 | 40738 | ungeratener-Julian | 2288.05 |
| 8.42 | 19124 | unvollendete Helin | 2270.46 |
| 1.05 | 1283 | verlogene-Sidney | 1224.96 |

Table 2: Average $\frac{\text{gaze points}}{s}$ and total amount of gaze points logged in the first experiment. The average value was calculated as the division of *gaze points* by *timespan recorded*. In contrast, the experiment time stated above denotes the time of webcam recordings.

were saved every second. The time difference Δt between the first timestamp of the video stream and each gaze log entry was calculated and the corresponding fields populated. After that querying log entries by video time (second precise) was a simple matter of finding matching rows. The simple method for time matching was defined within the *Jupyter* notebook while a printed copy of the notes was placed on the desk, and the video file of the webcam stream was started. Notes have been manually annotated line by line. Gaze data provided the corresponding paragraphs for each line. While the notes themselves were not decipherable on the videos captured (the light in the room was turned off in order to maximize eye-tracking accuracy, the brightness of the second screens at each desk was set to maximum brightness, and a white image was displayed in fullscreen, the monitors were tilted towards the desk to improve illumination while writing and especially for capturing the writing on video), the lines recorded by the webcam could (in most cases) easily be matched to lines on the copies, due to unique patterns. In a few cases, the handwriting was too neat or uniform. Therefore lines needed to be counted on the screen and the printout in order to verify the matches. Finally, the video was paused once writing started, and the minutes and seconds of the video entered as variables in a search method within a *Jupyter*. The search usually returned between 0 and 30 rows, in some cases more uniform results (see table

3), in others more heterogeneous ones (table 4). At this point, at least two different options were available: One option would have been to apply a strict rule (algorithm) to chose a specific value according to rule. The advantage of this system would have been reproducibility and reliability. I chose, however, a different option: My prototype was to emulate an intelligent system. Why, then, should the decision which element to chose as an anchor for a note be a ‘stupid’ one? Thus, common sense was applied for tagging each line in the notes with the best fitting relation. Sometimes the exact second returned an empty dataset. Then the data was scrolled second-wise forth and back. In other cases, the returned dataset was too heterogeneous to make an instantaneous decision, also for this case scrolling has been applied. If also scrolling was unsuccessful, a minute wide window of data has been sighted for clues. This method worked since reading a sentence or paragraph takes many seconds. Therefore longer fixation on one paragraph multiple seconds before the note was taken was considered a valuable clue, in combination with the webcam material. Additionally, the content of the notes was considered in tough cases since they usually related to the content of one of the (usually) two potential paragraphs. Every line (and in some cases smaller units of text) could be related to a specific paragraph (or similar tag) of the source text.

| timestamp | elementId | video_m | video_s |
|---------------|-----------|---------|---------|
| 1579710410614 | p5p1 | 13.0 | 37.0 |
| 1579710410646 | p5p1 | 13.0 | 37.0 |
| ... | ... | ... | ... |
| 1579710411551 | p5p1 | 13.0 | 37.0 |
| 1579710411584 | p5p1 | 13.0 | 37.0 |

Table 3: Example for a homogenous subset of log data returned for minute 13, second 37 of lauterer-Jannik’s webcam stream.

In the next step, a data structure was created using an *Excel* document. The use of a database has been considered, but the amount of work for setting up a database server (or local version using, e.g. *SQLite*) was deemed unnecessarily complex. My prototype was to be used one-time only, and adding a proper database backend would not have changed the outcome of the experiment in any way. The same goes for *XML*, while (with *TEI* and *RDF* in mind) it would allow for interesting data structures when dealing with annotations and notes, the storage technology did not influence the experiment. Therefore this makeshift solution was chosen. For each participant of the digital test group, a sheet was created, named by the pseudonym. Additionally, a ninth sheet was added, called ‘blank-blank’, which stayed empty and was needed for technical reasons. In each sheet, the same columns

| timestamp | elementId | video_m | video_s |
|---------------|-----------|---------|---------|
| 1579710526709 | p5p3 | 15.0 | 33.0 |
| 1579710526738 | p5p3 | 15.0 | 33.0 |
| 1579710526769 | p5p2 | 15.0 | 33.0 |
| 1579710526802 | p5p2 | 15.0 | 33.0 |
| 1579710526958 | p5p3 | 15.0 | 33.0 |
| 1579710526989 | p5p3 | 15.0 | 33.0 |
| 1579710527019 | p5p2 | 15.0 | 33.0 |
| 1579710527052 | p5p2 | 15.0 | 33.0 |

Table 4: Example for heterogenous data. The eyetracking data is jumping between two paragraphs. This has already been observed as a shortcoming in the pilot interviews. (Note: two data rows have been removed to keep the example short.)

(`position`, `reference`, `text`, `image`, `reference_to`) were created. The first column served as an index starting at one, incremented with each line. A line consisted of one or multiple lines of the original note. If, for instance, three lines after another of the paper note belonged to the same paragraph of the source document, they became one row in the sheet. If, on the other hand, there was one line between two of the same relation, but the middle one referring to a different one (non-linear notes), these rows were split into three rows of the sheet. The decision was based on the look of the scanned document when slicing it into smaller images. The main question was how they could be displayed in *HTML*. The id of the *HTML* element referenced by a note element was entered in the `reference` column. For the `text` column, each piece of information on the paper notes was transcribed manually. Once more, automatic transcription of handwriting may exist, for the small set of artefacts manual transcription was probably faster, as automatic ones would certainly have needed correction as well. The `text` column was treated as *HTML* content. Therefore every line was surrounded by `<p>` tags. If a row in the sheet incorporated more than one line on the original note, each line was contained in a `<p>` tag. Special care was taken to preserve layout and symbols as close to the original as possible. Depending on the complexity of the notes, `<table>` elements and `<u>` lists were used. Special symbols, like arrows have been translated to equivalent characters (`⇒`) and almost every note included + and - symbols, *UTF-8* emoticons were used to represent these.

The `image` column was filled with the path to an image file relative to the application. These files were created in *Adobe Photoshop*. With the help of the wand tool, the background was replaced with transparency. After that, the contrast and darkness of the page were adjusted. Once readability of the

scanned handwriting was maximized, the slice tool helped to create square images corresponding to each of the sheets' rows. When slicing attention was always paid to choose the same length of the images, even though this meant for many slices to have trailing transparent fields. This decision was a technical one, if the length of each image was approximately the width of each page, scaling the images by the width parameter guaranteed the same scale factor for the content. In some cases (non-linear notes), it was not possible to slice them by squares. In these cases, new files of the same length were created and using different selection tools, the content added. In this process, the original layout got lost, as a decision for uniformity was made. One option for these complex cases would have been to add the selected content to the images at the same x-coordinates. For some notes, this would have recreated the layout of the originals, preserving meaning connected to layout decisions. For others, however, it would not have made much sense, since the position on the x-axis did not appear to be relevant. Instead, they were running out of space when adding information at a later stage to a space surrounded by notes. Thus, the option to always add a new element to the left-hand side of new images was chosen.

Finally, the `related_to` column was introduced only after transcribing and recreating the first notes. For some notes, the complexity of non-linearity could not be represented by a linear structure any more. Thus, relations between note elements were introduced. They have been applied in two cases: 1. Some people added at later stages information to earlier lines of their notes. In most cases, these were references or small pieces of information. These were added to the row with the lower index. A copy has been added to the paragraph the relation was pointing to. Thus the particular note appeared twice: At the location of note-taking and at the location chosen by the user when writing the note down. The `related_to` column linked the elements. This solution allows displaying information in the layout intended by the note-taker, while still adding the positional information to both note elements. 2. Others used lines and arrows to connect different lines or pieces of information. In the case of subsequent lines, it was easy to display, since in most cases the paragraph they referred to was the same. Thus, the images displayed the arrows at the right place with the flow of the elements, the same for the transcription. If the arrows connect two elements over a wider span, the `reference_to` field was filled.

5.2 Eyetrack-Reader v2 – Translation Assistance for Excerpts

After creating the two test groups, inviting the participants for their corresponding time slot and transcribing notes, everything was ready for the second part of the experiment. The Eyetrack-Reader application has been reused in parts, while more functionality was added and Eyetrack-Writer was created as a second application for writing.

5.2.1 Setup

While multiple combinations between digital and analogue reading and writing would have been thinkable for a prototype, screen reading was chosen for this experiment. It has been reported as an option by most interviewees, and a majority of students uses pen & paper methods for note-taking. There is, however, a difference of writing behaviours between note-types: Information scrap type of notes are mostly written by hand, while for excerpts, it appears to be a question of personal preference. Eventually, a decision was made, based on the prior analysis of interviews with students, to incorporate the combination of digital reading and longhand notes into the experimental setup. Due to interviewees' responses, other setups would have been thinkable and have been considered: one rejected combination would have consisted of a mobile eye-tracking device and analogue reading and writing. Thus the subject might well have been observed in situ – say the office or library. Same goes for the combination digital reading and digital note-taking, this variant could have been captured by either eye-tracker, stationary or mobile, in situ or laboratory. For a first evaluation of the exploratory results from the interview series, the laboratory setting allowed to test a larger quantity of subjects in the available time-frame, thus promising the cost-benefit ratio.

The second iteration of Eyetrack-Reader asked the user to enter a PIN at the entry to the application. These PINs identified the datasets, which were requested in the form of a *JSON* file by *JavaScript* upon entering the PIN.¹⁹ The *JSON* file was the product of a small *Jupyter Notebook* which read the *Excel* sheets created above into a *pandas* data frame and saved the data frame as *JSON*. Once a correct PIN was entered, the same reading interface as the

¹⁹At the beginning of the first experiment, each participant received a slip of paper with a unique pseudonym and PIN. The pseudonym was entered in the questionnaire and thus allowed the identification of datasets. PINs were chosen, as checking them is less error-prone – pseudonyms include non-Latin characters and capital letters, it was anticipated, that users might try entering a pseudonym which would not match for a simple equality check in *JavaScript*. All in all, PINs allowed for lower complexity.

week before loaded, this time, however, the right-hand side of the screen was filled with the users' notes. By default the notes were displayed next to the paragraph, they belonged to.

Belonging to means in this context, next to the *HTML* element whose id attribute matched the column **reference** in the dataset. By default, the image slice was displayed. When iterating over each row of the dataset, the **reference_to** column was checked as well. In the case of non-empty values, a connector between the parent and child were drawn. The parent here is the element, which references to the child. The optical connector was assembled as a *SVG* element within *JavaScript*: The browser API allows to query coordinates for elements. Thus the parent and child elements were queried and set as starting and ending points. Each of these connectors got a different colour and distance to the note boxes (each note was set to the same width), this small detail made sure that connectors stay distinguishable (see figure 19). Double-clicking a note element resulted in the image disappearing in the transcribed text to appear in its place. Note elements had a default maximum height of the paragraph they were relating to (to prevent overlapping of elements); in rare cases, the content would not fit. In this case, a scroll bar for the y-axis was displayed, and a single click listener added to the element: a click on that note expanded the node to show the entire content. When the mouse was positioned over a note element, the corresponding paragraph in the source text was highlighted by changing its background to a subtle yellow colour. When the mouse left the element, the background was reset.

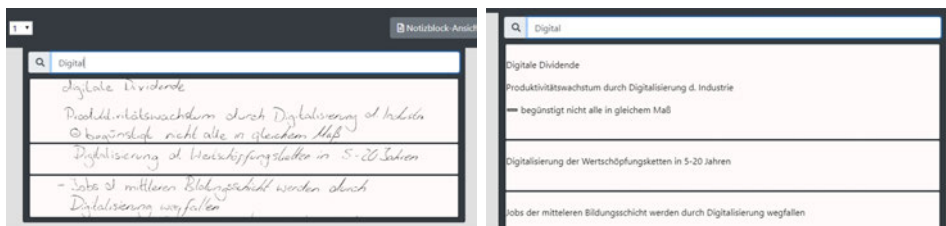


Figure 18: The search bar, on the left-hand displaying the scanned note, on the right-hand side showing the transcribed text.

Further, a search bar was added to the notes side of the reader, see Figure 18. Powered by the *Fuse* package, the content of the transcriptions was tokenized and used for full-text search. In the default mode, viewing the scanned versions of the notes, search results were also displayed in the scanned version. As for the notes, changing the display mode swapped the images of handwriting to the transcriptions of the notes' content.

Finally, Eyetrack-Reader also introduced a second mode for showing the notes: Upon clicking “Notizblock-Ansicht”, the notes' *CSS* class was swapped,

and all displays were pulled together into the anchor element. Now, instead of showing notes next to each paragraph, the notes section consisted of a second white, page-like, frame of a fixed height, offering its own scroll-bars. Any padding and margin between each row of notes were removed. All in all, this display mode emulated as close as technically possible the original look of notes when originally written on paper. On mouseover, the corresponding paragraphs were still highlighted, and a subtle yellow square element was displayed to the left of the corresponding note element. This little animation helped to distinguish between different note elements pointing to different paragraphs. Clicking on an element also scrolled smoothly to the corresponding paragraph of the source document. The notes were, of course, also in this view mode available as either scans or textual transcriptions.

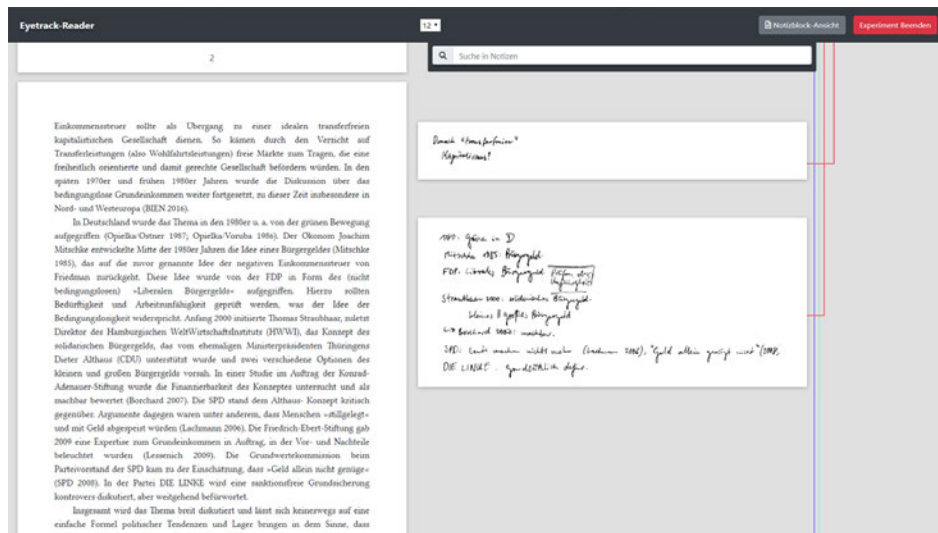


Figure 19: Version 2 of Eyetrack-Reader. Here with notes and connectors, showing the scanned version of notes. (For production systems a barrier free colour palette should be used)

In order to evaluate the prototype, the subjects were split into two groups. The digital group was allowed to use all functions of Eyetrack-Reader just described. The analogue control group was assigned the same task, while they were allowed to use the paper notes from the previous week. The task was:

Bitte schreibe eine kurze Zusammenfassung des Textes, den wir gestern²⁰ gelesen haben. Du kannst dir dabei vorstellen, dass der Text Teil einer Hausarbeit / Studienarbeit ist, die du gerade schreibst. Nun möchtest du den Inhalt kurz (z. B. in der *Related Work* Sektion) deiner Arbeit vorstellen.

²⁰This is, of course, a typo. The experiments took place on two consecutive Wednesdays

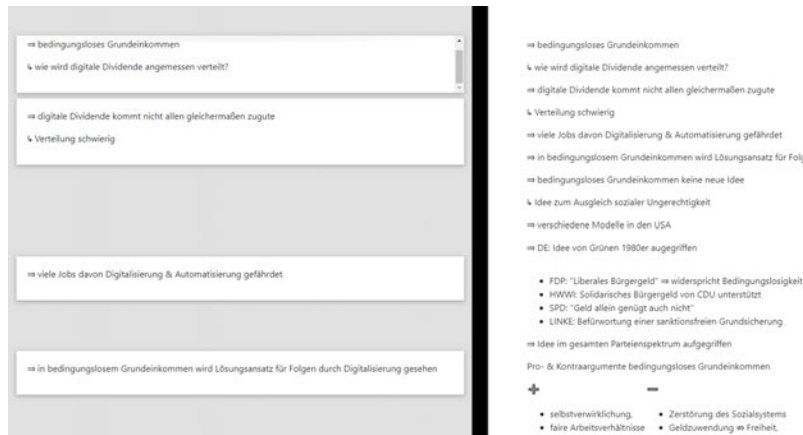


Figure 20: By doubleclicking a note, or clicking a button in notepad-view, the scanned image was hidden, and the *HTML* transcript was shown. Here in comparison, to the left the note view, to the right notepad-view.

Analogue users were all assigned the PIN 0000 when accessing the reader with this PIN, an empty dataset was loaded. Thus the interface looked the same, notes, however, were not displayed. The reading application was displayed on the secondary monitor, to the right-hand side of the main monitor.

The main monitor displayed Eyetrack-Writer in fullscreen-mode. It was another *HTML* and *JavaScript* application, following the same look as the reader. The writer's main page integrated a *TinyMCE* ('The Most Advanced WYSIWYG HTML Editor — TinyMCE', n.d.) WYSIWYG editor, offering typical formatting options. Logging capabilities were split between the two browser windows: Eyetrack-Reader captured the webcam and screen (of the reading monitor), additionally a log for events of interaction with the UI. Eyetrack-Writer captured the gaze data and logged every key-stroke of the editor used. At the beginning of the experiment, users were first instructed to log into the reader. The digital group got a short introduction and was allowed to get to know the new interface freely. Then, same for both groups, the eye tracker was calibrated, first through the manufacturer's software, afterwards through a custom module within Eyetrack-Writer. Following bad data from the first experiment, I integrated a small calibration module in Eyetrack-Writer: It displayed a large black dot, once a set amount of data points of the user looking at the black dot were registered, the dot turned red. The user was instructed to look at her notes until a beep sound was played on the headphones. When hearing the sound, the user was instructed to look at the red dot until it turns black again. Only then access to the task and editor were granted. It improved the situation slightly, this time only one log file was suspiciously small. Additionally, it may serve as a baseline when reusing the experiment's data.

5.2.2 Results

All in all, a mean of 430.25 and median of 394.5 tokens²¹ were written by the subjects for the summary task, with a maximum of 861 and minimum of 130 tokens. Writing the summary took between 50:48 minutes and 19:12 minutes (mean 31:17; median 44:00 minutes). For an overview of descriptive time measures between the digital and analogue group, see Table 5. While so far *R* has been used for most calculations, from here on *Jupyter* notebooks were, for technical reasons, mainly used, supported by *pandas*, *SciPy* (Virtanen et al., 2020) and *matplotlib* (Hunter, 2007).

| | Digital | Analogue |
|--------|---------|----------|
| min | 19:12 | 21:44 |
| max | 50:48 | 37:35 |
| mean | 33:33 | 29:01 |
| median | 35:40 | 30:38 |

Table 5: Overview of task-completion times grouped by the use of analogue vs. digital notes.

In order to infer the time a user spent writing, or, vice versa, the subject spent searching for information or reading. Two data sources were combined to create a robust measurement of interaction with the writer application: Gaze data was joined with the writer’s event log. All data was recorded in milliseconds, for the analysis, however, I decreased the granularity of my data. I decided to analyse interaction time second-wise, because the eye-tracking setup recorded only at 30Hz, thus interaction for every second looking at the editor, would be *True* for about 30 rows (=30ms) in my dataset, while 970 rows are *False*, not because the person was not looking at the editor, but because of a lack of data. Possibly one or two more rows may be *True*, due keystrokes being recorded; still, the lack of data results in non-interaction for a majority of time on a millisecond-level – which is wrong, interaction took place, there is just no record of the interaction. While, of course, the same proportions of this error applies to all logs and all data, it still creates a wrong impression. Thus, the interaction was measured second precise.

To calculate interaction values for every second of a log, an empty table for the range between the minimum and maximum timestamps of the gaze logs of each participant were created. This table was then merged with the gaze log and the log data of the writer. The gaze log has been filtered. Only data points of the user looking at the writer’s iframe were selected. Using

²¹The final line of each writer log was stripped to text using *BeautifulSoup* (Richardson, 2015), tokenized with *NLTK* (Bird et al., 2009).

boolean logic, a column was created, *True* if a keystroke **OR** a gaze point has been logged at the timestamp. Thereafter the table was expanded with a seconds value, starting at 0 incrementing every 1000 rows. Finally, the data were grouped by the seconds column. If the sum of *True* interaction rows were > 0 within each group, the group (or second) was flagged as interaction, if neither gaze nor keystrokes were recorded, the second was classified as reading or searching. Finally, seconds with interaction were summed up, see Table 6. The proportions in the table were calculated by dividing interaction time by the total amount of time for task completion.

| | Digital | Analogue | Digital (%) | Analogue (%) |
|--------|---------|----------|-------------|--------------|
| min | 12:36 | 10:52 | 60.96 | 46.64 |
| max | 31:40 | 27:57 | 78.87 | 74.37 |
| mean | 23:01 | 19:11 | 68.22 | 65.58 |
| median | 25:27 | 19:23 | 65.17 | 67.68 |

Table 6: Interaction time with the writer in seconds. See the corresponding paragraph for a definition of interaction time and an explanation how the times were calculated.

While looking at the boxplot (Figure 21) of interaction time and total time for both groups, the difference between the groups looks quite small. Using the relative numbers, interaction in relation to the total time spent on the task, the differences look even smaller (see Figure 22). In order to proof Hypothesis **H1**, the difference in interaction time between the two test groups needs to be tested for significance. First of all, a Shapiro-Wilk test was carried out to test the normal distribution of interaction time. H_0 of the test, values were drawn from a normal distribution, is not rejected for 1. the total population ($W = .943$, $p = .393$) 2. the analogue group ($W = .984$, $p = .981$) 3. the digital group ($W = .879$, $p = .185$). Next, a Levene-Test of variance homogeneity was carried out. The result was not significant ($F = 1.18$, $p = .296$). Thus, all requirements for a univariate two-sided Welch t-test are fulfilled. The t-test shows no significant difference of interaction time between the digital ($\bar{x} = 1381s$, $sd = 455.33s$, $n = 16$) and the analogue group ($\bar{x} = 1151.38s$, $sd = 320.47s$, $n = 16$), $t(13) = 1.17$, $p = .265$. Next the relative interaction time (interaction divided by total time), was tested. Once more normal distribution was not rejected by the Shapiro-Wilk test (total population ($W = .930$, $p = .242$), analogue ($W = .861$, $p = .122$), digital ($W = .856$, $p = .109$)). Same for the Levene-Test ($F = .040$, $p = .844$). Once more, H_0 , the relative interaction time is the same for the digital prototype ($\bar{x} = 68.22\%$, $sd = 7.00$, $n = 16$) and analogue version ($\bar{x} = 65,58\%$, $sd =$

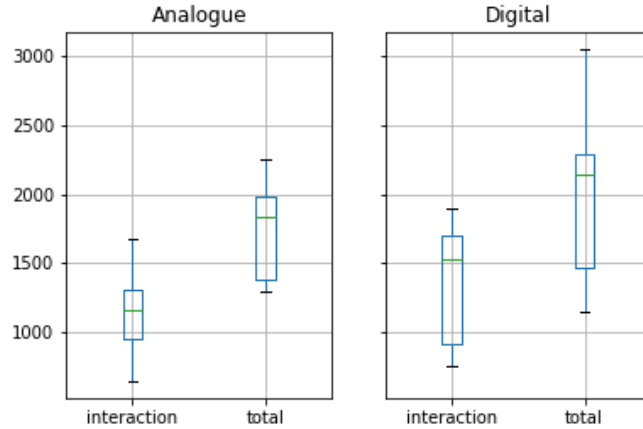


Figure 21: Boxplot of interaction time (in mm:ss) compared to the total time spent on the task.

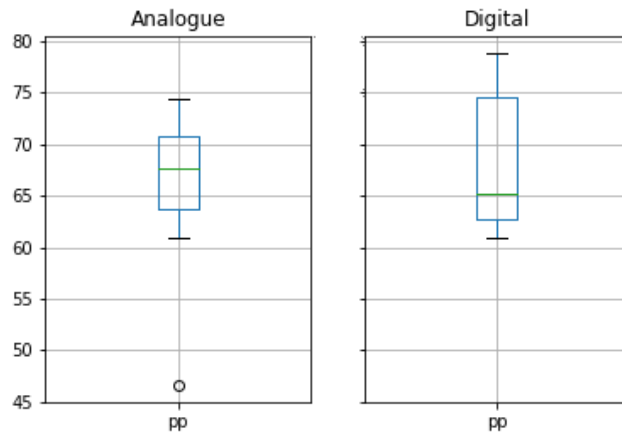


Figure 22: Boxplot of relative interaction time (in %).

8.80, $n = 16$), can not be rejected by the t-test's results ($t(13) = .664$, $p = .518$).

For further scrutiny, the dataset was imported into a *R* session, and the dataset of interaction time, total time and word count was merged with the dataset of the survey. This allowed checking for correlations and effects of demographic data on the results of the experiment. The following effects were found:

1. A linear regression shows a significant effect of the length of notes (words) on the interaction time ($F(1, 14) = 9.02$, $p = .009$). Each word adds 2.86 seconds of interaction time; the model explains 34.85% of the variance. The effect size, according to Cohen (1992), is $f = \sqrt{\frac{R^2}{1-R^2}} = .731$, large. Evaluating the model, the QQ-Plot appears to be lightly tailed, and the Scale-Location plot suggests that homosce-

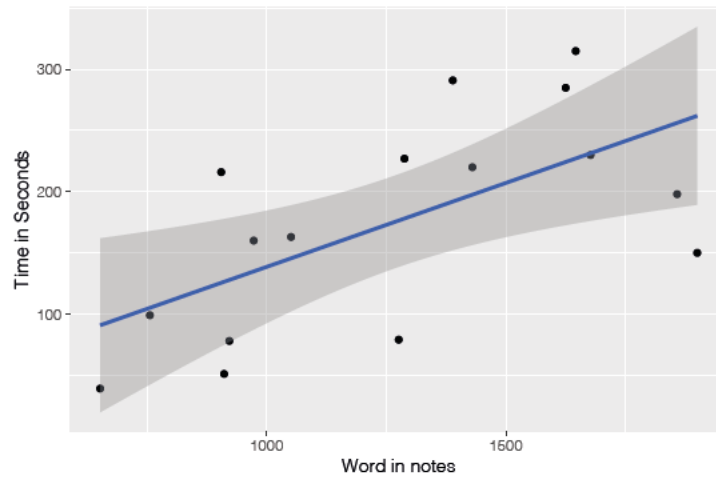


Figure 23: Plot of the linear model fit and observed data. The x-axis shows words in notes against the interaction time in seconds on the y-axis.

lasticity is breached (Figure 27 in Appendix D). All in all, the results show a significant effect of the number of words written while note-taking on interaction time with the editor. Adding any demographic items or group membership to the model did not increase its quality (R^2 value). See also Figure 23.

2. Another item was found to have a significant effect on the interaction time: The agreement to writing for university assignments ($F(1, 14) = 3.17, p = .097$). With each step of the Likert-scale, the interaction time increases by 129.98 seconds and the model explains 12.62% variance. Cohen's effect size $f = .38$ is medium. The plots (see Figure 28 in Appendix D) suggest caution, with the Scale Location plot once more suggesting breach of homoscedasticity, and the QQ-Plot showing a heavy tail.

Finally, my prototype showed no significant effect on interaction time with the writer. The two linear regressions presented do not create a better model when integrated – combining both items, word count and agreement to writing for university assignments does not result in a better model than considering only the count of words in the notes, in fact in a multiple regression model the later item loses its significance. Thus, displaying notes next to a digital text does not appear to have any influence on the time spent interacting with the writer – or, vice versa, reading or searching for text passages – in relative and absolute numbers. To answer the apprehensions about the aspired degree's influence on the results has been checked as well, no significant effects on the interaction times were observed. The results of the linear regression suggest the following:

1. My experiment, possibly, did not measure the difference between the digital prototype and the analogue notes, rather differences between note-taking or scholarly work affinity. Standardizing note-taking could have controlled this through, i.e. limitations or specific sub-tasks. Another option would be to move from a between-subjects experiment design to a within-subjects design. For such an experiment, each subject would read two different texts through different sessions. After each reading session, a writing session would take place, once with the digital notes, once with the analogue ones, in a randomized sequence.
2. The correlation between the agreement with writing for university assignments and interaction time suggests, that for future experiments, a more homogenous population is needed. A within-subject design might also help control for the effects of affinity with written assignments (which might just be another predictor for the note-taking affinity).
3. Future experiments should incorporate more specific tasks. The number of words written as notes, as well as the number of words written for the summary, need to be limited.

This being said, a multiple regression analysis does not show a significant effect of group membership, while controlling for the number of words ($F(2, 13) = 6.07, p = .0137$). While the model explains a larger amount of the variance (40.35%) than only taking the number of words into account. The effect size, according to Cohen, is large. However, group membership is not a significant predictor ($p = 0.154$) for the regression. Therefore it is disputable, whether a fixed length of notes would make any difference in the outcome of the presented experiment.

The design of the prototype for translation assistance offered multiple display combinations. First of all, the user was able to switch between transcriptions and her handwritten notes. Additionally, the notes could be displayed next to the text or in notepad view, emulating the original look on the paper notepad, see Figure 25. While the intention, to offer subjects as natural a view as possible, and to improve the usability, this might well have interfered with my object of investigation. The Eyetrack Reader logged events, such as mouseovers and clicks on notes, and captured whether the reader was displaying the notes in notepad mode or relative to the primary text. Similarly a boolean captured whether the scans or transcriptions were displayed, but an error in my code prevented the update of that variable. Thus, table 7 only shows the time spent in notepad view for each user. All in all, the relative

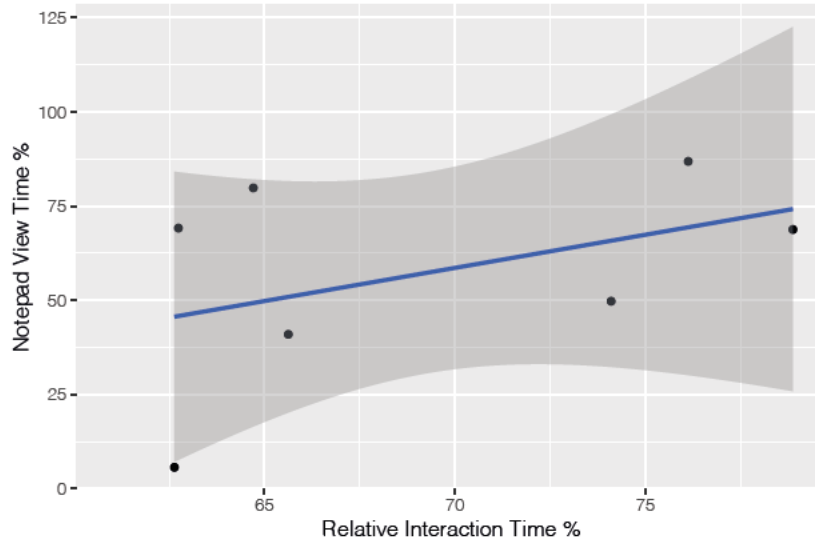


Figure 24: Linear correlation between relative notepad mode view time and relative interaction time. While the plot looks promising, the actual regression model does not show a significant correlation.

mean of time spent in notepad view is 57.27%, while the standard deviation is rather high at 25.76. While figure 24 suggests a linear correlation between the relative interaction time and relative notepad view time, the linear regression is not significant ($F(1, 5) = 1.16$, $p = 0.330$, $R^2 = .027$). All things considered, the case number is quite low ($n = 7$); hence at this point validity may well be contested. Therefore I suggest conducting future experiments with a fixed display style (relative or notepad view), to increase the quality of log data by excluding disruptive factors. Eventually, after each view type has been evaluated by itself, a comparative study between view types may well follow.

| pseudonym | Notepad View (ms) | Relative Time (%) |
|-----------------------|-------------------|-------------------|
| lauterer-Jannik | 1102910 | 69.14 |
| brave-Summer | 35104 | 5.66 |
| konstitutive-Nahla | 638014 | 40.94 |
| religiöse-Zazou | 2323264 | 86.86 |
| unvollendete-Helin | 0 | NaN |
| szenische-Lilith | 2187942 | 79.81 |
| erinnerlicher-William | 1267208 | 49.73 |
| interner-Quirin | 1710731 | 68.77 |

Table 7: Time per user spent in notepad view (ms), and relative to total time (%). The log file for unvollendete-Helin is missing.

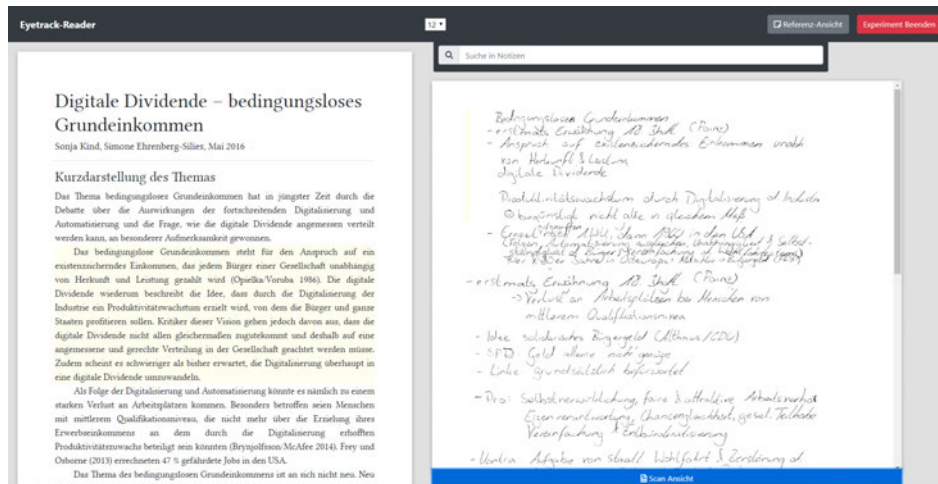


Figure 25: Version 2 of Eyetrack-Reader, here in notepad-view showing the mouseover effect. A line in the notes is hovered by the mouse, thus the line receives a yellow left-hand border and the corresponding paragraph is highlighted in the text.

5.2.3 Qualitative Feedback

The participants of the user study were asked to take part in a very brief focus group, just after writing the summary for the second experiment. Due to the second experiment taking longer than expected²², these group conversations were shorter than planned: Once the first test group's session ended, participants for the second session have already been waiting for 15 minutes. Nevertheless, some interesting feedback was gathered through open-ended questions:

While several participants in the digital group called the prototype 'praktisch', practical, one person instantaneously saw a use-case: She does not like to take notes on PC as she finds it hard to concentrate, yet she would like her notes to be – as she called it – online, for instance for sharing. She argued that for her, the notes definitely saved time for the task. Another set of people did not share this enthusiasm since they argued they would not take notes by hand. Thus they saw the display of the notes as practical, just the conversion of handwritten to digital would not serve them any purpose. Finally, it appears that transcription needs to be as accurate as possible. Several people mentioned, that the transcription had mistakes, mostly mentioned were wrong conversions of abbreviations or missing formatting, which was important to them, but missing in the transcribed version. Since the scanned version of the notes was just one click away, this problem could be fixed. However, the

²²at the beginning of the first session, some problems with the eye-tracker calibration occurred. Thus, the actual experiment started later than expected. Additionally, some wrote much more than expected.

participants expressed a strong interest in correct automatic translation in order for them to use such a system. No one reported the use of the search function. When the connectors between notes were mentioned, two people's memory was triggered. One of them appeared, upon thinking about them, amazed how the connection between these, for him, related notes appeared, another person was rather indifferent, for her, the connection was a given. Finally, one person expressed doubts, whether her notes could ever be interpreted correctly by a system since she has a particular notation system, which a system would need to understand and use for digitized notes as well. This doubt was linked to her missing indents in the digitized notes. The group agreed, another respondent suggested that it should be possible to customize a system, to train it to spot the details and reproduce and interpret them correctly.

Subjects of the analogue group brought up some interesting thoughts about their note-taking practice. One person realized that some filtering took place while taking notes and another one reported a loss of concentration between the first part of the primary text and the second, resulting in differences of the quality of the notes. Since most people took notes chronologically, they were able to find the anchors belonging to lines of notes in the primary text again. One person would have liked to use the search function²³ because she spent some time looking for specific information as her notes were not thorough enough. Another person reported the use of Firefox's inbuilt search function to find specific keywords in the primary text again. All in all, the students saw their notes as a helpful resource for finishing the task, since their notes were pre-filtered outlines on one page. Finally, also, participants of this group reported differences between the experimental setup and their natural reading and note-taking practice. In this group, the main critique was, while the detractors were digital readers, they lacked the possibility to annotate the text, as they would typically do in *Adobe Acrobat Reader*. One person saw the experiments as extremely difficult since she never works digitally. Finally, one student mentioned how the second monitor was actually quite helpful when working, and another person stated how she wants to become paperless. Therefore she bought a computer with a hardware pen, which she uses for digital annotation. Thus she was missing the possibility when reading for the experiment.

²³Unfortunately the 'Search Notes' field was displayed for this group as well. In hindsight, it would have been better to hide the search bar for the analogue group, to avoid confusion.

5.3 Final Assessment

In summary, the users of the digital version found the ‘translated’ display of their notes useful. Nevertheless, they expressed a keen interest in detail and customizability for a system to be beneficial. The users of the analogue group deemed their notes as helpful in fulfilling the task, few people wished for better searchability. Also, it appears that note-taking or excerpt production, while different to annotation, might in the future not be thought of as two independent activities, instead, it appears, that there exists an interdependency. Hypothesis **H1** could not be proofed, since the statistical analysis to proof **H1.1** showed no significant difference in interaction time between the digital and analogue test group. The preparations for the second experiment proof **H2.1** through **H2.3** to be true – the data collected in the first experiment was sufficient in order to reconstruct anchors for notes in the text. The qualitative feedback suggests, that **H2.4** is also correct, as mistakes in transcriptions were immediately noted, while there was no negative feedback about wrong relations between notes and text. Thus I assume **H2** to be accurate, silent assistance linking hand-written notes to the right anchor of a digital text through the use of eye-tracking is possible.

6 Final Discussion

At the beginning of this thesis, I introduced the concept of excerpts as a millennial cultural technology. This technology evolved through time, its modern version sprouted in the early modern times, paired with the invention of the printing press and science's shift from a high value in oral debates and transmission, towards outsourcing memory by the mean of excerpts and notes. Thus, it is no coincidence that the English term 'note' in its first uses dates back to a similar time frame. Notes eventually evolved towards slip boxes for more systematic access of the outsourced memory, which eventually was a predecessor for the modern web. Bush's memex, has been a driving force for multiple researchers, trying to digitise the concept of a slip box and beyond.

Similarly, the memex became the vision for this thesis, since it is concerned with aiding scholarly research by the mean of a digital assistant, gathering knowledge through monitoring literature search, as well as annotation and excerpt production. While notes and excerpts are used synonymously, I investigated the differences between them and showed, how most students interviewed were actually producing excerpts, even though most did not use this terminology. Additionally, it transpired, and I believe this is one of the most important findings of this work, that students appear to manage their bibliographies in two ways: Through bibliographic entries (possibly managed in software), and through the collection of their excerpts. For the latter type, excerpts are an essential tool to organise their literature and manage their citations: On the one hand, excerpts help everyone remembering. Thus they work as memory cues, linking and to relevant passages in a text. On the other hand, for those who manage their literature through excerpts, they find the actual literature again by looking through their excerpts and find in most cases all relevant information for citations on their excerpts.

While the literature backed my finding for the relevance of excerpts for humanist research, I was not able to find any digital humanities project concerned with note-taking or excerpt production. Few papers deal with the theoretical question of how to anchor notes in *TEI* documents or how to display a note for collaborative research, none of the papers, however, deals with excerpts. After outlining the research of Personal Information Management, with a particular focus on document classification and landmarks, I summed up the reports of several prototypes, trying to improve the refinding of documents. The findings presented in the literature, suggest more context data and landmarks improve refinding. This motivated the development of a digital assistant for research, notated in a concurrent task tree model, with

a special focus on the translation assistance module. The system would capture the state of the user in the digital and analogue world, thereby collecting vital context data to be saved with documents. At the same time, the system would monitor the literature search, note and manuscript production, thus watch over all documents relevant for research. Combining these two sources of information, it would create a database, parallel to the operating system's file system, to allow for context-sensitive suggestions and recommendations while writing a manuscript. By intelligently capturing notes and manuscripts, it becomes the digital slip box, close to Bush's memex. Using the translated knowledge from excerpts, the system can display notes in the right place. Based on the PIM literature, which shows how landmarks improve refinding for documents, the concept of translation assistance is to improve refinding of relevant text passages, by using notes as landmarks when exploring the text for a second time.

The later has been evaluated with a prototype. While the experiments showed how, using a webcam and eye-tracker, it is possible to reconstruct text anchors for notes. The translation assistance applied did not show any improvements of efficiency for the task of summary writing between two test-groups, one using the prototype, the other using paper notes. As has been mentioned in the previous chapter, the experiment might have had some design flaws, measuring two interfering parameters. At the same time, the population of the experiment might have been too heterogeneous in their scholarly workflow, lowering the expectations for a valid result. Qualitative feedback for the prototype was motivating; for those who use the combination digital reading, analogue note-taking, the prototype emerged as practical. At the same time, participants emphasised, how important it would be for a digital tool to adjust to their system and needs. This is recurring feedback, found in the literature and emphasised in the interviews as well: The humanist does not want to adapt to a system, the system needs to adapt to the user.

When conducting the experimental evaluation of the prototype, a multitude of data streams has been captured. Not all streams were analysed for this thesis. Thus, data may be explored and reused further. The webcam stream of the second session, for example, might be used to manually tag the gaze data, for training a model determining whether the user looks at the main screen, the reader screen or notes. The summaries produced in the second session may be qualitatively evaluated, possibly in combination with a qualitative analysis of the excerpts produced by the subject: as the amount of words in the excerpts correlates to the number of tokens in the written summaries, the question arises, whether more extended excerpts pro-

duced summaries of higher quality. Similarly, the material might be used to explore, whether it is possible to automatically determine excerpt and summary quality, by comparing the produced texts to the primary text.

Finally, I am confident, to have shown how notes are at the centre of the humanist research and build the foundation of the scholarly slip box, allowing a digital assistant access to knowledge gathered by the user, offering the possibility to translate and display the information in the right place to aid research and improve refinding. While my evaluation was not able to prove higher efficiency of translated notes in summary writing, I suggest further research to be conducted, testing different translations in different settings. Ultimately, by investigating note-taking taking, I believe in having found the most critical context information for refinding literature, for a group of people forgotten by bibliographic management software development: notes themselves. One type of bibliographic management is all centred around excerpts; this finding should aid future development of bibliographic management tools and is mandatory for a digital research assistant.

A References

- Anderson, S., Blanke, T. & Dunn, S. (2010). Methodological commons: Arts and humanities e-science fundamentals. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences*, 368(1925), 3779–3796. <https://doi.org/10.1098/rsta.2010.0156>
- Andorfer, P. (2015). *Forschen und Forschungsdaten in den Geisteswissenschaften: Zwischenbericht einer Interviewreihe*. Göttingen.
- Antonijević, S. (2015). *Amongst digital humanists: An ethnographic study of digital knowledge production*. Palgrave Macmillan US.
- Balog, K. & Kenter, T. (2019). Personal knowledge graphs: A research agenda, In *Proceedings of the 2019 ACM SIGIR international conference on theory of information retrieval - ICTIR '19*, Santa Clara, CA, USA, ACM Press. <https://doi.org/10.1145/3341981.3344241>
- Barreau, D. K. (1995). Context as a factor in personal information management systems. *Journal of the American Society for Information Science*, 46(5), 327–339.
- Bazo, A. (n.d.-a). *Gaze-client.js* [Accessed: 5 January 2020]. <https://lab.las3.de/gitlab/eye-tracking-classroom/gaze-client.js>
- Bazo, A. (n.d.-b). *StarGazer* [Accessed: 5 January 2020]. <https://lab.las3.de/gitlab/eye-tracking-classroom/StarGazer>
- Beel, J., Gipp, B., Langer, S. & Genzmehr, M. (2011). Docear: An academic literature suite for searching, organizing and creating academic literature, In *Proceedings of the 11th annual international ACM/IEEE joint conference on digital libraries*, Ottawa, Ontario, Canada, ACM. <https://doi.org/10.1145/1998076.1998188>
- Bell, G. (2001). A personal digital store. *Communications of the ACM*, 44(1), 86–91. <https://doi.org/10.1145/357489.357513>
- Bell, G. & Gemmell, J. (2007). A digital life. *Scientific American*, 296(3), 58–65. <https://doi.org/10.1038/scientificamerican0307-58>
- Benardou, A., Constantopoulos, P., Dallas, C. & Gavrilis, D. (2010). Understanding the information requirements of arts and humanities scholarship. *International Journal of Digital Curation*, 5(1), 18–33. <https://doi.org/10.2218/ijdc.v5i1.141>

- Berners-Lee, T. (1980). ENQUIRE V 1.1 [Accessed: 5 February 2020]. <https://www.w3.org/History/1980/Enquire/manual/>
- Bernstein, M., van Kleek, M., Karger, D. & Schraefel, M. C. (2008). Information scraps: How and why information eludes our personal information management tools. *ACM Transactions on Information and System Security*, 26(4), 24:1–24:46. <https://doi.org/10.1145/1402256.1402263>
- Bernstein, M. S., Van Kleek, M., Schraefel, M. c. & Karger, D. R. (2007). Management of Personal Information Scraps, In *CHI '07 Extended Abstracts on Human Factors in Computing Systems*, San Jose, CA, USA, ACM. <https://doi.org/10.1145/1240866.1240995>
- Bird, S., Klein, E. & Loper, E. (2009). *Natural language processing with python: Analyzing text with the natural language toolkit*. “O’Reilly Media, Inc.”
- Blanke, T. & Hedges, M. (2013). Scholarly primitives: Building institutional infrastructure for humanities e-science. *Future generations computer systems: FGCS*, 29(2), 654–661. <https://doi.org/10.1016/j.future.2011.06.006>
- Boardman, R. & Sasse, M. A. (2004). “stuff goes into the computer and doesn’t come out”: A cross-tool study of personal information management, In *Proceedings of the 2004 conference on human factors in computing systems - CHI '04*, Vienna, Austria, ACM Press. <https://doi.org/10.1145/985692.985766>
- Bootstrap* [Accessed: 5 January 2020]. (n.d.). <https://github.com/twbs/bootstrap>
- Bradley, J. & Vetch, P. (2007). Supporting annotation as a scholarly Tool—Experiences from the online chopin variorum edition. *Literary and Linguistic Computing*, 22(2), 225–241. <https://doi.org/10.1093/lc/fqm001>
- Brockman, W. S., Neumann, L., Palmer, C. L. & Tidline, T. J. (2001). *Scholarly work in the humanities and the evolving information environment*. Washington D.C., Digital Library Federation Council on Library; Information Resources.
- Brush, A. J. B., Barger, D., Gupta, A. & Cadiz, J. J. (2001). Robust annotation positioning in digital documents, In *Proceedings of the SIGCHI conference on human factors in computing systems - CHI '01*, Seattle, Washington, United States, ACM Press. <https://doi.org/10.1145/365024.365117>
- Bush, V. (1945). As we may think. *The Atlantic*.

- Case, D. O. (1986). Collection and organization of written information by social scientists and humanists: A review and exploratory study. *Journal of Information Science and Engineering*, 12(3), 97–104. <https://doi.org/10.1177/016555158601200302>
- Case, D. O. (1991). The collection and use of information by some american historians: A study of motives and methods. *The Library quarterly*, 61(1), 61–82. <https://doi.org/10.1086/602298>
- Cevolini, A. (2016). *Forgetting machines: Knowledge management evolution in early modern europe*. Brill. <https://doi.org/10.1163/9789004325258>
- Cevolini, A. (2018). Exzerpieren. In H. Christians, N. Wegmann & M. Bickenbach (Eds.), *Historisches wörterbuch des mediengebrauchs* (pp. 149–166). Köln, Böhlau Verlag.
- Chau, D. H., Myers, B. & Faulring, A. (2008). What to do when search fails: Finding information by association, In *Proceedings of the sigchi conference on human factors in computing systems*, New York, NY, USA, ACM. <https://doi.org/10.1145/1357054.1357208>
- Chen, S.-C. (2019). Exploring the use of electronic resources by humanities scholars during the research process. *The Electronic Library*, 37(2), 240–254. <https://doi.org/10.1108/EL-08-2018-0170>
- Cohen, J. (1992). A power primer. *Psychological bulletin*, 112(1), 155–159.
- Collins, E., Bulger, M. E. & Meyer, E. T. (2012). Discipline matters: Technology use in the humanities. *Arts and Humanities in Higher Education*, 11(1-2), 76–92. <https://doi.org/10.1177/1474022211427421>
- Corbin, J. M. & Strauss, A. L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3. ed.). Los Angeles, Calif., Sage Publications, Inc.
- Crystal, A. J. (2008). *Design research for personal information management systems to support undergraduate students* (J. Greenberg, G. Marchionini, P. Solomon, D. Barreau & J. Gemmell, Eds.; Doctoral dissertation). University of North Carolina. The University of North Carolina at Chapel Hill.
- Cutrell, E., Robbins, D., Dumais, S. & Sarin, R. (2006). Fast, flexible filtering with phlat, In *Proceedings of the SIGCHI conference on human factors in computing systems*, New York, NY, USA, ACM. <https://doi.org/10.1145/1124772.1124812>
- Di Vesta, F. J. & Gray, G. S. (1972). Listening and note taking. *Journal of educational psychology*, 63(1), 8–14. <https://doi.org/10.1037/h0032243>

- Diaper, D. (2004). Understanding task analysis for human-computer interaction. *The handbook of task analysis for human-computer interaction*, 5–47.
- Dix, A., Finlay, J., Abowd, G. D. & Beale, R. (2004). *Human-computer interaction*. Pearson Education.
- Dowling, R. & Wilson, M. (2017). Digital doctorates? an exploratory study of PhD candidates' use of online tools. *Innovations in Education and Teaching International*, 54(1), 76–86. <https://doi.org/10.1080/14703297.2015.1058720>
- Drăgan, L., Handschuh, S. & Decker, S. (2011). The semantic desktop at work: Interlinking notes, In *Proceedings of the 7th international conference on semantic systems*, Graz, Austria, ACM. <https://doi.org/10.1145/2063518.2063521>
- Ehlich, K. (1981). Zur analyse der textart exzerpt. *Pragmatik. Theorie und Praxis. Amsterdam: Amsterdamer Beiträge zur neueren Germanistik.*, 13, 379–401.
- Evéquo, F. & Lalanne, D. (2009). I thought you would show me how to do it – studying and supporting PIM strategy changes, In *PIM workshop, ASIS&T*.
- Fahlander, D. (n.d.). *Dexie.js* [Accessed: 19 January 2020]. <https://github.com/dfahlander/Dexie.js>
- Freeman, E. & Fertig, S. (1995). Lifestreams: Organizing your electronic life, In *Aaai fall symposium: Ai applications in knowledge navigation and retrieval*.
- Gemmell, J., Bell, G. & Lueder, R. (2006). Mylifebits: A personal database for everything. *Communications of the ACM*, 49(1), 88–95. <https://doi.org/10.1145/1107458.1107460>
- Hartley, J. & Davies, I. K. (1978). Note-taking: A critical review. *Programmed Learning and Educational Technology*, 15(3), 207–224. <https://doi.org/10.1080/0033039780150305>
- Hughes, L., Constantopoulos, P. & Dallas, C. (2015). Digital methods in the humanities: Understanding and describing their use across the disciplines. In S. Schreibman, R. Siemens & J. Unsworth (Eds.), *A new companion to digital humanities* (pp. 150–170). Chichester, UK, John Wiley & Sons, Ltd. <https://doi.org/10.1002/9781118680605.ch11>
- Hunter, J. D. (2007). Matplotlib: A 2d graphics environment. *Computing in Science & Engineering*, 9(3), 90–95. <https://doi.org/10.1109/MCSE.2007.55>

- Ivanov, A. & Orozova, D. (2018). Virtual intelligent personal assistant for bat researchers, In *Proceedings of the 19th international conference on computer systems and technologies - CompSysTech'18*, Ruse, Bulgaria, ACM Press. <https://doi.org/10.1145/3274005.3274022>
- Jervis, M. (2014). How do people attempt to integrate the management of their paper and electronic documents? *Aslib Journal of Information Management*, 66(2), 134–155. <https://doi.org/10.1108/AJIM-01-2013-0007>
- Jones, W. (2007). Personal information management. *Annual Review of Information Science and Technology*, 41(1), 453–504. <https://doi.org/10.1002/aris.2007.1440410117>
- Jquery* [Accessed: 5 January 2002]. (n.d.). <https://github.com/jquery/jquery>
- Kalnikaitė, V. & Whittaker, S. (2007). Software or wetware?: Discovering when and why people use digital prosthetic memory, In *Proceedings of the SIGCHI conference on human factors in computing systems*, San Jose, California, USA, ACM. <https://doi.org/10.1145/1240624.1240635>
- Kalnikaitė, V. & Whittaker, S. (2008). Cueing digital memory: How and why do digital notes help us remember?, In *Proceedings of the 22nd british HCI group annual conference on people and computers: Culture, creativity, interaction - volume 1*, Liverpool, United Kingdom, BCS Learning & Development Ltd.
- Karger, D. R., Bakshi, K., Huynh, D., Quan, D. & Sinha, V. (2005). Haystack: A customizable general-purpose information management tool for end users of semistructured data, In *Proceedings of the CIDR conference*.
- Kawamura, T. (n.d.). *Paper-css* [Accessed: 5 January 2020]. <https://github.com/cognitom/paper-css>
- Khan, A. A. (2019). Gaze assisted voice note taking system, In *Proceedings of the 2019 ACM international joint conference on pervasive and ubiquitous computing and proceedings of the 2019 ACM international symposium on wearable computers - UbiComp/ISWC '19*, London, United Kingdom, ACM Press. <https://doi.org/10.1145/3341162.3349308>
- Khan, M. (n.d.). *RecordRTC* [Accessed: 16 January 2020]. <https://github.com/muaz-khan/RecordRTC>
- Kiewra, K. A. (1989). A review of note-taking: The encoding-storage paradigm and beyond. *Educational psychology review*, 1(2), 147–172. <https://doi.org/10.1007/BF01326640>
- Kind, S. & Ehrenberg-Silies, S. (2016). Digitale Dividende–Bedingungsloses Grundeinkommen [Accessed: 5 January 2020]. <https://www.tab-beim->

bundestag.de/de/pdf/publikationen/themenprofile/Themenkurzprofil-002.pdf

- Kluyver, T., Ragan-Kelley, B., Pérez, F., Granger, B., Bussonnier, M., Frederic, J., Kelley, K., Hamrick, J., Grout, J., Corlay, S., Ivanov, P., Avila, D., Abdalla, S. & Willing, C. (2016). Jupyter notebooks – a publishing format for reproducible computational workflows (F. Loizides & B. Schmidt, Eds.). In F. Loizides & B. Schmidt (Eds.), *Positioning and power in academic publishing: Players, agents and agendas*.
- Kuhlthau, C. C. (1991). Inside the search process: Information seeking from the user's perspective. *Journal of the American Society for Information Science*, 42(5), 361–371.
- Kuhlthau, C. C. (1994). Students and the information search process: Zones of intervention for librarians. In P. G. Irene (Ed.), *Advances in librarianship* (pp. 57–72). Emerald Group Publishing Limited. [https://doi.org/10.1108/S0065-2830\(1994\)0000018004](https://doi.org/10.1108/S0065-2830(1994)0000018004)
- Kwaśnik, B. (1989). How a personal document's intended use or purpose affects its classification in an office, In *Proceedings of the 12th annual international ACM SIGIR conference on research and development in information retrieval*, ACM. <https://doi.org/10.1145/75335.75356>
- Kwaśnik, B. (1991). The importance of factors that are not document attributes in the organisation of personal documents. *Journal of Documentation*, 47(4), 389–398. <https://doi.org/10.1108/eb026886>
- Lamming, M., Brown, P., Carter, K., Eldridge, M., Flynn, M., Louie, G., Robinson, P. & Sellen, A. (1994). The design of a human memory prosthesis. *Computer Journal*, 37(3), 153–163. <https://doi.org/10.1093/comjnl/37.3.153>
- Ludwig, B. (2015). *Planbasierte Mensch-Maschine-Interaktion in multimodalen Assistenzsystemen*. Springer-Verlag.
- Mainzer, K. (2016). *Künstliche Intelligenz – Wann übernehmen die Maschinen?* Berlin, Heidelberg, Springer. <https://doi.org/10.1007/978-3-662-48453-1>
- Malone, T. W. (1983). How do people organize their desks?: Implications for the design of office information systems. *ACM Transactions on Information Systems (TOIS)*, 1(1), 99–112. <https://doi.org/10.1145/357423.357430>
- Marshall, C. C. (1997). Annotation: From paper books to the digital library, In *Proceedings of the second ACM international conference on digital libraries - DL '97*, Philadelphia, Pennsylvania, United States, ACM Press. <https://doi.org/10.1145/263690.263806>

- McKinney, W. (2010). Data structures for statistical computing in python (S. van der Walt & J. Millman, Eds.). In S. van der Walt & J. Millman (Eds.), *Proceedings of the 9th python in science conference*.
- Milton, N. R. (2007). *Knowledge acquisition in practice: A step-by-step guide*. Springer, London. <https://doi.org/10.1007/978-1-84628-861-6>
- Mizrachi, D. & Bates, M. J. (2013). Undergraduates' personal academic information management and the consideration of time and task-urgency. *Journal of the American Society for Information Science and Technology*, 64(8), 1590–1607. <https://doi.org/10.1002/asi.22849>
- The most advanced WYSIWYG HTML editor — TinyMCE* [Accessed: 13 February 2020]. (n.d.). <https://www.tiny.cloud/>
- Mueller, P. A. & Oppenheimer, D. M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. *Psychological science*, 25(6), 1159–1168. <https://doi.org/10.1177/0956797614524581>
- Norman, D. (2013). *The design of everyday things: Revised and expanded edition*. Hachette UK.
- Ooms, J. (2014). The jsonlite package: A practical and consistent mapping between JSON data and R objects.
- Oxford English Dictionary. (n.d.-a). “annotation, n.” [Accessed: 20 January 2020]. <https://www.oed.com/view/Entry/7922?redirectedFrom=annotation>
- Oxford English Dictionary. (n.d.-b). Annotate, v [Accessed: 20 January 2020]. www.oed.com/view/Entry/7920
- Oxford English Dictionary. (n.d.-c). Note, n.2 [Accessed: 20 January 2020]. <https://www.oed.com/view/Entry/128546?rskey=l3bHOX&result=2&isAdvanced=false>
- Palmer, C. L. (2009). *Scholarly information practices in the online environment: Themes from the literature and implications for library service development*. OCLC Research.
- Palmer, C. L. & Neumann, L. J. (2002). The information work of interdisciplinary humanities scholars: Exploration and translation. *The Library Quarterly: Information, Community, Policy*, 72(1), 85–117.
- Paternò, F. (2000). *Model-Based design and evaluation of interactive applications*. Springer, London. <https://doi.org/10.1007/978-1-4471-0445-2>
- Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, 9(5), 1–6. <https://doi.org/10.1108/107481201110424816>
- Puhl, J., Andorfer, P., Höckendorff, M., Schmunk, S., Stiller, J. & Thoden, K. (2015). Diskussion und Definition eines Research Data LifeCycle

- für die digitalen Geisteswissenschaften. Göttingen, Niedersächsische Staats- und Universitätsbibliothek Göttingen.
- The python tutorial — python 3.7.3 documentation* [Accessed: 11 April 2019]. (n.d.). <https://docs.python.org/3/tutorial/>
- R Core Team. (2018). R: A language and environment for statistical computing. *Vienna, Austria*.
- Resch, O. & Yankova, A. (2019). Open knowledge interface: A digital assistant to support students in writing academic assignments, In *Proceedings of the 1st ACM SIGSOFT international workshop on education through advanced software engineering and artificial intelligence - EASEAI 2019*, Tallinn, Estonia, ACM Press. <https://doi.org/10.1145/3340435.3342723>
- Richardson, L. (2015). *Beautiful soup 4.8.1 documentation*.
- Ringel, M., Cutrell, E., Dumais, S., Horvitz, E. Et al. (2003). Milestones in time: The value of landmarks in retrieving information from personal stores (M. M. Matthias Rauterberg, Ed.). In M. M. Matthias Rauterberg (Ed.), *Human-computer interaction, interact '03*.
- SAP Design. (2018). SAP Inscribe - bringing digital ink to life [Accessed 1 February 2020]. Youtube. <https://www.youtube.com/watch?v=kICnfrqOizw>
- Schwappach, F. & Burghardt, M. (2019). Augmentierte Notizbücher und Natürliche Interaktion – Unterstützung der Kulturtechnik Handschrift in einer digitalen Forschungswelt.
- Soper, M. E. (1976). Characteristics and use of personal collections. *The Library quarterly*, 46(4), 397.
- Stachowiak, H. (1973). *Allgemeine modelltheorie*. Wien, Springer-Verlag.
- Strauss, A. L. & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications.
- SurveyJS: Free online survey and quiz tools* [Accessed: 19 January 2020]. (n.d.). <https://surveyjs.io/>
- Toms, E. G. (2008). Understanding the information and communication technology needs of the e-humanist. *Journal of Documentation*, 64(1), 102–130. <https://doi.org/10.1108/00220410810844178>
- Unsworth, J. (2000). Scholarly primitives: What methods do humanities researchers have in common, and how might our tools reflect this? [Accessed: 10 December 2019].
- VERBI Software. (2019). *MAXQDA 2020*. <https://www.maxqda.com/>
- Virtanen, P., Gommers, R., Oliphant, T. E., Haberland, M., Reddy, T., Cournapeau, D., Burovski, E., Peterson, P., Weckesser, W., Bright,

- J., van der Walt, S. J., Brett, M., Wilson, J., Jarrod Millman, K., Mayorov, N., Nelson, A. R. J., Jones, E., Kern, R., Larson, E., . . . Contributors, S. 1. 0. (2020). SciPy 1.0: Fundamental Algorithms for Scientific Computing in Python. *Nature Methods*. <https://doi.org/https://doi.org/10.1038/s41592-019-0686-2>
- Walker, A. (2018). Openxlsx: Read, write and edit XLSX files.
- Wandke, H. (2005). Assistance in human-machine interaction: A conceptual framework and a proposal for a taxonomy. *Theoretical Issues in Ergonomics Science*, 6(2), 129–155. <https://doi.org/10.1080/1463922042000295669>
- West, M. T. (2011). Ubiquitous computing, In *Proceeding of the 39th ACM annual conference on SIGUCCS - SIGUCCS '11*, San Diego, California, USA, ACM Press. <https://doi.org/10.1145/2070364.2070410>
- Whittaker, S. & Sidner, C. (1996). Email overload: Exploring personal information management of email, In *Proceedings of the SIGCHI conference on human factors in computing systems common ground - CHI '96*, Vancouver, British Columbia, Canada, ACM Press. <https://doi.org/10.1145/238386.238530>
- Wickham, H. (2016). Ggplot2: Elegant graphics for data analysis. Springer-Verlag New York.
- Wickham, H., François, R., Henry, L. & Müller, K. (2019). Dplyr: A grammar of data manipulation.
- Wickham, H. & Henry, L. (2018). Tidy: Easily tidy data with 'spread()' and 'gather()' functions.
- Wiklund, G. & Voog, H. (2013). It takes two to tango – making way for relevant research support services at lund university libraries (LUB). *ScieCom Info*, 9(1).
- Wiklund, G., Voog, H. & Kjellberg, S. (2017). It's all about keeping quiet—using focus group interviews to understand the everyday life of researchers in order to support their research. *Qualitative and Quantitative Methods in Libraries*, 3(1), 253–261.
- Yeo, R. (2014). *Notebooks, english virtuosi, and early modern science*. University of Chicago Press.

B Interview Framework

Interviewleitfaden

Michael Achmann

Stand: 5. August 2019

Wir führen das heutige Interview im Zuge meiner Masterarbeit. Darin möchte ich den wissenschaftlichen Forschungsprozess untersuchen, besonders interessiert mich dabei die Arbeitsschritte, die dich von deinen Quellen zu einer geschriebenen Arbeit führen und welche Funktion Notizen in diesem Prozess einnehmen. Deshalb werden wir zunächst darüber sprechen mit welchen Quellen du in der Regel arbeitest, wie du die Quellen aufbereitest und abschließend wie sich alle Informationen, die du in deinem Forschungsprozess zusammenträgst ergänzen und zu einem Text zusammenfügen.

1 Forschungspraxis

Übliche Quellen werden bereits im Fragebogen abgefragt, ebenso eine Einschätzung wie viel der Arbeit empirisch bzw. textbasiert geschieht.

1. Wie sieht Forschung in deinem Fachbereich aus?
2. Welche Schritte durchläufst du von der Idee zum Schreibprozess?
3. Wie suchst du deine Quellen?
4. Wie behältst du den Überblick über deine Quellen?
5. Wie bereitest du deine Quellen auf?
 - a) Annotierst du Texte?
 - b) Schreibst du eigenen Exzerpte zu deinen Quellen?
 - c) Machst du Notizen zu / in gelesenen Texten?
 - d) → Falls ja: Wie „speicherst“ du die Exzerpte und Notizen?
6. Gibt es in diesem Prozess etwas, das du gerne verbessern würdest?

2 Notizen

Fertigst du während deiner Forschungsarbeit Notizen an?

1. Wie fertigst du die Notizen an (auf welchem Medium)
 - a) Notierst du in das gelesene Buch oder ausgedruckte Kopie?
 - b) Nutzt du einen Block, Schmierzettel oder Notizbuch für deine Notizen?
 - c) Nutzt du für Notizen einen Computer?
 - d) Notierst du elektronisch direkt im eBook, PDF oder auf gescannten Seiten?
 - e) Nutzt du für deine Notizen ein Tablet?
2. Wann fertigst du die Notizen an? (z. B. vor / nach Lesen der Literatur)
3. Was notierst du?
 - a) Verwendest du Abkürzungen oder Codes?
 - b) Wären die Notizen für andere lesbar?
 - c) Sind die Notizen ohne zugehörigen Text / Quelle verständlich?
 - d) Wären sie für andere verständlich?
 - e) Werden die Notizen angefertigt, um später darauf zugreifen zu können?
4. Wofür machst du dir bei deiner Forschungsarbeit Notizen?
5. Würdest du an diesem Prozess gerne etwas verbessern?

3 Schreibprozess

1. Wann beginnst du mit dem Schreibprozess?
2. Welche Informationen (denke: Notizen, Dokumente, Quellen) benötigst du während des Schreibens?
3. Hast bereits eine der folgenden Situationen erlebt:
 - a) Du hast dir Literatur aus der Bibliothek bestellt, konntest dich beim Abholen aber nicht mehr erinnern weshalb du sie bestellt hast
 - b) Du warst dir nicht mehr sicher, ob eine Idee deine eigene oder etwas Gelesenes war
 - c) Du konntest dich nicht mehr erinnern, zu welcher Quelle ein Gedanke gehörte
 - d) Du konntest eine Textstelle, die du zitieren wolltest nicht mehr finden
4. **Fertigst du zum Ordnen deiner Gedanken Skizzen, Mind Maps o. ä. an?**

5. **Wie verknüpfst du die verschiedenen Wissens Elemente?**
6. Würdest du gerne etwas an diesem Prozess besser gestalten? (z. B. Gerne etwas effizienter gestalten, aber es fehlen die Werkzeuge.)

4 Archivierung

1. Nachdem deine Arbeit geschrieben ist, welche Informationen archivierst du?
2. Wie archivierst du diese Informationen?
3. Hast du in der Vergangenheit schon auf archiviertes Material zurückgegriffen?
4. Falls ja: Wie bist du vorgegangen?
5. Falls ja: Hattest du Probleme die Informationen wieder zu finden?
6. Wünschst du dir ein besseres Vorgehen bei der Archivierung?

C Concurrent Task Trees – Notation

| | |
|---|---|
| <i>Independent Concurrency</i> (T1 T2) | Actions belonging to two tasks can be performed in any order without any specific constraints, for example monitoring a screen and speaking in a microphone; |
| <i>Choice</i> (T1 [] T2) | It is possible to choose from a set of tasks and, once the choice has been made the task chosen can be performed and other tasks are not available at least until it has been terminated. This operator is useful in the design of user interfaces because it is often important to enable the user to choose from various tasks. An example is, at the beginning of a word processor session when it is possible to choose whether to open an existing file or a new one. Also the system can choose to perform one task from a set of application tasks depending on its current state. |
| <i>Concurrency with information exchange</i> (T1 [] T2) | Two tasks can be executed concurrently but they have to synchronise in order to exchange information. For example, a word processor application where editing a file and scrolling its contents can be performed in any order and they exchange information when they are performed because it is possible to edit only the information that the scrolling has made visible. |
| <i>Deactivation</i> (T1 [>] T2) | The first task is definitively deactivated once the first action of the second task has been performed. This concept is often used in many user interface implementations when the user can deactivate the option of performing a set of tasks and enable a new set of possible task accomplishments by a specific action (for example by selecting a button). |
| <i>Enabling</i> (T1 >> T2) | In this case one task enables a second one when it terminates, for example, a database where users have first to register and then they can interact with the data. |
| <i>Enabling with information passing</i> (T1 [>>] T2), | In this case task T1 provides some information to task T2 other than enabling it. For example, T1 allows the user to specify a query and T2 provides the query result that obviously depends on the information generated by T1. |
| <i>Suspend-resume</i> (T1 > T2), | This operator gives T2 the possibility of interrupting T1 and then when T2 is terminated, T1 can be reactivated from the state reached before the interruption. For example, the editing text task which, in some applications can be suspended by a modal printing task, and once the printing task is accomplished then editing can be carried on from the state reached beforehand. For example, this operator can be used to model a type of interruption. |
| <i>Iteration</i> T* | In the tasks specification we can have some tasks with the * symbol next to their name. This means that the tasks are performed repetitively: when they terminate, the performance of their actions automatically starts to be executed again from the beginning. This continues until the task is deactivated by another task. |
| <i>Finite Iteration</i> (T1(n)) | It is used when designers know in advance how many times a task will be performed. |
| <i>Optional tasks</i> ([T]) | They give the possibility of indicating that the performance of a task is optional. Optional tasks are indicated in square brackets. For example, we have optional tasks when we fill a form in and there are some fields that are mandatory and others optional. |
| <i>Recursion</i> | This means that in the subtree originated by the task considered there is another occurrence of it. This possibility is used, for example, with tasks that, for each recursion, allows performance of the recursive tasks with the additional possibility of performing some new tasks, until a task interrupting the recursion is performed. |

Figure 26: Notation for temporal relationships, taken from (Paternò, 2000, pp. 43-44).

D Additional Plots

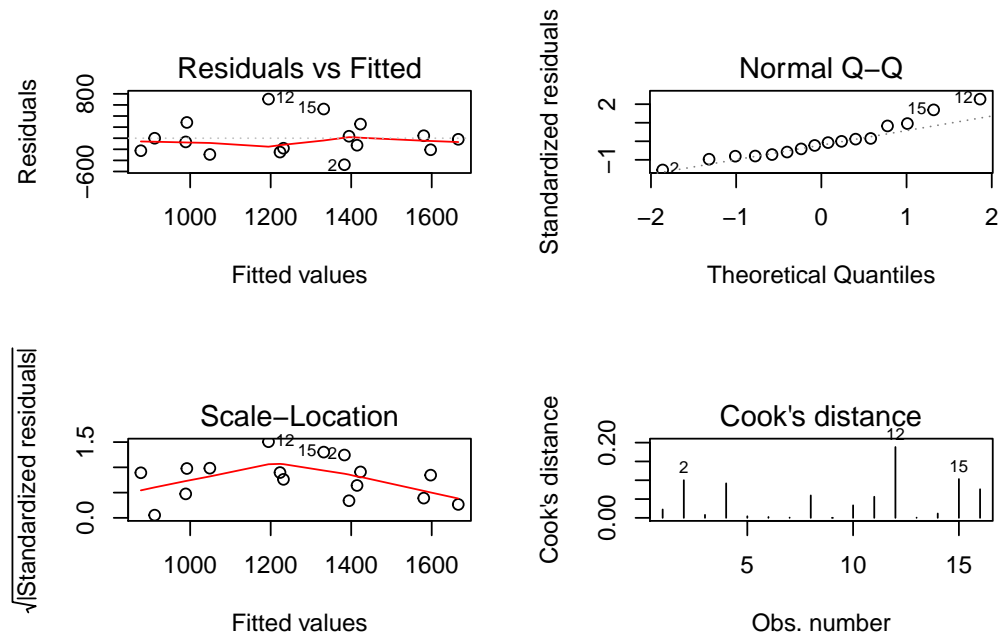


Figure 27: Plots for the linear regression model of words in notes against interaction time.

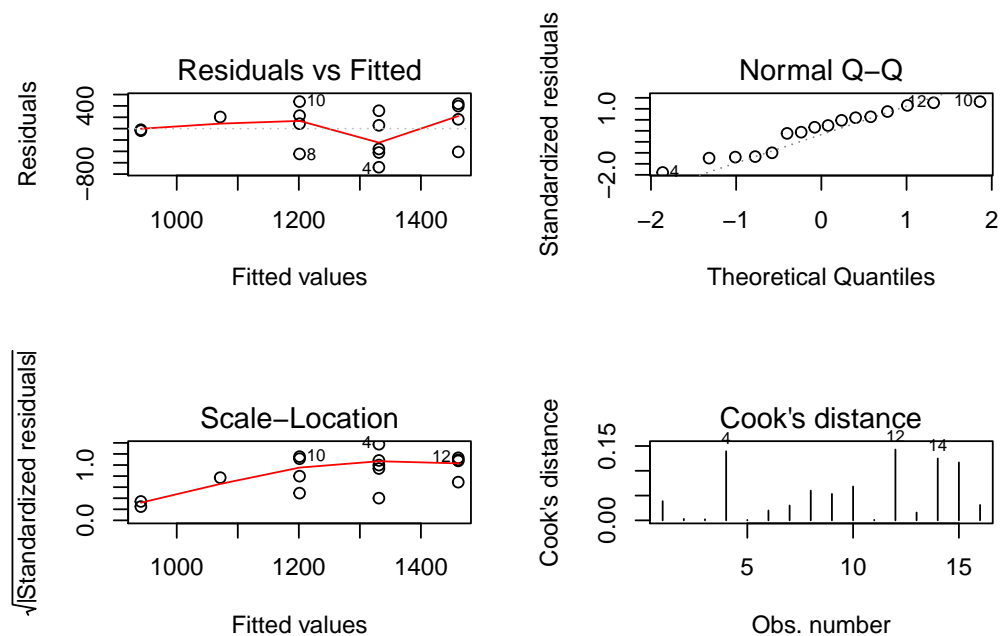


Figure 28: Plots for the linear regression model of agreement with writing texts for assignments against interaction time.

F Questionnaires

Master Arbeit | Stand 2 - Quantitativer Teil

In dieser Umfrage sind 23 Fragen enthalten.

Persönliches

Trage bitte hier das dein Pseudonym ein.

Bitte gib hier Deine Antwort ein:

In welchem Jahr wurdest du geboren?

❗ Deine Antwort muss zwischen 1900 und 2010 liegen.

❗ In diesem Feld kann nur ein ganzzahliger Wert eingetragen werden.

Bitte gib hier Deine Antwort ein:

Welchem Geschlecht ordnest du dich zu?

Bitte wähle nur eine der folgenden Antworten aus:

männlich

weiblich

Sonstiges

Welchen Studienabschluss strebst du gerade an?

● Bitte wähle eine der folgenden Antworten:

Bitte wähle nur eine der folgenden Antworten aus:

- M. A.
- M. Sc.
- Sonstiger Master
- Magister
- Diplom
- Promotion

In Welchem Fach / welcher Fächerkombination warst du im Bachelor immatrikuliert?

(Für Mehrfachbachelor an der UR: 1.HF+2.HF oder 1.HF + 1.NF + 2. NF, bei Einfachbachelor: Nur 1.HF ausfüllen.)

In welchem Fach hast du deinen Master gemacht bzw. machst du deinen Master gerade?

Bitte gib hier Deine Antwort ein:

In welchem Fach promovierst du?

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Promotion' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Bitte gib hier Deine Antwort ein:

Hast du vor deinem aktuellen Studium mehrere gleichwertige Abschlüsse erworben oder bist du gerade für zwei Studiengänge parallel eingeschrieben?

Bitte wähle nur eine der folgenden Antworten aus:

- Ja
 Nein

Ergänze bitte kurz die weiteren Abschlüsse.

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Ja' bei Frage '8 [multipledegrees]' (Hast du vor deinem aktuellen Studium mehrere gleichwertige Abschlüsse erworben oder bist du gerade für zwei Studiengänge parallel eingeschrieben?)

Bitte gib hier Deine Antwort ein:

Fragen zu deinem Studienverlauf

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Magister' oder 'M. A.' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Ein paar Fragen zu deinem Studienverlauf.

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Promotion' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Forschungspraxis

Du hast angegeben, dass du gerade Promovierst. Wie viele Stunden pro Woche kannst du dich auf deine Forschung (Dissertation & andere Forschungsprojekte) konzentrieren?

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Promotion' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Bitte gib hier Deine Antwort ein:

Wie viel Zeit investierst du in der Regel in eine Hausarbeit?

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Magister' oder 'M. A.' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Bitte gib hier Deine Antwort ein:

Wie viele Hausarbeiten fertigst du für deinen Master in der Regel pro Semester an?

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Magister' oder 'M. A.' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Bitte gib hier Deine Antwort ein:

Arbeitest du (z. B. als WHK) an weiteren Forschungsprojekten neben deinen Hausarbeiten oder deiner Masterarbeit?

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:

Antwort war 'Magister' oder 'M. A.' bei Frage '4 [degree]' (Welchen Studienabschluss strebst du gerade an?)

Bitte wähle nur eine der folgenden Antworten aus:

- Ja
 Nein

Welche Quellen nutzt du üblicherweise für deine Forschungsprojekte?

Bitte wähle die zutreffende Antwort aus:

| | nie | selten | gelegentlich | oft | immer |
|---------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Monographien | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Sammelbände | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Zeitschriftenaufsätze | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Archivmaterialien | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Medien (Foto, Film, ...) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Nutzt du weitere Quellen für deine Forschungsarbeiten?

Bitte gib hier Deine Antwort ein:

Zu wie viel Prozent ist deine Forschungsarbeit

🗨 Jede Antwort muss zwischen 0 und 100 sein

Bitte gib hier Deine Antwort(en) ein:

Textzentriert

Empirisch

Text-Zentriert ist z. B. hermeneutisches Arbeiten ([https://de.wikipedia.org/wiki/Hermeneutik_\(Methode\)](https://de.wikipedia.org/wiki/Hermeneutik_(Methode))). Unter empirischer Arbeit wird die methodisch-systematische Sammlung von Daten (<https://de.wikipedia.org/wiki/Empirie>) und deren Analyse verstanden.

Nutzt du ein Literaturverwaltungsprogramm?

Bitte wähle nur eine der folgenden Antworten aus:

- Ja
 Nein

Welches Programm verwendest du?

Beantworte diese Frage nur, wenn folgende Bedingungen erfüllt sind:
Antwort war 'Ja' bei Frage '19 [researchmanagementso]' (Nutzt du ein Literaturverwaltungsprogramm?)

🗖 Bitte wähle die zutreffenden Punkte aus.

Bitte wähle **alle** Punkte aus, die zutreffen:

Citavi

Mendeley

Zotero

EndNote

Paperpile

Sonstiges:

Welche Software verwendest du zum Verfassen wissenschaftlicher Arbeiten? (Im Zuge deiner Forschungsarbeiten)

Bitte wähle **alle** Punkte aus, die zutreffen:

Microsoft Word

Libre Office / Open Office

Pages

LaTeX

Office 365 Word Online

Google Docs

Sonstiges:

Welche(s) Betriebssystem(e) verwendest du? (Im Zuge deiner Forschungsarbeiten)

Bitte wähle **alle** Punkte aus, die zutreffen:

Windows

Mac OS

Linux (alle Distributionen)

ChromeOS

Sonstiges:

Welchen Browser verwendest du am häufigsten? (Im Zuge deiner Forschungsarbeiten)

Bitte wähle nur eine der folgenden Antworten aus:

Internet Explorer

Edge

Mozilla Firefox

Safari

Chrome

Sonstiges:

Absenden der Umfrage.

Vielen Dank für die Beantwortung des Fragebogens.

Kurzer Fragebogen

Bitte fülle den nachfolgenden Fragebogen bestmöglich aus. Falls dir zu einer Frage keine Antwort einfällt, oder du sie nicht beantworten möchtest, ist das kein Problem. Du kannst auch jederzeit Fragen stellen!

Persönliche Angaben

1. Dein Pseudonym *

2. Welchen Studienabschluss strebst du an?

- Bachelor
- Master
- Promotion
- Sonstiges

3. Für welchen Studiengang / welche Studiengangkombination bist du immatrikuliert?

4. In welchem Jahr wurdest du geboren?

5. Schreibst du überwiegend mit deiner...

- Rechten Hand
- Linken Hand

6. Welche Sprache ist deine Muttersprache (oder mehrere, falls du mehrsprachig aufgewachsen bist)

7. Welchem Geschlecht ordnest du dich zu?

- Weiblich
- Männlich
- Anderes (freie Eingabe)

Figure 29: Page one of the questionnaire answered by the subjects for the experimental evaluation of the prototype.

Wissenschaftliches Arbeiten

8 . Wie sehr stimmst du folgenden aussagen zu?

* Studienarbeiten: Projekte, Hausarbeiten, Abschlussarbeiten oder ähnliches.

| | trifft zu | trifft eher zu | teils-teils | trifft eher nicht zu | trifft nicht zu |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Während meines Studiums lese ich viele Texte | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Für meine Studienarbeiten* muss ich viele Texte lesen | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Gelesene Texte wiederzufinden fällt mir leicht | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Beim Lesen von Texten mache ich mir viele Notizen | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Für meine Studienarbeiten* fertige ich viel Texte an | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Lesen ist ein essentieller Bestandteil meines Studiums | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Notizen wiederzufinden fällt mir leicht | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

9 . Benutzt du ein Zitationssoftware?

Nein Ja

10 . Wie oft fertigst du Notizen an?

| | nie | selten | gelegentlich | oft | immer |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Ich fertige Notizen ... an | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Ich notiere ... mit Stift und Papier | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Ich fertige meine Notizen ... am PC an | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

11 . Wenn ich literature lesen muss, lese ich sie

| | nie | selten | gelegentlich | oft | immer |
|---------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| digital, am PC | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| digital, am Tablet | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| digital, am e-Book-Reader | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| in einem Buch | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| von ausgedruckten Seiten | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Figure 30: Page two of the questionnaire answered by the subjects for the experimental evaluation of the prototype.

G Digital Appendix

Raw experiment data, scripts and source code are located at [REDACTED]. The folder is structured as follows:

```
[REDACTED]_Achmann
├── 01_Interviews.....Original Audio files of the interviews.
├── 02_MAXQDA.....MAXQDA files for interviews & focus group.
├── 03_Source Code.....Eyetrack-Reader & Writer. See README.md.
│   ├── et-reader-master.zip.....For the first experiment.
│   └── et-reader-reader-experiment2.zip.For the second experiment.
├── 04_Raw Data
│   ├── 01_Reading.....First experiment.
│   │   ├── 01_Gazelog
│   │   ├── 02_Screencapture
│   │   ├── 03_Survey
│   │   └── 04_Webcam
│   ├── 02_Writing.....Second experiment, contains folders per subject.
│   │   ├── ...
│   │   └── logs-experiment-2.....Log files sorted for use with scripts.
│   └── 03_Focus Group.....Audio files.
├── 05_R Scripts
│   └── Plots.....Plots for reading activities.
├── 06_Jupyter Scripts
├── 07_Transcripts.....PDF files.
│   ├── 01_Interviews
│   └── 02_Focus Group
├── ActivityModel.pdf.....Informal flow diagram.
├── Arbeit.pdf.....Digital copy of the thesis.
├── ConcurrentTaskTreeModel.jpg.....Concurrent Task Tree Model
│   rendered as image.
├── ConcurrentTaskTreeModel.xml.ConcurTaskTrees Environment File.
├── Interviews.xlsx.....Overview of interviews.
├── Pseudonyme.xlsx.....Overview of pseudonyms and PINs.
└── ScannedNotes.pdf.....All notes created in the first experiment.
```


Erklärung zur Urheberschaft

Ich habe die Arbeit selbständig verfasst, keine anderen als die angegebenen Quellen und Hilfsmittel benutzt, sowie alle Zitate und Übernahmen von fremden Aussagen kenntlich gemacht.

Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt.

Die vorgelegten Druckexemplare und die vorgelegte digitale Version sind identisch.

Von den zu § 27 Abs. 5 der Prüfungsordnung vorgesehenen Rechtsfolgen habe ich Kenntnis.

Regensburg, 18.02.2020

Michael Achmann

Erklärung zur Lizenzierung und Publikation dieser Arbeit

Name: Michael Markus Achmann

Titel der Arbeit: Qualitative Analyse und Modellierung des wissenschaftlichen Arbeitens

Hiermit gestatte ich die Verwendung der schriftlichen Ausarbeitung zeitlich unbegrenzt und nicht-exklusiv unter folgenden Bedingungen:

- ✓ Unter einer Creative-Commons-Lizenz mit den folgenden Einschränkungen:
 - ✓ BY – Namensnennung des Autors

Außerdem gestatte ich die Verwendung des im Rahmen dieser Arbeit erstellen Quellcodes unter folgender Lizenz:

- ✓ Unter der GPLv3-Lizenz (oder neuere Versionen)

Ich willige ein, dass der Lehrstuhl für Informationswissenschaft diese Arbeit — falls sie besonders gut ausfällt — auf dem Publikationsserver der Universität Regensburg veröffentlichen lässt. Ich übertrage deshalb der Universität Regensburg das Recht, die Arbeit elektronisch zu speichern und in Datennetzen öffentlich zugänglich zu machen. Ich übertrage der Universität Regensburg ferner das Recht zur Konvertierung zum Zwecke der Langzeitarchivierung unter Beachtung der Bewahrung des Inhalts (die Originalarchivierung bleibt erhalten).

Ich erkläre außerdem, dass von mir die urheber- und lizenzrechtliche Seite (Copyright) geklärt wurde und Rechte Dritter der Publikation nicht entgegenstehen.

- ✓ Ja, für die komplette Arbeit und digitalen Anhang. Eine Veröffentlichung der *JavaScript*-Module Dritter bedarf gesonderter Prüfung.

Regensburg, 18.02.2020

Michael Achmann