Learning from the Past –

The Use of Secondary Qualitative Material in a Design Education Context

DISSERTATION

zur Erlangung des Grades einer Doktorin/eines Doktors
rer. pol.

der Fakultät III – Wirtschaftswissenschaften, Wirtschaftsinformatik
und Wirtschaftsrecht der Universität Siegen

vorgelegt von

Qinyu Li

Erstgutachter: Prof. Dr. Volker Wulf
Zweitgutachterin: Prof. Dr. Claudia Müller

Datum der Disputation: 29. 09. 2021

Dekan der Fakultät III: Prof. Dr. Marc Hassenzahl

Abstract

In this thesis, I examine the use of qualitative data drawn from existing project material as a resource for design education. The use of second-hand qualitative data has been discussed extensively in relation to the 'open science' agenda, but its use as an educational resource has not. To investigate the extent to which second-hand qualitative data might be useful for analytic work, I conducted a study in which students were encouraged to use Grounded Design – a user-centred design approach in Siegen Social Informatic group- as a means to leverage data of this kind. Four design seminars were carried out to allow Master's students participating in an HCI program access to substantial datasets collected in two long-term research projects that had finished some time previously.

In the first seminar, the students were asked to select content from this dataset, analyse it, and then, on the basis of this, form conclusions about possible design opportunities. The study reveals a number of challenges and insights regarding what it takes to use qualitative data as a resource for design. After that, I involved students in the second and third seminar in the design process of preparing the secondary research data, namely designing tools and curating data. An artefact called DesignCaser was developed, and later, tested by the fourth seminar students.

The evaluation of the processes undergone revealed both that students saw the exercise as useful and illuminating with respect to their understanding of how qualitative material can be used for design purposes but also, at the same time demonstrated some of the challenges involved. These were primarily to do with the amount of material, how it was curated, the nature of the data, and the time available to them.

Table of Contents

List of Figures

List of Tables

1 Introduction

Design has typically been recognized to be a creative, aesthetic and problem-solving activity (Blevis, Lim, & Stolterman, 2006; Coyne, 1995; Cross, 1993; Jones, & Gerber, 1970; Nelson & Stolterman, 2019), although it is also clear that the term can encompass a very wide range of activities. The design context has, for example, expanded to include both technology development and concern for new areas such as digital forms. As a consequence, 'doing design' has come to involve new methods, including "user-experience design" and "interaction design," which have been exported from HCI and inspired a new approach to design. Design has become an activity that merges practice and research to support human-centered computing. It means design not only builds functional and aesthetical artefacts, but also recognizes the need for "easy to use" and useful artefacts. This new form of working draws on various scientific foundations, notably psychology, sociology, and computer science.

New approaches to design carry implications for design education. If there is a value in collecting data about user needs, desires and practices, there should equally be a value in re-using such data for educational purposes. This research is based on the view that user-centred design education might usefully draw on previously collected data to provide useful lessons for students. At the same time, building a shared knowledge base utilizing existing domain expertise might involve numerous challenges for design education, especially when multidisciplinary knowledge is present.

The research discussed below was based on the principle that it should be possible to make past design cases' assets available for students and, in doing so, learn how design learning with past research data can be made effective. This carries wider implications. It drives more general questions about data sharing and curation relating to data accessibility in secondary design documentation. The research question which motivated the research, then, can be phrased as: *What value does prior research data have for design education in HCI and how might we make best use of it.*

Four design seminars have been carried out in the study. The first seminar brought un-curated research data to the design seminar, and helped us understand whether uncurated secondary

data can be a viable resource for design learning and the problems of accessing this resource. In the second and third seminars, students performed co-design activities with us and developed a functional artefact for accessing the secondary data. In the meantime, design case documentation was curated with those students. Finally, I appropriate this developed artefact and curated data in the fourth seminar to observe the impact of the artefact in real design context and observe new uses of secondary data(Mankoff et al., 2007).

Motivation

- e-Portfolio idea: we want to learn from the past design projects

My work started with the idea of e-Portfolio (Wulf, Volkmar, et al., 2018), and derives from an institutional design framework called Grounded Design. This vision is devoted to developing an ecological design environment for researchers and practitioners. Grounded Design entails an iterative approach to knowledge acquisition and design, using a pre-study, early design, in-depth study, further design, evaluation and appropriation studies.

The idea behind the work we discuss is to share a collection of design case studies and ultimately represent it in layers according to the level of detail, and to make it available to different audiences, such as practitioners, researchers and students. The e-Portfolio shared a similar vision with the growing number of researchers that call for a sustainable (in preserving design knowledge) design research environment. But design is confronted by the challenge of preserving past knowledge due to its high tactical, contextualized and constantly evolving characteristics. The design seminar, I anticipated, might uncover principles for the effective access to and use of up-to-now under-utilized design knowledge and the documentation of it.

- Under-explored project data

Many research assets are locked away when projects officially end. Publicly-funded resources are still under-explored by third parties, despite the ‘open access’ agenda. Open science has been proposed to a) make public-funded research outcomes available to the public, b) reproduce and verify research, and c) advance the research and innovation agenda (Arzberger et al., 2004; Murray-Rust, 2008; OECD, 2007; Wallis, Rolando, & Borgman, 2013; Wesson, 2006) Funding agencies started to recognize the strength of open sharing in the start of 21

century (Kervin & Hedstrom, 2012) and it has become a future agenda (European Commission, 2016[1]). However, many disciplinary and interdisciplinary research fields (e.g Social Science and CSCW) are not readily available for sharing in the same way as in Genomic and astronomy (Borgman, 2012) There are fundamental conflicts unresolved there (Mosconi et al., 2019). This means the potential surplus-value of project assets and resources yields little in those fields. In our institute, some researchers have estimated that two-third of past research outcomes remain unpublished. The constant move from the end of old projects to the beginning of new ones causes the data which exists to remain under-explored. Meanwhile, publication becomes the only accountable vehicle for accessing past design research.

The question that remains is whether a) publication can contain all gained information and knowledge, b) should be the only measurement standard for research practices, and c) how design disciplines can make knowledge accessible for later research.

- Lacking appropriate design education material

There is a call for designers to expand their capacity to undertake design with increasing sophistication(Churchill, Bowser, & Preece, 2014; Meyer & Norman, 2020; Norman & Stappers, 2015) Because of that, design educators also need to transform their design knowledge and pedagogic capacities to prepare students for complex design contexts(Weil 2020).

Grounded Design is a research framework of practice-based computing that conducts design study cases that "reconstructs the social practices observed before and during the design and appropriation of innovative artifacts." (Wulf, Volkmar, et al., 2018) Designers conduct GD to interpret the changes in practices that might result from technological innovation, and provide interplaying dynamics that form "infrastructures" (Stevens, Pipek, & Wulf, 2010)to enable design of IT artefacts. The HCI Master's Program in Siegen devotes itself to bridging gaps in existing design knowledge through engaging with design research practices. Students are

[1] European Commission, Public Consultation: 'SCIENCE 2.0': SCIENCE IN TRANSITION. Available at: http://ec.europa.eu/research/consultations/science-2.0/background.pdf (searched 03,02,2021)

encouraged to participate in design-related fieldwork where students can observe the interweaving of practice and artefact use while designing a feasible solution.

However, such resources often are expensive and time-intensive in education settings, not to mention the difficulty of accessing the end-user group. Primary empirical resources cannot easily be collected in the short-term, and so the teaching of iterative and user-centred ways of design tends to be done in the abstract. Educating user-centred, user participative iterative design method thus poses a challenge for design curriculums. Past documentation contains rich empirical data which might provide an opportunity for design learning exploration.

Aims and objectives

Aim: Experiment on secondary data uses in design activities to find a feasible way of educating Grounded Design by re-using past assets.

Objective: Run 4 design seminars with students by using the past project data, observe the design actions that has been taking in the process, and collect related empirical data to gain an understanding learning process of design in re-using research materials.

Contribution

My research question concerns how to make past resources usable in design education. It is relevant to current design research, design education, and secondary data research field. In both the design research and education field, there are calls for unifying past design knowledge to enable people to learn from the past; however, researchers and designers suffer from the inability to archive design knowledge easily since the nature of design is often highly tacit and not formally described or structured in an appropriate way. However, prior design work remains a potentially significant resource for design education and has arguably been overlooked in the research and education setting. As yet, the usefulness of past design data has not been tested in both fields (design research and design education). I have not yet understood what value stored data relating to design research might have for future designers and how to prepare my students to face complex design contexts. Proposing the use of past resource for design education, it is argued here, is a contribution itself.

Meanwhile, the field of secondary data research lacks real cases of people re-using data and overall, there has been little investigation of re-uses of secondary data in the educational context. My seminar provides a re-use case in a new context (design education) and presents a new approach to the use of secondary data.

Content Overview

The study will be described in six chapters. After I discuss the existing study and gaps in both the design research community and design education community, the study methodology is given next to elaborate the method used, study plan, participants and two shared projects used in seminars are introduced. The third chapter introduces the background to my study, and includes the fundamental design methodology of Grounded Design and the e-Portfolio design concept (Wulf et al., 2015)which inspired us to conduct this study, and the supply-demand relationship of two groups in the e-Portfolio concept: data reusers (students in Siegen HCI Master Program) and data providers (original design researchers), is demonstrated.

After understanding the epistemological standpoint and contextual base of my study, I present the process and empirical findings in the next 3 chapters which include four seminars with intentions that are elaborated above. Each chapter follows the same structure. The preparation work and blueprint of seminars is made clear at the beginning, and how it evolved in each seminar, based on the feedbacks of past students and experience of tutors, is also described. Empirical findings are shown in chronological order according the planned steps. After that, the concluding feedback of students towards secondary data for design learning and design of seminar is presented and a concluding summary is given at the end of each chapter.

Finally, my discussion brings all the discovered issues and learned lessons into one place. The first section of discussion reflects on the lack of learning of qualitative ethnographic data and knowledge required in making use of it in HCI design education. The requirements include knowledge of “real” design problems and learning iterative and user-centered methods. In the second section, I discuss the problems I identified in the real uses of secondary data in the design education context: something that is still unexplored in the open sharing community. I present the problems from a use perspective, currently underexplored in the open sharing community as well. It shows how different goals of reusing data can impact on sharing by

comparing new discovered problems in design seminars with existing problems in the open sharing community. The third section echoes the problems in the previous section and makes design suggestions for seminars with qualitative secondary data. It elaborates on the impact factors when selecting sharing projects, makes suggestions on curation steps for preparing secondary data for design learning and gives further design implications for using secondary data for design learning purposes. In the end discussion, I reflect on the limitations of my study in relation to limited sets of material, and argues there is more space of reusing past design research assets for design learning. My study just the beginning of these explorations.

2 State of the Art

In the rapid changing digital world and increasingly complex design environment, some design researchers call for the unification of design and research so that design knowledge can be adapted into a "scientific" academic format and transferrable(Dalsgaard & Halskov, 2012; Sas, Whittaker, Dow, Forlizzi, & Zimmerman, 2014; Zimmerman, Forlizzi, & Evenson, 2007; Zimmerman, Stolterman, & Forlizzi, 2010). This move towards a 'design science' (Hevner & Chatterjee, 2010), as we shall see, does not go unchallenged.

Unifying design involves risks since the use of designed artefacts is highly contextual and the degree to which design conclusions can be generalised across different contexts is unclear. Not least, there is an evident problem with how exactly design- relevant data is to be documented and systematically classified in such a way that it can support a standard way of doing design. Design knowledge, because of its interdisciplinary character, is arguably not directly adaptable to the "scientific" paradigm. Additionally, the design research field is still missing the research which shows us how the available design documentation can be made available in a usable form for others down the line. The educational environment which we inhabit allowed us to conduct design research to understand how to document design knowledge and ways to access it afterwards in a relatively risk- free manner. The outcomes, I believe, will bring value to design research and the design pedagogy field.

Meanwhile, the call for open science also lacks cases where reuse practices are discussed. It is challenging for disciplines like social science and medicine to share qualitative data due to ethical and usability considerations(Karpoff, 2006; Vertesi & Dourish, 2011; Yardley, Watts, Pearson, & Richardson, 2014). While reasons for not sharing become more apparent to the field, research about why people share and why people might reuse data is still missing (Borgman, 2012). Support for sharing can be developed if I can understand the circumstances in which people do or do not wish to share data, what data is useful in a re-use context and, perhaps most importantly, where to find such data in a usable form. My focus is specifically on the uses of such data in design education but I believe that understanding how inexperienced users of data in a multidisciplinary context try to make data 'usable' has ramifications in the wider contexts of design science and the data sharing community.

2.1 Design Practice and Design Research

2.1.1 What is design

Varies definition of design

"Design" is a term that is hard to define since it has been used widely both as a verb to represent process and a noun which refers to form. And its use varies considerably in disciplines like art, engineering and production that embody distinct professional understandings.

Design is sometimes thought to be about *artistic and decorative related*, that is about form as much as function. This remains the case in relation to digital innovations, where many people think it is about form making and interface styling. We can see this as a 'traditional' view of HCI. Although design was deeply rooted in aesthetics in art, it now means a great deal more than that. (Blevis et al., 2006)

Problem solving for instance is one of the popular definitions, largely in response also to mass-production in the 20th century(Cross, 1993). Bauhaus educators were the first ones to take design out of the art context and look specifically at function, a view that emerged from industry production. Later, design becomes progressively more complex because of the digital revolution, Design researchers now clarify that designers "*explore not only form and function, but also form and content, because content is what human beings seek in digital experiences*."

> *…the process of modelling users and systems and specifying system behavior such that it fitted the users' tasks, was efficient, easy to use and easy to learn. (Wright, Blythe & McCarthy, 2006: p.44)*

Creation and *Novelty* is also often given as a design principle (Coyne, 1995; Jones et al., 1970; Nelson & Stolterman, 2019). Jones outlined design as a hybrid term that includes art, science, and mathematics: "*both artists and scientists operate on the physical world as it exists in the present*."(Jones et al., 1970: p.10) And designers seek patterns of knowledge and information that can be applied to contextual solutions. And this intellectual process can be thought of as discovering and inventing:

> *The scientific method is a pattern of problem-solving behavior employed in finding out the nature of what exists, whereas the design method is a pattern of behavior employed in inventing things... (Gregory, 1966: p.6)*

Design was originally a practice discipline and has been long recognized as a vehicle for conducting research, later incorporating technology development and user experience research as design principles. Design, then, emerges out of both practice and research. And Brockman(Brockman, 1996) has proposed design to be the "*Third Culture*" beside art and science.

Overall, design stands in a unique position in both practice and research.

"Creative" and "Rational" Line of Design

HCI established itself as a research field in the late 70s and early 80s, distinct from computer science. Later the emergence of new disciplines led to the field becoming something of a "hodgepodge" field. Since cognitive psychology in 90s brought models and theories to HCI, there has been extensive discussion around the topic of *Design and* Science (along with the even earlier discussion of "Rational" and "Creative" design methods since 1960). In turn, social science broadened the scope of HCI in the middle of the 90s to larger interactions that include places, group and organizations rather just between individual human and computer, naturally bringing their method and frameworks into HCI and helped the community in think about design in complex social contexts. This is sometimes called, 'the turn to the social'

This blooming of multidisciplinary approaches to method and theory in HCI has also led to discussions about s unifying methods and theory- the search for a design science. In the following sections we will go through the two distinguishing lines of "creative" and "rational" approaches.

When we retrieve the history of design methods, a commitment to "Rationality" was present in early 1920s. Theo van Doesburg (Doesberg, 1923) and Le Corbusier (Corbusier, 1929) both see the value of design based on objectivity and rationality. Subsequently, two famous and quite different publications in the late 60s impacted on future design debates, Herbert A. Simon's famous book *The science of the artificial* called for a "rational model" that meant a

scientific and rational way of conducting design. Meanwhile, Christopher Jones's *Design Method* suggested that design is both rational and intuitive by introducing ergonomic data into the engineering design process. Simon was focused on formalizable methods and J. Christopher Jones was more open to *both* rational and creative design methods. Later, the rational method was challenged by Christopher Alexander, Christopher Jones, et al.

> *...There is so little in what is called "design methods" that has anything useful to say about how to design buildings that I never even read the literature anymore... I would say forget it, forget the whole thing. (Alexander, 1971)*

Later, in 1973, Rittel and Webber(Rittel & Webber, 1973) argued in their work *Wicked Problems* that understanding work practice, technology design and problem framing are not "tame" and not "scientific work". They are making the point that design cannot be thought of in terms of the traditional "problem/solution' framework because there may be many ways of thinking about the nature of the problem. Schön (Schön, 1992) also points out that design is a not linear process but a constantly reflective "conversation" with the social context. Schon rejected "technical rationality" entirely. Many other researchers realized that design practice has its own strong and unique culture. This led to the "argumentative" design discussion that criticised the inability of design to apply science methods to complex social problems, and that design research is unique and could provide supplementary knowledge that is different from traditional scientific methods.

While the blooming of "creative" and "un-linear" arguments in design community was one strand, Simon and Fuller called for the 'design science revolution' based on science, technology, and rationalism (Cross, 2007, p50) and this continued exert its influence, especially in the area of engineering design and AI design (Gero, 1991).

Löwgren(1995) later differentiatde the use of the term into *engineering design* and *creative design* and noted *engineering design* "*is to find a solution to the problem*" and *creative design* "*is explored through the creation of many parallel ideas and concepts*. *The given assumptions regarding the problem are questioned on all levels"* (p. 87)

Fallman (Fallman 2003: p.231) identified three accounts of design based on Löwgren, namely a *conservative account*(scientific), *romantic account(*creative) and *pragmatic account* (practical bustle with reality).

Wolf et. al (Wolf, Rode, Sussman, & Kellogg, 2006)again built upon Fallman's accounts and point out that current design in HCI suffers from legitimizing design choices through a formal iterative approach which is different from the creative "black art" design practice. "'*rigor' as a repeatable process, of a consensual standard of quality, in use by a professional community of practice."* (p.522)

These two dichotomous design approaches in HCI keep questions about "what is design?" current.

2.1.2 Call for unifying both in design research and education paradigm

Some researchers have observed the "*lack of rigour*" (Blessing & Chakrabarti, 2009) and 'valuable older work fading from our discipline's working memory.' in design (Erickson, T. and McDonald, 2008), and both are critical of the 'forgetting' process whereby the design knowledge legacy for structuring a "better" foundation for design research is ignored.

Hevner and Chatterjee (Hevner & Chatterjee, 2010), in the specific arena of IS, produced an argument that was subtly distinct. It should be noted that their position comes from concerns about the direction that IS was taking, and not from broader thoughts about the nature of the design process. They identified a gap between 'behavioural science' in IS and 'design science', arguing that the former had come to predominate, but that there was a real need to synthesise the two. Equally, the design science approach recognises the essential creativity of the design process but seeks to establish a theoretical basis for it. Put simply, they are trying to bridge the gap between design and 'science' – in some form.

Design science research, of course, must distinguish itself from design per se, and so it is held to involve a team documenting *"that their new "artifact" is better, faster, or more optimal through rigorous evaluation methods and comparison with similar artifacts, then new knowledge is indeed created"*(Hevner & Chatterjee, 2010: p.7). This new knowledge is essential because, it is suggested, design has become an extremely complex business and solutions can no longer be found without some reference to prior work.

Design education paradigm

Researchers, designers and educators identified the shift of moving from *artefacts* towards *interaction* that emphasis the process in the design of complex socio-technical systems. Churchill et al.(Churchill et al., 2014) suggested a progressive approach to teaching HCI, so that teaching methods in HCI courses change as the current state of socio-technical systems changes, and a multiple approach of design education to foster those changes.

The design field nevertheless still rarely thinking about how to constructs knowledge that reflects epistemic principles[2] and design knowledge remains largely tacit (even today).

> *One possibility is that to achieve these ranks, the person must have a broad, informed knowledge of a wide variety of topics and areas, must understand rigorous argumentation and the value of evidence, and must put the needs of the organization—or society—above the needs and views of any single profession. Here, design has largely been unsuccessful.(Meyer & Norman, 2020: p.46)*

Don Norman suggests design education needs to change in the increasingly complex modern world and that traditional education is no longer adequate (Norman 2015; Meyer 2020). Jeremy Meyerson also argues why design educators need to change their thinking (Myerson, 2016). In their view, design has evolved many subdisciplines today that require technological and analytical skills that traditional curricula do not cover. New design educators state that creativity, collaboration, communication etc. should be provided for the future design curriculum(Weil & Mayfield, 2020). New skills and a broad approach could help students to deal with today's (and future) complex problems.

> *The main trouble with design schools seems to be that they teach too much design and not enough about the ecological, social, economic, and political environment in which design takes place. It is impossible to teach anything in vacuo, least of all in a field as deeply involved with man's basic needs as we have seen design to be. To the problem of the dichotomy between the real world and the world of the school, there can be, understandably, many different answers. (Papanek, 1971: p.112)*

[2] The Bauhaus, the HfG Ulm, and the design methods movement are some of the exceptions.

Organizations have started to realize that designers could develop creative solutions to complex problems which derive from design-driven approaches(Westcott, 2014). Those researchers call for a design education organization and for schools to professionalize the design field.

The new era is changing rapidly, and new methods and challenges are constantly discovered. HCI design education, as a consequence, has suffered from the fragmentation of knowledge and interdisciplinarity itself poses new challenges. Grudin (2006) writes *'different views of human-computer interaction are presented ... and differences will remain'.* (p.59) and Churchill et al. formed a report analysing the challenge of HCI design education in dealing with the rapid evaluation of the field.

> *Pedagogical models employed by many HCI and design programs will risk becoming increasingly short-sighted if they do not provide students with knowledge domains that can account for understanding design, social context, and business strategies in addition to computing.*(Faiola, 2007: p.20)

Design has to deal to the "new challenges that centre on the long-term theories of design, systems, technology, and media.", and in some educators' views, the challenge can be resolved by integrating Business, Computing Social and Design philosophies in order to manage the large amount of information that is now relevant to design tasks(Faiola, 2007). In design education, teaching becomes a knowledge management activity, and an integrated knowledge container is required for the HCI curriculum.

Challenge of archiving design knowledge

In stark contrast to the above, there is an approach to research through design founded on very different principles, in the main associated with Bill Gaver (Gaver, 2012), who writes in the context of HCI. In his approach, he stresses the provisional and contingent nature of the design process. He observes that there is an impetus for *"integrating design research methods, approaches, and outcomes in HCI"* (Forlizzi et al., 2011) which further requires *"a proper research methodology that can produce relevant and rigorous theory"* (Zimmerman et al., 2010).

Design knowledge was, before such impetus, primarily transferred in a master/apprentice way, and thus knowledge remained largely tacit, since a) design and creativity happens on unexpected occasions, and b) practitioners (including sometimes research practitioners) face difficulties in articulating their practices.(Cross, 2006)

Design thinking encompasses processes that involve facing real world "wicked" or "ill-defined" problems. This entails two way thinking that navigates the "creative" and "linear" lines, where engineering tend to address problems in a systematic and linear manner(Dym & Little, 1999), whereas in designer's world, as Cross's work suggested, the design problem are hard to define since the problem space is evolving and changes constantly, and therefore needs continually reinterpreting and restructuring. And design problems themselves are often ill-defined, Cross points out:

> *That is to say, the designer-subjects jumped to ideas for solutions (or partial solutions) before they had fully formulated the problem. This is a reflection of the fact that designers are solution-led, not problem-led; for designers, it is the evaluation of the solution that is important, not the analysis of the problem. It is not just that problem-analysis is weak in design; even when problem goals and constraints are known or defined, they are not sacrosanct, and designers exercise the freedom to change goals and constraints, as understanding of the problem develops and definition of the solution proceeds. (Cross, 2001: p.82)*

Research through Design progressed by structuring design as a form of knowledge production. Frayling suggests an integration between designer's artistic (which is tacit, creative and ultimately focused on the particular) knowledge and scientific intersubjectively verifiable knowledge (Frayling, 1993). But there are continued efforts made to distinguish those two knowledges, Stolterman(Stolterman, 2008) points out "scientific research drives towards the *existing* and the *universal*, while design is in pursuit of *non-exsiting* and the creation of an *ultimate* particular" and "*method may be vital to science* (where it validates the results) *but not to design* (where results do not have to be repeatable)." And Jane Fulton-Suri, who trained in social science, points out that design is *future*-oriented while social research focuses on the *present* and *past*. Anna Blackwell identified the *novelty* (but not necessarily good) in research

contributions, while to the contrary, design contribution emphasis *good* more than novelty. Findeli et al.(2008) argue that the combination is only possible with scientific paradigm for the research activities in question.

Risk of Systematicity

Gaver(2012) is at pains to argue that, although there may be some justification for this move towards systematicity, it carries risks. The principal risk lies precisely in the 'scientism' of this kind of research. He has suggested, instead, a 'ludic' approach as *'an antidote to assumptions that technology should provide clear, efficient solutions to practical problems'* (p.938). As he points out, the dominant mode of research in HCI/CSCW depends on assumptions which are scarcely scientific at all. It is clear, then, that debate about research through design can be seen as an epistemological dispute between those who believe that systematicity requires some variant of science, those who adopt a middle way (appropriating scientific methods but recognising that design has specific characteristics, and those who are more willing to recognise the contingent and emergent nature of the design process.)

For our purposes, two features stand out, and both are aspects of the way in which the problem-solution space is construed.

Firstly, relatively little consideration is given to how, exactly, designers are to come to an appreciation of what the problem might be. This, of course is the foundation of the 'turn to the social' in system design- the idea that a careful (usually qualitative) approach to understanding the way in which users do things will produce a better understanding of what changes are feasible and desirable and, moreover, will provide other means by which one might judge the success of implementations.

Secondly, the way in which designers acquire and develop the knowledge and skills to do with first principles, understanding of context, and appreciation of goals, etc., that Cross speaks of, is not, in the context of ethnographic and related data, well understood. This has led others to emphasise the need for a specific approach to design-based teaching. It is this that we turn to now.

2.1.3 Design Knowledge System and Reuses

Design knowledge refers to conceptual ideas, lessons-learned, and materials collected while in the creation and problem-solving phrase. (Pearce et al., 1992)

Documentation of design has made some progress in the engineering domain, since documented and structured design knowledge provides existing reference for new problems and entry for relevant discussions. Of course, it depends on the quality of archive and retrieval procedures. Some researchers have developed systems for accessing those knowledges, like organization memory systems (Ackerman & McDonald, 1996; Cubranic, et al., 2004), case-based design and rational systems (Maher & De Silva Garza, 1997; Pearce et al., 1992; Schank & Leake, 1989), activity capture system(Ju et al., 2004; Klemmer et al., 2002), and component repositories (Cubranic et al., 2004; Tetzlaff & Schwartz, 1991). However, and typically, all of the systems capture individual design processes but do little to support designers in identifying design problems and fostering divergent thinking in the creation process (Sharmin et al., 2009). Sharman found that designers are searching for more than documented design cases, but needed also an understanding of the stories behind the process in which a design was created. That information cannot be provided by stored design outcomes, and there is a technical gap between providing a design knowledge management system and fostering creative design. Knowledge of the design 'rationale' is needed (see e.g. (Lee & Lai, 1991; Moran & Carroll, 2020) Reuse is important in all phases of design, and current research has largely neglected the creative domain of reusing prior design knowledge. The goal of our work is to fill the gap by understanding how past archives could benefit the creative design and how to build systems that allow those benefits to be visible.

2.2 Design Research and Design Education

Educators use design to advance their understanding and to serve as a measurement to test theories, so as the design researchers we discussed above. And in return, design education contributes to design research (Edelson, 2002).

2.2.1 Educating-through-design

Design-based education, originally associated with Ann Brown, and specifically located in an educational context, saw learning as being a process of "guided discovery"(Brown & Campione, 1994; Brown, 1992). Barab and Squire (2004) suggest that:

> *... learning scientists are finding themselves developing contexts, frameworks, tools and pedagogical models consistent with and to better under-stand emerging pedagogical theories or ontological commitments [...] In these contexts, the research moves beyond simply observing and actually involves systematically engineering these contexts in ways that allow us to improve and generate evidence-based claims about learning. The commitment to examining learning in naturalistic contexts, many of which are designed and systematically changed by the researcher, necessitates the development of a methodological toolkit for deriving evidence-based claims from these contexts. (p.2)*

If so, then there are good grounds for wanting to understand what is required for design education to be effective. We take as our starting point well-known discussions of the relationship between ethnography and design(Andrew Crabtree, Rouncefield, & Tolmie, 2012; Hughes, Randall, & Shapiro, 1992; Randall, Harper, & Rouncefield, 2007a). We note that, although considerable effort has been put into describing ethnographic practice and its potential importance as an input for design, relatively little attention has been paid to what people need to learn in practice to make use of qualitative data effectively and how what they learn might ramify in design practice. The design seminar attempts to illuminate this lacuna.

HCI Design Education Approaches and Materials HCI become a "hodgepodge" with constantly new disciplines joining in, and there remains is no single curriculum that could cover all the knowledge required. The HCI curriculum recommended by ACM CHI, entitled "ACM Curricula for Human-Computer Interaction", as of 1992 (Hewett et al., 1992), argued that HCI

> *... is fundamentally a tension between analysis and synthesis, between observation and design, between the emerging science of human-computer interaction and the poorly-understood craft of user-centred system design. We must seek, therefore, to educate a new generation of system designers, builders, and implementers who are truly sensitive to those who will ultimately use their software. (p.103)*

This general position holds true today but the huge expansion of HCI and its very eclectic nature requires examination of these relationships at a quite specific level. New and flexible approaches to teaching and learning are an inevitable feature of this expansion. Design educators have imported different methods from other disciplines in attempts to bridging design method learning and practicing. For instance, HCI imported traditional design education approaches (i.e, studio-based design (Reimer & Douglas, 2003) to their design curriculum (Lerner, 2005; Weil & Mayfield, 2020).

When we compare imported approaches of design education, it is not hard to find that they share the constructive and inductive (or abductive) pedagogies, i.e. Studio-based Learning (Lerner, 2005; Reimer & Douglas, 2003; Weil & Mayfield, 2020), Problem-based Learning (PBL ; e.g., Kolodner n.d.; Srinivasan 2007; Wesson 2006)), Project-Based Learning (PjBL; e.g., (Koutsabasis & Vosinakis, 2012; Neveu, 2009) and Case Based Learning(Macpherson, Berman, & Joseph, 1996; Ouh & Irawan, 2019; Somervell, Chewar, & McCrickard, 2004). The common character of those methods is that they are "learner centred" and "*practice-based*", encouraging collaborative group works and promoting the active in acquiring new knowledge.

In learner-centred approaches, material and instances play an important role in enabling the reflective learning process. Research shows students engaged with data and participating in some kinds of realistic process are more motivated and gain higher order thinking skills than other learner situations (Motschnig et al., 2016; Soloway, Guzdial, and Hay, 1994).

Nevertheless, when we scope down to the material those courses provided in each case (Koutsabasis & Vosinakis, 2012; Koutsabasis et al., 2018; Reimer & Douglas, 2003), we found that the material provided in class remains at a general level. It is represented in a form that Ryd (2004) called *design brief*, a short and coherent description on design context and design problems that students could start with. Students need to work within a context that is abstract without concrete references, there is an open space for tutors to improvise the teaching material and a framework for guiding educators in preparing those materials is missing. Somervell (op cit), an exception, has imported Case Based Learning that supports education material in this manner.

Some HCI educators who conduct learning-centred methods claim they provide evaluation of learning by constant observation, discussion and reviews from the tutor. The tutor and learning peers often play a role of design user, providing them with the interactive and practical experience of evaluation and testing students' design (Koutsabasis et al., 2018; Ribu & Patel, 2018). We believe there is a lack of reflection on whether the feedback that tutors/peers provide is comparable with non-professional people in real life, and whether such learning environments could reflect (or teach) the necessary skills of communicating with test users in real scenarios. Therefore, we argue that design educators should explore new opportunities to support reflective and iterative methods beyond *design brief* and *tutor review.*

2.2.2 Case Based Learning

Different from the other design learning approaches, Case based learning (CBL) provides more materials in the educational context. It is used in training courses and uses guidance to learners to provide resources which allow them to participate in live simulations of authentic cases. It has been widely applied in law, business and medical disciplines. And educators from other disciplines have started to examine its effectiveness in their fields. Ouh, for instance, has reported that CBL for software architecture courses has proven useful (Ameta, Tiwari, & Singh, 2020; Ouh & Irawan, 2019). Pearce (1992) also used architectural design cases within a small computer-based library, allowing designers access to previous architectural work providing knowledge about goals, plans and lessons, and by providing the perspectives of domain experts.

HCI educators have, to a limited degree, argued that the HCI curriculum will benefit from a wider adoption of case-based learning (Somervell et al., 2004) Other educators, have strongly argued for its relevance. It is argued that case-based methods can reconcile conflicting goals, providing teachers with the opportunity to both cover topics of significance for the courses they teach and providing students with practical experience in applying the concepts and methods they have been taught.

Somervell et al. (2004) stress the relevance of real experience in HCI courses, so as to prepare students as potential practitioners. Cases, according to them, are an alternative to real experience and can provide students with rich environments to learn how to address and solve particular problems. To make their point, they applied case-based teaching as a means to assess 5 kinds of materials in an introductory HCI course. The results show a high level of class participation, which enabled mastery of HCI concepts. The method was well-received by students, especially when they had access to professionally prepared case material (extensive material on a complete lifecycle design project from the Usability Case Studies library http://ucs.cs.vt.edu).

We are aligned with Somervell et al. (2004) and the few researchers who have elaborated on their approach. We argue that the findings presented by them provide evidence of the value of the approach. Nevertheless, we are sensitive to the fact that case-based teaching can demand a lot from educators, depending on how they decide to implement it. The ways that cases must be structured and addressed may add a further layer of complexity to the exercise. This may be one of the reasons preventing larger-scale adoption of the approach.

Our own approach differs in that we have not discussed existing cases with students, as was the case with Somervell et al). Instead, using empirical material generated in a previous Design Case Study (DCS) (Li et al., 2020; Rohde et al., 2017; Wulf et al., 2018), we asked students to build their own DCS. This resulted in a rich and valuable experience that allowed students to learn, among other things, how to analyse empirical data, use the results of the analysis to inform design, and illustrate their design ideas by means of scenarios, personas and low to high fidelity prototypes. Nevertheless, it also demanded a lot of effort both from educators and students.

2.3 Secondary Data Sharing and Uses in Education

Before we dive into the topic of secondary data, we need to be clear what constitutes secondary data in my study. *Any data* that is collected and has later been reanalysed for another purpose can be seen as secondary data. it includes but is not limited to fieldnotes, interview records and transcripts, analysis coding sheets, design sketches and brainstorming records and development coding etc. There are two kinds of secondary data which are worth discriminating here. The first kind of secondary data have existed for a long time and there are well established norms for their archiving (eg. Geography). As a result, they have mature sharing agreements and there are few disagreements over problems of ethics and ownership. When we look at some other disciplines, however, and particularly those which have no common agreements on sharing, the problems of ethics, legal and ownership issues and so on are more prevalent. This has acted to restrict willingness for data sharing in a broad context (Borgman, 2012). In our social technology/ HCI/CSCW context, in which many different methods and theories have emerged, there are unsurprisingly different views on sharing. This means that there is little adequate technical support for sharing secondary data in a sensible manner available in HCI as yet.

2.3.1 Call for Open Sharing

Research data can have significant value beyond the confines of the research projects in which it is generated. Secondary data has been proposed as a way to reduce repeated data collection, with the data being open to re-use for other investigations. In inter- and intra-disciplinary terms, making project data publicly available opens up the prospect of new discovery and innovation. The sharing revolution first started in sciences such as astronomy and genomics and encouraged the emergence of new fields (Wynholds, Fearon, Borgman, & Traweek, 2011). Later on, cyberinfrastructures were proposed to support the data sharing process (Cragin et al., 2010). With the growing popularity of Civil Science, the academic world has started to see a need to open the window to the “outside” (Kervin 2012; (Arzberger et al., 2004; Murray-Rust, 2008; OECD, 2007; Wallis et al., 2013; Wesson, 2006) . On top of this, funding agencies have recognised the benefits of sharing and have been actively encouraging public-funded projects to provide open data(ERC, 2017; NSF, 2010).

Researchers often associate secondary data with secondary analysis since both have been carried out mostly inside the research context. Secondary data allows researchers to access high-quality data that enables analyses from new perspectives and the discovery of relationships which may otherwise not be considered in primary research.

> *Secondary data analysis can help save time, money career, degrees, research interest, vitality and talent, self-images and marids of data from untimely, unnecessary and unfortunate lose. (Glaser, 1963: p.14)*

Therefore, from the research aspect, secondary data offers methodological and theoretical benefits. The grand vision remains a challenge for some disciplines (Papasolomontos & Christie, 1998; Smith, 2008) and the policy of opening data can sometimes discourage people from sharing(Mosconi et al., 2019).

Challenges of sharing secondary data

However, whilst common-sense might seem to suggest that data sharing is of obvious value to academia and society, many researchers approach the topic with caution. Some bring serious issues to the table that cannot easily be solved. Unlike many natural sciences, for instance, research data in interdisciplinary research is not necessarily easy to share. The argument mainly focuses on the rigor of data. Smith (2008) argues: "*Secondary Data is Full of Errors*" and it is "*Socially Constructed*", along with the fact that it that cannot be reduced to numeric form (for quantitative data) and detachment from its origins could result in misinterpretation, and they suggest that people should treat secondary data with appropriate scepticism and pay attention to the limitations when they are accessing it.

Some researchers are concerned with the detachment from the original context and they propose to provide contextual information to enable reuse (Faniel 2010). However, sharing values can still hardly deliver to re-users. As well as the technical issues (Borgman, 2012), Rolland and Lee (Rolland & Lee, 2013)found that people are unlikely to understand data when they have direct access because the knowledge cannot be directly separated from the original creator and context made explicit for users distributed in other time and space (Carlson & Anderson, 2007: p.647). Bowker (2006) and Gitelman (2013) stress out the fact that "raw data is an oxymoron".

Challenges of sharing qualitative secondary data

The friction of sharing becomes even more intensive in the ethnographic context. Sharing data discussed above is computationally relevant and serves mainly for structured (or structureable) data (Korn, 2017). The area of qualitative data is less studied. Corti (Corti, 2007)point out the variety of data collection in qualitative research, how the unstructured (e.g. scattered notes) is combined with the structured (e.g. semi-structured interview and transcripts), and un-digital (e.g. handwriting notes) combined with digital (e.g., typed notes). Qualitative context requires studies reporting the use cases of what contextual information is needed.

Qualitative data contains sensitive information (e.g. health data in our first shared aging project, business credentials in the second shared production project), even including political and religious views of participants. It requires extra care to prevent the identity exposed. Qualitative works are based on trust-building, data reflect the relationship between researcher and participants, and includes personal experience of researchers(Eberhard & Kraus, 2018). Researchers may involve measurements like anonymization, informed consent and ethical guidelines to protect their participants from being identified. However, anonymization sometimes fails and can cause decontextualization in uses (Heaton, 2004; Corti, 2000; Nespor, 2000; Rock, 2001).

Research data sharing is discipline specific, and people should understand the disciplinary specifications before systematic attempts at curation are made (Mosconi 2019). HCI design research has borrowed ethnographic methods from their original fields and inherited the same issues. Our primary empirical research data echoed the above issues. Our context has involved industry partners and other outsiders, and data are hence more varied. It includes development code, design prototypes and brainstorm sketches etc. and it demonstrated that people have different opinions on different data formats.

The reuse scenario has rarely been discussed. Borgman argues it requires more studies of understanding reusing practice closely. "*Only with this knowledge in hand, coupled with a richer understanding of the array of physical and digital objects that might be considered data, can better policies, practices, services, and systems be developed to support the sharing of research data*." (Borgman, 2012: p.1073)

Past design research assets still remain inaccessible for people outside the original research team. Our seminar looked specifically at the HCI field and is an attempt to deal with precisely these issues.

2.3.2 Qualitative Secondary data in the education context

Education research has been accused of being not very influential, useful or well-funded (Burkhardt & Schoenfeld, 2003; Hargreaves, 1996) and, similar to design research, education researchers also call for a greater unity of research and practice. Similar debates take place about how this can be achieved. Some follow the systematic and scientific line while others have concerns about the "dubious dichotomy" (Payne, Williams, & Chamberlain, 2004)which exists in qualitative and quantitative methods. The ESRC reported the lack of skills in using quantitative data and building research capacity by sponsoring centres such as Social Science Research Method hub and UK Data Archive etc.(Gorard, Rushforth, & Taylor, 2004)

Using secondary data for teaching in Social Science

The idea of "reusing qualitative data" is not new in academic disciplines such as the humanities and social sciences. There, the approach has been used for comparative research (Fielding & Fielding, 2000), re-studies/follow-up studies (Danzig, 1974), re-analysis/secondary analysis(Charlesworth & Fink, 2001), research design, methodological advancement and verification.

An example of using second-hand data for teaching purposes is given by Corti and Bishop (Corti, Witzel, & Bishop, 2005a). They set out to investigate ways in which ESDS's Qualidata, a data sharing platform from the Economic and Social Data Service (ESDS) association, can facilitate the use of qualitative data to train sociology students and novice researchers. They argue that there are several benefits for learners in using second-hand data when learning methods. They also outline certain challenges, such as ethical considerations and the lack of technical support to make the reuse of data easier. The most significant issue, however, that reflects our own experience, is the move from data to interpretation, as we will discuss below.

This makes it all the more surprising that there are few, if any, examples of data reuse for teaching design in HCI. Indeed, despite the extensive literature concerning the potential relationship between ethnography and design (see below), little attempt has been made to understand how and whether the secondary analysis of data and published resources as a teaching and learning strategy can help, guide or instruct designers.

Whilst the above approaches are relevant, we will be arguing here that teaching design practices has its particularities and requires something different. For students to learn how to practice user-centred design, they do not only need contact with successful cases, as was the case with Somervell et al. (2004), they need to actually undertake it. This was the main purpose of our initiative: providing users with material that would allow them to engage in user-centred design, by trying to understand users' contexts and practices through the analysis of second-hand data, or in design thinking language, to empathise with the users. This understanding is the basis of the 'define' phase of the design thinking process, which is followed by ideation and prototyping.

Our seminar has shared two kinds of data-sets with students. In the first and second seminar the data was lacking any pre-processing, because we were interested in discovering and analysing the way in which participants made sense of qualitative resources made available to them. This would potentially approximate to the issues that designers might have to contend with. In the other words, the data was collected with specific project goals in mind and was prepared for a learning activity. Our goal was to understand how (and whether) students would use the materials in a way that indicated some critical appreciation of the connection between the methods of data collection and analysis and their design practice.

2.4 Summary

The development of design philosophy in the academic and education environment is indivisible, Design education ideas will eventually be implemented by educators who will bring their own different design thinking and methods in return. In both cases, there is arguably a need for the establishing of a knowledge base while retaining the unrepeatable, regional and in-situ values typically present in design. The unique nature of design such that it solves "wicked problems" and is "in-situ", means that design documentation is not easily replicated in any existing settled mode. A container that summarises the contextualized design cases and their rationales, is clearly required.

There is a demand for public funded research to be made available the public. However, there has been little practical progress in achieving this aim in the last decades, and there are the unresolved gaps between public pressure and researchers' needs. As yet, there are very few cases (especially in the humanities and newly emergent disciplines), reported which demonstrate real re-using cases of academic data.

While the value of secondary data from past design research remains under-explored because of these unsolved challenges, the design and education environment are at the same time calling for better documentation which contains contextualized design knowledge. We suggest a new method for fostering design learning by bringing secondary data into the education process. It allows us, a) to observe the design cognitive process and to understand the relationship between design and ethnographic work, b) to foster the design learning process of interdisciplinary students by providing a real-context, c) to develop perspectives on data reusing, to contribute the data sharing community, and to transform what we learn into the later design of an e-Portfolio (a collection of design case for use by wider communities).

3 Methodology

The methodology of my study is inspired by a methodological framework called Grounded Design, a user-centred and practice-based research paradigm for researcher to conduct design research in real contexts and to understand long term processes of appropriation of designed artefacts by users. Three steps have been suggested iteratively for GD (but not necessarily sequentially), namely *pre-study*, *design* and *appropriation*, also called a Design Case Study (DCS).

Our seminar goes beyond the fixed steps of DCS since we did not totally plan our seminars in advance as pre-studies and, in fact, we tackled different problems in the four different seminars we conducted. Even so, the seminars were linked in that what we learned in the 1st one fed into the design of the 2nd, and so on. Each seminar used secondary data for different design activities.

3.1 Seminar as a Prax-Lab

This seminar is a semi-experimental simulation environment -- students as a vehicle for us to understand design processes and the support needed for them in this environment. Our "experiment" here means in the broad sense of 'trying something out to see if it works' (Koskinen et al., 2011) or an action-oriented intervention(Elliott, 1985; Hayes, 2014). Through those action-lead seminars, we were able to derive knowledge about whether and how people learn desired design methods when using past resources.

Seminar overview

Significantly, in the beginning, there was no clear overall plan to design all 4 seminars since this idea started with the general hypothesis that providing students with a body of secondary data might give us information about how they use such data and the challenges they face in so doing. What we discovered subsequently influenced the design of subsequent seminars. Each seminar is designed based on the prior lessons- earned.

The first seminar was intended to teach principles of Grounded Design by reusing past projects which applied the same research framework. Students were set the task of analysing data about

a specific user group (elderlies) in order to do design work for that same group. After the feasibility of reusing past project data had been assessed in the first seminar, some problems of accessing the past project data emerged.

We applied a participatory design approach with our students in the second and third seminar, where a new artefact was designed and developed the aim of which was to facilitate access to past resources. Students used past project data for new and different purposes. Here, the past project data constituted the design problem for them. Their task was to find ways of making the data available for future students in a usable form. In this way, we turned the end-user group into the future seminar students. And the fourth seminar went through the same process as the first one except that they used the designed artefact for accessing the past project data. It thus had an evaluative function

	SECONDARY DATA RESOURCE	SEMINAR ACTION	DESIGN OBJECT	SECONDARY DATA USE PURPOSE	DESIGN OUTCOME
1 SEMINAR:	Past project data	Design	Elderly (same as original project)	Inspirational resource + Learning reference (e.g., method)	Design for Elderly
2 SEMINAR:	Past project data + Self-collected data	Design	Students	Design Problem/ Simple for address data reusing	Accessing Secondary Data for students - DesignCaser
3 SEMINAR:	Past project data + Design from last seminar	Re-Design + Development	Students	Design Problem/ Simple for address data reusing	Accessing Secondary Data for students - DesignCaser
4 SEMINAR:	Past project data	Design	Machine Operator (same as original project)	Inspirational resource + Learning reference (e.g. method)	Design for Machine Operator

Table 1 Seminar Overview: secondary data resource, seminar action, design object, use purpose and design outcomes

Two patterns become visible from the chart：

In the first and fourth seminar, we are '*using past resources for design learning',* by taking past project data as an inspirational resource, providing examples of design cases and learning material for design methodology. The design object arrived at is aligned with the original research data.

In the second and third seminar, we are '*designing for past resources for design learning',* intending to use secondary data as the material which constitutes a 'design problem' and which provides the resource for conducting design tasks.

Naturally, the outcome for our academic study overall, despite the differences in outcome in each separate seminar. is learning about how past resources could impact the design learning context and design practices.

	MAIN IDEA	TUTORS' ROLE	TEACHING METHOD	FREQUENCY
1ST SEMINAR:	**Understanding** Context and Problems	Resource, coach, reviewer lectures, facilitator	Mixed: Lecture, Studio	Two weeks
2ND SEMINAR:	**Design** on Problem	Resource, coach, reviewer, lectures, facilitator	Mixed: Lecture, Studio	Mixed: Per-week/ flexible
3RD SEMINAR:	**Implement** Design	Resource, Reviewer, facilitator	Mixed: Lecture, Studio	Flexible
4TH SEMINAR:	Designed Artefact in **Real Uses**	Resource, coach, reviewer lectures, facilitator	Mixed: Lecture, Studio	Flexible

Table 2 Seminar Overview: idea, tutor role, teaching method and class frequency

The later seminars produced knowledge both of “design of products” and of “research into design practice (design learning in higher education)”. The experimental seminar itself produced an environment for studying design research, and also the DesignCaser as a typical technological design product outcome designed with and by students trying to address the problem of accessing secondary data for design learning.

e-Learning tool support

The technical tools were evolved to improve the learning experience, but there were different demands from students in each phase of the design learning. I categorize them into 5 types, and the tools which emerged in the end became embedded in an integrated platform – ResearchHub(see table 3).

- Communication tool

Student-teacher’s communication outside classes had tended to be only via emails, a tool that is of limited value when support for discussion is required(Kruchinina et al., 2016). Moving to a social platform helps students build a closer relationship and encourage more participation in discussions.

- Sharing secondary research data

I made secondary data available for students in the original repository platforms in the first three seminars. The student, at this point, therefore, could immerse themselves in the original archive environment until I developed a solution for them to access the secondary data more easily.

- Sharing teaching material and submit seminar outcomes

There was an e-learning platform provided in the university and we shared our teaching materials on that alone in the first seminar. Subsequently, in order to making the materials more centralized and easier for students to use, we unified a space both for sharing teaching materials and for submitting students’ design proposals —Sciebo, a repository that is more user-friendly and is used by tutors on a daily basis.

- Manage seminar tasks

We learned from the first seminar that students need support in making their contribution to group work visible outside of classrooms. It is hard to retrieve the design process and individual workload, which makes it hard to evaluate the student's contribution to group collaboration and participation beside the giving of presentations and the evidence of design outcomes. Therefore, in the second seminar we transferred everything to Research-hub (not available in the first two seminars). The Trello board was a good tool to manage each design task and worked as a means to archive the group activities and discussions. However, students found it requires extra workload to manage the board.

	COMMUNICA -TION	SHARE PROJECT DATA	SHARE TEACHING MATERIAL	OUTCOME SUBMISSION	MANAGE TASKS
1 SEMINAR:	e-Mail;	BSCW (with in Tutor's Computer)	Moodle (e-Learning platform provided by university)	Sciebo	None
2 SEMINAR:	e-Mail;	BSCW (with limited access in personal computer)	Sciebo	Sciebo	Trello
3 SEMINAR:	e-Mail, Research Hub	Sciebo	Sciebo	Sciebo	Research Hub
4 SEMINAR:	e-Mail, Research Hub	DesignCaser (merge to Research Hub later)	DesignCaser (merge to Research Hub later)	Research Hub and Sciebo	Research Hub

Table 3 Tools-using in seminars

Because of the differences between disciplines, cultural background and level of design experience, we limited student work to specific design methodologies in the seminar. These were selected to allow completion of the design task learning cycle of concept and practice in parallel. Greenberg asserts that "good design" is a matter of providing students with knowledge concerning what is usable to people. (Greenberg, 1996)

- Grounded Design and Design-case Study

It is key to give students a clear goal and a clear understanding of what they will learn in the seminar. In every seminar the Grounded Design framework was introduced to establish our epistemological standpoint, pedagogical aim and research goal. We wanted, in this way, to provide them with a clear sense of what they are participating in and contributing to the study and therefore motivate their design activity and process documentation.

- Qualitative Data Analysis (Thematic Analysis)

Data analysis, or how to format data for research purposes is not something that many students are familiar with. We expected that few of them would have knowledge of how to handle data.

The shared projects are based on qualitative study and so we recommended our students to apply Thematic Analysis as a way to handle the research data. It is a common method used in qualitative research analysis and becoming more and more popular since Clarke and Braun(2006) published the article, "reflective thematic analysis" in 2006.

We decided to introduce Thematic Analysis in the design seminar for three reasons, firstly, this method is flexible, students could use it to analyse various types of qualitative-based research data (interview, video, pictures, websites etc.). Also, the method is comparatively easy to use and more accessible than other qualitative analysis method (e.g. Grounded Theory) according to some HCI researchers (Blandford, 2013). Thirdly, George(tutor) is experienced in using

Thematic Analysis(Braun & Clarke, 2006) in his design research, and his experience supported students in learning how to address secondary research resources.

The analysis method is not mandatory for the students to use in our seminars, and students could employ other analysis methods as well. Our goal in introducing the analysis method is help students make sense of shared qualitative research data and therefore help them formulate their design problems.

- Scenario-based Design

User scenarios are a commonly used tool in the design formation process that helps designers remain user-centred. Design problem forming based on secondary data analysing can be even more challenging for seminar students. This story-telling method is prepared for students who have various experience of design and education backgrounds, and promotes communication in groups (Carroll, 1999).

- Prototyping and Sketching

We also demonstrated a variety of formats for visualisation of existing prototypes (e.g. storyboard, paper prototypes and hand drawn sketches etc.) and levels of fidelity. Thus, students can choose an appropriate format to present their design ideas. Considering not all of our students are professionally trained in graphic skills, it was important to emphasise our evaluation would not be focused on the skill of drawing the interface but to clearly demonstrate design ideas graphically.

Hands-on and co-learning activity

Students learned and practiced these methods for their design project in the seminar, based on lectures given on HCI design methods, (e.g., User-centered Design and Participatory Design;

Qualitative data Analyzing; Personal and Scenario Design; Sketch and Prototyping; Cooperative Evaluation etc.).

In turn, we documented the design cognitive process, observed and interviewed students, and asked them questions and discussed design findings with them. We call this co-learning

activity. Hands-on means, all of the learned methods were to be practiced in their seminar tasks. The students were to engage with real fieldwork via data (first and third, fourth Semester) or real users (second Semester) and even test it with their own design results.

Co-creation and co-curation

The co-design activity is also a main characteristic of our seminars. The tutors prepared the relevant teaching resources and built-up knowledge foundations (see preparation work in each section) for planned designed tasks. And each seminar was re-designed based on the feedback of students, for instance, with regard to the tools needed, the format of sharing and the frequency of meetings, all of which were adjusted based on the students' suggestions. In the meantime, students were asked to design (or provide suggestions to design) the artefacte with tutors. They, as a part of the user group, have reflected on the need for accessing secondary data themselves and have provided insights to the design of systems for secondary data.

The student, also as data re-users, were asked to co-curate the secondary data. We learned from the students in the first semester that empirical data, especially data from the pre-study are important for performing design activities, but that how to curate the data for interdisciplinary students remained a problem. We started to ask the students to reflect on those questions and curate the data in hand, and in the end, the data was curated by the tutor and students together in the second and third seminar, and reused by the fourth seminar students.

3.2 Participates

All the participants are anonymized and a fictional name is assigned to each student (see the table 4). Some students have participated in more than one seminar, and the name of the group is a combination of seminar and groups. “A01” means Group A from the first seminar.

Since some nationalities would expose the identity of our students, we will split them into German or International students which is enough for understanding the required context.

- 1st Seminar

12 students participated and there was one drop-out due to the friction in the group collaboration. The students formed into 3 groups with deliberate grouping on the basis of disciplinary background. Group A had Design backgrounds, Group B had engineering background, and Group C had a mixed background. We expected that organising the groups in this way might reveal something about how different disciplinary backgrounds might influence data selection and design decision- making.

- 2nd Seminar

6 students were recruited in the second seminar and 2 groups were formed. Each group was assigned at least one German speaker this time and the groups were not divided based on their disciplinary background anymore. We aimed for a truly participatory design approach, and the mixed group components, we hoped, would be useful in such a design environment.

- third Seminar: Students with development skill

Only 4 students participated in this seminar due to the restriction of programming skills being necessary. We involved a student assistant, Jacob, who has 1-year experience with developing in the required development environment. Charles, who has the experience in dealing with the second-hand research data, and who had participated in the first seminar.

NAME	SEMINAR	GROUP	EDUCATIONAL BACKGROUND	GERMAN & INTERNATIONAL	WORK EXPERIENCE
HANNAN	1st	A01	Digital Media Art	International	-
MACIA	1st	A01	Computer Science & Design	International	1 year in Developing and Partly Design
CALVIN	1st	A01	Business Management	German	3 years in Management
WESLEY	1st	A01	Interaction Design	International	2 years in in Interaction design
ANDERSON	1st	B01	Philosophy& Computer science	German	-
TAHAN	1st	B01	Sociology	German	1 year Student Assistant in Research Project
JOE	1st	B01	Interaction Design	German	2 year in Interaction Design
HENRIETTA	1st	B01	Sociology	German	-
CHARLES	1st & 3rd	C01/A03	Mechanical Engineering	International	-
JOLINA	1st & 4th	C01/B04	Computer Science	International	-
BRITNEY	1st	C01	Computer Science	International	-

TRACY	1st	C01/C04	Computer Science	International	-
JENNY	2nd & 4th	A02/ A04	Industrial Design	International	4 years in Interaction Design
CHLOE	2nd	A02	Computer Science	International	-
MIA	2nd	A02	Sociology	German	-
MARC	2nd	B02	Computer Science	International	2 years in Development
NANCY	2nd	B02	Sociology	German	-
ELAINE	2nd	B02	HCI	German	-
MISTY	3rd	A03	Computer Science	International	-
JACOB	3rd & 4th	A03/ A04	Computer Science	International	5 years in software engineering
AKELA	3rd & 4th	A03/ A04	Computer Science	International	-
CHARLES	1st & 3rd	C01/A03	Mechanical Engineering	International	-
MAGGIE	4th	A04	Business Administration	International (Middle level German)	1 year in UX
ROWENA	4th	A04	Computer Science	German	-
JACOB	3rd & 4th	A03/ A04	Computer Science	International	5 years in software engineering
AKELA	3rd & 4th	A03/ A04	Computer Science	International	-

JENNY	2nd & 4th	A02/ A04	Industrial Design	International	4 years in Interaction Design
ANTHONY	4th	B04	Car Engineering /Computer science	International	-
SADIE	4th	B04	Computer Science	International	1 year in teaching assistant
BRITNEY	4th	B04	Computer Science	International	-
JOLINA	1st & 4th	C01/B04	Computer Science	International	-
KENNARD	4th	C04	Electronic Engineering	International	-
ALICE	4th	C04	Computer Science	International	-
TRACY	1st	C01/C04	Computer Science	International	-
STAN	4th	C04	Computer Science	International	-

Table 4 Student information list: participated seminar and group, education background, nationality and work experience

- fourth Seminar: half of the old students from past seminars

13 students participated in the seminar, and it is worth mentioning that 6 of the students participated in at least one of our past seminars and were interested to see how this seminar process went next. Therefore, those re-entry students already had experience of engaging with old project data and thus could help other new group members to establish a better understanding of using it. We intended to distribute at least one German speaker and experienced student in each group. However, group C did not have a German due to the lack of German speakers.

3.3 Collected Empirical Materials

We conducted interviews with the secondary data provider and re-users to reflect on the secondary data in a design education context. Here, we will demonstrate the list of various materials that we collected both from researchers and participated students. (see table 5)

	PRIMARY INTERVIEW WITH RESEARCHERS	FORMAL INTERVIEW WITH STUDENTS	VIDEO RECORDS (CLASSROOM)	STUDENT SELF-DOCUMENTATION (OUTSIDE CLASSROOM)	REPORTS AND DESIGN OUTCOMES	OBSERVATION NOTES
AHEAD SEMINAR	9	-	-	-	-	-
1ST SEMINAR	-	4	11	20	9	11
2ND SEMINAR	-	3	10	15	6	10
3RD SEMINAR	-	3	7	15	2	7
4TH S	-	6	11	14	12	11
AFTER SEMINAR	2(tutor George)	-	-	-	-	-
SUM	11	16	39	64	29	39

Table 5 List of collected empirical data

1. Primary research with Institute Researchers on data sharing:

We conducted semi-structured interviews to collect general opinions regarding sharing of the data they have collected in their projects beyond the group. In summary, 9 interviews were carried out with a duration ranging from 90 to 153 minutes (average = 120 minutes).

2. Two interviews performed with the other tutor (George)

An experienced post-doc was invited to conduct the seminar together with the author. He has been teaching HCI related courses since 2013 and has rich experience in bringing social aspects to the design process and has interests in teaching systematic analysis methods. He is also the lecturer of CSCW -- a mandatory module of the HCI Master Program, since 2018 when he joined the research institute. Furthermore, it is worth noting that George participated in the second project, and he provided additional information about the original project and added extra support to help students make sense of the secondary resources.

The seminar as an experimental project has been designed following discussions with the two tutors; the discussion was documented and two interviews carried out after the seminars to reflect back on the overall teaching experiences. The first interview lasted for 103 minutes and the second one lasted for 50 minutes.

3. 16 interviews with Seminar Students

16 interviews have been carried out with participating students. The questions are partly semi-structured and partly individual based on the content of each different design seminar. The Semi-structured questions are related to the background of students (*what is your nationality, education background and work experience?*), understanding of design *(eg. What is designed for you? Are you a designer?)*, faced challenges *(What is the most challenging task for you in the seminar)*, reflection *(What you learned from the seminar?)*, group collaboration *(how your group worked together)* and suggestions *(What needs to be improved? what can secondary data be used in other design scenarios?)*. The other questions were designed based on the design outcomes and documented materials we have in hand.

In the first seminar, we were interested in the difficulties of accessing the secondary data, reflection on designed seminar tasks, and whether (and how) they connected secondary data with the design result. For instance, *how did you make sense of the provided material? How did you work with your groupmates? What you learned from the data and which part was carried to the design idea?* The interviews carried out with the students on average took more than 180 minutes (average=192 minutes).

Interviews inducted after the second and third seminar (average=88 minutes) were more concentrated on the experience of designing from secondary data and reflections on playing a double role (being a designer and a user group in parallel). The questions were, for example, *what is your opinion about secondary research data? how did you identify the design needs of users? What are the advantages and disadvantages of being a designer and user group? What is missing and what would be the next step?*

The interviews from the fourth seminar asked similar questions to the first seminar, and added further feedback about the developed artefact. (DesignCaser).

4. Inside classroom: video records and observation notes

Every meeting session that involved tutors was recorded both with audio and video devices. When there were technical issues with the camera, the audio served as the back-up. An observation note recorded the interesting moments in the discussions.

5. Outside classroom: Self-documentations

There is documentation that students themselves also recorded, including audio recordings and document protocols. Self-documentation of this kind was recommended to form part of their submission, along with their seminar materials. We encouraged students to share all the materials, including but not limited to presentations, analysis files, reports, sketches, audio records and notes etc. The sheer amount of material available for review meant that not all of it has been reviewed.

6. Reports and Design outcomes

The design outcomes are presented in student presentations and also documented in the local server. The design seminars focus on the hands-on experiences, the reflective learning and practice learning experience, so the report contents are not “all or nothing”. Students were free to elaborate on their thoughts and make critiques in their reported materials.

Content transcription and analysis

The data quantity, as pointed out, was beyond our capacity to fully utilize and we had to employ a strategy to handle those data. Multiple forms of material were selected to transcribe and analyse based on the degree of richness the collected material contained.

The *interviews* reflected the individual thoughts of participants and were conducted during the final session of each seminar record and transcribed. Data about the other *video records from the classes* was collected through *observation notes from classes* (all the fieldnotes had a time-stamp where specific interesting discussion was to be found. The *reports and records after classes* which are documented by students, were to be used as a reference when their meeting protocols were showing interesting topics. For example, a meeting protocol script showed how, because Macia joined the group A01 late, her group mates from A01 guided her through the selected materials, and there they mentioned the reason for choosing a specific file and the strategy behind it.

3.4 Data Resources – Two research projects

The resources used for our design education purposes consisted of data from 2 research projects. The first project was an international research project which had several researchers and partners involved in research into the topic of aging. The second was a German research project involving collaboration with local companies in the production environment. Both projects collected empirical data from the local groups and the language is German.

Project iStopfalls: Design for aging society (1-2 semester)

The data we used in the first two teaching seminars come from the sub-group of the aforementioned research team that carried out research on "ICT for aging". We re-activated the repository after it ended 2 years previously. Since the repository had not been opened for a long-time, the technical team had stopped maintaining the platform and we could not initially access the data. After talking to the researchers, we found they normally had their own documentation stored in their local drives for further publication purposes.

ITC for Aging was a 3-year international research project aligned with several cutting-edge research institutes, SMEs and a world-leading company who worked collaboratively on the technological application intended to prevent falls by seniors. The Siegen group was the lead partner and collaboration centre of this project. The documentation is extremely rich. They archived all research data (that include but not restrict to administrative, IT development, design, empirical data etc.,.) in a repository called BSCW. The repository divided again into two sections internally, one shared with institutional and industry partners and containing more than 2200 files. including the administrative files (milestone, deliverables, prototype versions and development codes, work packages, consortium meeting documentation, press and media, conferences and festival documentation, project proposal, project reports, reference publication and cases etc.)

The empirical data collected by the Siegen group was only locally accessible. It contained more than 300 different types of files, and included over 60 interviews and transcripts, numerous observation notes (from pre-study design and appropriation phrase), along with over 20 files of tested health measurements from participants.

This local research group was composed of one senior manager and 4 PhD researchers, 3 of whom worked as master research assistants in the first project. The group is currently working on a research project that builds substantially upon a previous one. Two other student assistants, who did not participate in the first project, make up the team in the second one. The researchers come from diverse educational backgrounds, which is not unusual given the highly interdisciplinary character of HCI research. For instance, the project manager holds a PhD in physiology and has specialised in the design of medical technology; the 4 PhD candidates come from areas such as healthcare, economics, sociology, business informatics and computer science – some of them holding degrees in more than one area.

Project Cyberrüsten 4.0: Design for machine operator in local factory (3-4 semester)

In the 2 semesters which followed, we shared another project's data with the students to examine our ideas with different research project data. Cyberrüsten is a 3-year project for designing solutions to shorten the complex and time-consuming setup process on production machines. The interdisciplinary research team involved in the project consists of the Chair for Information Systems and New Media, Technology Management and Metal Forming Technology, and three local industry companies. Two researchers from our institute, a post doctor and a PhD student with a background in mechanical engineering, are responsible for the empirical study and the design of this project. The post doctor is also the tutor (George) in my study, and graduated from computer science (bachelor) and HCI (Master and PhD). Researchers use empirical qualitative methods to analyse the supply chain as well as the set-up process on bending machines in a factory setting. The Knowledge transfer gap that causes inefficiencies in the set-up process was detected through their empirical work. In order to resolve the issue, they designed an Augmented Reality system by using HoloLens to improve the set-up processes and tested it with machine operators. The result of the project shows that operators could transfer knowledge more efficiently, and the duration of a setup process can be significantly shortened using this new AR system.

The project involved a coal company and one German institute; therefore, the project size is much less than the previous international project. The data has been shared and contains 4 folders (4.4GB, 220 files). The *Administration folder* contains project description, application, time plan, the *Design Case study folder* (171) includes kick off meeting, workshops, interview

(20), usability test; the *Dissemination* (49) folder include media files like demos of designed artifact, newspaper report, presentation slides, posters and papers. Finally, the Literature folder contains hundreds of related literatures they summed up and categorized according to topic.

Different from iStopfalls, data has been shared and curated by the researcher George (also the tutor of the seminar). He structured the shared resource in a similar fashion to the above four categories of file, but the data shared with students was pre-processed by the researchers and sensitive data has been removed due to the confidentiality of information identified with the company. George obtained agreement from his associated partners and asked only for the data that did l not raise ethical and legal challenges. Company A, for instance, have a commercial interest in the design of the bending machine and they requested that the visual documents of those machines, for example, the eye-tracking video record and many other pictures from the workplace containing machine details be deleted from the shared document.

Ethical aspect

Ethics is a vital issue for secondary sharing and an important motive as well for researchers who investigate peoples' behaviours. Also, the ethical aspect is an important part of our pedagogical content. We emphasised the need for collecting empirical data and trying to design a safer environment for sharing secondary empirical data together in a way which respected ethical considerations.

Before sharing the resources, we confirmed with project leaders that we could share the resources in our HCI education environment, and we took precautions to limit the sharing range, as follows:

- Anonymization

We anonymized selected secondary empirical data in the first seminar by replacing the real identities (people name, institution name and location), However, this measurement failed somehow in both seminars. In the first seminar, students were still able to recognize identities by comparing the interview content with public resources (video for project introduction). In the third and fourth seminar, the tutor (data provider) had already anonymized his data-set during the project and we shared those data directly, but some anonymization in shared

materials was missed out. Fortunately, students could not differentiate real names from the pseudonyms.

We did not anonymize the second seminar for two reasons, firstly simply because anonymizing all 60 interviews and hundreds of observations was impossible for us for resource reasons. Secondly, we held a co-design activity in the second seminar, and students as designers needed to have an overview on the problems we faced. We decided not to anonymize the data in the second seminar after discussing it with the leader of the project.

- Sign Confidentiality and Consent Form

In order to guarantee the shared data would not be revealed to third parties, students had to sign the prepared confidentiality form to gain access to the data. A consent form was distributed after explaining the intention of collecting research data for study purposes, Students have the right to withdraw their data at any moment without justification. Fortunately, we received all the consent forms and confidentiality forms from all the seminar student. After the project, the students will no longer have permission to access the data anymore by cancel their access rights in the repository.

- Collected and Documented data from Seminars

The data that we collected from the students are located in our local server, so the data is only accessible by two tutors and two research assistants. Research assistants also signed confidentiality forms and only had limited access to the documents.

4 Research Background

Within the institution, as with many others, valuable research data from past projects usually remains unused once the project has officially ended. Some researchers estimated that only around two-third of the potential insights to be gained from project data ever get published. However, ongoing exploitation of the data at a local level is often impossible because of the obligation to deal with new research agendas. It was part of an initiative to design an e-Portfolio(Wulf, Volkmar, et al., 2018), i.e., an artefact to share data about present and past research projects. My study grew from this idea and considerable primary work being done before we began this study. Before presenting the empirical findings from the seminars, the background of my study will be elaborated in the following three sections.

This seminar was grounded in a methodological framework called Grounded Design, in which a group of senior design researchers summarized their design research experience over the past 20 years (Rohde et al., 2017; Wulf et al., 2015; Wulf, Pipek, et al., 2018). e-Portfolio is a design concept originating from Grounded Design, which aims to provide access to documented design case studies in order to understand design researchers' practices. It formed the motivation for conducting our seminar work and constituted the background to our work. The first section will introduce the methodological framework and motivation for teaching Grounded Design, and its relation with e-Portfolio.

The second section introduces the local HCI curriculum. The pedagogical method is aligned with the epistemological views of the research group, and emphasises the importance of bridging the design methods and "real" experience derived from fieldwork. The section describes the current design learning curriculum and the view of the students.

The third section consists of the primary empirical work for the e-Portfolio, where we interviewed members of the group to cultivate their opinions regarding the prospect of sharing such data so that other people might be able to realise its value. On the one hand, our informants immediately recognised the value of data sharing. On the other hand, they also raised concerns about the nature of the data, its ownership, the need for a shared language, the incentives for sharing, and the kinds of public policy to which they are accountable. We tried in the first

instance to understand the nature of research documentation from a past research project and the challenges of sharing It.it offered us an overview of qualitative research work and the ethical perspective when dealing with the secondary uses of research data, and gave us insights into possible solutions as to how best to share within our education environments.

4.1 Overarching methodological foundation: Grounded Design and e-Portfolio

Grounded Design is a methodological framework established by the Siegen HCI research group. There are currently more than 30 researchers which includes senior professors, PhD students and postdoctoral students. They have conducted and are conducting more than 20 research projects that cover the broad areas which include "ICT for aging, Industry 4.0, Research-environment Infrastructure, design for marginal populations, Fab-lab and Food etc." These design research projects apply the same research broad framework, and have produced significant research outcomes for the past 20 years.

e-Portfolio is a design concept that is resolved from the methodological framework of Grounded Design. It is one of the major motivations for conducting the seminars in design learning.

4.1.1 Grounded Design -- a practiced-based approach to user-centred computing

Grounded Design highlights three characteristics of conducting design research. 1) it emphasizes ethnographic research into design and IT appropriation; 2) and applies participatory design methods where researchers, practitioners and end-users design prototypes and test them; 3) moreover, it seeks to identify the changes in long-term appropriation by adapting designed artefacts in response to changes in the social practices. Therefore, compared with the normal user-centred design thinking methods, Grounded Design emphasizes the "*social-practices*" in "*long-term appropriation*" of designed artefacts with a focus on using "*qualitative methods*".

Practice-based Design—the "practice turn" in HCI

"Practice" is the core of Grounded Design. It examines the appropriation of the designed artefact in "the wild", a method that differentiates it from design research that is conducted in a stable laboratory environment. It argues that the usage of artefacts that is observed through a long-term perspective in a "real" environment produces research outcomes which capture the change in context-specific circumstances and informs new insights for redesign over time. End-users sometimes surprise researchers when they start to involve a new artefact in their daily

activities, since their routine has been impacted by the new tools and versa vice. For example, a chair can be used for sitting, but users may use it for hang their clothes or even as a stair for getting things from high places. Those untended adaptations of design become visible in long-term appropriation. The transformative impact of designed artefacts and potential development insights in social practice is the focus of Grounded Design.

Iterative 3 steps in Design Case Study

There are 3 iterative steps summarized in Grounded Design, which is Pre-study, Design and

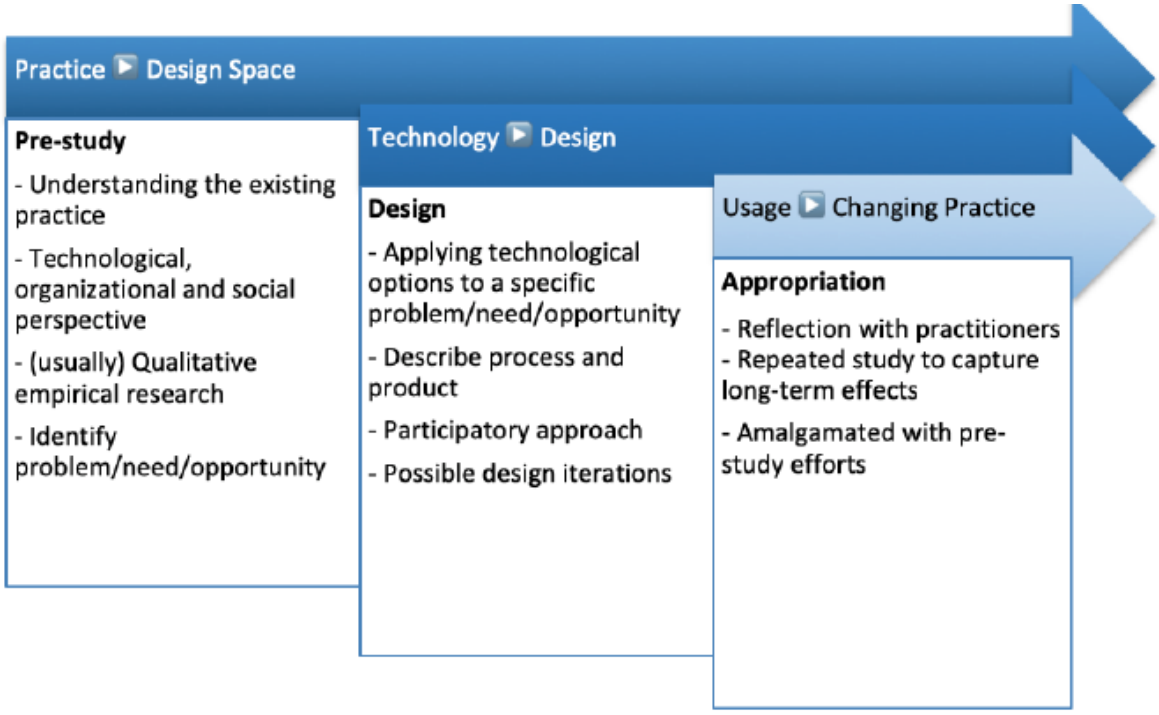

Figure 1 Grounded Design: three steps in Design Case Study

Appropriation (see figure 1). GD is also a user-centred, highly contextualized and participatory design approach so one can discover similar design processes in other user-centric design frameworks. However, it emphasizes the "practice" tone here. What the researchers believe is fascinating and makes a difference from other design frameworks is that design can be understood in the context of artefactual use daily routines. Researching design in real settings could help them to gain contextual aspects and real experiences. Therefore, the three stages of design involve design objects' iteration and encourages co-designing and co-developing activities.

4.1.2 E-Portfolio: an ecological collection of Design Case Study

The initial idea of e-Portfolio was first introduced in the socio-informatics book (Wulf et al. 2018). It detailed a collection of design case studies that document all relevant materials from pre-study to appropriation of design artefacts within highly contextualized situations. Wulf et al. envisioned a procedure that makes design research trajectories last longer than its project lifespan (see also in Friedman & Yoo, 2017). In doing so, they propose a platform that could enable sharing research assets beyond the original research team and suggest bringing research outcomes other than publications into the academic system, thus bringing otherwise invisible research works to the forefront to accelerate reflection, comparison, transferring insights and concept forming in design research environments. Similar consideration has been proposed also by other researchers and educators. Wixon noted that current publication and literature failed in presenting HCI practice results in examples and opportunities for interface design meta-analysis were thus lacking, since design processes are largely non-standard and proprietary (Wixon, 2003).

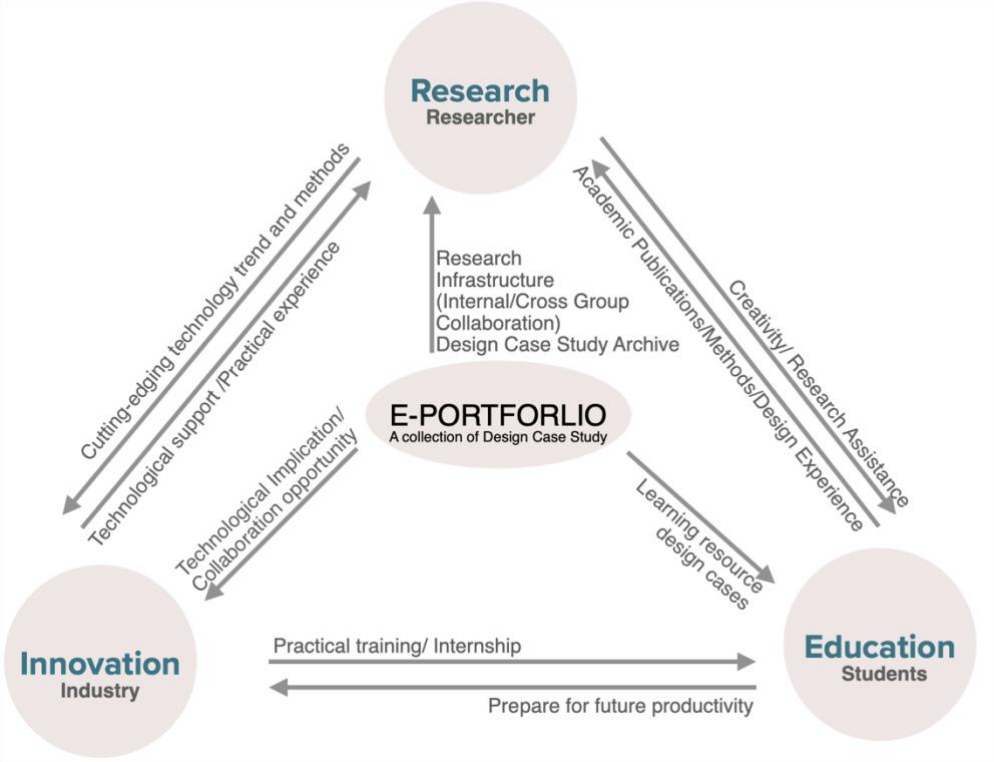

Figure 2 Three parties of e-Portfolio concept

E-Portfolio was constructed bottom-up in three layers. It supports internal team design work that includes all kinds of data in the whole research process, such as empirical data (ideally raw data), design data, development codes, and connections among the study cases that allow for cross-comparisons with concepts and outcomes on the top.

We identified several parties that could benefit from the design of e-Portfolio (see figure 2).

- Researcher: Related researchers that are associated with the research topics can benefit from the insights from former researchers and add new insights to enable the new knowledge.

- Industry: Industrial and commercial companies that collaborate with research institutes or with interests in experimenting novel technological artefacts could learn advanced scientific methods and technological trends for discovering new opportunities for their market. In turn, researchers could gain practical knowledge and extra technical support.

- Students: HCI students that are interested in learning design methods together with practicing design, and discovering priority how experienced design researchers in the "wild" acquire and analyse knowledge. Wild here means the ethnographic work that identifies what is done by done by users in their daily life.

The e-Portfolio is a collection of design case studies that are carefully documented by researchers, allowing different parties to learn from it. My study here is concentrates on the triangle of researcher, students and e-Portfolio. (see figure 3)

The researchers provided the research documentation that we then stored in a centralized repository. This repository held processed data and we shared it to the students, and students re-used the collected research documentations as learning materials, bringing new insights and

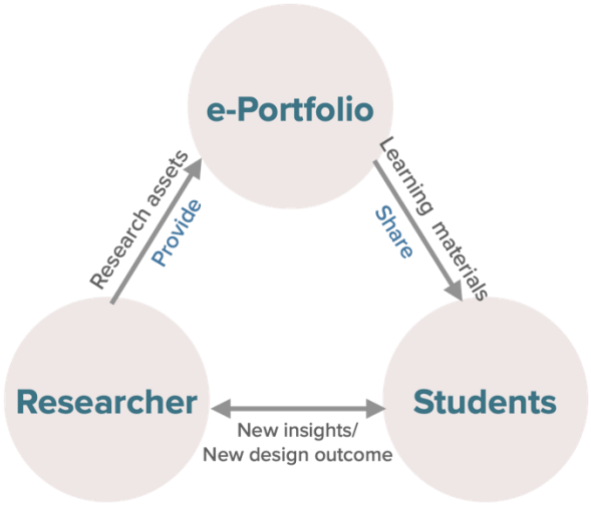

Figure 3 Relation between e-Portfolio, Researcher and Students

ideas to the original design study. The relationship may look simple and direct but, nevertheless, the challenge of presenting the data in a sensible way to enable the accessibility of information for interdisciplinary and intercultural students was significant. It was, put simply, a learning experience for all, including myself.

Inevitably, when it comes to sharing data, there are the issues of ownership, of intellectual property, of incentives for sharing etc., which have been the subject of much discussion in the open-science community. This topic is, as yet, new to the HCI community and, therefore, researchers that participated in this project have been interviewed to understand their views on knowledge transfer and sharing in this interdisciplinary context. We find sometimes the interests of the e-Portfolio concept and those of researchers are in tension and careful handling of qualitative research documentation and its peculiarities is needed. (Li et al., 2020; Mosconi et al., 2019) Before we simply ask researchers to open their research data access to students, some fundamental issues within this particular must be understood. (See further details in Researchers --the aspects from the data provider).

The technical artefact relation - Research-Hub & DesignCaser

The e-Portfolio shown above is a complex and ambitious concept that envisions bringing new audiences to the research work in question the concept targets 3 user groups. Research-Hub[3] is a technical artefact that we designed for the e-Portfolio concept in are search context. It has been developed for the past 3 years as part of another research project called SFB, which shared a similar vision – support for data sharing beyond internal research groups. Beside the ethical and political issues of sharing, another major empirical finding previously identified was that the research environment typically lacks knowledge about, and technical support for, managing research data. Crucially, this makes data sharing extremely difficult(Mosconi et al., 2019). We designed tailored functions for fostering data management and collaborative research work, including functions such as *stream*, *Onlinedrive* (a centralized repository space associated with other adapted repositories (e.g. Google Drive and Sciebo) in research environments, *calendar, notes, votes, wiki* etc. It is an ongoing project that involved 737 users (researchers and students)

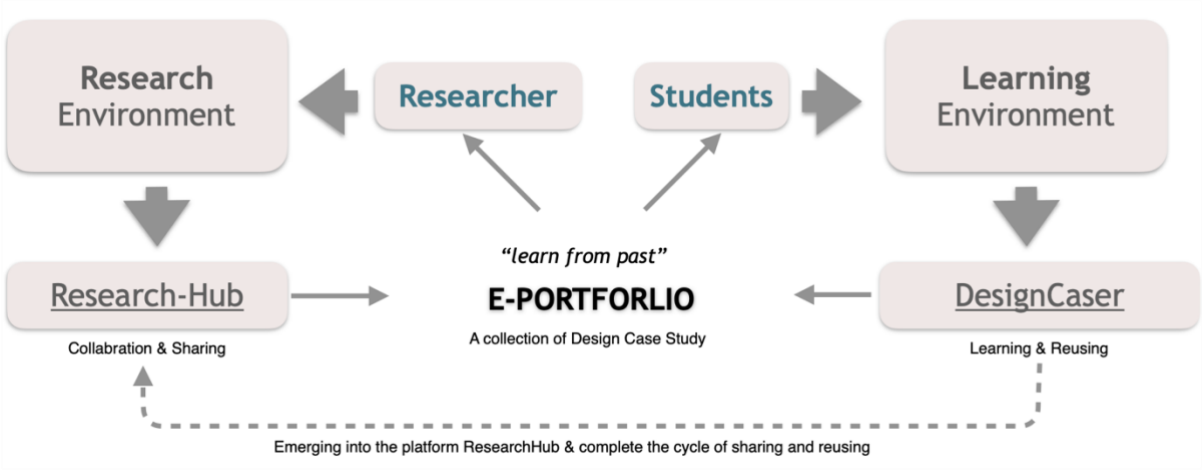

Figure 4 Technological outcome of e-Portfolio

[3] https://research-hub.social/. Accessed 20th, Oct. 2020

within 76 working spaces[4]. In the beginning, there were only a few designed modules customised for researchers from SFB1187[5] and the Siegen socio-informatic group[6].

We started to expand the user group by involving students from our seminars after reflecting on the needs of students in our educational environment. Students started to use it for managing group design tasks and communicating with tutors in the third and fourth seminar we conducted, and we received positive feedback from them in the feedback session.

DesignCaser is one of the design results from our design study, it aims at fostering data users (in our case, students) to access past design project assets. This module was co-designed, co-developed and tested with the students. Currently, this module is emerging on the Research-Hub platform, in order to complete the cycle of sharing (providing) and reusing (see figure 4).

[4] https://research-hub.social/directory/members. Accessed 15th, Feb. 2021

[5] https://www.mediacoop.uni-siegen.de. Accessed 15th, Feb. 2021

[6] Social Informatics included 6 research groups in University of Siegen:Information System and New Media(https://www.wineme.uni-siegen.de/) ; CSCW(https://www.cscw.uni-siegen.de/) ; ICT for Aging(https://italg.wineme.uni-siegen.de/); Cyber-Physical Systems(https://cps.wineme.fb5.uni-siegen.de/); IT Security(https://www.itsec.wiwi.uni-siegen.de/). Accessed 15th, Feb. 2021

4.2 HCI Master Student--the Aspect from the Data Re-User

The documentation for design thinking, knowledge extraction, and the theory forming process can impact the design education area deeply. In the e-Portfolio design concept, students are one of the groups we identified that could gain value from the past documentation of research projects. Students often lack authentic material and instances for their daily design learning practices.

Lack of authentic resources and instances

Students often lack authentic material for their daily design practices. The education systems can be contrived and oversimplified (Jonassen, Strobel, & Lee, 2006; Spiro et al., 2013) in lectures. Constructive learning environments address this problem by integrating practical experience with prior knowledge to construct an active learning experience (Jonassen, 1991), and authenticity often takes place in those constructive learning contexts (Maor, 1999; Strobel et al., 2013). Students in the HCI curriculum have been encouraged to use the learned empirical methods and test their design in real fields, and it is mandatory for our students to collect evidence from the practice-based design projects. As tutors, we are aware of how valuable the empirical resources are for students and we also understand the difficulty of recruiting the voluntary users for students' projects, as they later reported in the interviews.

> *...we sent more than 20 emails (last month) to those companies (for investigating our group design topics), but so far, we haven't got any reply. (Sadie, Group B04, interview)*

> *...We do not have the opportunity to talk with the local people (as international students who do not speak Germany), and we spend most of the time in university...I have to rely on my friends to make interviews and (gain) feedbacks in that project. (Hannah, Group A01, interview)*

The design learning environment, on the other hand, often lacks an overview of how a completed design project has been carried out and also lacks good instances for grasping obscure methods and theories, especially in co-design and test phases. Students turn to

searching for instances in publications. Nevertheless, it does not provide an adequate description of *how* knowledge is acquired and used, nor for a grasp of the richness of social practices. In this case, formative lectures and publications are poor vehicles for understanding the relation between design practice and design methods.

Am I a designer? – lack of recognition of empirical work as part of design skill

The self-identity as "designer" in higher degree level of design education is problematic in HCI. A typical answer received from the students who are not trained traditionally from creative-way-of-thinking and graphic design areas is "I do not consider myself as a designer, I do not have the graphic skills and creative mind." (Jacob, Group A03&A04, interview)

And some students lack the confidence to identify themselves as "designer", "at least I am trying to be a designer, I trained as a computer scientist but my passion is design although I am still not able to create the beautiful interfaces" (Jolina, Group C01&B04, interview)

A creative mind and the ability to create aesthetic interfaces are recognized as the basic quality of being a designer, which are also critical in the job market. Nevertheless, abilities related to empirical capacities, for instance, to identify design problems, to build design concepts and evaluate design environments which are equally important to design have not been fully recognized by the students -- and not just them. We should remind ourselves that design learning is not only about teaching design skills but also about transforming their epistemological foundations, which has to do with expanding their mindset and making them open and confident to their future career.

Training our students in a series of activities illustrating the design method is not enough to build a sufficient image of 'doing professional design'. A deeper sense of belonging and purpose of 'doing professional design' needs to be built and design related-careers need to be made available for the students from diverged disciplines.

Showing the power of the empirical and helping them to build a series of knowledges for doing professional design is required in the design education curriculum.

4.2.1 A practice-based HCI Master Curriculum

HCI programs across the world are exploring the approaches that adapt themselves to new epistemologies including design thinking, since no single disciplinary approach covers everything. Our HCI program in Siegen is associated with the Socio-Informatic group, a group that works with practice-based and largely ethnographic approach as a main element of research, and the teaching methods have inherited the tradition of conducting design projects with Grounded Design. We explore, in our curriculum, effective methods to help students learn practice-based design.

4.2.2 Why should students learn Grounded Design?

Technology is advancing at an unprecedented rate and HCI educators have been exposed to several challenges for current design education. The knowledge base becomes broader with technology now present everywhere in life and learning. The HCI curriculum, we believe, should cover abilities to self-learn, to produce one's own design outcomes, to work in interdisciplinary groups, to do iterative design and to cultivate a human-centred attitude. Grounded Design is thought to furnish these criteria.

- Socio- informatics System

Firstly, aligning with the institutes' fundamental research framework, this curriculum allows students to acquire a solid and substantial basis of methods and techniques for conception, design and implementation as well as the testing of IT systems in social contexts.

- Practical and Context Awareness

Classic usability often works with (quantitative) lab studies, but in this programme, we are convinced that this is not enough and the human as a whole is not adequately considered in this process. Therefore, we mostly conduct our research ethnographically (qualitatively) in the field, i.e., in the context of the user. Students are intended to learn the ethnographic approach to understanding users, and to co-design and test their ideas with their end-users.

- Research and Learning

Research and teaching go hand in hand in Siegen. Students often work directly in research projects, which are also sometimes carried out in cooperation with industry. Here, students can find not only a relevance to their studies but also have the opportunity to work in real practice design research projects with associated industry partners. Many students have experiences working within practice-based design projects and later bring those learned experiences to peers in our seminar.

HCI design is user-centric and requires knowledge and skills for understanding people, people that live in various changing contexts and how to find design solutions as well. Learning design through the understanding of social practice allowed students to be involved in a mixed research and practice environment and enabled learning in a conversational and reflective manner which fed iteratively into design practices. And we believe, learning Grounded Design is an effective preparation our interdisciplinary and multi-cultural students for the rapid changing design environment and hence their future design careers.

4.2.3 Why secondary research data for Grounded Design Learning?

This practice-based approach is highly encouraged in the curriculum of Siegen. Design educators are committed to exploring ways of connecting their learned research practice with design seminars. The idea of using secondary data for learning design was proposed as a means to supply students with data from the field- resources which they otherwise lack in their learning environments.

Research data can contain explicit knowledge of the whole design process of a research project, a valuable resource for bridging the following gaps:

- Gap between design research and design education

Research data was not visible for students before unless they joined the project as research assistants. Therefore, specific material was not used for teaching purposes and knowledge from projects could only be gained through the public outcomes -- most of the time this is publications and final artifacts which do not, in themselves, cover the detailed design process and the nuances of knowledge gained.

- Gap between learning and practicing: Exemplification of design knowledge

Many valuable knowledges relating to the design process get lost while transferring, such as explicit problem-solving process, the using of method in various conditions, and the complexity of real scenes gets lost. Many educators tend to share their experiences by presenting their real design cases in classrooms, and students can then associate the learned methods to specifications. Our assumption was that research documentation could contribute to this issue as well, and how that might happen.

Many educators have explored ways to bridge the linkage between theory and practices and we bring secondary data to the learning environment in 4 seminars with and for students, as another means to do exactly that.

4.3 Researchers--the Aspect from the Data Provider

A great deal of valuable research data ends up sealed in virtual repositories after research projects come to a close. Sharing data beyond the confines of such projects has been proposed as an important vehicle for re-productivity and sustainability. In this way potentially valuable insights and synergies are not lost once projects have ended. However, HCI researchers are not always prepared for sharing. Sharing data in this way is rife with many challenges (Sardanelli et al., 2018). We show that, in practice, there are two strongly contradictory voices regarding data sharing beyond specific project groupings, and discuss the ethical and practical implications of this for sharing design project data based on qualitative research. We elaborate on these findings across the section and show sharing beyond local teams raises significant ethical issues and is wrapped up in complexity. Clearly, the sharing of research data is an intricate and complicated problem in practice. We believe there is a need for ongoing discourse in HCI around the key issues and challenges we have identified and call for further research on the matter. However, my study is not aiming to address data sharing challenges in a research context, in fact, this issue might need to be re-discussed since its challenge in practice can look insurmountable (see detail in Mosconi et al. 2019). Understanding sharing from a data provider's perspective is an essential step for us to be aware of the potential risks, and could help us in creating measurements protecting those data in a way that respects the positioning and responsibilities of the researcher.

4.3.1 Affirmative Voices

Some of the PhD students interviewed had a positive attitude towards sharing. For instance, the ones with a sociological background saw sharing as a means of communicating with people outside the loop.

> *[…] We have students come from other disciplines, when they have an easy access to know this project, they might come up with a new concept, new solutions which never, none of us thought about before, because we do not have that domain's specific knowledge. (PhD candidate, Sociology)*

Another PhD researcher with a background in economics and healthcare wants to *"learn how people analyse their data"*. And those researchers, such as our tutor, who shared the data within

the seminar, feel the responsibility to bring things back to the public and believe it is a potentially good practice for the future research environment.

The collaborating tutor George also expressed the view that he is only willing to share the "raw" material, the 'intellectual' part will not be his best interest to share with the researchers but data is very "object-oriented" and he is curious about how others would analyze their data.

4.3.2 Dissenting Voices

Other researchers, however, questioned if sharing data is feasible from ethical, legal and privacy points of view. In the following we present the 7 themes that emerged from their arguments.

- Stakeholder Ethics and the Legal View

The manager of the research project expressed the strongest resistance to sharing by arguing that consortium agreements would impede it. Data can be shared only if every stakeholder in a project agrees. *"*In this consortium agreement, it is defined that everything will not be published, will be handled with care, and will not be disclosed". He suggested that the consequences would be unaffordable, because large enterprises "will never open up any data they have acquired in such projects. They will punish us, if we would open up any of data without their permission". The group would have a financial penalty imposed that could get as high as "four-times" what they "have earned in the whole project".

- Pressure to publish Hot data

Another ethical issue is the tension between researchers: Researchers have a deep relationship with their data. They have invested time, passion and intelligence into its accumulation and analysis. In increasingly competitive research environments where publication is a key measure of success, many researchers are reluctant to give up their data, especially "*unpublished data*". Respondents said they would "*feel bad*" about this and considered it "unacceptable" for somebody else to use their data to get published before they did. People also hold different views on how to differentiate what kind of data is not shareable. For instance, the tutor George holds an open attitude about sharing the *unanalysed data*, only the "*intelligent part"* of data,

meaning the analysed result, is not shareable for him due to the same reason to do with publication. And based on our interviews, analysed data is the part that other interviewed researchers are most interested in.

- De-contextualization

Our analysis reveals a view that if data is separated from its context, it becomes devalued. Data can be enormously diverse in character and be handled in a variety of ways. Removed from the context in which it was generated and assembled, data can be hard or even impossible to interpret. A PhD student argues that "*if you're working on the project, you know where to go, but for those who are not involved, it is harder; you don't know what is behind it, there are a lot of data (in the repository).*" Communication between data-owners and data-users may assist here, but increases overheads such as workload and time.

- Unguaranteed Privacy of Anonymized Data

Most HCI researchers anonymize data as a matter of course, largely as a means of guaranteeing their participants' privacy. In iStopfalls project, only the manager and 1 PhD student were allowed to access the un-anonymized data, which was stored on a password protected local server. However, they would not entertain sharing even the anonymized data publicly, because they believed specific individuals would still be identifiable. The manager explained: *"with an interview transcription, you are always able to identify the persons, because they explain everything, even if you are blinding the names."*

Cyberrüsten 4.0 is better prepared for sharing compared with iStopfalls. They discussed issues of sharing within the research team, as well as collaborated with the company and participating end-users. They are opening for sharing anonymized material and of course, the research object is less sensitive (operational engineering) comparing with the iStopfalls project (Elderlies)

- Responsible Research

An ethical perspective is deeply rooted in academic traditions. Researchers take on a responsibility to protect collected data from misuse, above and beyond what might be stipulated in data protection acts. Emotion also plays an important role, especially with regard to more

vulnerable groups in society. Researchers can build up a relationship with participants over years of weekly or bi-weekly meetings, and acquire a strong investment in *"build(ing) a better place for them"*. This imbues the data captured in these meetings with a strong personal relevance, making it far from something neutral to be shared.

- Intensive time investment and lack of incentive

Data cannot be accessible without investment in time and labour, though some researchers have been pushing to make their resources available so that their data can be useful for people not involved in the project. However, investment in preparing the secondary data is costly. There are measures for trying to improve the situation, for example, providing economic support by funding agencies and seeking the services of data professionals. However, researchers reported those measurements fail to encourage research sharing and, in some cases, even discouraged it(Johnston et al., 2018). Researchers have to spend their time wisely, and yet there is no feasible suggestion as to how to address the incentive issue so all the investment in sharing is in some way repaid.

4.3.3 Share data in the education context

Our primary research into the behaviour and attitudes of HCI researchers showed us a very similar pattern and arguments in social science and medicine. Where data collection tends to be qualitative, there is case to case variation and the data is people-focused. Reasons for why data is not shared became clearer, however. Research rarely looks at why people reuse data, one of the questions for these researchers is who might be using those data.

> *The reasons that researchers do not share data readily are becoming better understood. However, even less is known about why researchers do share data and why they reuse data. Thus, much more research is needed about practices in fields that do share data consistently and practices in fields where data are consistently reused. Only with this knowledge in hand, coupled with a richer understanding of the array of physical and digital objects that might be considered data, can better policies, practices, services, and systems be developed to support the sharing of research data.*(Borgman, 2012: p.1073).

Due to the fact that researchers are reluctant to share their data, my study of reuse in the education context could be a valuable case for showing the practice of why people reuse data and support the development of data sharing.

4.4 Summary

Grounded Design is a practice-based design method that has been applied at an institutional level of design research and has resulted in the accumulation of a considerable amount of knowledge for the past twenty years. Researchers, even so, estimated that two third of their research outcomes have not been published from the past projects, and the idea of e-Portfolio has been proposed to expand that accumulated knowledge to border groups to make underexplored public funded data accessible. Students are one indispensable part of it.

The HCI curriculum is calling for preparing students for future complex design context by integration of border disciplines of user research. But students often lack the empirical resources to learn socio-technical design in their learning programs. We propose the idea of accessing the past empirical resources by sharing secondary design case.

However, on the other side, researchers articulate their concerns about sharing research data beyond local research groups, the data sharing (especially qualitative data sharing) becomes a conundrum (Borgman, 2012). There is a lack of understanding of incentive and reuse cases, and our seminar with students could provide a real-reusing report on why people re-use research data and thus contribute to the data sharing community.

5 First Seminar: Understanding Secondary Data in Design Learning Context

The first seminar opens the new resources for learning Grounded Design, a design methodology that emphasizes the investigation of the living situation of user groups, and encourages reflective thinking in users' needs from long-term iterative design processes.

This seminar is the first one that shares the internal research data with students. It is an experimental research practice for exploring the possibility of using secondary design case studies for design education and learning the usage of secondary data in real cases.

Considerable work has been invested in understanding the researchers and their collected data before the seminar. Tutors have been exploring the data with the help of the original researchers. Following the regular design process, 4 steps have been planned to guide students through the seminar and the process has been systematically documented both inside and outside the classroom by tutor and students together.

There were 12 students participating in the seminar and they showed how they select, analyze secondary data and design technical solutions for the elderly group. The 3 groups of students developed 3 design artefacts in the end, and they employed multiple design methods to achieve it. In this section, we report the first seminar that shared secondary data in design learning context and discovered it.

5.1 Preparation Work and Setting

There was necessary preparation be done to match the pedagogical goal of learning Grounded Design. There was no existing policy or recommended procedure for us to prepare such material for students and, therefore, two tutors discussed collaboratively the seminar plan and prepared secondary material themselves.

5.1.1 Curate education materials

Neither tutor participated in the original research project and so the first step was familiarising with and evaluating data and thinking about methods of making data available for students.

Tutor as the data curator

Tutors went through the project repository thoroughly and recorded the whole exploration process. In the meantime, they reflected on students' needs and thought about what the challenge that lay ahead for them might look like. And three major issues stood out in the preparation process:

1. Lacking background knowledge

- Methodological Concept: Prax-lab

Tutors were not sure about the meaning of the applied concept in the project, even though researchers can have an instinctive understanding of the method. We needed, then, to rephrase certain usages so as to make them clearer for the students. For instance, in our case, George (tutor) interpreted the Prax-lab as an artificial simulation environment for test design of artefacts with users. However, in the documentation, testing with users involved the living environment in which they conducted their daily life routines.

- Terms and abbreviations

Another challenge for the tutor is making sense of the terms from other professionals like medicine and care science, and numerous abbreviations that could be only understood by the original researchers. Those terms and abbreviations needed to be noted by the tutors as well,

- Original team composition

The data was constructed and maintained by the manager, who also is a senior researcher in the Siegen group. Besides the local Siegen group, several industry and research institutes also contributed to the data repository. Understanding each partner and the role they played in the project helped us in understanding the project context and the data produced.

2. Language

The local empirical study carried out with local users was conducted in German. However, most of our students are non-German-speakers. Tutors needed to make material available by translating those data. However, with more than 60 interviews and numerous observations notes available, tutors were not able to translate all of it. Then we decided to only translate the materials that students selected.

3. Data Messiness

There are interviews which are not anonymized and some that lack a transcript; thus data needs to be pre-processed by the tutor before it is shared with the students. As with the second issue of language, we were not able to process the whole of the large data-set and we decided to anonymize the data being selected by the students.

Constructing the knowledge foundation

Neither the tutor nor the students had participated in the original project, and contextualized knowledge was therefore missing in the exploring process. According to the experience we gained in the familiarization step, we decided to employ a top-down and shallow to deep method to demonstrate the project and project material. The video made for public media was the first selected material for students to gain an overview of the project.

1. Project introduction

A video that was created by the original group for introducing their project was initially presented to students. . The video contains clips where professionals introducing the project-context and end-users speak about their experience and their interaction with the designed

artefact. In this video, students could gain a basic overview, and visual information about the final designed artifact and the stakeholders who participated in the project.

2. Methods and Methodologies

I gave students lectures on related methods and methodology since they come from various backgrounds and levels, especially novice students in relation to design.

I summarised four related methods for students to progress their design.

I introduced two applied methods in project work: Grounded Design (Rohde et al. 2017; Wulf, Pipek, et al. 2018) and the Prax-lab approach (Müller, Schorch, & Wieching, 2014; Ogonowski et al., 2013; Panek et al., 2007), a research infrastructure for *long-term* involvement of users with a participatory design philosophy.

After students had an overview of the project and data structure, we introduced the data analysis method (Thematic Analysis) to help students make sense of selected researcher data. HCI research has involved many data analysis methods from anthropology, psychology and sociology. Analysing qualitative data is an important skill needed when accessing the empirical data, but we found HCI curriculum does not pay much attention to the delivery of this skill. Our participating students, especially the novices, do not know how to process shared research data. Then we decided to introduce an available analysis method for students, as we introduced in the Methodology chapter. It is an easily-accessible, flexible method that could be adapted to various types of shared secondary resources.

Scenario-based Design methods and examples of design prototyping have also been introduced in order to support the varied experiences of students.

Curate research data

- Represent data structure

The original data structure was presented in the classroom. It is important to mention that we did not pre-process the project data structure before we shared it with the students. We assumed that students from various disciplines would be interested in different data files and any

arbitrary decision on our part should be avoided to allow them to select and use those data for design purposes in whatever way they saw fit.

- Sign consent form and confidentiality

It is mandatory for students to sign a confidentiality agreement before they access the research data. We also explained our research experiment and the purpose of the seminar, and asked permission for recording the sessions. Luckily, all students agreed to document the sessions and this helped us record their design process outside the classroom.

- Restrict data access

I had already learned that the research data is sensitive and researchers were nervous of sharing their research data with border groups. The project data is stored online by using the institutional server, and students used the tutors' computer to access the data. The list of data-sets was shared with students as well, because we could share everything with the student directly.

- Translation and anonymization

Due to the time restriction, we could not translate all the empirical interviews and observation notes, which is another reason we did not share the data directly with students. After they selected the data, it would be translated and anonymized manually, which created a large workload and time-cost for tutors.

Applied technical tools

I employed the e-learning platforms provided by the university in this seminar.

- Submission and Archive

The university provided an e-learning platform named *Moodle* that allows tutors to manage their learning materials and give announcements in the system. And students were able to receive emails once new updates have been made in the system.

However, it does not provide a convenient space for submissions. Therefore, the submissions and shared documents are stored in Sciebo, a non-commercial cloud storage service for research studying and teaching with 30 participating institutions in Germany[7].

It is worth mentioning that project data is not directly shared with students in the original repository (BCSW) since students do not have the access to it. The secondary data was processed and shared via Sciebo later.

- Email Communication

Although Moodle[8] provides us with the function of making announcements, it is not really sufficient for the exchange of information, proposing questions and nor is it flexible with regard to daily communications.

[7] Sciebo project: https://sciebo.de/en/project/index.html(accessed at 04.01.2021)

[8] e-Learning Moodle:https://moodle.uni-siegen.de (accessed at 02.02.2021)

5.1.2 Plan for 4 steps

I established 4 steps in the first Semester, our intention being to explore with the students how to use second hand data for design use.

1. Data Selection (1-4 weeks)

Students were not constrained in their selection of data, but in practice all three groups gravitated towards the qualitative data, especially interviews. As they put it, *"we know what an interview is about" (Hannah, Group A, Design, feedback Interview)* [9].

Each group chose more than 10 interviews and some observation field notes from the local empirical space, along with some other explanatory materials in the public folder for understanding the project context.

The data content list was also circulated to students to encourage them to select more materials, but none of them came back to ask for other needed materials, since they were already overloaded by the data in hand.

Our first step was to understand *what* students were aiming at when they start with a huge amount of valuable and yet messy research data. The main question for us was to understand which kind of data might be most interesting for the students when they have access to the data that they are not familiar with, and which data set is understandable and useful for them and what kind of data can be neglected. Our intention was, also, to try to see what kind of data is missing from their point of view and to use tutors as a window to service the data and the students (as data users). And then, I could reflect on how I improve data acceptance.

2. Data Analysis (5-8 week)

Very few of our students were familiar with standard data analytic methodologies. Although they had heard about approaches such as Grounded Theory (Glaser and Strauss 1967) and

[9] All names are fictional for the sake of confidentiality.

Thematic Analysis (Braun and Clarke 2012) briefly in other lectures, they were confronted here for the first time with a substantive problem. For them, it was a completely new way to process empirical data for design. They had been collecting the empirical materials by themselves but had never interpreted those materials by using well-established analysis methods and tools.

In a series of lectures, they have been introduced to the specificities of Thematic Analysis (Braun and Clarke, 2012) and have been advised to use the method to analyse the selected data. We decided on Thematic Analysis for it is a flexible and resourceful approach to analysis, which targets both novice and experienced researchers. It is also a very powerful tool to draw requirements for the design of computer technology, as discussed by (de Carvalho et al., 2018).

Although students were advised to use Thematic Analysis for the analysis of their data, they have not been constrained by the method. Group C, for instance, decided for qualitative Content Analysis (Bengtsson, 2016), as some of its members were familiar with the method and had used it before, though not for the analysis of user contexts and generation of system requirements.

The second was to see *how* students would use those data, what kind of data is useful and analyisable, how much time they would invest and what kind of methods they would use from the learning experiences they had in the past. Also, we were particularly interested in their different backgrounds of students. We saw them as the container of interdisciplinary knowledge, who could add to the given data with various interpretive flavours. We were also looking forward to seeing how the data could be renewed.

3. Scenario Building (8-10 week)

The students had been asked to build two scenarios, extracted from the data, following Carroll's approach to scenario-based design(Carroll, 1999). These represented their conception of the design problem and possible solutions. They were encouraged to draw on the analysed material and to reflect on their own experiences to create links between the data and the potential design. Put simply, they were asked to use the scenarios as a means to identify what some requirements for design might look like.

The third was to see the impact of the data and its connection to further design ideas. We wanted to see what students' minds had imagined, what data had been processed and what kind of ideas students had based on the selected data. We were also interested in the triggering problem (s) they found and whether they were different in different groups and disciplines.

4. Design (10-12 week)

Finally, students were requested to design a technical solution based on their vision of the design problem. All three groups addressed this issue with a degree of competence, using visualisation techniques, mock-ups, and so on. I could then trace how the design outcomes from the groups had travelled over the last 3 steps. How is their data linked with design? I were not only focused on how innovative the design ideas are, but the design problems they have generated and how to address them by learning from the past experiences, and the degree to which they were perceived differently. What challenge do they have when they come up with their ideas, and does data help?

5.2 Step1. Data Selection

In the end, all 3 groups asked for the material from both external and internal folders. They chose material from external folders to get a better overview of the projects by looking at the work packages and slides. The internal material was more interesting for them, and all groups chose more than 10 interviews, and a few observation notes in every project stage.

5.2.1 Understanding secondary data is challenge

The issue identified from our exploration process resonated with the exploration experience of the students. Data sharing and reuse has been proposed for a number of years to improve academic transparency and reproducibility. Nevertheless, progress has arguably been rather slow – see (Mosconi et al., 2019) for a discussion. Even in more 'scientific' domains, a series of problems have been identified and, where a degree of success can be demonstrated, it is usually as a result of long-term collaboration. In short, it is agreed in the main that the re-use of research data is difficult. Moreover, as Mosconi et al. have shown, there are some very specific problems associated with data re-use in the context of qualitative enquiries. This in no way implies that the reuse of ethnographic data is impossible, but does demonstrate that there are some obstacles to overcome.

Below, I build on these insights to show how these difficulties relate to particular features of the data provided. With regard to data selection and analysis, I identify *data messiness*, *data overload* and *time constraints* as the 3 major obstacles to data reuse. Other factors including *disciplinary and cultural background differences* also played an important role in the process of sharing user experience related qualitative data.

Data mystery

Unsurprisingly, the existing structure of the data was appropriate for use by the original researchers who collected it. They had organised the data in ways that seemed sensible and appropriate to them. It was remarkable, therefore, to see just how obscure the data structures were to the seminar groups. One student called the project documentation a *"mystery"*.

When students first opened the documentation, the data naming was not generally transparent for them. Not least, file naming in this context contained a mixture of German and English,

with a number of unfamiliar abbreviations and file names that were not indicative of the file's contents.

> *There is a folder called 'pdf' with almost 200 files inside, when I now go back into the folder, I find a lot of very useful information like the redesign results, but we did not notice the usefulness at all at that time because the file name is not at all obvious and hidden so deep…Some filename seems very useful but show very little information, some filenames are obscure, but contain very rich information, often more than 10 pages of useful stuff. (Hannah, Group A01, Design, feedback interview)*

They also found some missing data, which they otherwise considered to be important. For example, one group asked for information about the evolution of the design interfaces which did not appear to be documented in this repository, and for some development data which turned out to be unavailable because one partner had removed it. Moreover, some data files had not been transcribed, nor had they been anonymised. While this is largely unproblematic in the context of internal use, it is very much otherwise in the context of re-use.

A further problem came about as students reported that they were unable to understand parts of the interview data. In the first instance, this was reported by the group containing foreign students, and was therefore no surprise. However, native speakers also had the same problem. Thus, while we might expect translation difficulties resulting from idiomatic or colloquial language, it is clear that something else is also going on when native speakers report similar trouble.

> *Especially when they are talking about the software. Language-wise it is clear. But we do not know what the exercise is they were referring to. (Billy, Group C, Computer Science, Feedback Interview)*

These problems include deictic reference, inadequate transcription of emphasis, mood or emotion, and so on. The point here is that the omission of such things is less likely to be problematic for the researcher who constructed the file because they have contextual resources to draw on: they were there. Secondary users of the data do not share this resource and hence have difficulty in interpreting some parts.

Data overload

A second issue had to do with the quantity of project data, which caused a degree of panic and confusion. The file list was over 54 pages long when every sub-folder was expanded. Trying to make sense of such a mass of data is challenging, even for those who are familiar with the domain. For students, who lack that familiarity, the prospect is daunting.

> *We have so many folders and so many subfolders, which we have no idea about, because, somehow, we have something in mind, like design appropriation, design case study and everything. And it is usually step by step for us, but then we saw the folders, first of all, it aligns a thematic folder, so, it just feels like too much. (Emmett, Group A01, Design, Group Discussion after Class)*

After data had been selected, the students said there was too much irrelevant information and that it was time consuming and confusing to read even the selected amount.

> *According to the file sequence, I already go through more than 200 file titles, and I have to download data to get a preview sometimes, but I got nothing useful for me. (Hannah, Group A01, Design, Meeting Minutes)*

This leads to the question of what data is relevant and useful for design learning. It is clear that relevance is perceived differently according to different disciplinary and experiential backgrounds. It is a real challenge to identify what the 'core' relevance might be understood to be.

Failed anonymization

All shared empirical data was anonymized with double reviews. Name, location and any information which could reveal the real user has been replaced, and even the file-name in the shared file-list has been erased. A group of students reported they still could identify the real person in the interview. by referencing the publically-shared video which annotated the participating person's real name and age. Students from group B quickly identified the participants from age and gender details that we provided in the shared data. Also, a similar issue later was reported by the tutor, who shared his material in the third and fourth seminar. Anonymization is, again, a challenge for the data sharing process. And technical support may

not be the solution, given the various ways in which the real identity of users could be established.

Time consuming work

Students had to fulfil the tasks in each step within a limited timeframe. However, reusing data is a very time-consuming process. In the selection process, data messiness led to demands for 'a reasonable time' to familiarise themselves with, and make sense of, the data. The issue of the quantity of project data was also problematic, so much so that the students did "not know where to look" when they opened the repository. They opened almost every file, asking themselves, 'what is this file about, what was the purpose of creating this?' Working with the tutor helped here but even so, the problem of overload was evident.

5.3 Step2. From Data to Analysis

The design research team in this department has a tradition of both using qualitative resources for design purposes and of advocating its use in course material. That students often expressed considerable frustration when reporting their experience of trying to make sense of the data to hand was, therefore, instructive. Exploring ethnographic data and transferring empirical findings to design insights was difficult, not to say vexing.

Most frustration had to do with deploying data analysis methods. Put simply, they found coding to be extremely challenging. Nevertheless, and I felt it was a significant and teachable finding, our students reported in a post-interview that the exercise was valuable training.

> *I like the Mathematic approach more, and I am not as sensitive as Sara (backgrounded in social science) while we analysing data… And there isn't a lecture ask us to perform the data analysis practice before, what I learned the most in this seminar is, making sense of our collected data. (Mike, Group C01, Philosophy and Computer Science, Feedback Interview)*

To be clear, more experienced students had been taught about qualitative data analytic methods such as Grounded Theory, Thematic Analysis and so on in their lectures, they had never, until this point, ever engaged in the practical business of trying to deal with real fieldwork data

before. They typically argued that such approaches are, *"... too vague and general to be understood".*

Students who had limited knowledge of data collection methods recognised their own limitations in relation to this: *"I could not conduct an interview as good as this yet.";" we did not know what a research interview looked like before."* One student, reflecting on his new applied design project in post-interview said,

> *I am starting to do interviews by myself (this semester), and I have realised how important the kinds of question you ask are. (Charles, Group B01, Engineering, Feedback Interview)*

In a similar way, students struggled with user-centred design methods exemplified by, for instance, participatory design workshops and usability test documents.

In various forms, there was agreement that, "*We need examples."* The point here is that the 'classic' approach to design teaching is to provide curated design project outcomes, often in the form of published work. Such work, we suggest, while furnishing information about the outcomes of project work, seldom provide information concerning how these outcomes were arrived at. Thus, and for brief example, when we are told that 'interrater reliability' was arrived at through shared analysis of data in published work, that is seldom accompanied by any description of how, in practice, such agreements were arrived at. Our point is that this was precisely our students' problem: how were they to arrive at the desired outcomes? To put it another way, experiential data tends to be missing and rather more 'tacit' information is what students felt they most needed.

5.3.1 Acquiring "how to" knowledge

This knowledge gap, of course, recalls the classic distinction between 'knowing how' and 'knowing that' (Ryle, 2009). The data given to students, even after a sifting and sorting process on their part, still did not confer upon them a 'design sensibility'. They did not, initially, know what to do with it. This, after we had shared with them our own use of a thematic analytic approach and our use of Maxqda (a digital qualitative data analysis tool that is commonly used in HCI research teams). Two groups eventually managed to analyse, respectively 2 interviews,

and 4 interviews. That hands-on experience in analysing data, proved to be valuable to them. Above all, it provided a link between lecture content and hands-on experience. Strikingly, students felt they had learned, 'something new and useful'. As one interviewee put it *"we have to interpret users because they do not know what they need so they could not tell us directly"*.

Challenges of qualitative analysis in group work

Much as the implicit nature of qualitative data and analysis was a problem for students, so was time management. One group estimated they spent about 6 days altogether on 2 interviews. They estimated 4 days working individually (2 days per interview), and 2 more days for merging codes together:

> *We spent a single afternoon, rough estimate 6 hours, to go through an interview, we do not have more hours to spend so we are not able to follow strict method steps, it is time-consuming and boring. Sometimes the expressions from the interviewees do not make sense, and we cannot find much special things, because elderly life is dull. (Charles, Group B01, Engineering, Feedback Interview)*

The interdisciplinary nature of HCI adds an extra flavour to group collaboration. Qualitative data interpretation is deeply associated with personal experience, culture and disciplinary differences. In terms of cultural background and personal experience:

> *Coding itself is very subjective because everyone has their focus…And our German groupmate is sensitive to the perspective of health insurance and connects it with his social and political system, but others do not. (Hannah, Group A01, Design, Feedback Interview)*

Disciplinary differences, not entirely surprisingly, reveal epistemological divisions:

> *He is more from the quantitative side and I am more qualitative, so we have a lot of divergences… They (other two groupmates) are not showing much understanding at all, and struggle to follow the procedures (in analysing data qualitatively). (Sara, Group C01, Social Science, Feedback Interview)*

In terms of language and disciplinary differences:

> *I am very familiar with the data, but everyone has their own way of naming it, we have the same meaning most of the time but use different words. It requires extra time to discuss and merge it. (Charles, Group B01, Engineering, Feedback Interview)*

Interdisciplinary group collaboration has always been a double-edged sword because, while it enriches experience through complementary perspectives and promotes group communication, it also requires a lot of patience and understanding. Our students, it has to be said, were not well-prepared for such challenges.

Using qualitative data Inefficiently

Another challenge related to data analysis data for design purposes is that students find it difficult and, at least in and through recommended processes, something of an irritation. They expressed a concern about *systematic* data analysis in terms of investment and reward in design work. They suggested they needed to learn more about data analysis and the different approaches to it if they were to use empirical data effectively.

> *Not all the data is useful, only some provide design information. And I sometimes get confused with the actual purpose of coding, it is just adding annotations on the data and using the software to make it more systematic, I did not see the point. But it is useful because I do not know any other effective data analysis approaches. (Hannah, Group A01, Design, Feedback Interview)*

To sum up, students lack knowledge of "how" to use qualitative methods that they, in principle, are supposedly familiar with. And it leads to problems in accessing ethnographic data in depth.

5.4 Step3. From Data to Design Scenarios

Sorting for data relevance and doing data analysis, of course, are only part of the process. It was intended that our students should be able to utilize their findings, as well, to produce design ideas. We encouraged students to adopt methods for 'retracing experience' through use of scenarios, personas and storytelling to transcend this gap between knowing that and knowing how. Design has been identified as "wicked" problem (Buchanan, 1992) and the process has long been recognised as an iterative one. The processes of analysis and reflection undertaken by our students very much reflects this. The connection between data and design problems, while not linear, can nevertheless be seen when we examine the way in which qualitative data affected students' design decisions.

5.4.1 Articulate empirical findings through stories

The empirical data, then, were given this 'personal' quality, having been translated into personas and scenarios (Hensely et al., 2015). Students described these scenarios in often minute detail, having invested a lot of energy and time in reading and interpreting the data They argued that the assembly of the materials – the analytic work – gave them a more vivid view of the research process.

> *It is not like that I create a character after I read the data and then build the story. While we are reading the data, we can already reflect some interviewee's life stories and their emotions by the situation and atmosphere the documented data descripted, then there is a character with his/her life scenario and stories around him/she in ours head, and all is created simultaneously. (Hannah, Group A01, Design, Feedback Interview)*

Students, then, clearly saw the purpose of providing some version of the life-routines of users and the concomitant insight into lived experience. Such data is not always easy to obtain and, again, gave the students insight into how best to manage this.

5.4.2 Descriptive data and directive data for design

The process of assembly entailed the separation of material into descriptive elements and more 'purposeful' elements, the latter being thought of as direct design ramifications. Descriptive data that do not reflect on the creative outcomes directly however formed the idea forming process.

> *...such as society situation: sound sport facility and elderly personal characteristics, they cannot directly transform into an explicit design idea. But those data affect story building because we started to realise that doing sport outside triggers elderly's social engagements. (Hannah, Group A01, Design, Feedback Interview)*

And design directive data are normally reflecting on the final creations, for instance, the theme that students stemmed from the analyses claimed as the design resources.

This creation process did not involve direct one-for-one translation of data elements into design factors. Rather, the management of the material itself can be thought of as entailing an ongoing transformative process in which the data and reasoning about the data exist in a mutually constitutive relationship.

5.4.3 Find "real" design problems

The scenarios obtained from available data often dovetailed with personal experience, giving a kind of intuitive comparison possibility. For many students, who were not familiar with the local culture and its relation to their design objects, the data provided access into the lives of others. In particular, it provided a completely new and detailed picture of their user population, even for those more familiar with the local context.

> *...I have not much understanding of elderly peoples' daily routine before, even though I was raised by my grandparents. I did not know what they are doing every day. The interview gave me a new insight into their life. It is disciplined and well-planned (Charles, Group B01, Engineering, Feedback Interview)*

The envisaged design problem sometimes underwent a transformation as students realised their basic assumptions might well be inaccurate. The design thinking process, in such cases, can be thought of as a recontextualization. An example is:

> *I found it surprising that elderly is not like what we imagined! I was imagining elderlies are always acting passively in social engagements and hardly go outside by themselves. But through the data I found those elderlies are very active, they participate a lot in outside sport events like swimming, climbing, jogging. An interviewee says he might be old in age but not old in physical body, they do not feel that they are 'old'. (Hannah, Group A01, Design, Feedback Interview)*

Now, it might seem that these students are particularly naïve, but we would suggest this is not the case. Their initial assumptions are not, in our view, dissimilar from those of system designers who have little or no contextual information to go on. Design, as has been pointed out before (Randall, Harper, & Rouncefield, 2007) is often seen as "problem solving", with too little attention paid to examination of the problem itself. Problems at the core of a design need to be carefully considered. The students came to realise that the factors that constitute a 'problem' are very complex and embedded in the practices made visible through such data. It is interesting to see how the 're-specification' of problems that has been spoken of by, for instance(Hughes et al., 1992), was clearly visible in the work done by the students here.

5.5 Step 4: From Data to Design Outcomes

As we pointed out above, there were three groups involved in the design seminar. They came from a variety of backgrounds but were each motivated by a common desire to provide an outcome based on a design problem that they had identified in and through their use of the data. “core” motivation of choosing their design problem.

> *Design practice is frequently influenced by factors such as personal preferences, pragmatic concerns, experience with "what works," and familiarity* (Hannafin et al.,1997*: p.103*)

Nevertheless, they did so in different ways, building on discreet amalgams of cultural background, social experiences, educational background, and so on. In each instance, design outcomes could be understood as data transformed by the application of a ‘method’, but mediated by a constellation of experience. We discuss the different outcomes below.

5.5.1 Design initials triggered by emotional resonance

The design idea from Group A was largely triggered by empathy with a design subject. They reported themselves to be deeply affected by comments from one end user. As one student said, “*his needs were so intensive*” Then they eventually took a path to design for promoting social engagement by designing a Live-Game in customized traveling scenarios with other players.

Group B01 and C01 on the other hand tended to locate the design problem by relating it to their own experiences, resonating the end-user’s problems with their personal experiences. Group B associated the interviewees with their families and designed a platform that could evaluate the user’s health state and promote enhanced medical knowledge for elderly people.

> *More than one of my elderly relatives did nothing, not examining themselves at all until their illnesses deteriorated. And I linked it with me … thinking about if a disease were to be detected in me … then I would regret that I have not done the physical examinations regularly. (Charles, Group B01, Engineering, Feedback Interview)*

Group C01 interrogated what they saw to be characterological matters, and sought to find solutions for that type of character:

> *We find the interviewee is making excuses for not going out: "I try to, but", he is protecting himself from new experience because he wants to stay in his comfort zone. We always link to my brother because he is always lying around. (Mike, Group C01, Philosophy and Computer Science, Feedback Interview)*

The system they designed was a system for both passive and active users. The passive user could help by using a 'Mascot' as a health consultant to motivate themselves by sending them events and notifications.

> *We find in the interview he said he did not want to sit on the computer, and he feels guilty after. So, we think about an implication that can motivate him by pushing, and shows people are thinking about him. So, we have the idea of "other-determined" (Mike, Group C01, Philosophy and Computer Science, Feedback Interview)*

Students are, of necessity, involved in an interpretive process, such that they have to assess how and in what ways the data they find interesting might provide some inspiration for design decisions. How exactly they do so varied.

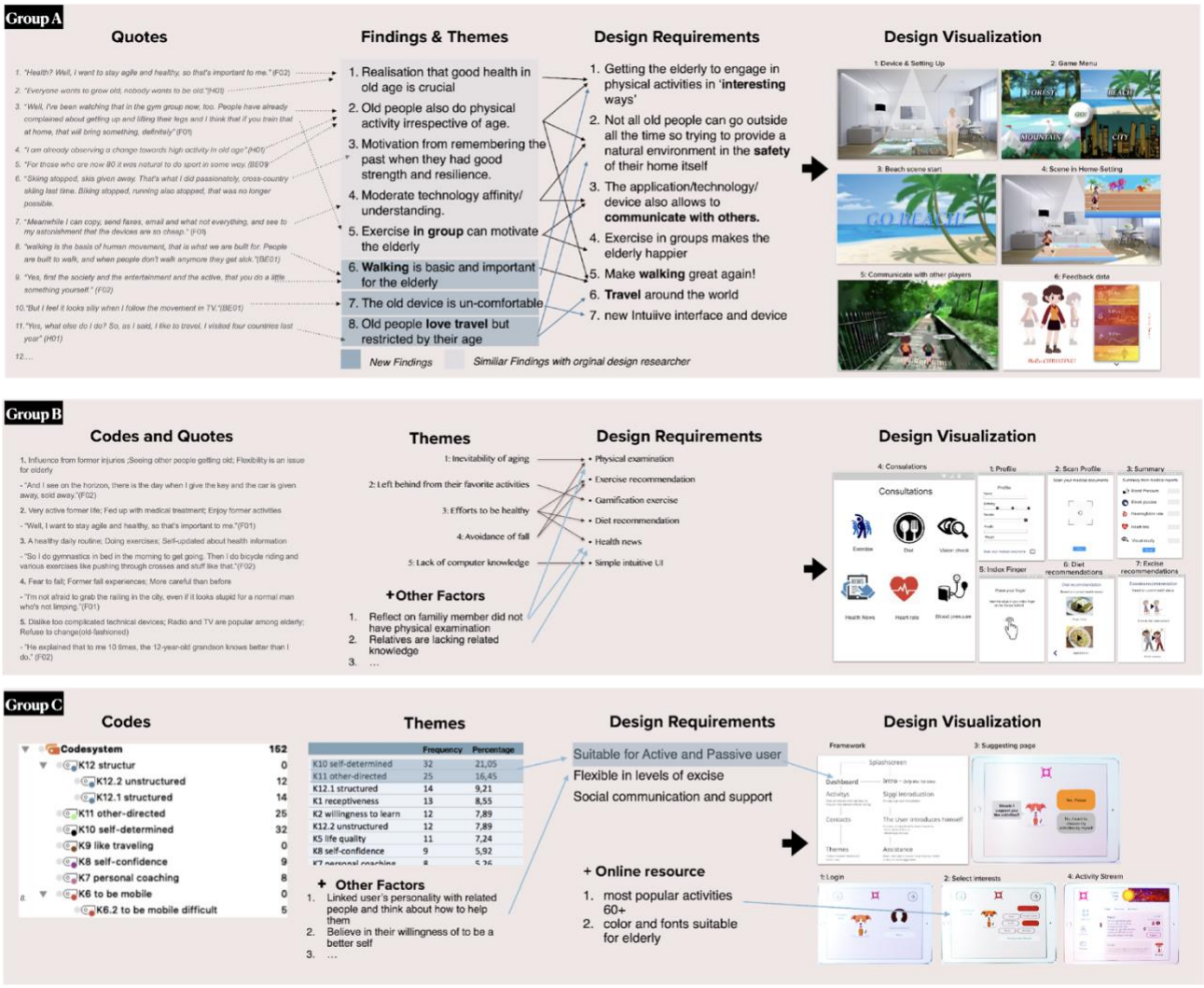

Figure 5 Retrieve design ideas from three group of students

5.5.2 Approaches to re-using research data for design

We observed two broad strategies for reusing data for design, Group A took inspiration from design decisions they found in the existing material, as a consequence of which they adopted a much more thorough approach to the data, interrogating it in depth in order to see what revisions they might make to original designs. Groups B and C were more creative, and used the data as a resource for determining a broad direction for their design work.

Re-design based on the data

The original researchers had a clear agenda to 'promote social engagement' and this was visible in the direction that their enquiries took. Students in group A took that to be a fundamental

requirement for their decisions. They designed a Live-Game for use in customized traveling scenarios, the scenario being projected on the ground to provide an immersive experience which could be shared with other people in the target population. Subsequently, they decided to analyse 2 more interviews from the artefact appropriation phrase to gain relevant user insights. The consequence was that they became more critical of the original research:

> *The data mentioned the disadvantage of using the designed artefact is that users sometimes feel very silly following the television. Users doubted the usefulness of the concept, and doubted whether those performed activities in the game were useful for their health. (Hannah, Group A01, Design, Feedback Interview)*

At this point, group A started to explore how to provide activities that would feel more natural and comfortable for elderly people:

> *We chose walking because it is the most effective and low-risk activity for elderlies, there is more than one interviewee mentioned about walking. (Hannah, Group A01, Design, Feedback Interview)*

Furthermore, when designing the game scenarios, they wished to incorporate elements that had not been considered originally. Thus, and for instance, they determined that positioning several tourist sites to be explored in the game might be more stimulating for users. *"One interviewee mentioned that she really wants to go outside, she loves traveling. I can feel her desire is very strong"* (Hannah, Group A, Design, Feedback Interview).

In order to address the issue of motivating end-users, they also improved the visualization of the activity results at the end of the game. By accessing the original data, students were able to compare their design with the original design and redesign based on their data- driven discoveries.

Project data gave them considerable scope for reflection. It had been collected in the main by experienced researchers, all with some training in data collection methods, who had spent extensive periods of time with their end-user participants and had established trustful relationships.

Combine with other resources

Group B and C depended more on their personal experience to understand the design problem. Some of them were of the opinion that, on its own, the data provided was insufficient:

> *Data only tells me where to start, … I linked it with my personal life reflection, and integrated those functions with them. (Charles, Group B01, Engineering, Feedback Interview)*

These students used a variety of resources to make decisions. The data was an initial inspiration, combined with reflection on personal experience, but they also went further and searched online, for instance for "*most popular activities 60+*" and used what they found for further inspiration. Their concern was that the original datasets might not be of relevance to all older people and their policy was to expand on the original ideas embedded in the material.

In sum, the data provided was an inspirational resource and a reference for conducting other design projects rather than a set of requirements.

5.5.3 Concerns of designed outcomes based on secondary resource

Students not only reflected on their design ideas, they also motivated themselves by participating in such tentative seminars and bringing their concerns by using past resources for design activities.

Sense of lacking creative character in design

The students from Group A questioned whether their design idea could be characterized as "creative" since the ideas that they generated from the data are similar to those of the original researchers. Even the idea of the doing exercise in virtual tourist spots were inspired by the participants' hobbies. In their own view, reflecting on the originality of design problem formation and the concepts they formed, they had not been very original.

Bias of using secondary data for design

Students from group A and C also reflected on the viability of their created designs. They questioned whether the sample for forming their design requirements was too narrow since they were only able to analyse data from 2 to 4 interviews and thus, the felt, their design could not be adaptable for a more general context. They were also concerned about the timeless issue of secondary data, and doubted if the collected information from the past could be still valuable for the current design context.

5.6 Feedback on Educational Setting

Students gave us feedback at the end of the seminar to support us in the design of future seminars. Overall, they reported a positive attitude towards the learning experience, they experienced a research field that had not been visible for them before and they learned new facts about design and fieldwork. However, they also experienced stress and a sense of uncertainty in the learning process and suggested some solutions.

1. Restricted data access creates barriers

Since the mass of data was not completely sanitised, we did not give the students the direct access to the data repository. Students have to explore the secondary data in the classroom with the tutor's computer and send requests when they need more, and the tutor would process the data once more before sharing it with students. We designed the sharing method this way not only to restrict access. We also wanted to observe and understand how students interact with data afterwards.

However, students selected as much as they could in the first round and none of the group asked for more data afterwards. Students were quite passive in asking for secondary data, and they were not comfortable in negotiating for access. It means sharing methods creates extra pressure more overhead for students in accessing the data. Therefore, it would be better if the secondary data in real uses could be accessible online and minimize operational requirements to ease access costs.

2. Time limitation

One of our intentions in sharing empirical data was trying to improve the data retrieval process, but almost all the students expressed their problem in terms of time management. In the seminar, students suffered from these time limitations, and they felt overloaded by unfamiliar tasks.

Nevertheless, when students reflected back, they said that the tasks were not un-accomplishable but the sense of uncertainty in learning new things makes them feel time as critical. Design is an unpredictable process with emotional challenges, since design learning is often obscure and

a sense of insecurity, lack of patience and awareness of limited time impacted on them when making design decisions.

3. Need for frequent meeting

We had a fortnightly arrangement in the first seminar, but students suggested more frequent meetings for the future They felt they needed more frequent feedback and suggestions from their tutor and needed some basis for comparison with other groups. Due to this new form of design learning, students lacked a reference point and prior experience to support them performing tasks. This created a sense of uncertainty and made it difficult for them to self-assess in the learning process. They needed, they argued, immediate feedback from tutor and peers during the learning process.

5.7 Summary

In this chapter, we described a design teaching seminar which took place over the first seminar of four semesters. It showed us the feasibility of using secondary empirical data for design learning purposes, and in return, made us learn valuable lessons in reusing past ethnographic research data.

From the aspect of pedagogy, students showed interest in data that contained, for them, most possibilities. This meant data from the pre-study, in order that they could avoid too similar design outcomes that the original designer conducted. With proper guidance, they could connect with the project participants and connected these insights with their personal experiences. They reported that they finally could know *"where" can their design come from*, and *"how" empirical data could support them in the design process* although the students had different ways of using it for design decisions. We find the value of doing such a design learning seminar with secondary data to be significant, because secondary connected the students with real design contexts.

However, the seminar also proved that sharing and reusing also generated problems which need to be solved. The new purpose of utilizing secondary data creates new challenges. Except the general issue of data sensitivity, decontextualization and ownership that were raised by the data provider, issues of data overload, data messiness, failed anonymization, missing contextual information, limited time resource and interdisciplinary collaboration barriers all existed on the data re-user's side. And most importantly, students lacked knowledge in handling the empirical data without guidance, and found it difficult to access the research data and reflect on the real contextual information in depth. Based on the primary findings of this seminar, we reflected back on the sharing process, and aimed to further address the issues of making secondary data more accessible. We start with thinking about how data can be represented so it can be easily accessible for students who come from various disciplines. The biggest challenge is in the specific needs of various students, so in order to learn how to represent data from a student's perspective, we undertook a co-design seminar with the second seminar students.

6 Second/third Seminar: Designing and Developing for Students & with Students

In the first Semester, many critical issues of data reuse arose. Improving *the experience of accessing research data for future students* became the major design problem for us to address next. In doing so, we designed two seminars for a co-designing activity to address this design problem together with students. Secondary resources played a different role in those two seminars. Students needed to make sense of the given research data and reflect on their needs in using secondary data, come up with a new concept to represent the massive dataset and then, design a solution so that future students could access secondary data. It meant that they would be using those data as material in creating the platform instead of using it directly as an empirical resource for design. Put simply, the second and third seminars had more to do with problems of data curation.

Our expected outcome was a functional prototype that would be rolled out in a future seminar, where students would use it to access past project data and use it for their own design tasks. Under the constraints of the educational framework and time available, the design and implement phases were separated completely. The second seminar students were engaged with design and testing activities, and the third seminar students made the previous design prototype fit with the development environment (Humhub) and implemented it. From the tutor's perspective, this separation of design and implementation caused a certain level of constraint in that the design process was not visible to developers and design initiatives were lost. We applied a few methods to bridge between the students in those two seminars.

Aspects of what we had learned and the challenges we (and they) faced from the last seminar were represented to the students, and tutors provided the design topic, the knowledge and material in the second seminar that would be needed. Students went on to explore the problem and create a solution for it. Tutors were not actively involved but played a secondary role as reviewers of the work. The reason behind this was again that the students could be re-users of provided data, but were tasked with designing a feasible solution for themselves. On the one hand we could learn from students what their pain points and their needs in making sense of

the secondary data might be, and on the other hand, students could apply their learned method in a practical design project together with design researchers (tutors). In other words, students were to understand the design problems from the perspective of a user, and then use their own design knowledge to design a new repository for secondary data for future students. In the meantime, the design process was purposefully documented. It is crucial for developers to understand design decisions and implement them into a usable prototype. The whole process of transferring design and implementation was observed by tutors.

In this chapter, design education environment setting is introduced first, and then findings and outcomes are demonstrated in chronological order. Received feedback is summarised at the end of this chapter.

6.1 Preparation Work and Setting

We designed two separate seminars to perform co-design and co-developing activities with students. The design of the seminar changed according to our pedagogical and research aims.

6.1.1 Prepare for second seminar

Beside the consent and confidentiality agreement previously mentioned, we also prepared new materials for students and signed a more comprehensive authority in using the data with the permission of the head of the project, based on the feedback from the last seminar.

Sign higher authority for accessing data

The tutors previously mediated the process of sharing data and playing the role of data curator. Students from the last seminar were very restricted in their access to the datasets, in order to protect the data from misuse. The project data could only be accessible from the tutor's desktop in the seminar classroom, and selected data had to be translated and re-anonymised before sending to the students. Due to the fact of long processing before they actually got the data, students never came back to ask for more materials and they also pointed out that this prevented them from understanding the project context better.

For the tutors, it was a challenge to sign the demanding access requirements for the students. As we mentioned in the research setting chapter, researchers are reluctant to share their data with the broad community outside of their research team and measures to protect their assets need to be taken. After work with the head of the project, we managed to assign students to a higher level of access because in many cases they were working in the research groups as student assistants and researchers do not treat them as outsiders after they signed the consent form. They thus became more aware of the responsibility to protect the project participants;

> *Of course, students are special in this case (of data sharing), right? We share the data with them because they signed the contract and consent form. (Manager of project iStopfalls, interview)*

Also, students are not a competing group for researchers since they use data for a different purpose than publication (see sharing problem at: *Research Setting: The Ethics of Preserving*

Context and Devaluation). After discussion with the head of the project, we were finally able to give students access to the data with some necessary protections.

Restrict rights and ethic education

Access of data was restricted for students in the following way. The students could not perform any changes to the original data-set but only have *viewing* and *downloading rights*. And some data-sets, especially the data related to the project budget is blocked for the students. At the same time, we emphasised in the seminar that the data has never been opened for external use before due to the privacy issues and they thus had an obligation to protect the end-users. End-users, as we pointed out, trust researchers with whom they have had a long term interaction, and may be very open about their personal life. We also warned them about the possible consequences if data was misused. Students appreciated the ethical perspective brought to them. Two years later, we have not detected any negative consequences from sharing the data with the students.

Construct knowledge foundation

We also structured new materials in order to establish a common ground for this new seminar schema. Compared with the last seminar, students had to learn more about data sciences (i.e., *Data Visualization* and *Data Curation*) and understand relevant initiatives and background knowledge (*Data sharing challenges and experience of the first seminar*), so they could perform the design tasks.

1. Grounded Design, Design Case Study and e-Portfolio

The methodological framework, Grounded Design, was demonstrated at the outset not only because we are practicing this methodology in the seminar but also due to the project data being structured under the same methodological framework. In order to align the vision of design for learning by using past research assets, we explained our motivation for the e-Portfolio concept, that is building a collection of design case studies that people beyond the original group can make sense of.

2. Introduce the project and project data

The introduction round was highly appreciated by the students from the last seminar and so we provided the same experience here as well.

3. Experience in first seminar

The reflections we have gained from the *researchers on data sharing* and *first seminar students on data re-using* was shared with students.

4. What is Data Curation, Data Visualization and Metadata?

After analysis and discussion on the feedback from the previous seminar students, we found that the data curation concept was not familiar for the students. In order to let students quickly understand the context, we decided on two existing research topics that they should learn about, which are Data Curation and Data Visualization. We had a brief introduction o the definitions and origins of those concepts and asked them to go deeper by reviewing the highlighted literature.

5. Add new tool enable the group cooperation and task management

Based on the last semester's feedback regarding time management and group integration, tutors wanted the task division in the group to be more transparent and therefore, Trello was recommended in this semester. Students were to use it for managing their tasks and share their thoughts, and tutors could track the activities had been taking place and give feedback when there were any issues ongoing.

Weekly class-arrangement

In this semester, we took the experience from the feedback of the previous semester into account, and we decided to give weekly meetings and guide them "in-side" the classroom. However, students still felt overwhelmed by dealing with the tasks and presenting outcomes in the limited time and space available. We adjusted our strategies to a more flexible approach, being there for help every week but not compelling their attendance.

6.1.2 Prepare for the Third Seminar

Beside the background information that past seminar students had, students in this seminar had to understand the design outcomes from it as well.

Building knowledge foundation

Again, some related information had been given to the students before they engaged with the materials.

1. Grounded Design, Design Case Study and e-Portfolio
2. Project and project data
3. Developed seminars and outcomes.

The design prototype and initiatives were presented by the students from the second seminar.

4. Introduce Development Environment

The student assistant, Jacob, gave the presentations on the development language(php) and related knowledge about developing on Hum-hub, which is a flexible open-source platform that allows the implementation of new functions. This open platform has also been implemented for use by the group of researchers in the institution, in a version called Research-hub, designed by the author in collaboration with others, and it is intended that the designed artefact by seminar students will be integrated into Research-hub in the future.

Manage unexpected changes in teaching

We received the system registered numbers two weeks before the first course of seminar, only four students registered for the development seminar, the number being less than we expected. Then the strategy for structuring the seminar had to change accordingly. Instead of forming two groups to develop two separate designed artefacts, we decided to merge the two designs into one system since those two designed concepts did not conflict but complemented each other. We added a new step of merging two existing designs with students in the new design seminar.

Invite students from second semester and build contacts

One of the findings from the previous two seminars had to do with the importance of contacts with data creators. In order to create the contact and transfer the design ideas more directly, we invited the students from the last semester to give the presentations on their own designs. After the presentation, students from third semester were able to pose questions and build a closer relationship with the former design students.

Involving experienced student

Since we have the plan to migrate the final result into the ResearchHub platform, we invited a student assistant that had worked on the Research-Hub project for 1 year, and let him lead other students in developing this designed artefact in the required development environment and providing all needed resources.

Curate for new project data (project B)

We decided to implement a new project for two reasons, a) students from the second semester suggesting the inclusion of data from original research who participated in the project before. Cyberrüsten is one of the projects that tutor George conducted in the previous three years. We adopted that because the same project data had been used for the last two semesters. In the new seminar, a new project aimed at supporting the adaption of the developed data curation concept was explored.

1. Shared awareness of sharing

The researcher had confidence about the sharing of the data without legal concerns by grounding the sharing awareness from the start of the research process. It was not difficult to convince the original research team to share the data, since the awareness of sharing was discussed in the research team before. Also, the tutor had discussions with both team members, participants and company partners. It was clear for him what kinds of data are confidential and he could delete it from the sharing environment. This shared agreement about *what could be shared* addressed the problem of legality of sharing. Earlier agreement on sharing, who to share with and what to share achieved made it easier for researchers to prepare the secondary data.

2. Delete sensitive data

Two kinds of information were excluded from the shared document.

- All the visual information about the working environment was excluded since the company partners concerned about the business secret of their advanced and unique bending machine. The recorded video concerned tracking the eyeball movement while operators operate the machine, a video taken in vivo.

- Administrative data contains project budgets were also deleted from shared documents, since that information is irrelevant to design activity learning and original researchers uncomfortable sharing it.

3. Anonymization

Empirical data was anonymized during the project, and tutor George re-checked the data to ensure real identities were replaced with pseudonyms.

4. Same data structure: time constrained and personal mind-set

The tutor did not spend more time on reorganizing the data simply because he does not have the time. He believes the original data structure to be easily understandable as it stands and was accessible for students.

An integrated platform for e-Learning -- ResearchHub

As reported in the past seminar, tutor and students needed multiple e-learning tools in their daily design practices. Required functions included *space of sharing education materials (Module and Sciebo)*, *space of inquiring tutors (email)*, *space for collaboration and discussion (Google Drive and Whatsapp group)*, and *space of task management (Trello and personal calendar)*.

The currently provided e-learning tools are scattered and lacking some functions that we required for a design education environment. For instance, we found students needed extensive attention in the design phrase and required feedback within their design processes, and

discussions in an open space so tutors could participate in their discussions and retrieve their activities and thus assist students.

An internally developed collaborative platform, Research-Hub, has also been introduced to the students for them to arrange their group activity, archive their materials, and make activities transparent to tutors. This tool has been developed by the tutor and a group of researchers for the past 2 years with the aim of supporting the research collaboration environment. It contains the required functions for daily research work (e.g., post stream, calendar, repository, notes, news updates, wiki and task management) that could be also useful for the group collaboration that is required in our education environment.

Flexible time arrangement

The flexible arrangement from the previous seminar was effective for providing the feedback required and created less pressure for sharing updates, Students could use informal weekly meetings to discuss the design with tutors and classmates across the group. Thus, we applied the same strategy as in the second seminar, weekly meetings at the start for building an interactive environment and students and tutors to be reachable whenever needed in the later stage.

6.1.3 Plan for 7 steps

Second Seminar： design and testing

After we explored what kind of issues were noticeable when people explore data with design practice in view in the first seminar, we passed our learned experience and design question to our students and started to explore design ideas with them: how could we improve the secondary data accessing experience for students who utilize past data for design purposes. 6 students were separated into 2 groups. Group A02 had two international and one German student, Group B02 had one international and two German students. Naturally, curating the data became smoother because they both had native speakers in their groups.

The seminar can be divided into 4 steps with a different agenda to that of the previous seminar.

Step 1: Understanding context by reviewing literature and analysing secondary data structure. (1-2 week)

Similar to the first seminar, getting into the context is always the very first step for students, so after we gave an initial presentation on the data, we demonstrated the methodological framework of Grounded Design, a project overview (the same video of the original project and an introduction to the repository), experiences from the last seminar and the design problems we were facing in the project. We analysed the design problems of secondary research data and found two relevant concepts available in the research field for addressing the problems: *data curation* and *data visualization,* two concepts which were not familiar to students. Then we gave a brief introduction on the two concepts, and in the meantime, students dived into the design problem with the given secondary data and literature in parallel. In doing so, students were able to iteratively compare academic results and the practical problem of dealing with data, activities which encouraged reflection.

Step 2: Design and Prototyping (4-6 week)

Students used the findings from a shared repository and reflected on their needs when accessing the secondary data, and in turn proposed new ideas to represent the secondary data. After the design concept had been established and discussed in the class, they needed to make a clickable prototype for the next step.

Step3: Run Cooperative Evaluation with user group (7-9 week)

All the students learned the method of cooperative evaluation in a mandatory entry course called CSCW (Computer Supported Cooperative Work) which was also hosted by our seminar tutor. They had not yet practiced this method with their own designed artefact before. Considering the original user group of our design project was very accessible, they were able to plan a complete Cooperative Evaluation in our seminar and practice it with the clickable prototype with 3 to 5 participants they recruited. Before they actually tested with users, the plan was reviewed and discussed with the tutors.

Step 4: Redesign and refine the design prototype (10-12 week)

Having collected data from the users that had to be analysed, and based on the analysed outcomes, students needed to perform the redesign to improve their designed artefact. Materials were submitted in Sciebo to prepare the development work of the next seminar.

Third Seminar： redesign and implement

The semester had been originally planned for two of the development student groups since we had two designed artefacts from last semester. Nevertheless, we finally recruited only 4 students who were interested in the seminar, and working assigned tasks in pairs would be beyond manageable. Hence, we decided to combine the two design ideas since they are complementary to each other. Then, we added a new step - combine two design ideas into one development framework.

Step 5: Transfer design ideas from last semester (1-2 week)

After the e-Portfolio and Grounded Design had been presented by the tutors from the last two semesters in the first week and links to access the design prototype and all related materials had been shared since the beginning of the seminar, so the students were able to prepare their questions for the next week. Another two presentations had been given by the previous semester's students in the second week, each group presenting their idea for 20 mins, and leaving 20 mins for prepared questions.

In the meantime, students got access to the research project data that was generated by the project researchers. Accordingly, the introduction to the original project was given and the recorded video was shared with them as well.

Step 6: Merge 2 design ideas in one interface (3-5 week)

This newly-added step took much more time than tutors expected and added new challenges to the seminar. It had been made clear that the two designs *must* be integrated into the final prototype, but the interface could be adjusted to adapt the new development framework, Research-hub. Students not only understood how to develop the design, but also redesigned it

in a concrete framework that delivered the same concept as students from the previous semester.

Step 7: Curate given materials and develop a pilot prototype in parallel (5-12 week)

While they did development work on the software, material had to be prepared at the same time to feed into their developed artefact. Before they migrated the project assets to the developed artefact, the new data structures were presented to the tutor to make sure the data was correctly interpreted and was to be displayed in the right place. The intention was that the data be uploaded to the developed prototype and the functional artefact would provide material that could be used by the next semesters' students.

6.2 Step1. Understanding Context and Analysis

As we showed above, relevant topics for the design topic were demonstrated and students were required to perform both a literature review and an analysis of the data structure in hand in order to comprehend the design topic. We gave access to the data in the first week and students had 5 weeks to go through the data and perform the literature review, and finally come up with a concept to re-organize the data.

Since the two tasks were running in parallel, students compared the state of given materials with surveyed literature and identified the research gap and problems. Naturally, the strategies of reviewing literature and analysis of repository and data structures hand in hand led them to different design concepts and ideas.

6.2.1 Literature review

Students were asked to perform a brief literature review of two concepts: *Data Visualization* and *Data Curation* after a lecture explaining those two concepts. They were required to elaborate the concept of data curation by reflecting upon the strategy needed for storing data under an interdisciplinary framework; examining what hindered the usage of a given data-set and repository; and what strategy is needed for well-functioning repository. Students were expected to understand the idea of requirements elicitation from the literature in relation to what the strategies applied for data curation typically are and what the challenges of aligning with those strategies might be.

Group A02 first began to examine the most cited literature on data sharing and were attracted by the paper of Witt Carson (2009), which resonated with what they saw as the challenges they faced and what design solutions there might be. Beside a deeper understanding of the design topic, the paper also provided a guideline for them to comprehend given data.

1.On Automating Basic Data Curation Tasks	2.Constructing Data Curation Profiles	3.Data Curation	4.Digital Curation	5.Toward a Conceptual Framework for Data Sharing Practices in Social Sciences: A Profile Approach

		Profiles Toolkits		
Beheshti et al., 2017	Witt, Carlson & Brandt, 2009	Carlson, 2010	Elizabeth Yakel, 2007	Jeng, He & Oh, 2016

Table 6 Literature review list from Group A02

> *The extensive literature on the profiles approaches not only conveyed existing efforts towards a standardized framework for data curation but also served as a rough guideline for the analysis of the repository. (Group Report of Group B02)*

Students used it for analysing the data and repository structure, by reflecting on the problems faced. The first gap they identified was that the data curation was only discussed in a research context without involving other groups, in our case, students.

They found inter-disciplinary issues were also rarely discussed in the literature they investigated. However, as disciplines become increasingly interlinked and heavily reliant upon each other, catering to these different needs is indispensable. This is particularly important in Human-Computer-Interaction, an inherently interdisciplinary field that thrives on the cooperation and collaboration of scholars and professionals from vastly different backgrounds.

Group B02, on the other hand, got involved in the specific issues of Curation and Meta-data, focusing less on the sharing and visualization issues. From their chosen literature, we can see that they were trying to discover the links with available technical systems and specific functions, addressing the issues identified from the data and repository platform in hand.

They hoped the data curation and visualisation concepts developed in the course of this project would help them to address gaps in the existing approaches.

1. The DDC Curation Lifecycle Model	2.Data Curation at Scale: The Data Tamer System	3.Linking to Scientific Data: Identity Problems of Unruly and Poorly Bounded Digital Objects	4.Data Curation oder (Retro-)Digitalisierung ist mehr als die Produktion von Daten	5.Analysis of Large Digital Collections with Interactive Visualization
Higgins, 2008	Stonebraker, et al., 2013	Wynholds, 2011	Klaus, 2015	Xu, Esteva, Jain, & Jain, 2011

Table 7 Literature review list from Group B02

The two groups, then, had different strategies for selecting relevant literature and their choices impacted on their design decision later. Group A02, inspired by Witts's work of "constructing data curation profiles", designed a data curation method structured by individual disciplinary backgrounds. Group B02 took the suggestions from Higgins' work on "lifecycle" and Xu's work on "visualization", and designed a concept that focused more on the creation of metadata and how to visualise it.

6.2.2 Analyse the original data-set and repository

We ask students to analyse the data with two initial questions, a) What hindered the usage of BSCW, b) Which resources are interesting for students that are generating a new design idea grounded in the data from the repository.

New aspects in using second-handed research data

The data curation profile toolkit (Carlson, 2010) was used as a guide by group A02 for a rough analysis of the current repository, a general-purpose groupware tool. Furthermore, a content inventory (see Table 1) was constructed to understand the scope of the dataset and the current structure of the repository. After the analysis of the materials, they found further issues that the first Seminar had not, the access-rights and meta-data for instance:

> *...Access rights are currently handled via restricting access to certain folders, breaking up the file structure. This is very inflexible and makes it hard to establish a logical usage flow. Lastly, the meta-data available to the user is very limited. This makes it difficult to understand the available data... (Group Report of Group A02)*

#FILES	Level 1	Level 2	Level 3	Level 4	Level 5
271	Calendar istoopfalls				
12	Contact List				
10	Adminsitration and management				
6		Administration forms			
2			Eu documents	Periodic-report-template.doc	
				Form-c.pdf	
6			Xls for Eu	ait-PM report	
				dashs-PM report	
				ibv-PM report	
				Kaasa-PM	
				pre-PM report	
				Usi-PM report	
			Template-finalcial report		
			Template-PM report		
			Template Risk Assessment table		
			Template ST progress Table		
3		Administration Guides		Financial guide	
				Project reporting	
				Project review	
3		Amendment		DOW iStoppFalls	
				GPF iStoppFalls	
				287361 iStoppFalls	

Figure 6 Content inventory analysed by Group A02

On the other hand, Group B02 point out other issues related to *search, mixing formats, duplicated files* and *lack of curation structure.* And they also reflected on the design requirements, defining three issues that a well-functioning repository must support:

> *1) Well-explained context for the data e.g., through contextual meta data like labels etc.*
>
> *2) To dedicate an employee to be the curator to assist the researcher*
>
> *3) A general standard for the structure of how the data is stored and labelled (Group Report of Group B02)*

Suggest which resources are interesting for students

We made clear in the last chapter that data was un-curated before we gave it to students because we could not decide for them what was valuable and what was not, especially in respect of students from different education background s who may have unanticipated interested in different resources. Two group of students tried answering these questions more deeply with two different approaches:

- Group A02: Running informal Interviews and auto-ethnographic reflections

After identifying the gaps in the existing data curation approaches, informal interviews and auto-ethnographic reflections were conducted by group A02 to address these gaps. The informal interviews were carried out with an ad hoc sample of fellow students coming from various academic backgrounds. It resulted in two central findings. Firstly, regardless of background, students' desire to first acquire a brief overview of the project was a dataset concern. Frequently mentioned in this context were the *topic, methods* and *central results* of the project.
As the exploration of a dataset progresses, differences according to discipline become increasingly apparent. Once a rough understanding of the project and the respective dataset had been accomplished, students looked for assets that were particularly *interesting to their discipline*, ranging from more general meta-information to assets that might serve as inspiration for their own work, or might even be reusable. Examples that were mentioned by the students were *graphics* and *prototypes* for Design, *code snippets* for Software Engineering, or *medical*

assessments for Medicine. Students also mentioned the desire to have access to the *contact information* of a representative of the project.

- Group B02: reflects as the target group

The first category highlights folders and files that the group thought were relevant for analysing the data. This includes *interviews, audio, transcripts* and *interview guides* to understand exactly what the researcher had done and to reconstruct the content. *Videos* and *usability tests* were also seen as relevant to examine the results of the research. *Drop-outs* were interesting for the student to see what problems occurred and why some participants dropped out. *Deliverables* and *translation files* were important for us because we had international students in our program. The work *packages* themselves were not considered to be very informative, but they included the "*User Context Analysis*", which was important to understand the context of the users and the research. Secondly, they grouped them under the aspect, "important for getting an overview". This included the *publications* and *references*, but also the *communication media* and *press files*. For testing the system ourselves, we also found the *software* and *the corresponding API* for documentation useful. As a particularly successful idea, they found the provision of *a contact list*, which they assigned to the third category "important for asking questions". There was also the category "resources which are (maybe) not interesting". Under this category they classified the *administration and management* data, which in their opinion were probably more interesting for business students or the like on the one hand and on the other hand do not contribute the generation of a new design idea from the data. Since it seemed very important to them, the export of metadata got its own category. If you export the metadata of a folder or a file, you get an Excel spreadsheet with a formatting which is not understandable at first sight. Students wanted to see a more clearly designed variant, which might also include more details such as rights/permissions.

The problems of using seconded-hand data identified were very similar that found with the first seminar For someone coming into the repository without any previous knowledge, the amount of only semi-organized data is overwhelming and disorienting. Exploring the data is difficult and time-intensive, it makes the current repository unsuitable for second-hand data access. The second initial question of reflecting on what data they were interested in and for what reason, helps us understand the issue of selecting files in secondary use for design

purposes. The result from the data of interest shows that many data can be interesting for students with certain backgrounds and the empirical data were more popular than the administrative data for design purposes. Students will be seen to be thinking about how to use the analysed result for their design in the next step.

6.3 Step2. Reflect, Design and Prototyping

After tackling the question of what data was interesting, they reflected on their needs and designed two curation concepts for the secondary research data.

6.3.1 Identify user needs

Group A02 had two main findings from their interviews and analysis, people *searching for clear overview of the context*, and *people tended to search data related to their disciplines.* They had the idea of displaying the data through a visual metaphor and displaying the data based on the user's education background.

Group B02 reflected again on their needs as students and in the report they pointed out the following needs. From the curation perspective, they asked for a uniform and clear structure to find ways through the data: a) *Descriptive meta-data* which helps us to get an overview about the context*;* b) A way to *communicate rights/permission* to know what we are allowed to do with the data; c) *Summaries/Descriptions* that provide information about the findings without the need to read everything.

From the visualization perspective, they asked that the data artefacts, their results and linkage were displayed: a) They suggested a *Mind map* concept or something similar to have an overview about data linkages and to find a way to cluster and categorize it; b) *Summaries/Abstract* that provide information about the findings at first glance without the need to read everything; c) *A permanent and extended search functionality* to be able to search and find the data; d) *A way to navigate* dynamically to see the linkages between the data

6.3.2 Design and prototype

Based on their findings and reflections on their needs, each group developed its own strategy for data curation and visualized the outcome in their prototypes.

Group A02:

- "Iceberg" Metaphor for Curation

In this group, students were mainly dealing with two design issues which resulted from their literature review, interviews and self-reflections: *Overview* and *Interdisciplinarity*. Firstly, an *"Iceberg"* metaphor was derived from the need to explore the data from an overview, moving through more general information into specific files. In keeping with this metaphor, the user should be guided into the project data starting at the "tip of the iceberg", which concerns only the most important cornerstones of the project. The user then "snorkels" into an introduction of the project. Once the user has gained an understanding of the project, they take the "deep dive", moving in a structured way into the raw data. This metaphor guided our curation of data to ensure a natural usage flow that familiarises the user with the project data without being overwhelming.

Secondly, from the differing needs according to the discipline and goals of the user, the concept of "views" was created. Through establishing a user's background and goals, the exploration of the data is customized to suit their specific needs. This serves to streamline the experience, removing excess clutter and confusion.

These two ideas guided the curation of relevant data and served as the foundation upon which the visualization concept was built.

- Visualize Design Outcome

With the visualization concept only relevant data will be displayed to the user according to the selected discipline and the user will be guided into the project with increasing complexity, creating an intuitive sequence usage flow. Wireframes of the described flow are pictured in figure XX.

The user can navigate through the file list with basic metadata. Throughout the new design of the visualization, usability heuristics such as visibility of system status, user control freedom and efficiency of use are considered in the design to provide the user with information, feedback and error prevention.

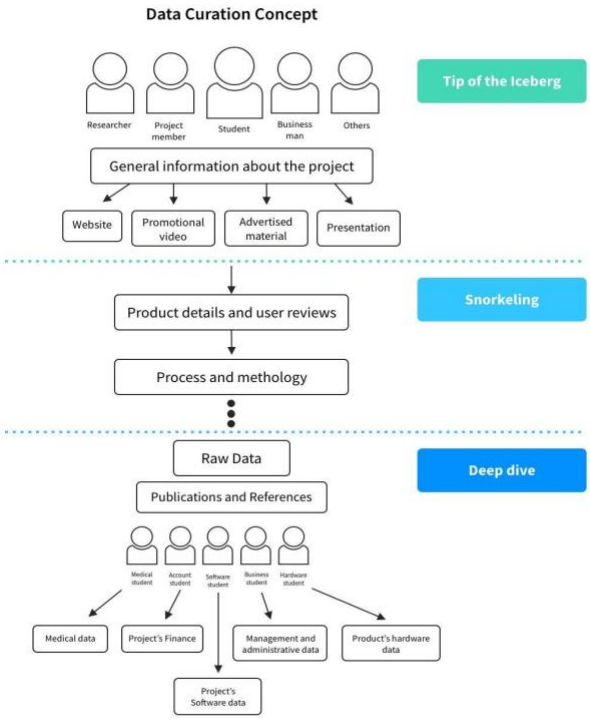

Figure 7 Design concept from Group A02: Iceberg metaphor

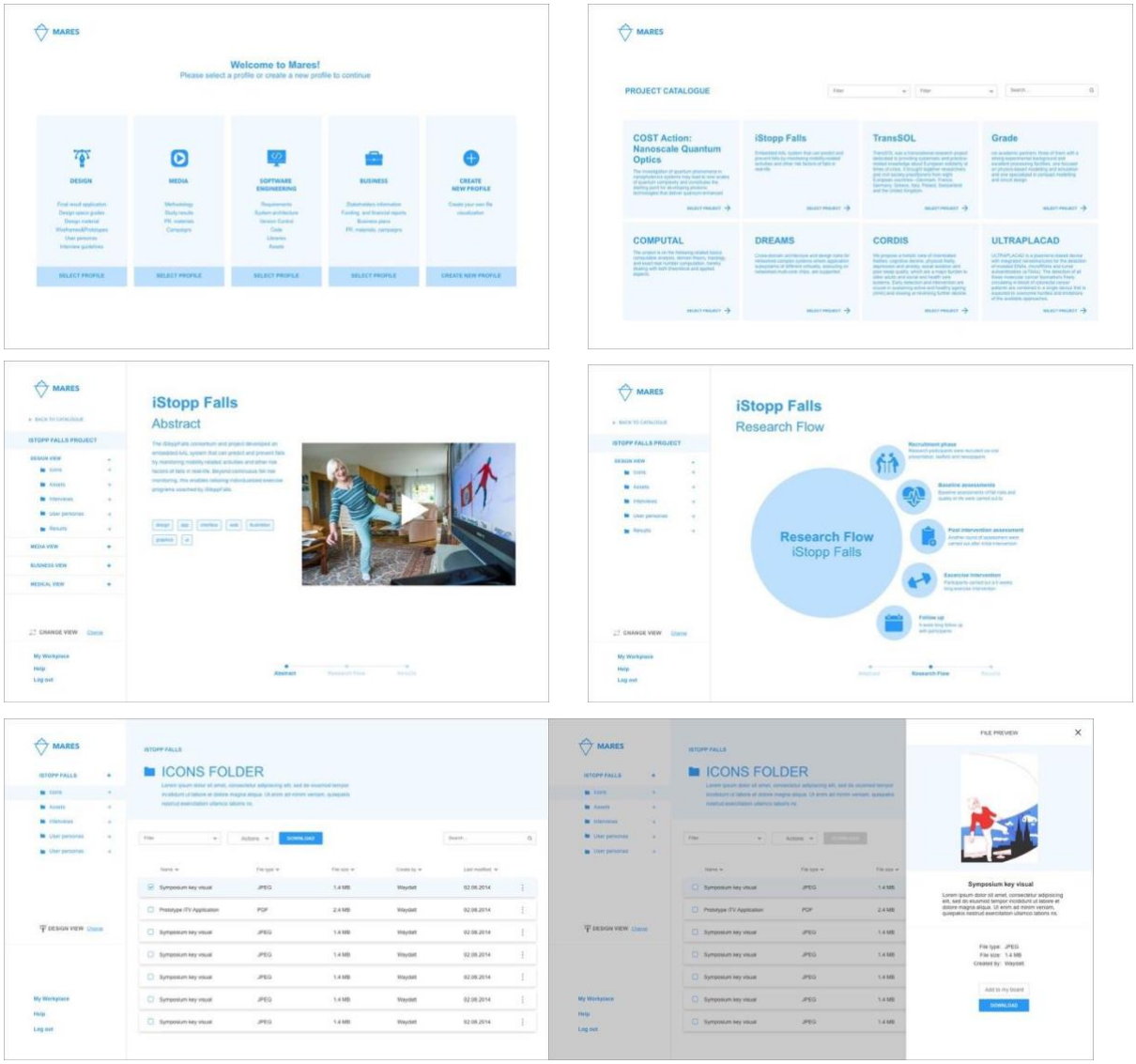

Figure 8 Design Prototype version 01 from Group A02

Group B02：

Group B02 set-up a template for processing the data, and for thinking about the process that was established in the beginning of a project, to help the project member or curator better maintain the data. A crucial criterion was to ensure the description of the data, and this is done in the concept on the second level of detail in the descriptive (meta) data. Also, the wish to provide rights and permissions for the use of the data was made available in the folder attributes, which makes it directly clear to the user to what extent the files contained in this folder may be used. The required contact list has also been retained in the concept as well as

the desired descriptions and overviews of the phases and data. This means that not all files have to be read, and can also be realized using suitable attributes for the descriptive (meta) data.

Thus, the concept generally realizes a clear, unambiguous structure of the research data.

- Construct a fundamental framework for curation

Applied to the data from the given research project, the group created a template and developed

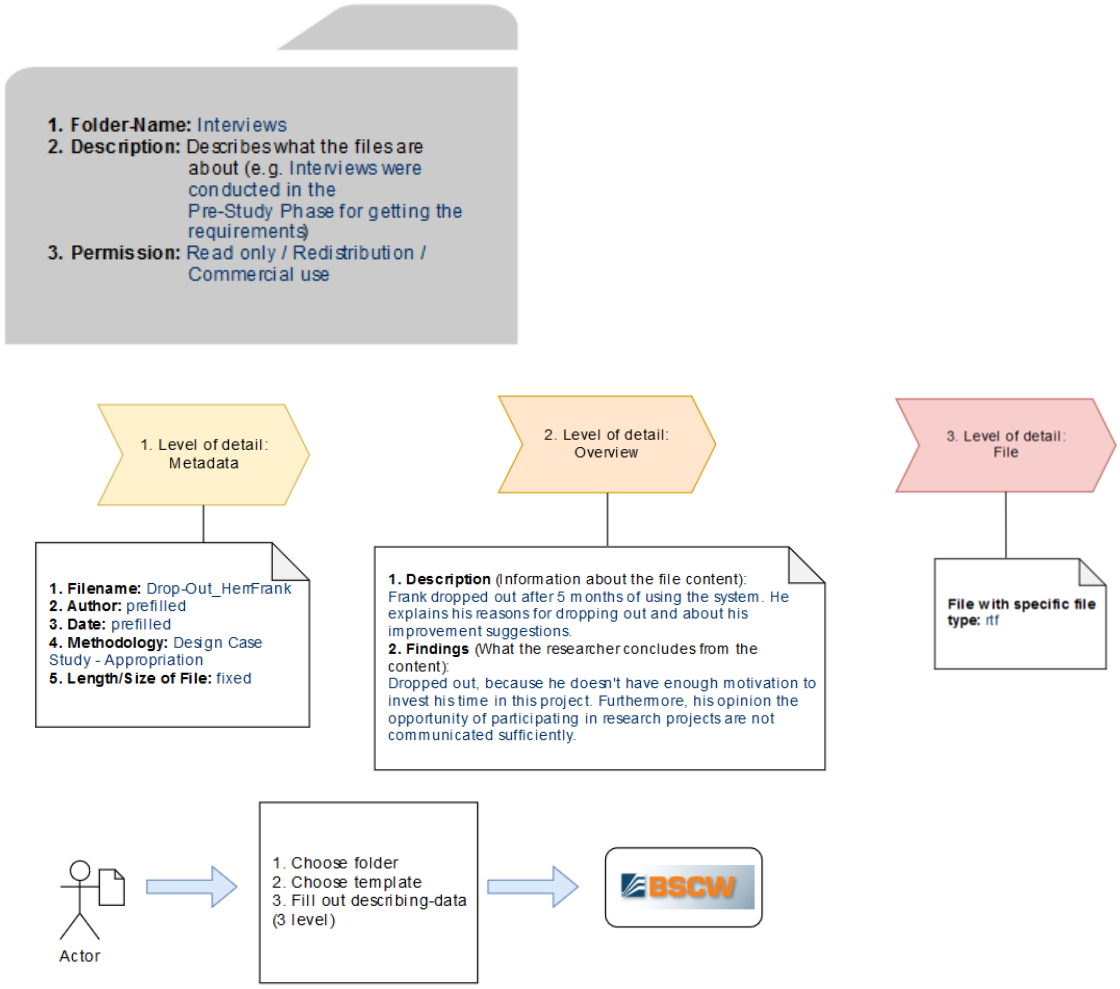

Figure 9 Steps of uploading designed by Group B02

the necessary attributes for folders. The framework was developed to represent the clear structure of data representation and necessary information for accessing the subfolders for secondary uses.

The file template contains three levels of descriptive (meta) data. First the actual metadata is queried, in the next step an overview of the file content is requested and in the last step the file itself is selected (see Figure 9). The file template contains three levels of descriptive (meta) data. First the actual metadata is queried, in the next step an overview of the file content is requested and in the last step the file itself is selected (see Figure 9). In the figure, the three levels are explained in more detail using an example of a drop-out file. The students described the demands of each level there.

They also established a journal for people to upload the files. Anyone wishing to upload a file in the repository needs to perform a series of actions that are already established. This whole process is comparable to a commit process in a software version control system, so the file cannot be uploaded if there is no descriptive (meta)data to ensure consistency and completeness of the generated data. The whole process of curation that results is demanding but efficiency will be improved.

> *Once these characteristics have been defined, the work for the data curator is done. At first this seems to be a big effort, which is relativized, because after a one-time setting of the data curator the consistency of the whole project is guaranteed and therefore no more time-consuming curation work is necessary. (Group Report of Group B02)*

- Visualize Design Outcome

The concept aims at realizing the desire to display data artefacts with three levels of visualisation, namely folder structure, finding structure and methodology structure. The visualization concept is based on the fundamental approach of being able to switch between different views of the data for different purposes and needs. The needs of the users were aligned to different application scenarios. On the one hand, all data was required to be available at first sight, so that an overview of the research results can be obtained quickly without actually reading all files. Furthermore, the methodology also plays an important role for the students' use case, given an interest in which files have been generated in which phase. Should there be a wish for a known structure despite the situationally adapted visualizations, the general folder structure has not been completely discarded for this case.

1. Folder structure

Figure 10 Folder structure designed by Group B02

2. Findings at first glance

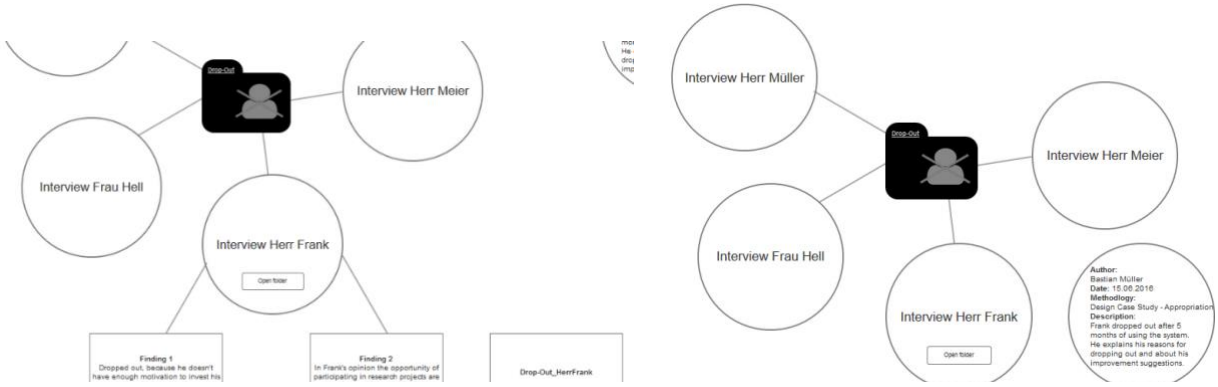

Figure 11 Finding in one glance designed by Group B02

3. Methodology structure

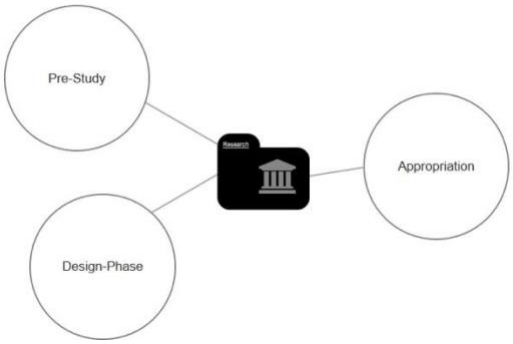

Figure 12 Organize data base on methodology structure (Group B02)

- Permanent search function

A further concept element is the extended search function, which is permanently available on all pages and in all visualization variations. The special thing about it is that not only file or folder names can be searched for, as usual, but metadata, file types and methodology may also be taken into account in the search.

In addition, these attributes can be linked via various parameters so that, for example, the input "design case study + appropriation phase + .mp4" can be used to search for video files of type .mp4 in the approval phase.

Furthermore, it offers most searched suggestions in a drop-down list, so that the search can be offered more efficiently.

- Summary based on user needs

Various user needs were also taken into account in the visualization concept. Thus, the desire for categorization/clustering was realized with the help of the mind map concept in different variations. It is also possible to quickly obtain a description of the data in order to get a quick overview. Dynamic navigation is now also possible, since, for example, the corresponding file can be called up directly on the basis of the findings or one can move dynamically through the phases of the methodology.

Association with collected materials

We find both designs are sub-associated with the material they have been in touch with before. Group A02 designed a view background with the assumption that interdisciplinary students will search for files that are linked with their education background. This is obviously impacted by the work of Data Curation profiles that was done by Witt Carson and which students had read. The same happened in group B02, influenced by the work of the DDC curation lifecycle model from Higgins (2008).

- Design with same primary design problem

In the file exploring process, we found the problems (data overloading, data messiness and context lacking) encountered by the two groups were very similar since they explored the same material. However, the design focus grew very different later, and we found the main influence factor here was the literature that students explored in the field. The identification of primary design problems are related to personal experiences but the framing of concrete design problems and design goals was largely reliant on external resources, especially when students had relatively little knowledge about topics of data reusing and data curation before this. Design itself is complex and it is hard to grasp the cognitive process of designing. The materials they have explored is an entry point that allows us to see some of the factors that influence their design decisions. This on the one hand supported the view that the material provided in the learning space is crucial for guiding students and is therefore an essential theme for educating design. On the other hand, it confirmed that the documentation of design knowledge needs management, not just about design capture inspirations and document sketches, but also support for documenting the materials explored by designers. Then, the complex design process can be better understood and analysed.

- Design resources and relation to design outcome

Exploring material becomes a focus for learning about the design context. It can be compared to the empirical material we provided in the first seminar. Students have both learned from the material, identified their design focus and done design work by adding personal experiences. But rather than offering information about people's daily needs, the literature reviews give a

broader view on the design topic and allowed students to identify their design opportunities from a more general perspective.

The problem here is that the resources do not yet fully prepare the students to design a system without reflecting on contextual needs of users. We took advantage of the fact that students acted as both designer and user of the design project, in order to ask students to reflect on their needs as a user of making sense of secondary data. Even so, students were still searching for empirical evidence (primary interview on students) in their design activity. Design requires amplified materials to support the process, and one of the most important resources is empirical data. It constitutes design experience that cannot easily be substituted for by other resources.

Resources provide ‘chemical reactions’ in the design stage, meaning that by giving adequate design materials, the design learning experience can be amplified.

6.4 Step3. Practice Cooperative Evaluation

After the first iteration of the design prototype was completed, a cooperative evaluation session as proposed by Monk and colleagues (Monk et al, 1993) was conducted to gain initial insights from potential users and identify existing issues. In order to test the prototype, this framework was chosen as it enables identifying the most pressing issues with minimal resources.

We had not lectured on this method here because the relevant information had been provided by another tutor in a separate and compulsory course. Students were able to practice on this learned method and engage with the real user with their own design artefact here. The users were students themselves so recruiting test users was not a challenge. Group B02 conducted 4, and A02 conducted 3 Cooperative Evaluations with recruited end-users, and an interactive and partially functional prototype was constructed from a set of screens and tested with a task-based think aloud evaluation. A plan was submitted to the tutors before they performed those tests. This plan included 3 sections (before, during and after) of the test, and students needed to think about the required materials and resources (e.g. checklist, Consent form, recording device and incentive gifts), appropriate narratives and tasks, to prepare for problems which might occur and have a contingency plan. After the CE, they submitted a report that covers the preparation, conduct, and results of the cooperative evaluation, as well as the planned changes derived from it. In the following we will report the process and findings in this learning process, or more accurately, practice process.

6.4.1 Exercise on Qualified Cooperative Evaluation

This was the first time that students tested the prototypes in a more systematic manner with users. According to the feedback of the seminar students, they were satisfied with their practical experiences.

> *Aside from the insights it provided for the refinement of the prototype, the cooperative evaluation proved to be a valuable learning experience for the team. Since none of the team members had previously conducted or participated in a cooperative evaluation, the opportunity to gain experience in this regard was particularly useful. (Group A02, feedback session)*

- Gain Feedback from their tested users

Students received feedback from their users about their performance of the evaluation, and both groups gained positive feedback on CE and only experienced a minor problem in understanding the required tasks.

- Learned Ethical Issues

We asked student to pay attention to any ethical aspects in the activities, since the users will have access to some part of research data. Confidentiality and consent forms for their users were needed.

- Experiences with overall arrangements

Another aspect to consider is the setup of the environment. Many detailed problems were revealed in the practice of evaluation, for example what time to send out the consent form, how to make users feel comfortable while they are recording, where to sit and how the group distributed the tasks etc. Those tasks may seem very easy in lectures, but in reality making overall arrangements and ensuring quality was not straightforward.

- Standard Form in Practice

  Students also carried out the exercise in a formal manner: distributed Information Sheets, signed consent and confidentiality forms, gave an official introduction and cautions, recorded the session with back-ups, transcript records and analysis, found emergent codes and reflected on, and wrote the final report collaboratively.

  > *...Additionally, two of our group members, who did not lead the session, noted their observations of the cooperative evaluation session. However, they were sitting in the background, so that the participant did not feel observed or felt uncomfortable. (Group B02, report)*

- Tacit Experience in handling emergencies

They also gained experiences of handling unexpected events. During the test, there were 1-2 incidents where the link in the prototype was not correct, but this was not an obstacle as the leader of the session quickly led the participant to the appropriate webpage in the prototype.

Students also reflected back on their mistakes. One of the major lessons learned was the importance of a heuristic evaluation as a pilot before the cooperative evaluation. Due to time constraints this was omitted, which led to some issues that could have otherwise been avoided. As suggested by the lecturers during feedback, future prototypes will be evaluated using a set of usability heuristics to prevent unnecessary usability problems. Similarly, it became clear that tasks needed to be evaluated by an unbiased participant beforehand to ensure that they were understandable. This way, participants can concentrate entirely on the interaction without feeling insecure about the task at hand. This issue could be somewhat mitigated in the evaluation session by a comfortable atmosphere and a trustful relationship between the participants and the team members. In conclusion, the mistakes made during the cooperative evaluation will be regarded as opportunities for improvement and kept in mind for students' future projects.

6.4.2 Test on data curation methods

The main focus of this CE is not to test the designed interfaces but the design concept behind them. Students want to know if the data can be more accessible.

The group of A02 tested the understanding of different views, fits to the user, designed overview and navigation through levels when exploring the files. We found that the metaphor was well received, the views and levels could be understood by tested users, while most criticisms focused on the visualization issues.

1. All tested students found it easy to pick the views that fit the described background since the narrative was given to them before they perform the tasks. [10]

[10] However, in the fourth seminar that we test with students, it was not well perceived in the real context.

2. Testers could better understand the Project Overview through the designed levels. Participants were able to tell what the project was about after reading the overview and preliminary description. They were able to clearly define the functionalities of the designed system.

Group B02 examined three variants of visualisation and the concept of grouping data by using the methodology in the origin project, in this case the three stages of the Design Case Study.

1. The idea of “Three variants of visualisation” was well received and tested users found that they could think about it in their different use scenarios

> *In the debriefing session, participants were asked which view they would prefer. It turned out that it depends on the reason why the system is being used at that moment. The participants seemed to like the bubble view because it offers more options. Additionally, participant 3 mentioned: "I like this more maybe because it gives me options and it gives me control over what I want to see." [Participant 3 - 15:20, Task 5]. (Group B01, evaluation transcription)*

2. Bubble View and Metadata: the bubbles bring a new idea of visualizing folders and representing the file size in a more intuitive manner. The Metadata provided was also highly appreciated.

> *The bubble view almost exclusively provoked good reactions. Often participants were impressed by this view and its submenus [Participant 1 - 6:57, Task 4], it was even described as the best part of the system [see Participant 1 - 21:20, Debriefing] ... it was noted that the bubble view and its submenu provided a self-writing and a simple way to explore the existing data. (Group B01, evaluation transcription)*

Their design concept for curating the data has successfully delivered but with certain defects with reference to visual design and wording issues.

6.4.3 Apply prior knowledge in practice

Previous learned knowledge was also deployed from other places, and they evaluated the design environment and strategized for selecting participants accordingly.

- Two strategies for Selection of Recruited Participates

The two groups also had differences in carrying out their tests with their recruited users, A02 group recruited users only with a Software Engineering background because they curated a data case only for this group of students. They wanted to emphasise their multi-view concept here. It has been proved very "effective", because the task:" *Log into A02 and select the view fitting your described background*. "brought them positive feedback*: "The connection to the provided scenario was clear; for instance, one participant mentioned that "she is a software student...so I think I should go with the software." (Alena, Think Aloud)."* This so-called exemplary Use Case gives the user a clear goal and helps them feels comfortable in performing tasks. In comparison with A02, Group B02 was more open in choosing the end-user group and reflected on the disadvantage of this recruiting method:

> *It would be beneficial, if the students already had knowledge in the domain area, as it would allow the context of the project to be grasped faster in this case. However, it would also be a disadvantage, as the wording in the explanations of the methodology could not be tested by a novice user. Therefore, the system might also be interesting for students of social sciences but since we can easily reach HCI students, we considered them as our main target group for the cooperative evaluation. (Group A02, reflection session)*

- Extra Data Collections in two groups

- The groups had two approaches for gaining extra feedback from their users, A02 groups listed a chart for the task completed and the time taken. Group B02 set-up a SUS questionnaire after the user has formed all the tasks to rate the usability of the application.

Completion of Task (A02 Group)

Participant	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
Arjun	✓	✓	✓	✓	✓(hint)	✓	✓
Yakub	✓	✓	✓(hint)	✓	×	✓	✓
Alena	✓	✓	×	✓(hint)	✓(hint)	✓	✓

Time on Task (A02 Group)

Participant	Task 1 and 2	Task 3	Task 4 and 5	Task 6 and 7
Arjun	00:50	03:43	02:22	01:26
Yakub	00:36	01:10	04:00	00:11
Alena	00:16	05:00	06:45	00:43
Average	**00:34**	**03:20**	**04:20**	**00:36**

Figure 13 Extra data collected from Group A02

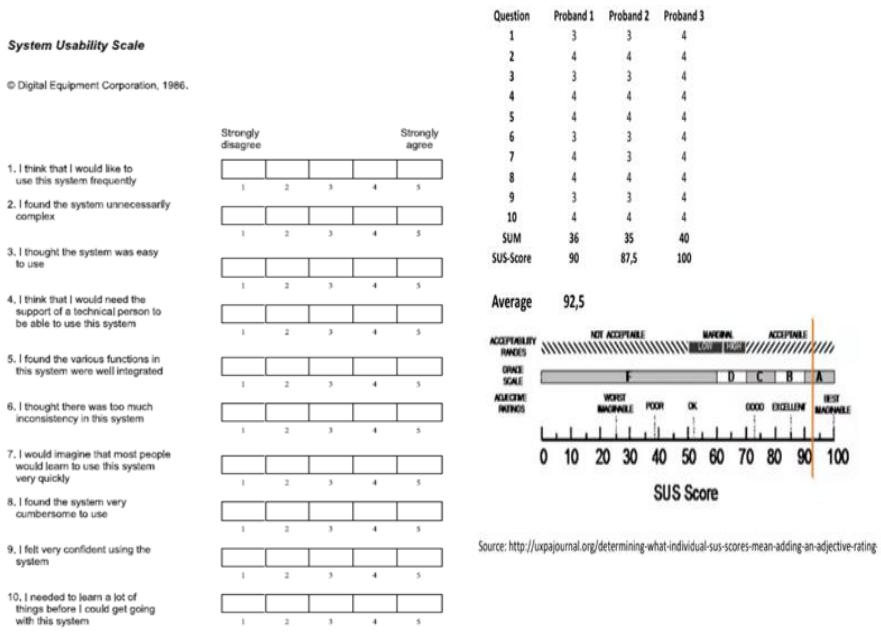

Figure 14 Extra data collect from Group B02

6.5 Step4. Redesign and Refinement

Testing and redesign was a stage that most of the students have not previously practiced or experienced. Both groups had the feeling that they gained valuable feedback from the tested users, and the recordings were transcribed, analysed and reflected on.

From the result, both design concepts were well received by tested users but usability issues remained. Re-designs were mainly focused on the visualization (arrangement of visual components, icon, fonts, etc.) and interaction of systems (click-on, hang-over and dropdown menu bar etc.)

6.5.1 A process of "break" and "rebuild"

This practice experience of test prototypes was considered to be a take-away from the seminar. Although the iterative test method itself is not new for students at all, the experience of practicing brings a new sense to students.

Destroy for breaking mind-set

They describe the process of testing as a process of "destroying" and was a motivating factor.

> *Marc: The feedback from enforcements is really valuable, it is really significant*
>
> *Jenny: Ye, it is small but it's really significant, it is just like a comment and you are like, …*
>
> *Marc: How can I miss that!*
>
> *Jenny: Because we are so committed to the whole process, get a fresh bill, that makes a whole difference, that is the beauty of working with users. I do like that, I like that they destroy your project, that means you get better… to you it makes sense, but to them it does not make sense, you have get a balance between that. (Discussion inside classroom)*

Test feedback breaks the designer's fixed mind-set, and leads to a search for new balance between user's and designer's mental model (Staggers and Norcio 1993). This experience is new to novice students who have been "destroyed" by the user's reactions, which is the most exciting part of the design learning experience.

Rebuild the design

A02 group had to totally redesign the interfaces even though this group had a professional designer with 3-year work experience in it. Their tested prototype was aesthetically pleasant, the interface being designed by using a blue-tone, which matched their Iceberg concept. The test result gave feedbacks, though, that a) blue represents a hyperlink so their users felt that everywhere was clickable, b) it was not colour-friendly for the users because the contrast is not enough, c) prototype looked too real so tested users were not treating it as a prototype anymore. A02 group had a professional GUI designer with rich work experience. The design interface was very mature and the tested end-users all thought it was a launched platform while they performed the tests.

> *The participants expected these keywords to be clickable links, one participant even specifically called them "quick access links". One participant tried to find out about the methodology using the levels navigation, which to him looked "like a timeline of the project"（Group A02, evaluation report）*

Group B02 has gained a very high score in the tests, the lower fidelity bringing a better result because the users saw that they were performing the test with a non-functional prototype.

6.5.2 Reflect design limitation:

There are design limitations that were raised by students and tutors in the classroom and discussed. This entails the complexity of our design problem on the one hand and demonstrated the reflective nature of design thinking by students on the other. 3 design limitations were discussed in the seminar:

- Design for the Frequent user and the Novice user

While they were designing, this problem appeared frequently. Firstly, because the designed platform is unlike any repository in their former experience, people needed time to adjust to new concept for discovering the data. The novice user might need guidance with which to lead them through the structure of data and this takes steps. Both our design and user-tests deal with this scenario; but it is less user-friendly for frequent users, who find it irritating and boring to go through all the steps that were designed for new users.

> *we have to think about if a user that has used the platform frequently, it is will very annoying to go through all the steps we have designed what especially for figuring out the data structures. (Group A02, Mia, Sociology, discussion in classroom)*

Tutors suggested quick links for 'recently used files' so that frequent user would not have to go through each step as a new user would need.

- View of curator or uploader

When we discussed the issue of who should be the one that performs the metadata editing activities, and how this looks, students recognised this problem for the first time. While not yet incorporated into the design, we have the basic information concerning what would be the information needed to create such a view from the front-end design, such as the categories we would need to give to the people that upload the file. This became a task for the next semester's students.

- Problems of "View of backgrounds" in A02 group

The data should be structured in a way that is suitable for certain groups of students. A02 had to go with the software engineering view and one of their groupmates, Chole, was originally studied. However, they said:

> *Mia: It should be (done by) someone familiar with the project and data, to decide which data should go top of the level and what data is not that so important, we aren't able to do that just Chole could do that because she knows what an engineering think like…*

Chole: I can just do it with the name of the file, because I cannot read and understand every file, so I could not do it in-depth manner (discussion in classroom)

Time restriction in reading through the materials and the data they selected meant they were not familiar enough with the project, and so they thought it better if someone from the project could do curation work or at least verify the work done.

6.6 Step5. Transfer Design Concept and Data

Materials were accumulated throughout the development of the seminar. We created two channels for transferring the design: a) explicit documentation that was organised for target users (third seminar students), b) contact with original designers (past students and tutor).

6.6.1 Design presentation and development discussion

Each group of students from last semester gave a presentation to the new students. This included the whole process from the problems identified to how they developed the designs and redesigned through the Cooperative Evaluations. The presentation also been recorded and shared with the new students. Students from the two seminars also discussed some problems around the issue of interdisciplinary gaps in sharing secondary design resources.

Clashes of two mind-set

- Unexpected development problem

After the presentations, new students asked prepared questions to the students from the previous seminar. An interesting question was proposed by the development student:

> *Jacob: You know, from a developer perspective, I see things a bit differently, this size of bubble depends on the size or the number of the files. (question tone)*
>
> *Marc: The findings we are gaining from the interview effects the size of the bubble, a lot of the transcripts and interview videos will make the size of the bubbles go larger, or the amount of contribution of the project, that what we want communicate with the bubbles*
>
> *Jenny: I think it's both, the number and how much weight (Design idea transfer session, inside classroom)*

This discussion around what the measurement of the bubble size is for is new for the designers, who took it for granted that the size of bubble automatically showed the weight of information content in the file. The development student explained:

Jacob: But it is not the same in my context, because they have long transcripts and video. It will take many MB in one file, but if it is the number of files, it will just take 2MB.

Jenny: okay, you have to do criteria to…(interrupted)

Jacob: If just size of the file that is also an issue, you know, it might be too little less to show the meta-data which just showing in the bubbles, the text will be smaller and too small. (means that the bubble size is too small to be able to show the metadata)

Marc: it cannot be just the file size…(Design idea transfer session, inside classroom)

No specific solution was given and a consistent size measurement of bubbles had to be rethought by the new students after discussion. We can see a typical case from above, to do with how design ideas have been formed differently in the designer's mind and the engineer's mind. In the words of a student, Charles: "*Developers do not like complicated ideas; they like simple designs that are robust and will not crush*" … "*designers want pixel accuracy*" and "*without thinking the mechanism behind the interfaces*". *(Charles, Mechanical Engineering, report)*

- Complicated development

Related issues were also exposed in the whole process of development. Jacob, in the interview after the seminar, while reflecting back on the whole process of development, said,

I like the idea… but I am not convinced by their design (visualization concept), like the bubble idea… and the (background)views that to select, it is too difficult to implement and also difficult for the people to curated the data, that is too much work. (Jacob, Computer Science, feedback interview)

From his perspective, the design ideas are too complicated to implement, and designers did not take other fundamental factors into account. Available resources and feasibility are his first priority in designing a system.

6.6.2 Mis-interpreted design concepts

Some effort has been made for better transfer of the design after student feedback, a) documentation of needed to be done in a detailed and curated way that is simple and clean (development students also agreed on this); b) the design process has to be presented by the original group; c) the contact details of the data provider should be provided; d) The tutor should provide extra information since they have been involved in whole design process and the major design decisions. Students overall felt that they could use the resources provided, but the right message in the beginning. was necessary and had not really been delivered.

1. A tacit understanding case

When the students from last semester presented their idea of *background views*, both tutor and students agreed on its suitability without discussion because both took it for granted that the backgrounded view only affects the structuring of data. However, students from the third seminar misinterpreted this design concept, and *all* development students believed that data should be filtered by different background views. This meant that data shown in one selected background view might not appear in the other view. This was never made explicit in the presentation given and so the issue was not revealed until the development students submitted the first version of their design. Our seminar plan got delayed due to this problem.

2. The disciplinary differences

The above issue has often occurred between graphic designers and developers in design projects. This is also a language issue created by disciplinary differences. The design students gave an explicit example of how design concepts are easy to deliver between designers in her feedback interview:

> *…In the other lecture, we had a brainstorm for a project related food topic, the team had the idea to show the transformation process of on the package of the bread. She just said two words, "projector" and "mould" I immediately understand what is her idea, but others team members do not, we have to elaborate the idea for them. You know… (Jenny, group A02, feedback interview)*

And this tacit agreement does not exist when working with people from different disciplines.

1. Ambiguity of Design

The prototype seems crystal clear from the designers' point of view, and they were very confident in showing their design to the developers before the design was questioned. All software students pointed out the problem about the bubbles,

2. Two Thinking patterns

This also demonstrates another issue-- the gap between design thinking vs. system thinking (Greene et al. 2017),

Developers have to design the missing elements by themselves. Designers might not be able to consider every aspect, which forces developers to do some design work by themselves. For example, neither design indicated how the data should be added to the platform;.The designers from ANA did not consider that the long file name might not fit in the bubble; or that data sharing websites with multiple users usually need administrators. Neither design considered administration. Therefore, the developers had to come up with designs to cope with these missing points.

- Designers want the implementation to be the same as the design

Designers all have the thought that the development product should look and behave as "*pixel perfect"* as the original design.

However, designers also anticipate that the product will be different from the original design because they are aware of the possibility of technical or other constraints.

- Developers want a complete design

Developers do not want to think about the ambiguity in design. They want the design handoff to be as specific as possible so that they can concentrate on development.

[. . .] if it's the login page, I want to know the password requirements, such as what the minimum length is [. . .]" (Jacob, Computer Science, feedback interview)

- Different mindsets

They care about different things, and yet they do not know what the other side cares about.

Designers care about the appearance such as the layout, font, and color; Developers care about the efficiency, feasibility, scalability, and future maintains. .(Charles, Mechanical Engineering, Group C01/A03, feedback interview)

Designers have complicated ideas compared to developers because they consider the user's needs more. Developers do not like complicated ideas; they like simple designs that are robust and will not crash. Designers care about why (why design in this way); developers care about how (how to develop).

They always ask to change this, change that, what's the difference between the button on the left and on the right?!" (Jacob, Computer Science, feedback interview,)

6.6.3 Passive attitude on request information

Communication is the way-out for addressing the issue, however the communication channels provided were often neglected by students.

Contact-list is not working

Tutors organized a list to connect the two generations of students, because we thought they would be able to communicate with each other easily that way. However, students did not engage with this provided resource. Contacts that were built were very thin. When we asked about this, they explained that they are not sharing the same study goal and it feels "*bothersome*" to the design students "*because they are busy at other lectures*".

They only contacted the designer after they got the feedback from the tutor saying the design concept was misinterpreted.

> *They failed to understand the concept and the logic of the design (such as the iceberg concept). After the first failure, we(the developers) had to consult one of the designers to understand the concept correctly. (Group A03, report)*

This barrier created extra time and effort for the development students and tutors. And when we reflect back, this barrier existed in all four semesters, contextualized materials rely on people-to-people communications since not everything can be documented. However, students behaved passively in accessing the indirect information requirements, and did not always communicate even with the people that they were familiar with.

6.7 Step 6. Combine two Designs for Development

Before they got to the implementation stage, the re-designed interfaces had to be presented to the tutors. Nevertheless, the first version of the combination was totally missing the core concept from the original design. They redesigned an interface based on their experience of developing for a repository. and they mirrored that fixed framework in this context. They explained that traditional repository design is simple and robust to keep the system running and questioned the original design concepts:

> *There are different types of engineer, and you chose software view and it does not give you satisfaction, how you deal with it?... If I am an engineer, should I see other views every time? (Group A03, discussion in classroom)*

However, after 1 hour explanation of the design, we had to draw a boundary, because we realised it was extremely hard to elaborate everything for development students who had not been involved in the design phases.

> *If we explain all the design decision that has been made to the prototype, it will take forever. We just want you to know that all the elements have been tested with the end-user and there is a reason behind it. (Tutor 02, redesign presentation feedback)*

Due to the inefficiency involved in transferring the design ideas, the redesign phase has been prolonged. Students had to go to the designers for elaboration, and it took 2 more weeks than we expected to complete the design combination.

After it was confirmed that their understanding of the design concept was mistaken, they redesigned based on the new understanding of the design concepts which was much more like what designers had in mind.

6.7.1 Solving the remaining Design Problems

Since the designs had some unconsidered aspects, the developers had to connect everything and address those unconsidered issues.

Bubble view to reading time

The students said the concept of the bubble is very nice, but the visualization is not ideal since it has many limitations. Firstly, they would use another parameter to indicate the content inside of files, since the size and the file counts do not speak to the users. After a brainstorming session, they found "*reading time*" was the one that could indicate the context of a file. And they needed a more consistent form to indicate the information instead of the bubbles, Therefore, they designed a *bar* indicate the *reading time*, see figure

Undesigned content

Some of the views did not exist in the provided prototypes even after testing with the users. For example, the view for uploading the files, how data will be created, levelled and meta-data added into the file. This was recognised in the previous semester but it was too late to design for it.

Since the view was not designed, the developers improvised to design the background view, the mechanism to upload the file was very systematic but required too many steps. One developer said:

> *It is too much work to upload the files and editing the meta-data, you know, I have to … too many steps have to click and it takes too much time to upload the files.(Charles, Mechanical Engineering, Group C01/A03, feedback interview)*

Also, something that was not taken into account in the design protype was the design for a customized view. The reason for this is because students had not tested the requirements to create a new view. The developers also have to complete this part.

6.8 Step 7. Curate and Develop

After the re-design adapted from the previous semester, students moved to implement it. In this step, students been divided into 2 task groups; two students working on the development and two othersworking on the database.

6.8.1 Being data-curator and data-reuser in parallel

From the former work of the data providers (see section: Researchers--the aspects from the data provider) in the institute we learned that researchers were not prepared to curate past project data for others because they were constantly under time pressure. Although some methods and strategies for curating research data have been evolved in other locations (for example, Digital Curation Centre from the UK proposed DCC Curation Lifecycle Mode, and the Australian National Data Services (ANDS) designed ANDS Data Sharing Verbs), most of the researchers have neither the training nor are aware of the need for curation in the beginning of their project work. As a result, the archived data was only accessible by the original team.

One solution to the curation of the data is to assign the curation task to others. The students from the previous semester could be suitable candidates for this since they are the group that will be using it. Therefore, we also assigned the curation tasks to them, but only the data that was to be used in the design prototype. This semester, students needed to prepare the curated data for the students in the next seminar. Thus, the given materials needed to be renamed, restructured and a metadata added, based on the design concept.

Curate with the original project researcher

Cyberrüsten 4.0 is a German project and all data are pre-processed by the project researchers before being handed over. The data structure from the original repository remained, while some visually-based files were deleted after negotiation with project stakeholders.

One of important reason of why project data has been changed to Cyberrüsten 4.0 is to help students establish a better connection with the project. We learned from previous seminars that students lack contextual information in making sense of the data, and many files are documented with a specific context in view. Often, tutors contributed information which provided more accurate and better contextualized information in the curation process.

Provide contextual information

Contextual information is necessary in the curation process since the data was not collected for secondary uses. That information is not explicitly recorded so it is hardly accessible for outsiders. Tutor George as the data provider played a vital role here in providing that information, and often made the rationale behind of files explicit.

From the interaction between tutor (data provider) and students (data re-user), we found the nature of contextual information to be elusive. Providing contextual information is dependent on the purpose of using and the type of data (Van Den Berg, 2008), Van Den Berg suggested six categories of information for interviews and Lee listed nine classes of contextual entities to articulate research collections(Lee, n.d.). However, contextual information can be far more than that.

In our case, students were missing related knowledge. For instance, there was no mention of the contextualised abbreviations and technical terminology in the mechanical industry. They were unfamiliar with research project procedures, what a deliverable is and what a work-package is. All were totally new concepts for them.

Moreover, it involved tacit decisions that had been made in the project which students had no knowledge of:

> *Why company C have less empirical data than company A? (Group A03, discussion inside classroom)*

Labour and time-intensive work

Students are aware of what kind of data is needed for learning purposes. However, creating that information is labour and time intensive. It requires extensive reading, constant reflection on context and an ability to summarise content. Students are not professionals in doing curation work, and such task are normally considered beyond students' reach.

In the end, they only managed to give some basic metadata for one view: the designer view (see figure 15). As we can see from the screenshot, besides the normal metadata that can be found in other repositories, language, reading time, and abstract descriptions were added.

6.8.2 Practical development

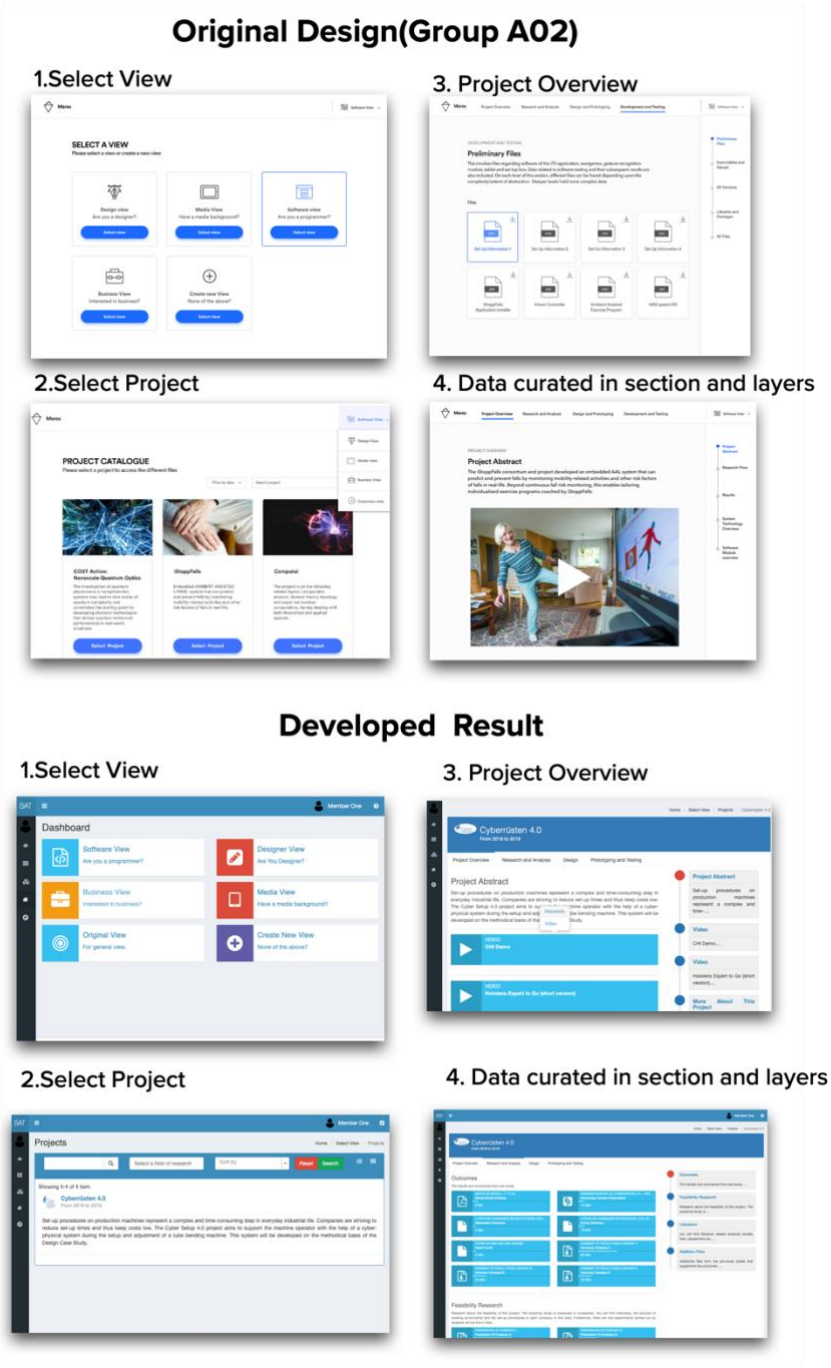

Figure 15 Comparing development result with original design from Group A02

The re-design phase cost more time than we expected, and students had to develop an operational prototype within 2 months. Our student assistant was leading the development group and created a functional artefact with curated project data. The final prototype mixed the

design concept from Group A02 and B02 (see figure 15). They also add new aspects and design elements to complete the artefact.

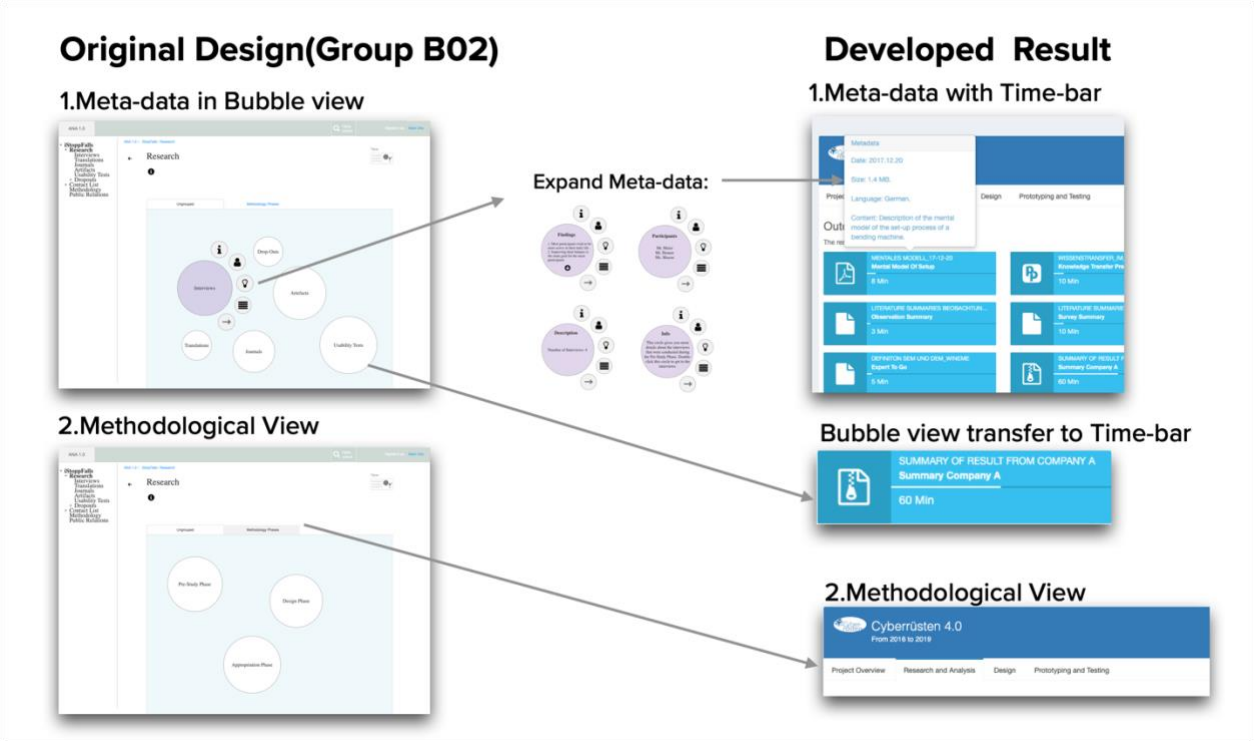

Figure 16 Comparing development result with original design from Group B02

Making new design decisions

Two main design decision have been implemented in the new prototype,

Since designers failed to design for uploading view, developers designed new interfaces to provide those functions. They designed a process for uploading files with the requirements of adding metadata and adding levels.

Economic develop environment

The development of the designed prototype needed to adapt to the Hum-hub environment with the language requirement of PHP and therefore, some basic structures were given.

6.9 Feedbacks of Educational Setting

The time constraints

In the previous semester it had been proposed to meet students every week because they felt the need for guidance, leaving them to perform tasks outside the classroom. Here, we also decided here to change the seminar into once per week, and we expected most of the tasks to be done in the classroom. However, the students reported that they felt stressed because some of them needed more time to read or think.

> *Asking us doing literature review within 2 hours in classroom is too much (Group B02, Marc, Computer Science, feedback session)*

In order to match their routine, the seminar changed into a studio form, where tutors were in the classroom all the time, and students could decide whether they wanted to come for support or not, so they could be more flexible in dealing with the tasks. This involved, for students, a balancing act.

Sense of being lost

The plan and goal of seminar had been introduced in the very beginning, since it was an unfamiliar topic. Students remained confused to some extent, especially when facing a massive dataset, and the concept of curation and data management, something that have never appeared in their life.

> *"when we been asking to explore the BSCW and I opened it, I said, oh my god, how am I supposed to understand it in two weeks." (Mila, Sociology, Group A02, feedback session in classroom)*

They had to guess what the tutor expected, even though time was spent on explanation. The purpose of the tasks was unclear until they experienced it.

> *First, I thought it (this seminar) will be about visualization and some theory and how to do it, and there is a lot of works that I do not know why I do this, at the beginning it was not clear, what is task and the purpose, and later it*

becomes clear and we can link everything together (Group B02, Nancy, Sociology , Interview)

A missing step before development

Due to the time limitation, we had no time to test the redesigned prototype with users because progress lagged far behind of the planned time schema. This created another challenge in the next seminar (see details in chapter 7). Therefore, the developers started to develop directly, based on the prototype they had designed.

6.10 Summary

The two seminars introduced in this section showed a co-design and co-development process of creating a prototype for future students accessing secondary research data. The seminar has created interesting roles for students. Students in our seminar played the role of designer/developer, curator and user-group in parallel. They reflected on their own needs and designed a solution. The co-creation experience with students helped us to learn how to design for the secondary data from a completely new perspective, in terms of how to organise and represent it.

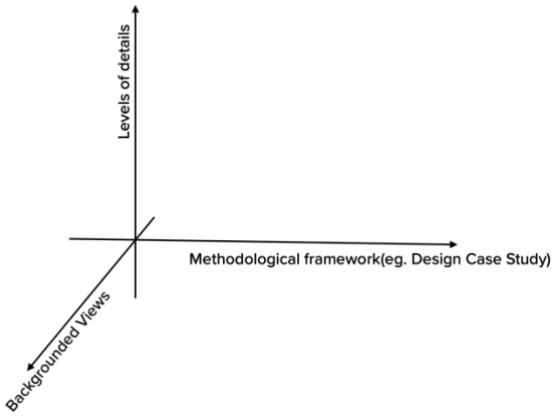

Figure 17 Three dimensions of exploring secondary data

Students as the data re-users were interested in exploring data in three dimensions: creating parallel multiple views on the same data and allowing re-users to explore it based on their educational backgrounds or reuse interests, b) horizontal categories in sections based on the methodological framework or project timeline, c) vertical levels of information from shadow to deep sequence, abstract information on the surface and linked to detailed information below. They also required descriptive metadata that could support them to make sense of files with minimal effort.

While we transfer the design clickable prototype into the program coded operational version, we also learned more about the special quality of design documentation and design knowledge.

Concrete design ideas can be transferred by visual methods quickly, but backgrounded issues and subtle design decisions are more difficult to communicate due to the division of interdisciplinary mind-sets among third seminar students. We spent large resources in explaining past design obstacles. Students as the re-user and re-designer of past design documentation have shown us the major challenges in accessing past design knowledge and the critical function of different mindsets. Neither explicit documentation nor personal experience could alleviate the cost of transferring. Documentation of design processes needs more investigation of how to build a concrete narrative of design ideas and support the bridging of distinct mind-sets. But the ambiguous and obscure understanding of design to be found on the part of students does not necessarily impair design itself; development students in the redesign phrase have brought us new and feasible functions that original designers overlooked.

From the pedagogical view, both seminars' students played a major role in the creation process, tutors only provided suggestions in the design process. They practiced the Grounded Design method they had learned within a facilitated design environment and experienced one complete design cycle of discovering, design, testing and redesign.

Testing experience was noted as the most important take-away for students, the reflection gained from an iterative design process was reported as an otherwise missing element in the design education curriculum. The absence of testing experience is caused by the lack of empirical resources and time, and there is a clear gap in the provision of opportunities for reflective iterative practices in the design learning environment.

As facilitators and designers of seminars, we also reflected on the constantly changing environment which has posed challenges for design research based on the existing educational settings. Normally the educational environment is considered to be a stable environment with controllable factors. From our experience it is not the case, and managing seminars within a limited timeframe and limited human resources requires flexible adaptions.

7 Fourth Seminar: Design Based on the Curated Data with Mediate Solution

In the fourth semester, we finally brought the past experiences and the designed artefacts to our students. We wanted *to explore with the new seminar students the appropriation of a platform for access to second-hand data during a Grounded Design activity*, and a) reflect on using the platform for second-hand data access; and b) realise innovative design based on the analysis of past project data (raw data, data analysis reports, scenarios and prototypes)

7.1 Preparation Works and Setting

The seminar took place online, largely because of the pandemic. Virtual courses and our developed tool, Research-hub, were introduced as a basic infrastructure the communication environment.

7.1.1 Virtual settings—unifying learning tools

ZOOM for seminar meetings and Recording

The seminar was running during the lockdown of pandemic COVID-19. We organized ZOOM meetings for students to participate in the seminar and established other tools for communication and cooperation. All information was recorded on video in a shared repository. Important discussion was summarised in text format and announced in Research-hub to avoid information sharing problems.

Research-Hub for communication, archive, task management and group collaboration

We introduced ResearchHub again because we found it is easier to communicate with students and for giving them feedback on time. We created a public space for all the seminar students. This public space has been used to arrange class meetings, announce information and hold cross-group discussions. Students organized themselves in three groups and created private group spaces, where they could arrange their group activities and share material inside the group space. All related material is centralized in ResearchHub. We listed the link of the

secondary data platform DesignCaser, and shared teaching materials (slides and archived video records) there.

7.1.2 Plan in 4 steps similar to the first seminar

The seminar was held in the same manner as the first seminar (see Plan for 4 Steps), with some adjustment based on the uses of material and feedback mechanism.

1. Data selection with DesignCaser (1-3 week)

The outcome of last two seminars—DesignCaser- was introduced to students and they were given signed access to the data, Two background views were available for the students, "Designer View" and "Original View". Other views were not available since a huge amount of manual work has to be invested first before the concept has been proven useful. Therefore, we decided to test the concept with real users first. This turned out to be the right decision.

"Designer view" was curated by the last seminar students, and they curated in a way that they believed was suitable for the students in the next generation in the design learning endeavour.

"Original View" was created based on the original researcher's data structure.

Students could register in the DesignCaser and gain the access to the data with permission. After they signed in they could explore the data individually and reflect upon the experience and write a user-diary.

2. Data Analysis with non-strict approach (4-6 week)

A discussion between the two tutors was triggered by the data analysing process while in the preparation stage. For the tutor George, epistemological stances are associated the motivation for running the seminar. He was very keen to teach systematic data analysis methods because design/HCI research in his eyes is the same as understanding social and peoples' needs, *"basically it is an activity that is doing social research."* We can understand how his educational background constructs this way of thinking. He is originally from computer science and CSCW and has a view of conducting design research akin to what Fallman called "Conservative Account" (Fallman 2003b) which associates with rational, structured

methodical steps in conducting design activities. This means simply that his view of design is research oriented and pragmatic, focused, so he believes, on a systematic approach which could help students in learning design efficiently.

> *data analysis requires experiences, same as design, they have to train themselves, if you do not train yourself, you cannot do it properly. (George, tutor)*

After several discussion about use of method, we agreed that students can use data analysis methods more loosely in their design learning activities since the seminars for students are more focused on design practice than design research.

3. Build Personal and Scenario (7-9 week)

The scenario we established was designed to is help the students in elaborating their data finding strategies and identify problems There were three groups but more scenarios were created this time, which has to do with contextual complexity. There are more roles and stages of work involved, and their relationships became interwoven.

4. Design Visualization and reflect on DesignCaser (10-12 week)

Base on the identified design problems, the design idea was to be represented through low to middle fidelity prototypes. Beside the design idea, a presentation was also organized to give us feedback and suggestions on the uses of the developed data module.

7.2 Step 1. Using Designed e-Portfolio for Data Selection

After lecturing on Grounded Deign and introducing related tools, a paper that reported on the project and a paper related to Grounded Design method was shared with the students. They then started to familiarise themselves with the project data and selected the final datasets that they wanted to analysis. This time, each student selected one dataset and wrote an analysis report collaboratively. In the end, therefore, each group will have 4-5 data sets being used for design purposes.

Designed artefact alleviate data access

Some identifiable problems and challenges reoccurred, including the sense that students were overwhelmed by the big quantity of data, especially for those that had never previously joined the seminar. However, students that had participated in the seminar before found it easier to get along with the project data even when it was not the same data asset that they had seen before. Experienced students reported that it was easier to make sense of the data and select the material they needed through the newly formed data structure. For new students, this was a totally strange resource that not been introduced to them for learning purposes before. It is understandable that was not well-accepted by those students. With more familiarity around data resources, this sense can be conquered and acceptance will make this process much easier.

We received far fewer questions about data during and after the seminar. The selection process was less demanding and students did not find many problems in understanding and searching for the data they needed. Only one student (Kennard, group C04) reported the difficulty of identifying the "right" document for his data analysis and suggested a list of recommendations on data. That opened up questions for us about how to define what empirical data might be worth investigation.

Three data selection strategy

It was not surprising for us to see that all students selected the empirical data in the end based on the past seminar experiences. One student was interested in analysing the published papers that came from the original project because that is what he was used to in the other lectures. However, he decided not to do so because he wanted to identify something new. He accounted for the decision:

> *...empirical data is most useful for design purpose, and in empirical data, the interview is most useful, especially the interview from pre-study. (Kennard, Electronic Engineering, Group C04, interview)*

Another similar point is that the data for reading and for analysing should be different. All three groups browsed through all the data in the module and downloaded more materials than they needed to for simply gaining an overview of the context.

In the beginning, Group A were very open about data selection and planned to select it randomly. But after looking at the range and variety of material on offer, they recognised they needed a strategy.

> *It makes no sense to go to the design stage if we want to create something new, because everything is fixed (Group A04, discussion in classroom)*

Group A decided to select four interviews from the *pre-study* phrase and one workshop transcript from the *design* phrase. But they discovered it was not enough for the creative stage of design, and they went back and forth, eventually selecting one interview from the pre-study and one use-case from the test phase.

Group B selected data that *all came from the design phase* and they were the first group to do so. The decision was triggered by their interest in investigating data from the co-design and testing phase since their current curriculum does not provide resources for practicing.

And Group C expressed the difficulty they faced in selecting the material due to the struggle of *selecting a representative file*. After browsing the empirical resources, they decided on 3 interviews with the managers of the companies. From their point of view, those could provide them with “a more comprehensive view on the design field”.

7.3 Step 2. From Data to Analysis

Thematic Analysis (Braun and Clarke 2012) had been introduced due to the absence of background knowledge/learning of students about analytic methods, but this time students were more open about the approaches they were taking. The key for tutors to evaluate the analytic results is the reflection students brought to the design context. This time, students did not need to analyse each sentence of a selected file. They wanted to avoid "*simply making annotations on data*" (Hannah, GorupA01, interview). We encouraged students to apply other analysis methods they found and understood. However, no students had experience of analysing research data with other methods. This again demonstrated that the teaching context was not fully engaging with ethnographic works.

Also, it is worth mentioning that each student was to analyse one piece of data that was selected by themselves this time. Students from the first seminar reported the group analysis created friction and some group member's voices could be submerged during the co-analysis process. In this way, students could analyse more materials and it promoted the efficiency of the analysing process. Nevertheless, in order to encourage group collaboration and enrich the analysis result, students needed to write an analysis report together, bringing synergies from individual results. This collaboration format caused less friction and was more efficient in bringing multi-perspectives from students with interdisciplinary backgrounds.

Data Analysis -- needs to be trained to be skilful

The tutor George taught the other mandatory lectures. He had found that data analysis expertise is helpful in design activity and since then, he had added this analysis practice to his CSCW lectures. Therefore, we had more students that had already practiced data analysis skills this time. And it is evident that students were feeling less stressed. A student that had the training in the CSCW lectures said:

> *...yes, that(analysis) is not a problem for me. (Jacob, Computer Science, Group A04, feedback interview)*

Also, people practiced in the data analysing estimated the time spent on this task is much less than the first seminar's students experienced:

...I did it (data analysis) not more than one week...I spent more time on selecting than analysing (Kennard, Electronic Engineering, Group C 04, feedback interview)

With regards to the students that have not practiced data analysis before, they have largely benefited from peer support. With the help of team members, they were able to grasp the

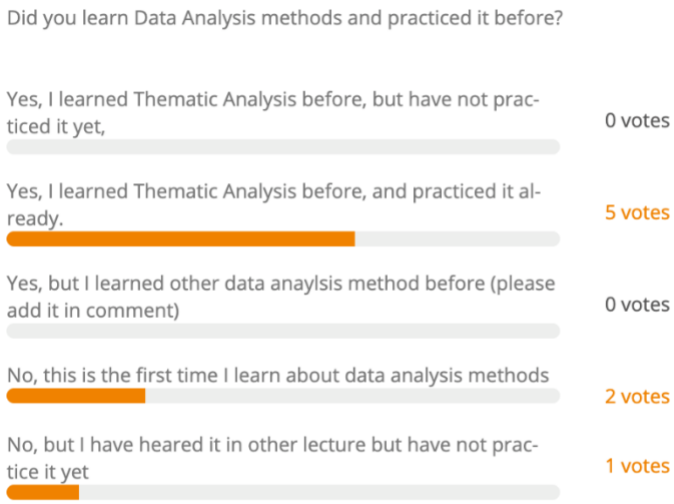

Figure 18 Survey on Thematic Anaysis method

required demands in data tasks.

Missing background knowledge and requiring external information

Design contexts are not always easily accessible and understandable for designers. Students from this seminar had to deal with an unfamiliar design context. The context of production involved professional terms and required basic understanding of machine operational knowledge. Group A and B suffered from not understanding the set-up process in machine production

Various technical terms were repeated, such as: Tolerance and worn-out information. Without the working experience and technical knowledge, it is difficult to imagine and understand the set-up procedure in the bending industry. (Maggie, Business Administration, group A04, feedback interview)

Each group analysed at least 4 empirical data elements. In their view, the analytical materials were enough for them to understand the manufacturing context and identify the design problems.

However, students faced difficulties in linking it with personal experience because the design context is unfamiliar for them. This was different from the aging context previously used. The manufacturing context involved professional descriptions on bending machines, and it required designers to understand the basic operating steps of bending machines. Although we gave an introduction in the classroom, students still found it hard to create a mental model of the bending machine working steps.

They turned to searching for related materials instead of consulting tutors. Maggie from Group A04 searched for help from a friend who was in related field and transferred acquired information to her group.

YouTube is a quick entrance for such needs, and all the interviewed students searched videos in YouTube to help them to understand the bending machine with one exception, a student with a mechanical engineering background.

Visual information about bending machines proved to be an indispensable part for student in making sense of the design context but was not available in the documentation for copyright reasons. Students had to find visual material elsewhere, but there were some doubts about the reliability of such an approach.

7.4 Step 3. From Data to Design Scenarios

All three groups identified the two overlapping themes of knowledge transfer and lack of collaboration support from the analysis phase. They took three different routes in addressing those problems. As we discovered from the first seminar, the phase also demonstrated to us how students linked their empirical findings with design problems. But, within a relatively complicated and unfamiliar context compared to the elderly (iStopfalls), all groups of students composed more than one persona to deal with the different roles in workplaces.

The personas were reported according to the design problems that they wanted to address, Group A created 5 personas playing 5 different roles in the company and demonstrated their roles in the working environment. After skimming through two more interviews to gain information for creating a contextualized scenario:

> *These interesting aspects (from additional findings) inspire us to focus on only one persona and one scenario. (GroupA04, discussion in classroom)*

Thus, they concentrated on the problem of an ineffective training process and built a scenario that described the learning process of a newbie through the help of the designed learning system.

Group B concentrated on the problem that AR technology brought up in the original design context. They reported two personas (experienced operator and novice operator) who had two different experience with AR devices in the first scenario, and proposed a more user-friendly design solution that could support workers who were not familiar with technology and sketched another scenario for using this newly designed device.

Group C constructed 2 personas (a segment manager and an operater) to replicate the collaboration process of setup, a design issue that they identified from the secondary data, and envisioned a remote system that could bridge this collaboration more efficiently.

Materialized design output

If we compare the first design project shared with students, the industry context has created even more challenge for students in imagining the design field. And this is the reality of system designers: they have to make sense of context using ethnographic resources. The material in hand supported students in reflecting the real design context and materialized their design ideas.

Students searched concrete parameters and terminologies to supplement their design ideas.

> *As outsiders from the bending industry, we face the challenge of building learning material for the newbie. The data analysis provides valuable hints for the contents used in the prototype. (Maggie, Business Administration, group A04, feedback interview)*

They identified the parameters, names of bending techniques and names of aggregates in this additional analysis, which helped them in the design process to complete their design set-ups.

Unfamiliar context and real design problems

The scenarios required a detailed picture of their user population and secondary data provided students with those materials.

> *I thought the tasks for workers are simple, turns out they are dealing with very complex problems in complex environment. (Sadie, Computer Science, group B04, feedback interview)*

Similar misapprehensions about user groups were also present in the first seminar,

> *I found it surprising that elderly is not like what we imagined! I was imagining elderlies are always acting passively in social engagements and hardly go outside by themselves (Hannah, Group A, Design, feedback Interview)*

The inaccurate assumption in the design process reflects the importance of ethnographic understanding in design work. The data provides an opportunity to recontextualize design

problems in complex settings so that solutions can be found for “wicked” design problems, even in an environment they are not familiar with.

7.5 Step 4. From Data to Design Outcomes

Compared with the first seminar, students found it more difficult to resonate with the design context due to unfamiliarity with the production technology. They relied on the empirical resources we provided as well as online resources to connect to the field Personal experience and emotional connection played no real part this time.

7.5.1 Two Approaches of reusing data for design

Similar to the first seminar, our students had two approaches to re-using research data in their designs, but this time two groups of students performed redesign on the same design problem as the original researchers had defined. Group A and group B both aimed at the problem of knowledge transfer and the limitation of AR technology, however they designed two very different types of innovation.

Re-Design on same problem

- Group A04: re-designed the whole design concept

Although Group A04 identified very similar design problems from the pre-study as the original researchers, they tried to avoid advanced technologies since they detected negative reactions and saw cost limitations of AR in the workplaces of SMEs (small and medium enterprises) from the original design workshops.

They designed both a new interface and interface support (tablet instead of AR). They designed a learning system for newbies to train the setup process, 3 modules were assigned to 3 training levels of difficulty, and once trainees qualified through a quiz based on each module, they could perform 3d simulation games at that module level. This 3d simulation game would guide the trainee along with the setup process, and the supervisor could access the trainee's dashboard for further feedback.

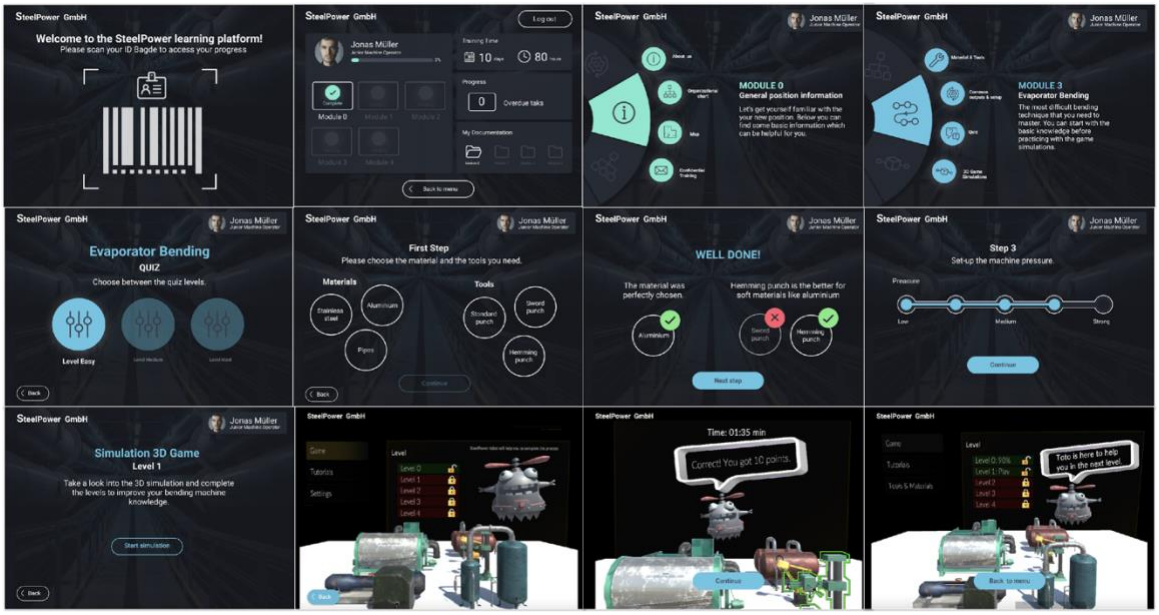

Figure 19 Designed prototype from Group A04

- Group B04: Redesign the interface support

Group B04 identified the discomfort of AR devices and the need of knowledge transfer as well, and they addressed this issue by designing a new device they called the *visible VR system*. The old interface in AR would be transferred to a vest that had an installed projector and camera.

The emphasised the collaboration limitation of AR glass that other workers are not able to see information in the devices. The vest, it was suggested, could support the learning and collaboration activities.

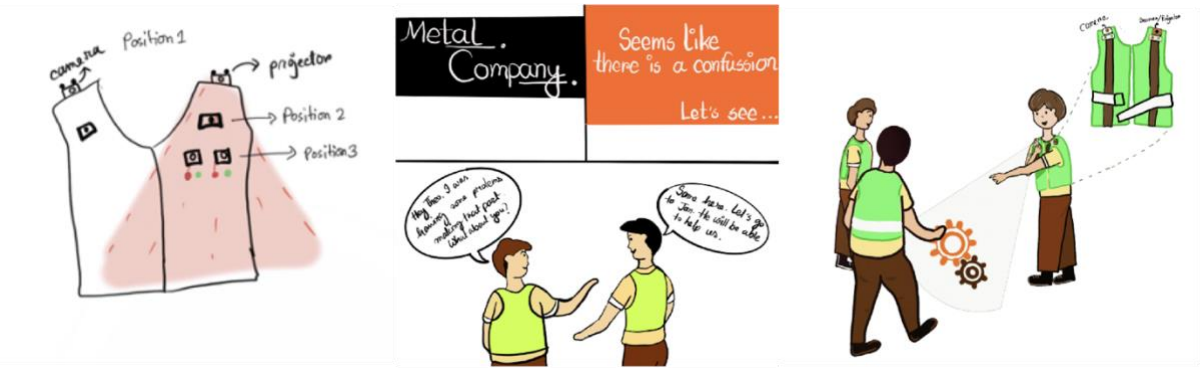

Figure 20 Designed prototype from Group B04

Design on other identified problems

Group C04 have identified the limits to collaboration in the workplace and promoted two design needs from the design context, namely *automatic collaboration* and *knowledge management system*. They addressed this issue by design a system that supports remote collaboration. Once the machine operator has set the parameters, the segment manager could grand the production after reviewing it from distance. This system will record all process in production so it could partly resolve the problem of knowledge archiving.

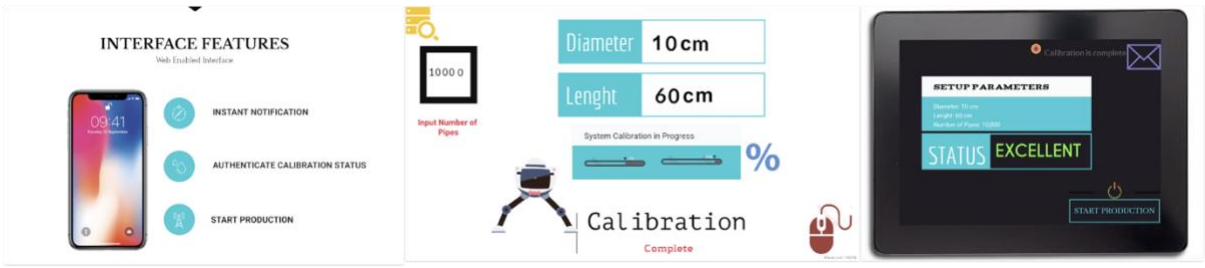

Figure 21 Designed prototype from Group C04

Those three groups have produced very different design outcomes, and all of the three groups has missed out some important elements of the original design context. Group A missed a perspective on collaboration in working environment. Group B limited their ambitions to simply changing the device, but with very little difference in the way of functionality. It was hard to understand their design idea from their sketches. It turns out Group C missed the most fundamental pain point in the design context, which is that operating the bending machine requires experiences that cannot be quantified. The operators have to make decisions to adjust parameters each time by observing slight changes in the machine.

7.5.2 Selected data impact design outcomes

The cognitive deviation above cannot be avoided in secondary data since the data did not replicate the research field in sufficient detail. The selection of data just gave access to narrow aspects of the context, and students needed a broader picture.

- Addressing wicked problems

Group A analysed 7 files from both *prestudy* and *design* stages from company A and B, and therefore they had a broader overview on the design field compared with the other two groups. The broad overview led to the wicked problem they faced of designing an easily accessible device that is acceptable by non-tech-savvy workers and a design interface that would not be limited in dirty and chaotic production environment at the same time. However, they did not find a feasible solution for it. They turned instead to another design breakthrough. They noticed that beginners needed to spend a very long time observing the operation process and they tended to make mistakes in the beginning and waste materials in real operation. The students thus designed a system for beginners to train themselves with a tablet. Outside of the real-time context.

- Select data from only managers from company

Group C04 selected the data from managers of company A. We found the description of production process had been simplified in the interview data. It created a superficial understanding of production process and an over-simplified design solution.

- Select material from only design phrase

Only group B04 (including first seminar) had selected the data *only* from the design phase. In our experience, that was unusual. Selecting data from the *design* phase showed the usability issue in the original design, and it directed them towards improving the past design.

The limited context with which they worked did not lead to a bad design. We noticed that students worked iteratively and reflected carefully on the identified design problems from multiple perspectives. They took a number of factors into account and met our expectations

There can be many factors that impact design decisions: selection of data, mix of group members and their background, culture/nationality, people who get involved, role playing in the group, level of interest in the topic, old design solutions etc. In all of these factors, empirical data plays the centre role in our seminar, and is a more inspirational resource for identifying design problems.

Based on the results from the seminar, we suggest selection of data should be made carefully in the sharing environment to avoid bias. The broader the selected data, the closer to the real design context the re-users can get. Within an educational setting, tutors need to become practiced in guidance about the selection of data to help students to gain a comprehensive view on the design context.

7.6 Step 5. Usage of DesignCaser

Students were motivated in using the technical tools provided to support their learning and they reflected on the uses of those tools. By the end of the seminar, they made a presentation and reported on the uses of the DesignCaser. They suggested to us some design ideas to redesign the platform to help us refine our solution secondary data access.

Four criteria have been brought up. The most critiqued issue is the visualization components such as the inaccurate semantics of icons, the wired- position of the menu bar and the lack of visual guidance. Students showed an expectation that the prototype (DesignCaser) was a full functioning platform instead of ongoing developing artifact. Therefore, the undergoing development errors and functions did not meet their expectations.

Usability issues

We have identified 18 usability issues from the feedback of students. They can be categorized into unclear icons, inappropriat propositions and inadequate introduction to functions.

Technical defection – uncomplete and ongoing development process

The artefact that we deployed is not the imagined version of the design. As one design student says: "design is much cheaper than development because we can change much more easily than coding". *(Jenny, Industrial Design, group A04, feedback interview)* Development requires a longer time than designing a prototype because of the problem of translating all design language into codes. Within a semester timeframe, the development of the DesignCaser platform is far from perfected.

- Missing function

The link to the profile of users is not available yet, so that users cannot create a profile of themselves. There was no specific design for profiles in prototype because students directed their attention to developing the main functions first.

- Broken links

Some files cannot be downloaded due to the broken linkage of files. Students contacted us and we sent them the files through emails.

- Preview on files

The preview of files was missing and significantly affected the usage of the platform. This was caused by the incomplete design of the interface in the original design. Both designers and tutors who were involved in the second semester took for granted the preview of file as a fundamental part and did not require interface redesign. However, the developers were not up to speed. By end of the third semester it was too late to correct due to the large amount of work to fix it.

Limitation of design concept

- Inadequate Metadata

Meta-data has been recognised as an efficient approach to understanding secondary data. Ideally, the editing of metadata has been done by those who provided the material, in our case the researchers. However, both the researchers from project iStopfalls and Cyberrüsten did not make the time to add extra materials for their files. Because the file is defined largely by its content, especially the empirical data files, adding metadata cannot be done efficiently by others. The students from last semester had structured and added metadata for the files, and even those inadequate metadata have already proved useful for secondary usage because it gave more information that the filename did. It gives extra information rather than the name of the file

The value of metadata is not yet, however, maximized due to the curators still lacking information about the context of the original research. We are currently searching for ways of incentivising the original researchers to construct new metadata in their future designs when bringing DesignCaser to ResearchHub.

- Concept of Reading Time

The time-bar has been mistaken as a download progress bar. Only 2 students reported that they understood the concept of time-bar. And the maximum value of the bar design is problematic since the length of reading and the range is hard to define.

- Confusion about (different background) views.

We also discussed the design of background views for accessing the secondary data.. People who have multiple educational backgrounds and work experience are confused when they select the views (eg. Anthony: car engineering and computer science; Maggie Business administration and UX designer)

New design ideas

The students expected certain functions in DesignCaser, where students could draw design ideas on what this platform should look like.

> *For some reason, I expected a collection of hyperlinked documents similar to Wikipedia…then it would be necessary to be able to tag data and its fragments to create relationships between them. For example, a certain time in video and a sentence in material. Coming together in a graph structure similar to a mind map. (Anthony, Car Engineering/Computer science, group B04, discussion in classroom)*

We have collected new ideas from them for the future designs.

Reflection of designer and developers

Three students from the second and third seminar participated in and observed the appropriation of their group wok. They noted the limitations and reflected on the process.

> *It is extremely interesting to see how others use the platform, we have been missing many perspectives while we were developing. It is more helpful if we could test the design again (re-design from third seminar) with students before we develop it, but do not have the time…And I think the time-bar is*

still a good idea, we should change the design for it… (Jacob, Computer Science, GroupA04/A03, feedback session)

They proposed three aspects of possible new design of the platform:

1. Add support to the background view

The designer who designed the background view addressed the confusions expressed about the background view and asked for more information in order to support users selecting the views.

2. Add more explanatory information for users to guide them in the process.

The system is new for exploring files for many, and some annotations and guideline on designed functions could support the first-time user.

3. Exploring new category of metadata

There should be more opportunity to explore the metadata, for example, adding linkages between files and texts could support students find relevant information on interesting files.

7.7 Feedbacks of Educational Setting

Peer learning is important in interdisciplinary group

Students that come back from previous seminars accumulate experiences in accessing secondary data, and the experiences have been transferred to the new seminar groups. This eventually played a vital role in the learning process in the fourth seminar. The tension of first-time accessing secondary data was alleviated by their assistance, and the responsibility of explanation of the work has mainly been a task of the experienced students. Also, students from different fields teach new software and analytical skills to the group members, and some new students reported that they learned more from their groups than they learned from the seminar classes. In design education, learning outcomes are often associated with environment in which learning takes place rather than the "teachers". The interdisciplinary group provided the nutrients for knowledge exchange, and the tutors could only provide the breeding ground for the peer learning, giving appropriate feedback when students felt it was needed.

The drawback of having experienced students is that they interpreted the goal of the seminar on the basis of their past experience and it sometimes affected the speed and outcomes of the seminar. Group A had 3 past students from the second and third seminars which was oriented to designing for DesignCaser, so that they had a fairly polished idea about redesign of the DesignCaser already. This did not align with the agenda and the pedagogical goal of the seminar, which was predicated on the principle of understand the complexity of the design context before developing design ideas. They ended to push the group towards their established ideas.

Peer learning has been employed by some educators in HCI (Plimmer & Amor, 2006)and it has been proved effective especially in the interdisciplinary groups, our seminar also benefited from it. However, involving experienced students should be planed, firstly, experienced students should be distributed equally to each group otherwise it is not fair to the groups that has less experienced students. Secondly, the disciplinary backgrounds should be considered in the design of groups while distributing the students.

Sense of being lost in design practice

All groups of students experienced the sense of uncertainty, as we reported before, and new students had never experienced similar seminars. Since the design of each seminar is different, the experienced students also cannot foresee the outcomes or even lead the team in an innovative direction. They all felt somewhat lost in the design process because they did not know what result might meet the tutors' expectations.

From the tutor's point of view, since we are experimenting with the possibility that empirical data could be brought to design ideas, we did not have a fixed vision and found it difficult to provide an accurate answer for the students when asked about 'success' parameters.

However, the sense of uncertainty can be alleviated by the confirmation of design ideas and reiterating the experimental attitude. Here, we found the traditional design teaching method--Studio-based design, was suitable in supporting the students to have beneficial communication with the tutors. Confidence tended to increase as we progressed and as the goal of the seminar became clearer over time.

Lack of experience of testing designed artefact

The iterative design approach is emphasised at the theoretical level in the curriculum, but practical application is still lacking (Wesson 2006).

Students from group B04 emphasised their need to learn design knowledge by analysing data from the participatory design workshop and design evaluation sessions. More than 4 students mentioned the requirement for practical testing experience, a) students want to know what feedback they could gain from end-users, b) students who had previous work experience reported that they had never experienced the testing in real situations.

Helpful Online Tools and lack of design learning tool

- Secondary data access – DesignCaser

The designed artefact has proved to be effective. Students from the first seminar reported the usefulness of access to data. Tutors also received zero complaints concerning how to make sense of data structures with the tool. Leaving aside the technical errors and visualization

issues, the technical tool does improve the sense making of secondary data and helped to accelerate the process of utilizing secondary data.

However, the design of DesignCaser is still limited since tends only to be useful in the early stages of accessing data and does not support closer contextual understanding. Eventually, DesignCaser will be merged with the Research-hub creating an ecology for data exchange.

- A centralized shared space -- ResearchHub

Students found it was very easy to communicate and access needed resources in Research-hub. It also functions as a centralized place that supports students when arranging their meetings, writing notes, accessing class records, uploading material for discussion based on it, asking questions and gaining feedback from tutors. All students reported that it was an improvement on the learning platform previously used.

In turn, tutors also found it created an open place for bridging students' needs. There were discussions around their processing tasks, arrangements of classes, announcements and summaries on each meeting. Overall Research Hub infrastructures the education environment by creating a shared virtual place.

- Lacking tools for creative collabration

Students also reported their difficulty in finding the right tool to collaborate on design ideas. The most challenging part is brainstorming where support for sketching and ideation is needed. Our setting does not provide the right tool there as yet.

Submitted documentation – lack of training of documentation

An interesting finding regarding the submitted files was that the fourth seminar submissions were less structured than in other seminars. We did not specifically teach or give strict guidance for self-documenting and submission. Past seminar students confronted more challenges with secondary data and thought that providing more information about documentation might promote awareness of its importance.

Sensible file structure got lost in the fourth seminar, since the students were not handling the un-curated past resources. They did not face the messiness of un-curated data and hence reflected less on this issue. This also points to an issue regarding of lack of training on documentation in the education environment.

7.8 Summary

The fourth seminar followed a similar structure to that of the first seminar, but with the assistance of the designed artefact (DesignCaser) created in previous seminars. The result showed that the students could access the data more easily and that it reduced the time involved in making sense of shared data structures. Students recorded their usage of DesignCaser, reported usability issues, reflected on the provided functions and provided us with suggestions to improve it.

Designers and developers (Akela, Jacob and Jenny) who were also involved in past seminars observed this appropriation of their own design artefact and reflected on the limitation of their design in real use. DesignCaser requires a) deeper understanding of background views and its relation with the data-user, b) explanatory information to guide the data using process, c) and new linkage between files and data providers.

Beside the appropriation of the designed artefact, we have discovered new aspects that were not visible in the previous seminars. In this seminar, we discovered new strategies for data selection and uses. Group B04 selected data only from design phase because it triggered curiosity about how design and co-design has been done in the field. All group students expressed their wish to engage with redesign activities. A lesson from this was that the existing HCI curriculum offered too little in the way of iterative method practice.

The selection of data impacted the choice of design method. People tended to engage with data from the redesign phase (Group A01, A04, B04) and as a result they tended to have similar data analysis outcomes.

Students became more confident and efficient in accessing material of value in this seminar. On the one hand, we relaxed the analysis process and adjusted the group work method based on the experience of the first seminar. On the other hand, we had students who were more experienced in analysing, and hence more skilful. This enabled peer learning, since experienced students supported the novice students to deal with the process of analysing. Secondary empirical data became a useable and useful resource for their design.

The design context changed on this occasion, and all students reported that their unfamiliarity with the machine bending topic created challenges. They could not find similar design contexts elsewhere and struggled to make sense of the production environment. Because of this, we found students' secondary analysis results often overlapped with original researchers' conclusions, and therefore, the design problems they identified were all related to the communication, collaboration and knowledge transfer issues. This unfamiliarity also impacted the creative process (scenario building and prototyping), and all groups created multiple personas to represent the design problems in this complex collaborative production setting. Two groups (A04 and B04) did some redesign.

8 Discussion

Both design research and design education are facing the challenges of documenting and transferring past design knowledge. In the meantime, past design documentation has rarely been shared beyond the local research group, and there is lack of understanding on how past design research documentation can be retrieved and accessed for broader groups.

We shared two sets of design case study documentation with the students from the HCI master program in four design seminars. We were trying to investigate the real uses of secondary research data in the design forming process, and thinking about how to support the access and reuse of it.

- The study has revealed the design process by looking at the analysis results from secondary data.

Firstly, my study illuminates something about the relationship between ethnographic data and design work. There have, over the years, been extensive discussions concerning what that relationship might look like (see e.g., Andy Crabtree, 2003; Dourish, 2006; Dourish & Button, 1998; Hughes et al., 1992; Randall & Rouncefield, 2008) and what kind of claims can reasonably be made for it. Despite some significant divergence, there is general agreement that qualitative data does not come pre-organised for design use and needs somehow to be structured in such a way as to be design relevant. Choices have been roughly characterised firstly as entailing 'over the wall' stances such that designers are simply given material and expected to make of it what they can. Secondly, much has been made of the need for a 'conversation' between designers and ethnographers. Thirdly, it is suggested that designers need to learn the analytic skills which will enable them to interpret ethnographic data. Further, we propose that design education in qualitative methods and their relevance to design is needed. However, the lack of support in helping students to learn how to use such evidence when dealing with complex design problem reflectively restricts progress. The in current curriculum provides no 'hands on' experience of dealing with secondary data.

- And we also reflected the problems and concerns of using secondary data in the design re-using context.

A limited number of cases reporting on real uses of secondary data show ethical concerns(Bishop, 2009), and my study reinforced them. From student feedback and our own reflections, we re-defined the anonymization level, what contextual information was needed and identified necessary boundaries in the design education context. Due to the diversity of design cases and various demands of re-users, we required a higher tolerance and elasticity in making decisions on those issues. Furthermore, data re-users showed the limitations of past resources and of their ability to access them for design ideation. It is in the nature of design that documenting every design decision and transferring it into explicit text is almost impossible. This places limits on interpretability for secondary users.

In the educational context, secondary data accessing become a negotiation around limited resource. Data sharing is time and labour intensive and we noted several demands in supporting this process of re-use.

Problems of language and interdisciplinarity are known problems in open science as well. In my study, those problems were alleviated by the use of technical systems. Currently available translation services proved more or less satisfactory. More important was the problem of communication and collaboration in interdisciplinary teams but we found that ResearchHub supported these endeavours well.

Nevertheless, it was clear that a supportive environment for accessing secondary data and interdisciplinary collaboration that specifically works in the design education context is important. It requires technical support in granting flexible access, detailed guidance, translation and interdisciplinary collaboration for making secondary data accessible, and it also requires an educational setting that supports immediate feedback, the building of knowledge and accelerated peer learning.

- Finally, the experience of our seminars has provided some lessons learned for tutors.

We identified three categories in supporting design learning from secondary design cases, Firstly, the selection of design cases can impact significantly on design outcomes, and tutors

need to make decisions on what they want students to learn and how to select suitable design cases to share on that basis. Secondly, preparing the secondary data requires a careful step-by-step approach. Thirdly, there is a need to connect data provider and data user within an ecological system.

The designed seminar and resulting artefact suggested secondary data as a usable resource requires technical support and reflection on educational strategy. Seminars are limited as a means to explore all the relevant resources, theoretical and practical, and require a balancing of teaching and self-learning. Our exploration of using secondary data as design learning resource is unfinished but, we feel, has made a contribution to our knowledge of design documentation and design knowledge in an educational context.

8.1 Learn Design Case Studies—a Material derived Learning Method

Design research is naturally both practice and research centred, and design knowledge cannot be isolated from social context. Learning experiences are equally an interactive process between the knower, the environment in which knowing occurs and the activity in which the learner practices(J. S. Brown, Collins, & Duguid, 1989). Enabling this realistic learning practice requires an environment that reflects the social context where various factors are seen to be co-constituted and not isolated. The current design curriculum lacks resources for learning design within "real" complex contexts.

There is a gap between theory learning and design practice, and there is a gap between providing resources for iterative learning and the actual business of redesign activity. The design curriculum has invested in *teaching iterative* and *reflective* design thinking, but this has not been fully appropriated in the HCI curriculum.

Our seminar shared the design case studies that were conducted under the framework of Grounded Design. The original design artefacts involved user participation and were tested over the longer term in real settings. Design was conducted reflectively and evolved iteratively. We aim at educating students into a Grounded Design philosophy which informs students in the conduct of design in that manner by using past documented design cases. While the design education curriculum has established courses and methods for creative design learning (Melles et al., 2012), students lack awareness and knowledge to engage with ethnographic data which informs the design context. Our idea of sharing secondary design case data provided our students with access to a complex design context, and allowed them to generate new insights based on past outcomes.

8.1.1 Need of recognition of empirical value in design education

Common beliefs (including many HCI students and researchers) have it that design is more about material building and testing rather than context learning, data analysing and problem

identifying. Those skills have been largely neglected in the design of the skill-set demanded. And skills relating to information architecture, privacy and ethics are considered as only *research-relevant*. Wilcox in his survey of the current design curriculums in HCI has found these are fewer common topics in HCI teaching(Wilcox et al., 2019).

Our students showed less confidence in categorizing themselves as "designers" when they trained. They failed initially to recognise ethnographic knowledge as component part of design learning and had to learn design as a constantly reflective interaction within a social context. This requires trained skills. Our view is that so-called *research-relevant* training has been neglected in the design of the curriculum.

In responding to the call for constructing a multi-disciplinary knowledge foundation for 21 century design education, we suggest a broader definition of design which include that the proposition that empirical skills should be equally emphasised in design curriculums. Providing ethnographic methods training fosters students and designers with confidence in its relevance and drives a deeper understanding of its fundamental role in their design process. The design community, we suggest, should reflect on the requirement of design knowledge for todays' design education, and should contribute to an on-trend, sustainable and relevant design learning environment for interdisciplinary students.

8.1.2 Need for knowledge about engaging with empirical data

Students expected that they were "*supposed*" to be able to comprehend empirical skills without training. Collecting empirical data and making sense in the current design curriculum is ed consider to be innate. However, our seminars revealed that competent data collection and interpretation require teaching and practice. In our seminar, interdisciplinary background students faced considerable challenges when engaging with empirical data, both novice and experienced designers were simply unfamiliar with the nature of qualitative data and had inadequate knowledge of utilizing those resource. That knowledge is not obscure at all, and by the fourth seminar, we found that students had gained enough experience that they were able to handle data in less time and more efficiently. It showed that analysis can be learned with proper guidance. It is a learned skill for design and can be trained efficiently through practice.

There are arguments about comparing primary data with secondary data in real design practice. It can be argued that primary data are more "speaking" and "provoking" to students when it has been collected by themselves, and our own students recognised that secondary data is at best a substitute for self-collected data. But, we argue, students should also be prepared in making sense of data that collected by others. Firstly, because design practitioners have to deal with the data that is collected from group members. For instance, design researchers and practitioners in design projects often face the fact that data is collected by collaborators, and utilising past data can prepare them for team-based design practice in the real world. Secondly, secondary data should not substitute for the empirical experience. Rather, it can play a complementary role in preparing ethnographic skills by developing awareness of how others have worked.

8.1.3 Need of infrastructure design problems under complex context

The problem area is often been neglected in design methodology(Dorst, 1984) and are recognised as "ill-defined" and "wicked"(Cross, 1993). Designers have a degree of freedom, it follows, in how they choose to define a problem. The design problem and how it is constituted needs to be understood as involving a specific professional knowledge(Goel & Pirolli, 1992). Even today, however, too little attention is paid to capturing how design problems were formulated and to supporting the learning of design problems (Sharmin et al., 2009).

We find that secondary data creates a problem space that is "ill-defined" and "wicked", where designers need to deal with real-world existing problems under several constraints using their professional knowledge. Interacting with this created problem space, we found, is beneficial for students.

Firstly, they dealt with the reality of a context that is not same as they imagined (e.g., students had stereotypes of elderly people being inactive, and workers dealing with simple tasks). It expands their vision and understanding of the end-user within a specific environment. Secondly, it provides a resource for explaining their design ideas, and making design decisions understandable at a certain level. They started to become aware of *where* the design idea come from and *which context* under *which constraints* mediates design decision- making. Especially in the groups that performed "redesign", their identified design problems showed a similarity

with those of original design researchers and was based on selected empirical data from design phases.

We argue that learning design is a process of learning how to formulate design problems in complex contexts. Design learning should provide a vehicle where students can explore design relevance in given social contexts.

8.1.4 Need of learn design with iterative and reflective approach

Orlikowski noted that practice is "situated" and is a lens for examining the interaction between humans and technology, and the ongoing practices of interaction impact and shape the existence of technology and its "situated use"(Orlikowski, 2000: p.408). It means the development of technology is a function of human actions and its negotiated uses in social practices over a longer time of period. If we transfer this insight to educating the design of information system, it suggests that students should not interpret design as a simple process of bringing technological solutions to a known design problem, but instead see it as understanding the appropriation of technology-in-use and factoring it into the process of design.

The iterative design approach we have examined is a process of evidence-based reasoning for design practice. Due to the limitation of education settings, students often lack the experience of engaging with design in complex environments which change over time. This core element of iterative design thinking is still missing in socio-technical design learning. The educational setting requires materials to support this method.

In the process of exploring secondary data, students start to gain a comprehensive view on a design case where time plays a role in the process. It demonstrates the need for constantly reflecting on how to conduct design. Because they could access data from different stages of design and observe the consequences of original design decisions and the way they were moderated by feedback, student groups were able to mobilise designs based on those deficiencies. Re-design might not be rare for design in areas like engineering research, where people can learn from problems encountered in the past and develop on that basis. However, it is a new form of learning in the HCI curriculum, and students are currently lacking the benefit that re-design brings to design learning. It promotes the practice of reflective thinking about

the past and fosters students' practice of an iterative approach. And many of our students are becoming more aware of the need for this knowledge in HCI curriculums.

8.2 Problems and Solutions of Learning Design with Secondary Resources

Using past resource, naturally, is not a magic bullet that address all the design learning problems and needs. On the contrary, it creates some problems. and those problems may, or may not, be addressed directly by technical solutions. We present here the discussion that was raised by the data provider (project researchers) before we shared the data with students. 7 issues were discovered there, namely "*Stakeholder Ethics and the Legal View; Pressure to publish Hot data; Data De-contextualization; Unguaranteed Privacy of Anonymized Data; Conduct Responsible Research; Lacking of Incentive; Lack of time".* Many of those issues regarding secondary data sharing are well-discussed in the research context (Corti et al., 2005a; Kelder, 2005; Savage, 2005; Van Den Berg, 2008; Yardley et al., 2014).

Our evolutionary seminar settings are designed in response to issues that are relevant to *real uses* of the empirical secondary resource in the *design education context*, a context that different from the normal secondary use context. and raises some different questions.

8.2.1 Ethical issue of using past qualitative resource

Qualitative empirical data raise concerns of data privacy and sensitivity (Bishop, 2009; Corti, Witzel, & Bishop, 2005b; Tripathy, 2013). We have measures to prevent the participants from being recognized—one of them is anonymization. However, anonymization is not guaranteed and deleting all identifying details risks distorting the information available. Both researcher and students revealed cases of accidentally divulging identification information about the participants. We decided on a compromise which was appropriate for the design education context, without losing too much context information. There has to be a balance. Secondary data has been accused of decontextualization from the original situation (Bengtsson, 2016; Corti et al., 2005a; Van Den Berg, 2008)), although we made considerable effort giving the background knowledge of projects since students are distanced from the research field. No matter how detailed text documents are, there always will be contextual information missing and have a risk of misinterpretation. In response to this issue, we discuss the required contextual information of qualitative secondary data utilised in the design learning context and make suggestions to alleviate this issue in the curation chapter. We also would like to highlight the

particularity of secondary data rather than first-hand material, not trying to substitute for real experience in the field but highlighting the “learning” aspects of secondary data.

There are ethical concerns about the boundaries of sharing as well. Our researchers showed their biggest concerns to be the legality of sharing (Corti, 2000) In which context and under what conditions could qualitative data be shared? Regarding this concern, we suggest this issue requires a prior negotiation between researchers, research partners, end-users (participants), funders, and even policy makers in each research project.

Level of Anonymization

Typical descriptions of anonymization entail removing *"information that breaches the confidentiality of the respondent or any other person or entity"* (UK Data Service, 2002). However, my study shows that anonymization is not a bulletproof means of addressing privacy issues. There is a profound tension between open data policies and the risk of exposure that has yet to be resolved.

In our seminars, shared data were anonymized with at the level of removal of direct identifiers, where the name of participant and region are replaced with pseudonyms. There are higher levels for anonymization with removal of indirect identifiers, removal of some stories and life histories and removing data from the set. The ultimate goal is making data only recognizable for the participant. However, as Rock state, reaching this level is a "large, complex task" (Rock, 2001) Corti et al. (2000: para.22) suggest that the "*appropriate level of anonymization*" depends on individual cases, and in some cases the revealing of name and region is not problematic.

In educational environments, removal all direct identifiers are sufficient. Firstly, because students with proper guidance could avoid data misuses to a greater extent, and it was a good practice for students to learn their responsibility for protecting their participants and protecting their collected data from exposure. Secondly, students could not separate un-anonymised data from the shared set in any case. Therefore, it was not a critical issue and we found in the study that proper guidance and common agreement is more cost effective than large efforts to make the data recognizable only by the participants.

And as many publications have pointed out *"efforts to disguise the identity of informants may also spoil and distort the data"* (Corti et al., 2000: p.83; see also Heaton, 2004; Nespor, 2000; Rock, 2001). This opens the discussion of decontextualization of secondary data, and we discuss this issue in the next paragraphs.

Decontextualization of past resources

Both secondary qualitative and quantitative research suffer from the same issue to an extent, but in the case of qualitative data, social context is critically important and decontextualization has been recognized as the major problem for quantitative research data. There has been strong scepticism directed towards qualitative secondary uses (Murphy & Schlaerth, 2010; Yardley et al., 2014). Bulcaen and Blommaert (1997) discussed why her research is not sharable since elements embodied in data are such that, *"intricate interplay had only gradually become clear to us, and there was no way in which simple things could be said about any of the data samples we had collected"* (p.32).

Decontextualization is the consequences of inefficiency in bringing the richness of original context to re-users. Instead of rejecting the potential of secondary data, a more important question is *what* information is *missing* in the secondary use context, and the relation between text and context. Van den Berg categorised six types of contextual information that are helpful in secondary interview data and points out the measurement of contextualization is dependent on the research goal and type of data. (Van Den Berg, 2008) Those discussions are well-known in the tradition of qualitative data reuse in the research context and not yet well demonstrated in the design context.

- Required contextual information in the design learning context

We suggest that contextual information should be more oriented to design education in the design discourse and less research question-led than Van der Berg has suggested in the research discourse. The contextual information follows the rule of top down and shallow to deep in the design context.

We suggest the overview of the design project, which means the high level of conceptual and abstract information, as the first step in making sense of the secondary data for interdisciplinary

design students. Unlike the researchers that are interested in finding data specific to their fixed research topic, design is more flexible in finding usable materials and searching for a synthesis. Unlike other disciplines, there are tangible outcomes in design projects which offer another aspect to the business of retrieval and may necessitate a more comprehensive view on the shared data.

This does not mean students do not need the subtle information, such as the character of involved actors, research settings, and discursive history of those actors and settings. On the contrary, that background information is key for accessing the value of documentation. When students dive to certain file(s) or topic(s), they are interested in more than design outcomes. The stories behind them and the reasons for them are the real value of design knowledge.

- Interdisciplinary data re-user and secondary contact-list data

Providing such information is a challenge for providers and curators who are not familiar with re-use goals and re-use groups. Even with a fixed group, as with our second project seminar, we could not draw a boundary around what information might be interesting for this shared group. Students have very individual needs in understanding secondary data due to their interdisciplinary backgrounds and the design questions they have. It is impossible to provide detailed contextual information concerning actors (interviewee, interviewer, relevant persons, setting) in advance of knowing the purposes to which it will be put.

Providing contextual information is comparable with what researchers call ‘tacit knowledge’ in Knowledge Management (KW), where actions being taking informally and hard to formalise in documents and made transferrable for others. We borrow the design solution from KM for contextual information here. For example, building the contact list is a common function in many platforms.

- A broader scope of contextual information

Providing such non-explicit information requires an active exchange environment, but nevertheless, as we detected in the seminars of reusers’ and sharers’ behaviours, this is an unrealistic solution since no-one is motivated to do so. It requires students communicating with people they do not know and they feel “burdened” and “shy” if requesting the contextual

information not provided in original documents. Meanwhile, data re-users rarely receive support from data providers for reasons of time and effort. We need to develop another form of sharing that might motivate people and be less demanding on labour.

There is another perspective on contextual information such that we should concentrate on who collected the data and what links the shared material and the topic the re-user is interested in. We do not think the shared secondary data is limited to one single project or person, and we believe there is a broader range of information that could be explored by re-users when they require it. For instance, information from the ongoing research project of data providers, related research projects from other contexts, collaborating companies and related researchers, are also helpful in constructing contextual information.

A space that combines the data provider and sharer and provides a space where re-users can explore relevancies with the combination of information across projects and researchers would be valuable and that is what we trying to build in the Research-Hub system to complete the secondary data life cycle.

- Compare with primary data

Perhaps a more critical question in relation to decontextualization lies in what information is missing in the educational context. People here are maybe interested in comparing secondary data with the first-hand learning experience of ethnography, unlike the research context where secondary data is often used for constructing methods and theories. Existing pedagogical concerns lie in the problem of how “learning by doing” can be done with such secondary data.

From the learned experience of students, we suggest it is not a particular problem. On the contrary, secondary data does not substitute for the data collection experience, but supports learning activities by providing existing instances of shared design cases.

Primary data provides the immersive ethnographic experience that secondary data cannot provide, but secondary data can play a role of preparing students by give qualified instances of design practicing.

Draw a boundary of sharing

It is hard to provide a general structure for the boundaries of secondary research data. It associates with issues of legibility, sense of ownership and disciplinary background etc. When the shared data involves several stakeholders, issues become even more complex. Each stakeholder has their own justified and distinct concerns about data being exposed to larger audiences.

Stakeholders in design projects have different sensitivities to data. Our seminar shared two sets of project data from very distinctive design fields. The aging project brought concerns more about the empirical data that recorded end-user's personal data that included their health measurements and personal life stories. The production engineering project involved more sensitivity from the aspect of protecting proprietary technology. The definition of sensitive data varies across design projects.

The attitude towards sharing is also affected by disciplinary norms and the type of data. The interdisciplinary nature of HCI design means that a common agreement about sharing needs to evolve since, for instance, computer science is more open to sharing code than sociologists are to sharing their empirical data. Sharing data beyond the original group is not yet a common fact in design research. How to manage the sharing activities and draw the boundaries of sharing, therefore, is case by case for each design researcher.

The first step of sharing in design research project is establishing an agreement on future uses of the project data within the local group and with stakeholders. The core is to understand what their concerns might be and propose a solution based on it. Only by doing so can we address later issues to avoid further conflicts.

Simply deleting the sensitive parts of datasets which are not part of the interest of re-users as we did it in the shared second project could cause a deficiency in the delivery of contextual information. Lucky, our students substituted for it by searching other similar public resources. Nevertheless, not all the missing contextual information could be supplemented by public content. We suggest, based on our experience, that if the data is not of major interest to re-user it can be deleted. However, the provider or tutor needs to be aware of the possible uses of alternative resources.

When the information cannot be substituted for by other resources, or the sensitivity is overlapping with the re-users'(students) interests, we suggest other solutions like anonymizing data, signing confidentiality agreements, performing privacy education and setting technical restrictions on sharing etc.

8.2.2 Concerns of using secondary data in design context

Corti, Thompson and Fink (2004)point out very few publications report the practice and applications of secondary qualitative data uses. Available ones point out the *unreliability* (Smith, 2008) and *decontextualization* from a users' perspective. And both problems demanded the re-users apply a critical lens to provided secondary data.

To the best of our knowledge, the real-uses of secondary data have not been reported in the design and design education context, which is an expanding area for empirical data use. The aim of learning design creates a whole new set of concerns than sociology (Corti & Bishop, 2005). In Corti's project, the main critique of students was focused on ethical issues, access and quality of data. Our case reports more concerns with the limitations and the unique demands of users in the design context.

Concerns about created bias

The seminar result shows students have concerns which are centred on representativeness and timeliness of past resources.

Students doubt whether small scale empirical findings from past resources can yield large scale results and serve for long-term uses, and they question how to work with ethnographic data properly in their design practice. Students' concerns came from a realistic standpoint, since the shared design research project has investigated a small group of local seniors and workers, and students understandably are uncertain about how far the results can be generalised to larger contexts. The extracted design findings, from their point of view, could not be claimed as design solutions in a wider context. This was one of the drivers for them to go for broader resources in understanding identified design problems.

From the aspect of pedagogy, students reflectively rethinking the relation between empirical data and design made for a learning outcome itself. It demonstrated to us concerns about the limitations of bringing secondary empirical data to design activity.

Working within ethnographic and design practices is not unproblematic (Dourish, 2006; Randall & Rouncefield, 2008). Many researchers are concerned that HCI oversimplified ethnographic work as "implications for design", and researchers need to work in bringing the gap between the two with acknowledgment of both disciplines as rich, creative and complex. From the view of design, it also involves concerns about the issues in bringing ethnographic work into their design in relation to previous understandings of design object and design problem framing(Crabtree et al., 2009).

Concerns about creativity

Students had never worked with empirical data involving long-term investigation by others, and the seminars we conducted showed us two forms design concept formed from their secondary uses. One is data informed and the other is panmictic. The prior one often exists in the research field where researchers search for the empirical evidence to guide design decisions that are related to the designed features. (eg. Research Informed Design and Evidence-Based Design (Stichler, 2016) Panmictic approaches imply a much more pragmatic, even random, relationship between design and forms of enquiry. The latter is much more common in industry and artistic design fields where quick response when facing user needs without long-term investigation.

Designing based on secondary data allows students to establish design ideas from past outcomes (eg. participatory design feedback and testing data) and they could progress design ideas based on knowledge of some past failure and success. It leads to a paradox in design and creativity, which has to do with the role of data and its retrieval. This contingent relationship reminds us of the two models of creative work: rationalism and romanticism (Williams & Askland, 2010). There is no doubt that design originates in real ways from creativity, and some researchers claim creativity can be taught. This raises questions concerning how free from real world constraint creativity can be, and what the limits of innovation and novelty might be.

- Originality of design problem and design concept

Some students expressed their concern about the issue of the novelty of design. The mysterious character of creativity implies something "new". Dorst and Cross (2001: p425-437) in their design studies, identified "the aspect of creativity in design related to the formulation of design problem and to the concept of originality". Since our students extracted their design insights from empirical data that others collected, it reduced, in their eyes, the degree of creativity in their work, especially where similar design problem as original researchers were identified (A01, A04, B04) and redesign was limited, based on the original designed artefact (A01, B04). Therefore, it is understandable that students missed the sense of creation and had no sense of surprise.

- Evaluate creativity in design education

Students unconsciously connected their novelty concerns with their design assessment. Blurry definitions of design make it harder to identify what design is "good" or not, and it leads to certain confusion in self-assessment (Rayment, 2007).

Creativity been recognized as desired and is normally a criterion for final evaluation in design courses. Then the question is, does the design education process teach creativity and how to evaluate creativity in designs?

Firstly, we need clarify that creativity is not promised in every design activity, but we consider students are still creative even when they frame similar design problems and build-up concepts on past outcomes. They employed unconsidered data into the design process, connected it with their own interpretation and experience and employed new ideas to address the design problem. As Dorst said, the creative character can be found in every design (Dorst and Cross, 2001).

Secondly, creativity as a romantic notion in design is hard to define. Therefore, it is hard to be evaluated from any explicit standpoint As Williams point out, there is "*a paradox implicit in current educational practices*". (Williams and Askland, 2010)

Therefore, in the context of using past resources for informing new designs, not all design should be evaluated as bad design if it is not creative from the aspect of originality. The

redesigns based on past outcomes could be evaluated from the view of reflection, the in-depth reflection on user needs, levels of connection with personal experience and outside resources, and liberal thinking on design solutions based on new synthetic reflections. The key is not fall into the extremes of presuming novelty and originality without considering local context or of presuming every feature needs to be evidence based.

- Directional secondary data

Normally, students carry their design project from the start and are involved in the design problem formulation process. Secondary data gives them another opportunity to start based on some previously collected materials and outcomes. We found secondary empirical data tends to direct towards certain outcomes and we observed that highly similar themes and design problems had been identified from 2 groups of students.

Since materials are collected by design researchers with intentions, students could be unconsciously led to those intentions and thus miss other potential aspects in the design context. Whether this matter or not depends on one's view of the goals of the course. If design outcomes are the parameter, then it arguably does. If knowledge of the uses of secondary data is the primary outcome, then arguably it does not. In the latter instance, though, a limited number of cases restricted the possibility of broader comparative work and access to more fieldwork resources might make for richer results. Hopefully over time, a corpus of studies will develop which will provide richer resources for innovative thinking.

- Excessive empathy with design objects

One the one hand, we consider it is a success in our seminar that shared secondary materials can support students in learning design within a realistic setting. It helped students reflect on the specific context and built empathies with their users. Students in seminars showed a deep empathy for their design target group through the data familiarity process and it does build a channel for a new standpoint on end-user experience.

On the other hand, design is a creative activity. Sometimes, excess empathy is considered harmful since designers arguably need to be distanced from their design object in order to have an open mindset. As we observed, two ways of using data to form their ideas demonstrated

how some groups of students intentionally distanced themselves from the provided context and searched instead for inspiration from other resources. Secondary data only provides an initial focus on the design space for those who want to design for a broader context.

Deficiency of Documenting Design

There are researchers proposing to build documentation of design knowledge (Koskinen, Binder, & Redström, 2008; Zimmerman et al., 2010). In their view, documentation of design could support design researchers in generating design knowledge and forming academic methods.

- Specification of design data – beyond Quantitative and Qualitative

We already know from available research that design decision making is individual and complex, many design initiatives are not documented since creation itself is mysterious process (e.g. Jones et al., 1970; Sternberg, 2006; Wong & Radcliffe, 2000). In the second seminar, the design data was purposefully constructed and documented in a regular repository for design users and for a defined purpose. It was accessible for all players involved in the design process, but students in the third semester were still not able to fully understand the embedded concepts. Beside the problem of the different educational background of students, the specification of design data was also a factor.

Design data contains varies forms. Normally we consider that visual methods (pictures, sketching and prototypes etc.) are easily understandable for people across disciplines, gender and age. Nevertheless, they arguably fail to communicate the process involved and reasons for primary design decisions in-depth. Text reports or slides allow others to understand their initiative better but are still not adequate for grounding information about reasons for design decisions. For instance, some design decisions were taken for granted in the second seminar among the designers and only active engagement with original designers in the third seminar revealed more about rationale.

- What is missing in design documentation?

There are two kinds of data involved in using secondary empirical data for design purposes. Some data is explicitly design related and normally triggers design decisions. Those data are often quoted when designers represent their ideas, and thus we can trace it very easily.

However, a significant amount of data is 'background' and hence any effect on decisions often gets lost in the transfer process. Our practice in design seminars helped us in partly understanding the uses of information by comparing their secondary analysis with their creative work (see figure 4). We were able to trace, in this manner, how ethnographic data affected their design decisions and helped the design documentation process. This kind of information is often otherwise missing in design documentation.

- Move beyond original set

It is impossible to recreate design experience for re-users, and we need to admit that some devaluation of design data is inevitable in the process of transferring. The information that been recorded was original to the creator. Secondary data has it is own specification and holds new opportunities for creation. We often found that ambiguity is important for creative design. Our students from the third seminar have showed that students use new designs to address the absent information and developed new ideas to address the same design problem.

8.2.3 Balancing limited resources with learning experience

We have discussed issues from the data provider and data re-user's perspective, and in this section, we mainly discuss the issue of secondary data in the education context for tutors/teachers. We treat the seminar as a design project: the educational setting is constantly changing according to the needs of design tasks, and critiques and suggestions students made over time.

As the designer of the seminars, the most challenging part for us was "balancing" the limited resources with maximal learning experience. Tutors in design play a relatively even role due to the co-evolving nature of design in HCI settings, and they can be viewed as more like a facilitator of the task environment and advisor in the performance of design tasks. The main obstacle to designing the seminar lies in the lack of a proper learning environment, time and human resources, and inconsistent disciplinary background and levels of design knowledge.

Restraints in original education setting

The e-learning tool that is provided in the university was only used for sharing teaching materials in our seminar. Other required functions are not provided there or are hard to use (e.g., update information and release announcements). Therefore, we have applied several technical platforms to satisfy our needs for archiving, sharing, communication and managing tasks. However, use is scattered and none of them are designed for pedagogical purposes. Communication outside classroom was lacking and it was difficult to track students' design work.

We later addressed those issues by employing a self-maintained and customizable platform that was employed in our research environment. This platform (ResearchHub) provides a centralized place for storing data, sharing pieces of information, communicating with tutors and across groups in a public space and collaborating with groupmates in a self-managed private space. However, there are still limitations to this platform in providing all the needed functions for students' seminar work. (e.g, instant message and brainstorming collaboration)

Furthermore, our designed seminar was also limited in bringing self-learning activities. Students are still lacking skills and technical support to access secondary data and utilized it independently in their design projects. Fostering this kind of learning requires more guidance of making sense of and making use of secondary data. Making sense of secondary data could be addressed by technical support curation and connecting resources with data providers. And making use of data requires training in making sense of ethnography data and connecting it with design knowledge.

Lack of time resource

Firstly, time is a scare resource and we are searching for the solution to progress this issue in each seminar. However, handling secondary property and arranging design tasks within a given timeframe is challenging. We identified the following issues as to why and what is consuming our time resources and how to better manage those problems.

- Working with a fixed timeframe

After holidays, each semester lasted about 12 to 14 weeks. There are necessary steps to using secondary data for design learning with interdisciplinary backgrounded students and tutors struggled to squeeze in all the tasks into this fixed timeframe.

All seminar students reported that they felt being rushed to finish the tasks with a strict timeline and being restricted in finishing with their own design. Some students felt they hadn't learned the principles of Grounded Design properly because they have not tested the designed artefact with the target users, so the design cycle is incomplete.

- The lack of experience in handling secondary data

Curating secondary data requires patience and experience. Secondary data use is differentiated from primary data, and students lacked the experience and skills in making use of those data and it affected their time management. The skills needed to manage tasks are significant, so that students have to learn how to make sense and use resources which they did not participate in originally, a skill required commonly in situations of real design project collaboration. Our experienced students demonstrated that making sense of secondary data and learning about analysis methods is a learnable skill, and they shortened time taken in analysing the secondary data and felt much more confident and comfortable the second time around.

The two factors demonstrated above indicate our struggles in the design seminar. A better solution we could think of is prolongating the length of seminar into two semesters, then students could concentrate on learning skills and collecting experience of sense-making of design research data and analysis of past resources alone in one semester, and the design activity of prototyping and testing activities in another. It would relieve the time pressure and give a more complete experience of design with testing.

8.2.4 Barriers for learning from past resources

Language barrier

The language issue can hardly be overcome since language is closely tied with social realities. Language translation has been reported as significant in cross-culture studies and it indicates that translators be seen as a co-producer of research findings (Simon 2003; Temple, Edwards, and Alexander 2006). Simon underlines that translation is a cultural intervention and Temple identified a similar characteristic between cross-cultural studies and secondary data usage, which is the recreation of original data.

Manual translation is extremely costly, with limited resource in hand, and we addressed this barrier by using mixed methods, machine translation tools (e.g., Google Translation, DeepL, Microsoft translation), peer support (German speaker) and tutor support (manual translation). The translating software gave the most support in our seminars, with many issues remaining. Besides the poorly expressed meaning and disordered sentences resulting from using translation tools, there are issues of the localization of language and culture gaps. Defective information led to the issue of whether "real" contextual information had been obtained, which could problematise the nature qualitative research conduct. The core debate here is whether students are able to take their interpretation of shared ethnographic data as a valid resource and translate it into design insights. While language translation plays a cultural role and is vital in cross-cultural ethnographic studies, it might be used and treated differently in design education. Our students suggest that although it was sometimes troubling to make sense of specific sentences by using machine translation tools, it is not crucial for students when extracting the backbone information that they use to form their design problem and ideas.

And it is not just international students that have issues of language, German-speaking students felt a similar constraint in understanding sentences due to the missing contextual information and mistakes in transcription. Some researcher report issues of translation are relevant also in translating ethnography to design (Alexander, 2003)b(Crabtree et al. 2009). And this goes back to the discussion of translating ethnographic data to design which we discussed previously. There is both a knowledge and technical support system gap in making ethnographic data a re-useable resource in the design context.

Interdisciplinarity barrier

I detected an interdisciplinary barrier in HCI-related research projects during our empirical work with researchers and students. People from different disciplinary backgrounds can have distinct views about data and distinct ways of talking about it, making interdisciplinary sharing and collaboration problematic. As we demonstrated in the first section of the chapter, working with data that is collected by interdisciplinary researchers who have a different purpose in mind is not unproblematic. Working with people with backgrounds in different disciplines promotes knowledge breadth by learning from each other, but creates inevitable frictions.

Obviously, it is important to establish a common understanding and tolerance of different human mind-sets in the learning environment, and learning how to collaborate within an interdisciplinary group is a core for HCI higher education. It is not easy at all when the clash of thought happens outside the classroom. One of the students from group B01 dropped-out due to the fact that her group-mates from other learning backgrounds dogmatically applied an analysis method (content analysis) that differed from her method (thematic analysis) and refuse to negotiate with her. Created friction sometimes requires an early involvement of tutors; students need to be supported when collaboration starts affecting their voice in the team. At the same time, there are groups which benefited from the diversity through peer learning, where the students learned new skills through communication. Interdisciplinary collaboration creates challenges for students in bringing their own views of accessing secondary data into the design process, and we addressed this issue from three aspects.

The first method is through infrastructure: a technological communications space (ResearchHub) with spaces both inside and outside the working group, so that the students could create their own communication space and share their discussions in the platform based on their needs, and quickly make requirements known to tutors and other groups when they needed extra help or suggestions.

The second method is establishing a common understanding in the beginning of the seminar. One part of this is building a knowledge foundation at the methodological level, making all needed materials available and making expectation of learning outcomes explicit. The other part is establishing a set of transparent evaluation mechanisms for their performance,

evaluation mechanisms which include participation in group discussions, contribution to teamwork, presentation involvement and final evaluation of other group members.

The third method, but not the least, is fostering a peer learning mechanism that encourages the students to share their skills and experiences. There is a large space for students working in divergent ways. This mechanism needs to be taken as a primary organizing issue for tutors, recognising levels of experience and expertise, interdisciplinary comprehension and even cultural difference and spoken language need to be considered while grouping students. Promoting diversity in groups could support learning in interdisciplinary collaboration.

8.3 Designing Design Seminar of using Secondary Data

The work I have described in my study had a specific purpose: to examine the usefulness of existing datasets for design education. The study was undertaken because students had very little experience of what a dataset looks like and, as facilitators, we had relatively little experience of what the examination of data looks like from a student's point of view. We complement these insights through the examination of the challenges faced and the lessons learned by all parties to those seminars.

The seminar is a co-learning process because students provided many valuable contributions from their points of view. We learned what data is interesting for design learning, what affects students in making use of data, and how data can be processed and redemonstrated for them. We summarised the lessons learned from the experience and feedback and made suggestions on how to make secondary resources accessible from the design education viewpoint in steps.

8.3.1 Select design research projects

I shared 2 existing design research repositories, and discovered some factors that are more relevant in the design educational context. Secondary data in the design (HCI related design) context is more complex and contains more varied forms when compared with the other disciplines since it involves disciplinary knowledge in interdisciplinary collaborations. Therefore, we listed some relevant aspects on selecting a design project for secondary-data-based design.

Quantity of project data

Quantity of the dataset is critical from the aspect of preparing secondary data, considerable investment has to be done in making the data accessible and the work is challenging. However, the quantity dos not make a notable difference from the students' point of view once they have been introduced to the project and guided through the data structure.

Both shared secondary design research projects had some strategy in organizing their repository. Project A has a bigger research team and scheme which lead to larger documentation. However, both projects required equal effort for guiding students through and supporting them in making sense of it. In all groups, students could only utilize a small

proportion of the research data and it requires a considerable amount of "background knowledge" and explanatory guidance to be able to make sense of given material in the first place, regardless the quantity of material in the dataset. Therefore, we are not convinced the quantity of data plays a decisive role in the selecting of projects for educational uses if the needed explanatory guidance and backgrounded knowledge is adequate. The quantity is more relevant for the curator (tutors) since they need to spend time in preparing the materials for the students.

Rawness of data

All group of students jump immediately to empirical data that contains the most condensed information about design subjects, and interviews from "pre-study" were most welcomed. They carried least in the way of 'editing'. In the early phrase of design, students tended to collect as much as they could get from the shared data.

The rawness of data also refers to the *narrativity* of given data, and the more details and stories the data contains, the more attractive and useful for the students.

And the extraction of context is also critical for the students in capturing an overview and detecting problems. Students tend to search the data which has a more comprehensive and reflective view of the design context (e.g., the interview of the manager in PB and interview of insurance companies in PA)

In other words, the richness of information contained in documentation could stimulate the interest of design students and the sharing of design projects should retain the rawness and richness of data.

Familiarities of design context and topic

Level of familiarity with design topics decided the level of dependency on provided secondary data. I noted that not all of the secondary data had been (directly or indirectly) transferred to design insights. Other materials play a role in the design ideation process. This process is extremely complex and does not represent a linear progression from data to solution. More than one solution remains possible. We are not able to trace all influential factors in design

decisions. However, when we compare analysis results from the secondary data and retrieve the reasoning students apply, we can discern a connection.

The two shared design cases demanded two levels of contextual knowledge. Students from the second projects did less exploration outside the repository due to the limited available resources online, and discovered their design problem specification in collaboration and through knowledge transferring. It brought both drawbacks and advantages.

The drawback is that resulting design problem specifications can be very similar due to the narrow vision that a single project can provide. It requires broader design cases that could provide the same or similar design contexts. Then students could gain a broader insight int unfamiliar topics and build novel design insights.

The advantage of providing unfamiliar design cases is that it prepares students to deal with unfamiliar contexts. In reality, designers have to deal with problems in various contexts that they may not be familiar with, and they need to make use of ethnographic and other data and learn how to access those data from different resources. The seminar trained students in this perspective.

8.3.2 Suggest curation steps for preparing secondary data for design education

Although our seminar applied secondary design research data, we have not established a norm for documenting design cases and we and the students lacked the technology support to do so, since design process involved multidisciplinary skills and are often proprietary. The lessons we learned emphasise the need for data curation from the first seminar, which is no surprise at all. Nevertheless, there were particular and distinct problems of curation in this instance. It became increasingly clear to us that we had not taken the problem of data curation seriously enough.

Data curation is, of course, a well-known, if unresolved, problem in the Open Science literature (see e.g. Lord et al., 2004; Ogburn, 2010). The data Curation Lifecycle Model been proposed for helping the organizations to manage their data in the research context (Higgins, 2008). The tutors in this instance had done a considerable amount of work in the first instance but it became evident that curating the data for the students needed to be an ongoing process. By observing

the whole process of the students reusing data for their designs, we reflected, together with them, on *how to best do that.* Preparing data for use in design learning involves taking particular steps. Figure 13 summarises the steps observed in this study. Notably, students have to be helped to understand documented data and how it might be reused in design practice. This is redolent of notions of sheer curation – see e.g. (Hedges & Blanke, 2013; Macdonald & Martinez-Uribe, 2010) – which entails the recognition that digital curation activities have to be integrated into the workflow of researchers, or in this case students. This is something that can be seen to resonate throughout the other lessons learned.

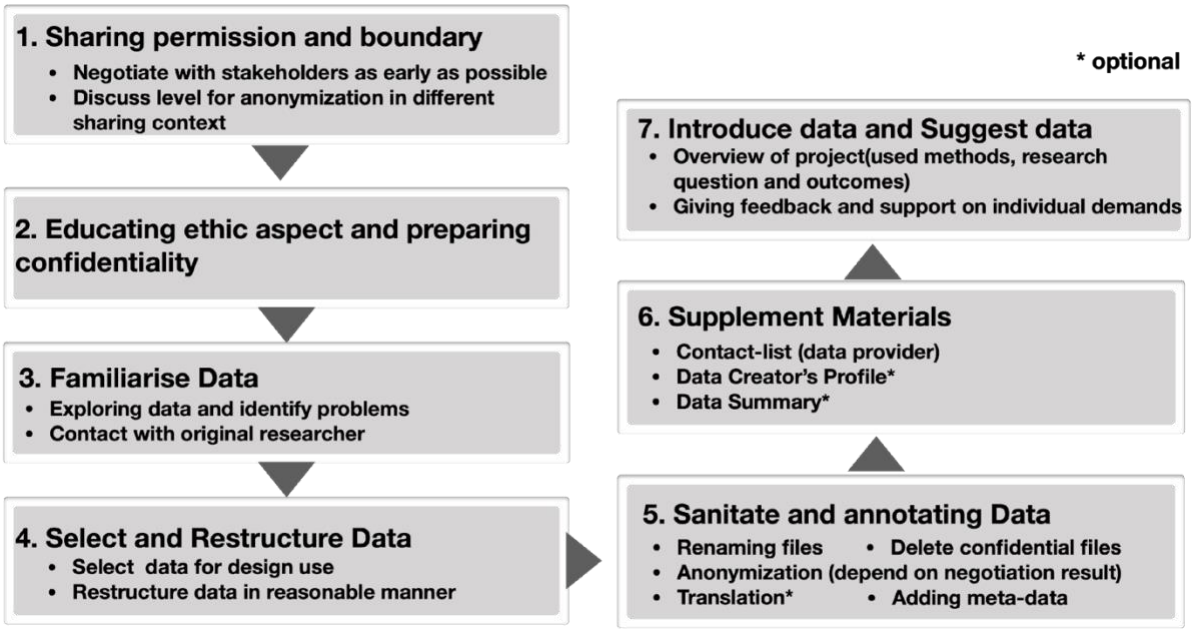

Figure 22 Curation steps in design education context

Negotiating sharing boundary with stakeholders

The first issue is clarifying what rights of access can be allocated. Existing research comes circumscribed with various restrictions, for reasons of privacy etc., and access needs to be carefully negotiated. And we suggest that the earlier negotiations take place, more easily processes are shared afterwards. Funding agencies have started to promote sharing by requiring a sharing agenda in the application stage, but it has not yet considered teaching and learning purpose as a special case. And in fact, sharing in the education context is different from the research context and sometimes less sensitive for data providers. We suggest that sharing for

education purpose should be re-considered as a case for discussion on issues such as level of anonymization to avoid unnecessary decontextualization.

Educating ethic aspect and preparing confidentiality

The process of preparing data for students was considered o be a learning process for us. in our seminar. Despite some mistakes we made, it did t train them from an early stage in a perspective of protecting design users and aligned them to the protection of the empirical resources. Students need to be made fully aware of their responsibilities in this regard, especially in relation to end-users and the possible consequences of sharing sensitive data with others. This has to be negotiated with data providers and, ideally, involves discussion of what information, or metadata, might help outsiders make sense of what is available. In our case, we offered a number of guarantees that were deemed satisfactory, but clearly such guarantees cannot be generic and have to be established according to the case.

Familiarising oneself with the data

Familiarising oneself with data can seem a trivial proposition but, in this case, it was not. The original dataset was very large and had, in some way, to be given an initial structure. This involved some delicate decision-making insofar as part of the lesson to be learned had to do with deciding on the relevance or otherwise of the data in question. However, the dataset needs to be manageable as well. We did not provide suggestions as to what students might consider for selection and analysis with the consequence that they tended to gravitate towards material that looked familiar and ignored material that had a more 'methodological' flavour. Thus, materials described as Usability Tests, Participatory Design Workshops, Cognitive Modelling, etc., were largely overlooked and, without tutor intervention, students were slow to determine their possible relevance.

Selecting and restructuring data

The groups clearly experienced a form of data overload. We asked students to reflect back on the usefulness of different kinds of data provided for design use and they suggested that qualitative data from the early phase of a pre-study was the most valuable. The reason for this is that initial data collection tends to produce more 'open' data, amenable to a variety of uses. In terms of acquiring contextual data concerning practice, students were more or less

unanimous that the interview data collected during this phase was the most useful. Data from later design phases was seen as being primarily useful for identifying what had not worked, so as to avoid pitfalls. The students suggested there were two kinds of data: one kind that can be transformed into an explicit design idea; another that can provide descriptive contexts. They felt that it would be useful to have the data pre-tagged to reflect this difference.

This implies a curatorial responsibility for finding a way to represent data in a dynamic fashion that can reflect evolving learning needs. There are various ways in which this might be done, including representing the data in a way that directly reflects the timelines of a project, as the timeline quite closely correlates with the stages of the methodology being learned. Data could also be presented in a hierarchical manner, with qualitative data being displayed at the top-level; descriptive data such as work packages, project presentations etc. at the middle-level; and other less relevant data at the bottom. Other ways are doubtless possible but key, in all cases, is a need for accurate metadata, where the technology comes into play an important role.

In our case, two groups of students from the second seminar reflected on their needs as the re-user for design learning purposes. We observed the method is vital for students making sense of the data and both groups applied a design methodological framework (3 steps of Grounded Design Case Study) as the appropriate method to represent the shared dataset.

Sanitising and annotating data

We suggest some key points we derived from the data preparation and the findings of our seminars.

- Deleting confidential materials

Shared data of Cyberrüsten is more prepared than iStopfalls since the tutor owns the property and was better prepared for sharing because negotiation with stakeholders' prior relationships. Beside the ethical issues, this established a clear boundary of *what can be shared.* And this boundary can clearly inform the curator (in our case the tutor) while conducting the curation process.

- Naming with established norm

To avoid the confusion that occurred when searching and sorting the data, it is clear that file naming is critical. In our design seminar, group B02 designed fixed steps for uploading files by borrowing the concept from the existing works, including examining the name and the description of files. Reflecting the interdisciplinary nature of design research projects, extra attention should be paid in the contextual abbreviations and professional terms which often go into file names. Students envisioned a name regulation on our system and a dictionary-like guide, which could supplement the sense-making process of interrogating secondary data structures.

- Anonymization

Anonymization is a *large, complex task* (Rock, 2001) and we detected some failures of anonymization in both projects in our seminars. We are not sure, as with many other researchers (Thomson et al., 2005), if we can always meet the anonymization standard, since there are open questions of *What is enough anonymization* (Nespor, 2000; Thomson et al., 2005).

Reflecting back on the past experience of secondary data anonymization, the degree of anonymization in learning environment was sufficient, in our view, even where there were reported failed cases. And we suggest, the contractual basis of confidentiality forms and education in data protection is more valuable than replacing the real identities.

- Meta-data

Meta-data summarises basic information about data. It has been widely used in Data Management Systems for finding and using past data sets and it exists for adding value to other information, but does not stand for value in itself. It could be applied in any form, and aligns with the purpose of reusing in ways that makes metadata meaningful. In the design education context, metadata plays a vital role for students to help them select the needed materials that serve for their own design questions. They suggested the abstract description on design outcomes is the most useful information of our system and it helped them to quickly making sense of data and identify the needed data.

After appropriating our artefact, they suggested adding more linkages between file and file, between file and texts like those Wiki provides, in order to provide a network of related information.

Supplementing materials

The original documentation, it turned out, was not enough. Extra materials are needed to render the data more intelligible. Such materials might include: a contact list (where appropriate); profiles of the data originators; an introduction to the nature of the data structures; a catalogue of the data content; and short descriptions of interview content through extracted metadata. And re-users recommend the combining of extra material resources when data is insufficient in giving needed content, as students did in our seminars, such as asking help of friends, searching in Facebook, Wiki, YouTube and News etc. to gain a comprehensive view on the design context.

And we are also aware that the students are curious about the real field. We propose, students can gain indirect contact with participants (end-users) from the past project with the assistance of original researchers. Mediated access to the data might enable students to collect related empirical data, and this channel may open another resource for design education. Our DesignCaser will be taking this element into our next design steps.

Introduce and Suggestion on data

Preparing data has been seen as a process of data curation. In our context, there are high demands on introducing and making suggestions for accessing the secondary data, curation needs to be a continuing and ongoing service also in the using process. Unlike the research context, students need support in building a foundation for access to shared data. It includes naming resources in relation to the *applied research method*, *research and design question, final research outcomes and design outcomes*.

We need to support students in the selection and reusing process as well. Curating appropriate data for students is an ongoing process. Students keep searching for data that more representative and comprehensive on design context and come back and forth to the empirical data. We observed the vulnerability of students' design learning processes, especially students engaged with an experimental teaching scheme. The openness of the exploring process led to

a sense of being lost in understanding the expectations of the seminar. Communication support is extremely important for students in their reuse activities, and tutors need to track the progress and actively engage with discussions and making suggestions.

8.3.3 Design implications for using secondary data in design education

There is a technological demand for a system that supports secondary data in a design learning environment; the current knowledge management system does not support the students/designers in exploring the past resources in the early design stage. And there is no research e-learning tool exploring this topic. We suggest some design requirements and solutions for building such a tool for this topic.

Allow exploring secondary data from various dimensions

Currently available file explorer technology does not support data sorting with students' needs in mind. Our students showed a strong need, while exploring new data and searching, for a certain logical guide through the visualization of file structures.

The design ideas of seminar students suggested 3 dimensions to explore the secondary research data, namely methodology, disciplinary background and level of detail. Each dimension might provide a linkage between data and re-users, and thus, supporting them in making sense of the project data more easily. The DesignCaser that was designed and developed by the students has shown the effectiveness of representing the project data by make it accessible for the fourth seminar students.

However, there was also a debate about curating data from each background view in the fourth seminar. It requires studies to have a better understanding of users' disciplinary interest in files and also requires large resources to curate for each view. An automatic detecting system of interest on data is a necessity for bridging the disciplinary background views.

A methodological structure has been recognized as the most effective approach for exploring the design case and also fostering the students in learning the Grounded Design method. The researchers also intended to structure their data in this way. With a short introduction on the method, students are able to identify their requirements in the data base (e.g., search open design problem in pre-study or redesign on specific design problems).

The level of detail (iceberg concept of Group A02) also helped students in making sense of the project data from the top down, and supports them in finding the topic of relevance and diving

deep into it more quickly. The limitation of the method also depends very much on the effort of organizing and linking files from the curation work.

Building an ecological system for secondary design data sharing and learning

We also identified a strong demand for establishing connections with the data provider. It is not surprising since data are not self-explanatory sometimes. It can be addressed partly by the extra information provided in metadata. We founded our provided meta-data only to support certain superficial understanding and there is more contextual information available, depending on individuals' design question and goals. Our DesignCaser needs to dive deep into building a relationship between researchers (data provider) and students (data re-user) and providing the needed contextual information related to individual needs.

Our seminar warned us about the passivity in data uses process, and students had concerns about requiring the information and researchers lack time and incentives to respond to contextual information requests. We drew an idea in the "A broader scope of contextual information" in 8.2.1 section, describing the possible materials for students to explore in ResearchHub. There is extensive information that the research management system could provide: the secondary data which can be connected with researchers where they share their research activities, and it might extend to their research interests, related projects and related researchers.

Beside the linkage between the two roles in secondary data using, secondary data needs to provide links to the foundational knowledge since design nowadays tackles all aspects of a problem from different perspectives. Giving a unified knowledge foundation could accelerate the process of understanding with given data, for instance, the link of explaining what a Prax-lab is in the first shared project and what a bending machine is in second shared project.

But it is obvious that links cannot address all the individual needs on contextual information, people have limits when exploring information. A mediating person (like tutors in seminars) is the most feasible and effective solution for accessing the past design case documentation, and the seminar is just one way of fostering the sense making of secondary data.

Limitation of My study

My study grew with a specific focus on sharing research assets, and it drives us in finding initial problems and solutions, addressing the conflict between sharing and re-using. We brought students together to think about the design solutions for making secondary data an accessible learning resource. We have shared two sets of project data within four seminars, and we found that many formats of secondary data, aside from empirical data, are still unexplored. We have not yet examined what the potential use of those data might be. And we are still lacking opportunities to explore on a broader design scale. We require more cases to realise the potential of secondary data reuse in an educational environment.

Limitation on investigated data formats

Seminars have been very open in the selection of materials but, nevertheless, all groups of students finally selected empirical data for their design project, which is understandable from a user-centric point of view. But many other data have been neglected. Tutors as a group of data providers believe there is more potential in other materials, for instance, the 'deliverable' basically provided a full-scale view on the research project which could be a good resource for identifying design opportunities, the visual files could be reused in the Group B04's design prototyping process and the quantitative data that was collected from collaborating research institutes etc. There are data formats still awaiting further discoveries.

Lacking on self-learning environments

We have not yet expanded the learning context for secondary data. The fourth seminar was designed for a more open learning environment by providing the opportunity to involve secondary data from other design projects but the opportunity for students to do so remained very limited.

Further, the students were relying on the support that we provided in the seminar and we do not know how to support the accessibility of material in a self-learning environment. There is a technical design gap in providing an independent functional system and testing its feasibility in that environment.

9 Conclusion

Within the new design era, design becomes a more integrated subject that allows the assembly of knowledge in broader disciplinary contexts, causing design knowledge integration to spike as never before. Constantly new methods and theories from various disciplines brings both opportunities and challenges for design and design education (Meyer and Norman 2020). Better preparing the students, a group also becoming more varied in terms of disciplinary origins, for the future design context is a current and pressing task for educators. Meanwhile, the design research context is also facing challenges in making design knowledge transferable. We shared two sets of design project documentation within the education context for the first time and developed four design seminars with the students. Those seminars have provided a new lens for looking at issues of teaching interdisciplinary knowledge in design education and for examining issues about retrieving and accessing secondary data in the design context.

We constantly received feedback from students in each seminar, reflected on their needs and problems and with them designed a supportive environment for them to learn Grounded Design with secondary data. In involving students in the design and development process of making secondary data available for future seminar students we gained a great deal of information about the design of technical support in the design context with the students.

There were two design results from the two parallel design activities described above.

a) A structured design seminar for utilizing secondary data for higher level of design education.

We aimed at examining the usefulness of secondary data in the design education setting, since the HCI students never previously had the chance to engage with past internal research resources. It presents us with what secondary data reuse can offer and has actually been beneficial for better understanding design learning and what problems hindered students' learning experience. Based on this, action has been taken to address the problems and utilise accumulated experiences in the seminar setting.

b) A designed technical assistant for students in utilizing secondary data for design learning.

Problems of accessing secondary data for the design education context indicated a requirement for technical support. A special design activity was developed, using students as a model for design practitioners. The design object group participated in students' design activities and developed an artefact for future students to use when accessing the secondary data and we appropriated and evaluated it in the last seminar. Feedback about the design artefact and suggestions gained there gave us a more explicit picture of how to make secondary data available in design education. We ultimately designed a complete circle for fostering sharing and reusing activity in one platform.

10 References

Ackerman, M. S., & McDonald, D. W. (1996). Answer Garden 2: Merging organizational memory with collaborative help. *Proceedings of the ACM Conference on Computer Supported Cooperative Work*, 97–105. Retrieved from http://www.ics.uci.edu/CORPS/ackerman,html

Alexander, I. (2003). Designing Collaborative Systems. A Practical Guide to Ethnography. *European Journal of Information Systems*, *12*(3), 247–248. https://doi.org/10.1057/palgrave.ejis.3000469

Ameta, D., Tiwari, S., & Singh, P. (2020). *A Preliminary Study on Case-Based Learning Teaching Pedagogy: Scope in SE Education*. https://doi.org/10.1145/3385032.3385045

Arzberger, P., Schroeder, P., Beaulieu, A., Bowker, G., Casey, K., Laaksonen, L., … Wouters, P. (2004). Promoting Access to Public Research Data for Scientific, Economic, and Social Development. *Data Science Journal*, *3*, 135–152. https://doi.org/10.2481/dsj.3.135

Barab, S., & Squire, K. (2004). Design-Based Research: Putting a Stake in the Ground. *Journal of the Learning Sciences*, *13*(1), 1–14. https://doi.org/10.1207/s15327809jls1301_1

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open*, *2*, 8–14. https://doi.org/10.1016/j.npls.2016.01.001

Bishop, L. (2009). Ethical sharing and reuse of qualitative data. *Australian Journal of Social Issues*, *44*(3), 255–272. https://doi.org/10.1002/j.1839-4655.2009.tb00145.x

Blandford, A. (2013). Semi-structured qualitative studies | The Encyclopedia of Human-Computer Interaction, 2nd Ed. *Intraction Design Foundation*, 36. Retrieved from https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/semi-structured-qualitative-studies

Blessing, L. T. M., & Chakrabarti, A. (2009). DRM: A Design Reseach Methodology. In *DRM, a Design Research Methodology* (pp. 13–42). https://doi.org/10.1007/978-1-84882-587-

1_2

Blevis, E., Lim, Y. K., & Stolterman, E. (2006). Regarding Software as a Material of Design. In *Design Research Society. International Conference in Lisbon. IADE* (Vol. 1).

Borgman, C. L. (2012, June 1). The conundrum of sharing research data. *Journal of the American Society for Information Science and Technology*, Vol. 63, pp. 1059–1078. https://doi.org/10.1002/asi.22634

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brockman, J. (1996). Third Culture: Beyond the Scientific Revolution. In *Amer. Zool.* (Vol. 36). https://doi.org/10.1093/icb/36.1.36

Brown, A., & Campione, J. (1994). *Guided discovery in a community of learners.* Retrieved from https://psycnet.apa.org/record/1994-98346-008

Brown, A. L. (1992). Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings. *Journal of the Learning Sciences*, *2*(2), 141–178. https://doi.org/10.1207/s15327809jls0202_2

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, *18*(1), 32–42. https://doi.org/10.3102/0013189X018001032

Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*, *8*(2), 5. https://doi.org/10.2307/1511637

Burkhardt, H., & Schoenfeld, A. H. (2003). Improving Educational Research:Toward a More Useful, More Influential, and Better-Funded Enterprise. *Educational Researcher*, *32*(9), 3–14. https://doi.org/10.3102/0013189X032009003

Carlson, S., & Anderson, B. (2007). What *Are* Data? The Many Kinds of Data and Their Implications for Data Re-Use. *Journal of Computer-Mediated Communication*, *12*(2), 635–651. https://doi.org/10.1111/j.1083-6101.2007.00342.x

Carroll, J. M. (1999). Five reasons for scenario-based design. *Proceedings of the Hawaii International Conference on System Sciences*, 123. https://doi.org/10.1109/hicss.1999.772890

Charlesworth, J., & Fink, J. (2001). Historians and social-science research data: The Peter Townsend collection. *History Workshop Journal*, *51*(1), 206–219. https://doi.org/10.1093/HWJ/2001.51.206

Churchill, E., Bowser, A., & Preece, J. (2014). Developing a living HCI curriculum to support a global community. *Conference on Human Factors in Computing Systems - Proceedings*, 135–138. https://doi.org/10.1145/2559206.2559236

Corti, L. (2007). Re-using archived qualitative data - Where, how, why? *Archival Science*, *7*(1), 37–54. https://doi.org/10.1007/s10502-006-9038-y

Corti, L., & Bishop, L. (2005). Strategies in teaching secondary analysis of qualitative data. *Forum Qualitative Sozialforschung*, *6*(1). https://doi.org/10.17169/fqs-6.1.509

Corti, L., Day, A., & Backhouse, G. (2000). Confidentiality and Informed Consent: Issues for Consideration in the Preservation of and Provision of Access to Qualitative Data Archives. *Forum, Qualitative Social Research / Forum, Qualitative Sozialforschung*, *1*(3), 13. https://doi.org/10.17169/fqs-1.3.1024

Corti, L., Thompson, P., & Fink, J. (2004). Preserving, Sharing and Reusing Data from Qualitative Research: Methods and Strategies. In *Essential Guide to Qualitative Methods in Organizational Research* (pp. 288–300). https://doi.org/10.4135/9781446280119.n23

Corti, L., Witzel, A., & Bishop, L. (2005a). On the potentials and problems of secondary analysis. An introduction to the FQS special issue on secondary analysis of qualitative data. *Forum: Qualitative Social Research*, *6*(1). https://doi.org/10.17169/fqs-6.1.498

Corti, L., Witzel, A., & Bishop, L. (2005b). On the potentials and problems of secondary analysis. An introduction to the FQS special issue on secondary analysis of qualitative data. *Forum: Qualitative Social Research*, *6*(1). https://doi.org/10.17169/fqs-6.1.498

Coyne, R. (1995). Designing Information Technology in the Postmodern Age. *The MIT Press, Cambridge, Ma and London UK*.

Crabtree, Andrew, Rouncefield, M., & Tolmie, P. (2012). Doing Design Ethnography. In *Lirmm.Fr*. https://doi.org/10.1007/978-1-4471-2726-0

Crabtree, Andy. (2003). Designing Collaborative Systems. A Practical Guide to Ethnography. *European Journal of Information Systems*, *12*(3), 247–248. https://doi.org/10.1057/palgrave.ejis.3000469

Crabtree, Andy, Rodden, T., Tolmie, P., & Button, G. (2009). Ethnography considered harmful. *Conference on Human Factors in Computing Systems - Proceedings*, 879–888. https://doi.org/10.1145/1518701.1518835

Cragin, M. H., Palmer, C. L., Carlson, J. R., & Witt, M. (2010). Data sharing, small science and institutional repositories. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *368*(1926), 4023–4038. https://doi.org/10.1098/rsta.2010.0165

Cross. (1993). A History of Design Methodology. *Design Methodology and Relationships with Science*, (1979), 15–27. https://doi.org/10.1007/978-94-015-8220-9_2

Cross, N. (2001). Design cognition: results from protocol and other empirical studies of design activity. *Design Knowing and Learning: Cognition in Design Education*, 79–104. Retrieved from http://www.elsevier.com/wps/find/bookdescription.cws_home/621428/description#description

Cross, N. (2006). Designerly ways of knowing. In *Designerly Ways of Knowing*. https://doi.org/10.1007/1-84628-301-9

Cross, N. (2007). *Designerly Ways of Knowing*. Springer.

Cubranic, D., Murphy, G. C., Singer, J., & Booth, K. S. (2004). *Learning from project history*. 82. https://doi.org/10.1145/1031607.1031622

Dalsgaard, P., & Halskov, K. (2012). Reflective design documentation. *Proceedings of the Designing Interactive Systems Conference on - DIS '12*, 428. https://doi.org/10.1145/2317956.2318020

Danzig, M. E. (1974). GLEN H. ELDER, JR. Children of the Great Depression: Social Change of Life Experience. Pp. xxiii, 400. Chicago, Ill.: The University of Chicago Press, 1974. $15.00. *The ANNALS of the American Academy of Political and Social Science*, *425*(1), 171–172. https://doi.org/10.1177/000271627642500136

de Carvalho, A. F. P., Hoffmann, S., Abele, D., Schweitzer, M., Tolmie, P., Randall, D., & Wulf, V. (2018). Of Embodied Action and Sensors: Knowledge and Expertise Sharing in Industrial Set-Up. *Computer Supported Cooperative Work: CSCW: An International Journal*, *27*(3–6), 875–916. https://doi.org/10.1007/s10606-018-9320-6

Dorst, K. (1984). The Problem of Design Problems Kees Dorst. *Design*, *4*(Cross), 135–147. Retrieved from http://research.it.uts.edu.au/creative/design/papers/23DorstDTRS6.pdf

Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem-solution. *Design Studies*, *22*(5), 425–437. https://doi.org/10.1016/S0142-694X(01)00009-6

Dourish, P. (2006). Implications for design. *SIGCHI Conference on Human Factors in Computing Systems (CHI'06)*, 541–550. https://doi.org/10.1145/1124772.1124855

Dourish, P., & Button, G. (1998). On 'technomethodology': foundational relationships between ethnomethodology and system design. *Human-Computer Interaction*, *13*(4), 395–432. https://doi.org/10.1207/s15327051hci1304_2

Dym, C. L., & Little, P. (1999). *Engineering design : a project-based introduction*. Wiley.

Eberhard, I., & Kraus, W. (2018). The elephant in the room: Challenges for ethnographic data management repositories. *VOEB-Mitteilungen*, *71*(1), 41–52. https://doi.org/10.31263/voebm.v71i1.2018

Edelson, D. C. (2002). *Design Research: What We Learn When We Engage in Design*.

Elliott, J. (1985). *Educational Action-Research.* Not available separately; see EA 017 423.

ERC. (2017). *European Research Council (ERC) Guidelines on Implementation of Open Access to Scientific Publications and Research Data*. Retrieved from https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/oa-pilot/h2020-hi-erc-oa-guide_en.pdf

Erickson, T. and McDonald, D. W. eds. (2008). HCI remixed: essays on works that have influenced the HCI community. In *Choice Reviews Online* (Vol. 45). https://doi.org/10.5860/choice.45-6835

Faiola, A. (2007). The design enterprise: Rethinking the HCl education paradigm. *Design Issues*, *23*(3), 30–45. https://doi.org/10.1162/desi.2007.23.3.30

Fallman, D. (2003). Design-oriented human - Computer interaction. *Conference on Human Factors in Computing Systems - Proceedings*, 225–232. https://doi.org/10.1145/642611.642652

Faniel, I. M., & Jacobsen, T. E. (2010). Reusing scientific data: How earthquake engineering researchers assess the reusability of colleagues' data. *Computer Supported Cooperative Work*, *19*(3–4), 355–375. https://doi.org/10.1007/s10606-010-9117-8

Fielding, N. G., & Fielding, J. L. (2000). Resistance and Adaptation to Criminal Identity: Using Secondary Analysis to Evaluate Classic Studies of Crime and Deviance. *Sociology*, *34*(4), 671–689. https://doi.org/10.1177/S0038038500000419

Findeli, A., Brouillet, D., Martin, S., Moineau, C., & Tarrago, R. (2008). *Research Through Design and Transdisciplinarity: A Tentative Contribution to the Methodology of Design Research*.

Forlizzi, J., Koskinen, I., DiSalvo, C., Wensveen, S., & Bardzell, J. (2011). Quality control: A panel on the critique and criticism of design research. *Conference on Human Factors in Computing Systems - Proceedings*, 823–826. https://doi.org/10.1145/1979742.1979497

Frayling, C. (1993). Research in Art and Design. *Royal College of Art Research Papers*, Vol.

1, pp. 1–5. https://doi.org/2016.01.18

Friedman, B., & Yoo, D. (2017). *Pause : A Multi-lifespan Design Mechanism*. 460–464.

Gaver, W. (2012). What should we expect from research through design? *Conference on Human Factors in Computing Systems - Proceedings*, 937–946. https://doi.org/10.1145/2207676.2208538

Geoffrey Bowker. (2006). Memory Practices in the Sciences. *Journal of Documentation*, Vol. 62, pp. 645–646. https://doi.org/10.1108/00220410610688804

Gero, J. S. (1991). Ten problems for AI in design, Workshop on AI in Design. *IJCAI-91*.

Gitelman, L. (2013). *'Raw Data' Is an Oxymoron | The MIT Press*. Retrieved from https://mitpress.mit.edu/books/raw-data-oxymoron

Glaser, B. G. (1963). Retreading Research Materials: The Use of Secondary Analysis by the Independent Researcher. *American Behavioral Scientist*, *6*(10), 11–14. https://doi.org/10.1177/000276426300601003

Goel, V., & Pirolli, P. (1992). The structure of design problem spaces. *Cognitive Science*, *16*(3), 395–429. https://doi.org/10.1016/0364-0213(92)90038-V

Gorard, S., Rushforth, K., & Taylor, C. (2004, September). Is there a shortage of quantitative work in education research? *Oxford Review of Education*, Vol. 30, pp. 371–395. https://doi.org/10.1080/0305498042000260494

Greenberg, S. (1996). Teaching human computer interaction to programmers. *Interactions*, *3*(4), 62–76. https://doi.org/10.1145/234813.234820

Gregory, S. A. (1966). Design and the Design Method. In *The Design Method* (pp. 3–10). https://doi.org/10.1007/978-1-4899-6331-4_1

Grudin, J. (2006). Is HCI homeless? in search of inter-disciplinary status. *Interactions*, *13*(1), 54–59. https://doi.org/10.1145/1109069.1109108

Hannafin, M. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development*, *45*(3), 101–117. https://doi.org/10.1007/BF02299733

Hargreaves, M. D. H. (1996). Teaching as a research-based profession: Possibilities and prospects. *The Teacher Training Agency Annual Lecture*, pp. 1–12. Retrieved from https://books.google.de/books?hl=en&lr=&id=9jZbbBGkUu0C&oi=fnd&pg=PA200&dq=HARGREAVES,+D.H.+(1996)+Teaching+as+a+Research-based+Profession:+Possibilities+and+Prospects+(London,+Teacher+Training+Agency).&ots=tR2qN7ohDK&sig=VufDdN4eXKKgtK2fHv052fc4nu0

Hayes, G. R. (2014). Knowing by doing: Action research as an approach to HCI. In *Ways of Knowing in HCI* (pp. 49–68). https://doi.org/10.1007/978-1-4939-0378-8_3

Heaton, J. (2004). Reworking Qualitative Data. In *Sage*. https://doi.org/10.4135/9781849209878

Hedges, M., & Blanke, T. (2013). Digital libraries for experimental data: Capturing process through sheer curation. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *8092 LNCS*, 108–119. https://doi.org/10.1007/978-3-642-40501-3_11

Hensely-Schinkinger, S., de Carvalho, A. F. P., Glanzinig, M., & Tellioğlu, H. (2015). The Definition and Use of Personas in the Design of Technologies for Informal Caregivers. *HCI International*. Los Angeles, CA, USA.

Hevner, A., & Chatterjee, S. (2010). *Design Science Research in Information Systems*. https://doi.org/10.1007/978-1-4419-5653-8_2

Hewett, T., Baecker, R., Card, S., Carey, T., Gasen, J., Mantei, M., … Verplank, W. (1992). ACM SIGCHI Curricula for Human-Computer Interaction. In *ACM SIGCHI Curricula for Human-Computer Interaction*. https://doi.org/10.1145/2594128

Higgins, S. (2008). The DCC curation lifecycle model. *Proceedings of the ACM International Conference on Digital Libraries*, 453. https://doi.org/10.1145/1378889.1378998

Hughes, J. A., Randall, D., & Shapiro, D. (1992). From ethnographic record to system design - Some experiences from the field. *Computer Supported Cooperative Work*, *1*(3), 123–141. https://doi.org/10.1007/BF00752435

Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, S. W. (2011). Design Research Through Practice: From the Lab, Field, and Showroom. Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, and Stephan Wensveen. [Book Review]. Retrieved 27 April 2021, from Elsevier website: https://books.google.de/books?hl=en&lr=&id=TlsHSK9E3yoC&oi=fnd&pg=PP1&ots=rJuhVYcH7N&sig=BLWBFjTzvVrjWvsdqlFEUCGIzq4&redir_esc=y#v=onepage&q&f=false

Johnston, L. R., Carlson, J., Hudson-Vitale, C., Imker, H., Kozlowski, W., Olendorf, R., & Stewart, C. (2018). How Important is Data Curation? Gaps and Opportunities for Academic Libraries. *Journal of Librarianship and Scholarly Communication*, *6*(1), 2198. https://doi.org/10.7710/2162-3309.2198

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development*, *39*(3), 5–14. https://doi.org/10.1007/BF02296434

Jonassen, D., Strobel, J., & Lee, C. B. (2006). Everyday Problem Solving in Engineering: Lessons for Engineering Educators. *Journal of Engineering Education*, *95*(2), 139–151. https://doi.org/10.1002/j.2168-9830.2006.tb00885.x

Jones, T. F., Jones, T. F., & Gerber, D. E. (1970). *Design Methods*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.359.988

Ju, W., Ionescu, A., Neeley, L., & Winograd, T. (2004). Where the Wild Things Work: Capturing Shared Physical Design Workspaces. *Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work - CSCW '04*. New York, New York, USA: ACM Press.

Karpoff, W. (2006). Global data sharing: Addressing the challenge of data locality.

Proceedings of the 2006 ACM/IEEE Conference on Supercomputing, SC'06, 261. https://doi.org/10.1145/1188455.1188729

Kelder, J. A. (2005). Using someone else's data: Problems, pragmatics and provisions. *Forum Qualitative Sozialforschung*, *6*(1). https://doi.org/10.17169/fqs-6.1.501

Kervin, K., & Hedstrom, M. (2012). How research funding affects data sharing. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*, 131–134. https://doi.org/10.1145/2141512.2141560

Klemmer, S. R., Thomsen, M., Phelps-Goodman, E., Lee, R., & Landay, J. A. (2002). Where Do Web Sites Come From? Capturing and Interacting with Design History. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Changing Our World, Changing Ourselves - CHI '02*. Retrieved from http://guir.berkeley.edu/projects/outpost/video/History.asx.

Kolodner, J. L., Hmelo, C. E., & Narayanan, N. H. (n.d.). *Rethinking HCI Education for Design*. https://doi.org/10.5555/1161135.1161161

Korn, M. (2017). *E-Infrastructures for Research Collaboration : The Case of the Social Sciences and Humanities*. 415–420.

Koskinen, I., Binder, T., & Redström, J. (2008). LAB, FIELD, GALLERY, AND BEYOND1. *Artifact*, *2*(1), 46–57. https://doi.org/10.1080/17493460802303333

Koutsabasis, P., & Vosinakis, S. (2012). Rethinking HCI Education for Design: Problem-Based Learning and Virtual Worlds at an HCI Design Studio. *International Journal of Human-Computer Interaction*, *28*(8), 485–499. https://doi.org/10.1080/10447318.2012.687664

Koutsabasis, P., Vosinakis, S., Stavrakis, M., & Kyriakoulakos, P. (2018). Teaching HCI with a studio approach: Lessons learnt. *ACM International Conference Proceeding Series*, 282–287. https://doi.org/10.1145/3291533.3291561

Kruchinina, G. A., Tararina, L. I., Sokolova, E. E., Limarova, E. V, Muskhanova, I. V,

Arsaliyev, S. M., … Tagirova, N. P. (2016). International Review of Management and Marketing Information and Communication Technologies in Education as a Factor of Students Motivation. *International Review of Management and Marketing*, *6*(S2), 104–109. Retrieved from http:www.econjournals.com

Lee, C. A. (n.d.). *A framework for contextual information in digital collections*. https://doi.org/10.1108/00220411111105470

Lee, J., & Lai, K. Y. (1991). What's in Design Rationale? *Humanï¿½Computer Interaction*, *6*(3–4), 251–280. https://doi.org/10.1080/07370024.1991.9667169

Lerner, F. (2005). Foundations for Design Education: Continuing the Bauhaus Vorkurs Vision . *Studies in Art Education*, *46*(3), 211–226. https://doi.org/10.1080/00393541.2005.11650075

Li, Q., Tolmie, P., Weibert, A., Schorch, M., Müller, C., & Wulf, V. (2020). E-Portfolio: value tensions encountered in documenting design case studies. *Ethics and Information Technology*. https://doi.org/10.1007/s10676-020-09533-3

Lloyd, M. (2013). Sara Ahmed, The Promise of Happiness. *Redescriptions: Political Thought, Conceptual History and Feminist Theory*, *16*(1), 200–207. https://doi.org/10.7227/R.16.1.12

Lord, P., Bechhofer, S., Wilkinson, M. D., Schiltz, G., Gessler, D., Hull, D., … Stein, L. (2004). *Applying Semantic Web Services to Bioinformatics: Experiences Gained, Lessons Learnt*. https://doi.org/10.1007/978-3-540-30475-3_25

Louise Corti, A. D. & G. B. (2000). Confidentiality and Informed Consent: Issues for Consideration in the Preservation of and Provision of Access to Qualitative Data Archives. *Forum, Qualitative Social Research / Forum, Qualitative Sozialforschung*, *1*(3), 13. https://doi.org/10.17169/fqs-1.3.1024

Lowgren, J. (1995). Applying design methodology to software development. *Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques, DIS*, *23-25-August-1995*, 87–95. https://doi.org/10.1145/225434.225444

Macdonald, S., & Martinez-Uribe, L. (2010). Collaboration to data curation: Harnessing institutional expertise. *New Review of Academic Librarianship*, *16*(SUPPL. 1), 4–16. https://doi.org/10.1080/13614533.2010.505823

Macpherson, K., Berman, T., & Joseph, D. (1996). Cases to courses: Mentored case-based training courses. *INTERNATIONAL CONFERENCE ON THE LEARNING SCIENCES, 1996*, 211–218. https://doi.org/10.5555/1161135.1161164

Maher, M. Lou, & De Silva Garza, A. G. (1997). Case-based reasoning in design. *IEEE Expert-Intelligent Systems and Their Applications*, *12*(2), 34–41. https://doi.org/10.1109/64.585102

Mankoff, J. C., Blevis, E., Borning, A., Friedman, B., Fussell, S. R., Hasbrouck, J., … Sengers, P. (2007). Environmental sustainability and interaction. *Conference on Human Factors in Computing Systems - Proceedings*, 2121–2124. https://doi.org/10.1145/1240866.1240963

Maor, D. (1999). A Teacher Professional Development Program on Using a Constructivist Multimedia Learning Environment. *Learning Environments Research*, *2*(3), 307–330. https://doi.org/10.1023/A:1009915305353

Melles, G., Howard, Z., & Thompson-Whitesidec, S. (2012). Teaching design thinking: Expanding horizons in design education. *Procedia - Social and Behavioral Sciences*, *31*, 162–166. https://doi.org/10.1016/j.sbspro.2011.12.035

Meyer, M. W., & Norman, D. (2020). Changing Design Education for the 21st Century. *She Ji*, *6*(1), 13–49. https://doi.org/10.1016/j.sheji.2019.12.002

Moran, T. P., & Carroll, J. M. (2020). Design Rationale: Concepts, Techniques, and Use. Retrieved 2 May 2021, from CRC Press website: https://books.google.de/books?hl=en&lr=&id=LAoHEAAAQBAJ&oi=fnd&pg=PP1&dq=Design+Rationale+Thomas+P.+Moran,+John+M.+Carroll&ots=S77pQuzw9A&sig=cx05oN4cLbzLgsFb6jzndYmX4B8&redir_esc=y#v=onepage&q=Design Rationale Thomas P. Moran%2C John M. Carroll&f=false

Mosconi, G., Li, Q., Randall, D., Karasti, H., Tolmie, P., Barutzky, J., … Pipek, V. (2019).

Three Gaps in Opening Science. *Computer Supported Cooperative Work (CSCW)*, *28*(3), 749–789. https://doi.org/10.1007/s10606-019-09354-z

Motschnig, R., Sedlmair, M., Schröder, S., & Möller, T. (2016). A team-approach to putting learner-centered principles to practice in a large course on human-computer interaction. *Proceedings - Frontiers in Education Conference, FIE*, *2016-November*. https://doi.org/10.1109/FIE.2016.7757576

Müller, C., Schorch, M., & Wieching, R. (2014). PraxLabs as a Setting for Participatory Technology Research and Design in the Field of HRI and Demography. *Human Robot Interaction Conference 2014*, (May), 5. Retrieved from http://ami.wineme.fb5.uni-siegen.de/View

Murphy, J. W., & Schlaerth, C. A. (2010). Where Are Your Data? A Critique of Secondary Data Analysis in Sociological Research. *Humanity & Society*, *34*(4), 379–390. https://doi.org/10.1177/016059761003400405

Murray-Rust, P. (2008). Open Data in Science. *Nature Precedings*, 1–1. https://doi.org/10.1038/npre.2008.1526.1

Myerson, J. (2016). Scaling Down: Why Designers Need to Reverse Their Thinking. *She Ji*, *2*(4), 288–299. https://doi.org/10.1016/j.sheji.2017.06.001

Nelson, H. G., & Stolterman, E. (2019). The design way : intentional change in an unpredictable world : foundations and fundamentals of design competence. In *The Design Way*. https://doi.org/10.7551/mitpress/9188.001.0001

Nespor, J. (2000). Anonymity and Place in Qualitative Inquiry. *Qualitative Inquiry*, *6*(4), 546–569. https://doi.org/10.1177/107780040000600408

Neveu, M. J. (2009). Educating the Reflexive Practitioner. *Enquiry A Journal for Architectural Research*, *6*(1), 1–8. https://doi.org/10.17831/enq:arcc.v6i1.5

Norman, D. A., & Stappers, P. J. (2015). DesignX: Complex Sociotechnical Systems. *She Ji*, *1*(2), 83–106. https://doi.org/10.1016/j.sheji.2016.01.002

NSF. (2010). Data Management Plans. Retrieved 27 April 2021, from National Science Foundation, website: https://www.nsf.gov/pubs/policydocs/pappguide/nsf11001/gpg_2.jsp

OECD. (2007). OECD Principles and Guidelines for Access to Research Data from Public Funding. In *OECD Principles and Guidelines for Access to Research Data from Public Funding*. https://doi.org/10.1787/9789264034020-en-fr

Ogburn, J. L. (2010). The imperative for data curation. *Portal*, *10*(2), 241–246. https://doi.org/10.1353/pla.0.0100

Ogonowski, C., Ley, B., Hess, J., Wan, L., & Wulf, V. (2013). Designing for the living room: Long-term user involvement in a Living Lab. *Conference on Human Factors in Computing Systems - Proceedings*, 1539–1548. https://doi.org/10.1145/2470654.2466205

Orlikowski, W. J. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization Science*, *11*(4), 404–428. https://doi.org/10.1287/orsc.11.4.404.14600

Ouh, E. L., & Irawan, Y. (2019). Applying case-based learning for a postgraduate software architecture course. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, (6), 457–463. https://doi.org/10.1145/3304221.3319737

Panek, P., Rauhala, M., Zagler, W., & Zagler, W. L. (2007). *Towards a Living Lab for Old People and their Carers as Co-Creators of Ambient Assisted Living (AAL) Technologies and Applications*. Retrieved from https://www.researchgate.net/publication/200017650

Papanek, V. (1971). *Design for the Real World by Victor Papanek*. Retrieved from https://www.biblio.com/design-for-the-real-world-by-papanek-victor/work/72440

Papasolomontos, C., & Christie, T. (1998). Using national surveys: A review of secondary analyses with special reference to education. *Educational Research*, *40*(3), 295–310. https://doi.org/10.1080/0013188980400303

Payne, G., Williams, M., & Chamberlain, S. (2004). Methodological Pluralism in British

Sociology. *Sociology*, *38*(1), 153–163. https://doi.org/10.1177/0038038504039372

Pearce, M., Goel, A. K., Kolodner, J. L., Zimring, C., Sentosa, L., & Billington, R. (1992). Case-based design support a case study in architectural design. *IEEE Expert-Intelligent Systems and Their Applications*, *7*(5), 14–20. https://doi.org/10.1109/64.163668

Plimmer, B., & Amor, R. (2006). Peer teaching extends HCI learning. *Working Group Reports on ITiCSE on Innovation and Technology in Computer Science Education 2006*, 53–57. https://doi.org/10.1145/1140124.1140141

Randall, D., Harper, R., & Rouncefield, M. (2007a). *Fieldwork for Design: Theory and Practice*. https://doi.org/10.1007/978-1-84628-768-8

Randall, D., Harper, R., & Rouncefield, M. (2007b). Fieldwork for Design. In *Cscw*. https://doi.org/10.1007/978-1-84628-768-8

Randall, D., & Rouncefield, M. (2008). Fieldwork for Design. *Proceedings of the ACM Conference on Computer Supported Cooperative Work Companion (CSCW)*, *(TUTORIAL)*, 1–140. https://doi.org/10.1007/978-1-84628-768-8

Rayment, T. (2007). *The Problem of Assessment in Art and Design*. Retrieved from https://books.google.de/books?hl=en&lr=&id=HM8W8BN_qIMC&oi=fnd&pg=PT1&dq=The+Problem+of+Assessment+in+Art+and+Design&ots=6ATRiwq1IZ&sig=s5yYihuWiy_1OxYmdS6FUnzsQzE&redir_esc=y#v=onepage&q=The Problem of Assessment in Art and Design&f=false

Reimer, Y. J., & Douglas, S. A. (2003). Teaching hci design with the studio approach. *International Journal of Phytoremediation*, *21*(1), 191–205. https://doi.org/10.1076/csed.13.3.191.14945

Ribu, K., & Patel, T. (2018). Systematic integration of project-based learning in an undergraduate human-computer interaction course: A case study. *Proceedings of the 20th International Conference on Engineering and Product Design Education, E and PDE 2018*. Retrieved from https://oda.oslomet.no/handle/10642/7452

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning. In *Sciences* (Vol. 4).

Rock, F. (2001). Policy and Practice in the Anonymisation of Linguistic Data. *International Journal of Corpus Linguistics*, *6*(1), 1–26. https://doi.org/10.1075/ijcl.6.1.01roc

Rohde, M., Brödner, P., Stevens, G., Betz, M., & Wulf, V. (2017). Grounded Design-a praxeological IS research perspective. *Journal of Information Technology*, *32*(2), 163–179. https://doi.org/10.1057/jit.2016.5

Rolland, B., & Lee, C. P. (2013). Beyond trust and reliability: Reusing data in collaborative cancer epidemiology research. *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*, 435–444. https://doi.org/10.1145/2441776.2441826

Ryd, N. (2004). The design brief as carrier of client information during the construction process. *Design Studies*, *25*(3), 231–249. https://doi.org/10.1016/j.destud.2003.10.003

Sardanelli, F., Alì, M., Hunink, M. G., Houssami, N., Sconfienza, L. M., & Leo, G. Di. (2018). To share or not to share? Expected pros and cons of data sharing in radiological research. *European Radiology*, *28*(6), 2328–2335. https://doi.org/10.1007/s00330-017-5165-5

Sas, C., Whittaker, S., Dow, S., Forlizzi, J., & Zimmerman, J. (2014). Generating implications for design through design research. *Conference on Human Factors in Computing Systems - Proceedings*, 1971–1980. https://doi.org/10.1145/2556288.2557357

Savage, M. (2005). *Revisiting Classic Qualitative Studies*. Retrieved from https://www.qualitative-research.net/index.php/fqs/article/view/502/1080

Schank, R. C., & Leake, D. B. (1989). *Creativity and Learning in a Case-Based Explainer*.

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. *Knowledge-Based Systems*, *5*(1), 3–14. https://doi.org/10.1016/0950-7051(92)90020-G

Sharmin, M., Bailey, B. P., Coats, C., & Hamilton, K. (2009). *Understanding knowledge management practices for early design activity and its implications for reuse*. 2367. https://doi.org/10.1145/1518701.1519064

Smith, E. (2008). Pitfalls and promises: The use of secondary data analysis in educational research. *British Journal of Educational Studies*, *56*(3), 323–339. https://doi.org/10.1111/j.1467-8527.2008.00405.x

Soloway, E., Guzdial, M. and Hay, K. (1994). Learner-Centered Design. In *Interactions , no. April (1994): 36-48*.

Somervell, J., Chewar, C. M., & McCrickard, D. S. (2004). Making a case for HCI: Comparing materials for case-based teaching. *Proceedings - Frontiers in Education Conference, FIE*, *1*, 1–7. https://doi.org/10.1109/fie.2004.1408550

Spiro, R. J., Vispoel, W. P., Schmitz, J. G., Samarapungavan, A., & Boerger, A. E. (2013). Knowledge acquisition for application: Cognitive flexibility and transfer in complex content domains. In *Executive Control Processes in Reading*. https://doi.org/10.4324/9780203063552

Srinivasan, M., Wilkes, M., Stevenson, F., Nguyen, T., & Slavin, S. (2007). Comparing problem-based learning with case-based learning: Effects of a major curricular shift at two institutions. *Academic Medicine*, *82*(1), 74–82. https://doi.org/10.1097/01.ACM.0000249963.93776.aa

Sternberg, R. J. (2006) 'The Nature of Creativity', *Creativity Research Journal*, pp. 87–98. doi: 10.1108/eb005923.

Stevens, G., Pipek, V., & Wulf, V. (2010). Appropriation Infrastructure. *Journal of Organizational and End User Computing*, *22*(2), 58–81. https://doi.org/10.4018/joeuc.2010040104

Stichler, J. F. (2016, October 19). Research, Research-Informed Design, Evidence-Based Design: What Is the Difference and Does It Matter? *Health Environments Research and Design Journal*, Vol. 10, pp. 7–12. https://doi.org/10.1177/1937586716665031

Stolterman, E. (2008). The nature of design practice and implications for interaction design research. *International Journal of Design*, *2*(1), 55–65. Retrieved from http://www.ijdesign.org/index.php/IJDesign/article/view/240/148

Strobel, J., Wang, J., Weber, N. R., & Dyehouse, M. (2013). The role of authenticity in design-based learning environments: The case of engineering education. *Computers and Education*, *64*, 143–152. https://doi.org/10.1016/j.compedu.2012.11.026

Tetzlaff, L., & Schwartz, D. R. (1991). The use of guidelines in interface design. *Conference on Human Factors in Computing Systems - Proceedings*, 329–333. https://doi.org/10.1145/108844.108936

Thomson, D., Bzdel, L., Golden-Biddle, K., Reay, T., & Estabrooks, C. A. (2005). Central questions of anonymization: A case study of secondary use of qualitative data. *Forum Qualitative Sozialforschung*, *6*(1). https://doi.org/10.17169/fqs-6.1.511

Tripathy, J. P. (2013). Secondary data analysis: Ethical issues and challenges. *Iranian Journal of Public Health*, Vol. 42, pp. 1478–1479. Retrieved from http://ijph.tums.ac.ir

UK Data Service. (2002). Qualidata process guide. Retrieved 27 June 2020, from http://www.qualidata.essex.ac.uk/docs/dataprocess.pdf.%0A%0A

Van Den Berg, H. (2008). Reanalyzing qualitative interviews from different angles: The risk of decontextualization and other problems of sharing qualitative data. *Historical Social Research*, Vol. 33, pp. 179–192. Retrieved from https://www.qualitative-research.net/index.php/fqs/article/view/499/1075

Vertesi, J., & Dourish, P. (2011). The Value of Data : Considering the Context of Production in Data Economies. *Cscw2011*, 533–542. https://doi.org/10.1145/1958824.1958906

Wallis, J. C., Rolando, E., & Borgman, C. L. (2013). If We Share Data, Will Anyone Use Them? Data Sharing and Reuse in the Long Tail of Science and Technology. *PLoS ONE*, *8*(7), e67332. https://doi.org/10.1371/journal.pone.0067332

Weil, D., & Mayfield, M. (2020). Tomorrow's Critical Design Competencies: Building a

Course System for 21st Century Designers. *She Ji*, *6*(2), 157–169. https://doi.org/10.1016/j.sheji.2020.03.001

Wesson, J. (2006). Teaching HCI from an Iterative Design Perspective. *HCI Educators Workshop*, (October). Retrieved from https://www.researchgate.net/publication/228965976

Westcott, M. (2014). Design-Driven Companies Outperform S&P by 228% Over Ten Years - The 'DMI Design Value Index'' - Design Management Institute'. Retrieved 24 April 2021, from DMI: Design Management Institute blog, 10. website: https://www.dmi.org/blogpost/1093220/182956/Design-Driven-Companies-Outperform-S-P-by-228-Over-Ten-Years--The-DMI-Design-Value-Index

Wilcox, L., DiSalvo, B., Henneman, D., & Wang, Q. (2019). Design in the HCI classroom: Setting a research agenda. *DIS 2019 - Proceedings of the 2019 ACM Designing Interactive Systems Conference*, 871–883. https://doi.org/10.1145/3322276.3322381

Williams, A., & Askland, H. H. (2010). The Design Studio , Models of Creativity and the Education of Future Designers. *Desire 10*, (August), 16–17. Retrieved from https://dl.acm.org/doi/epdf/10.5555/1854969.1854989

Wixon, D. (2003). Evaluating usability methods: why the current literature fails the practitioner. *Interactions*, *10*(4), 28–34. https://doi.org/10.1145/838830.838870

Wolf, T. V., Rode, J. A., Sussman, J., & Kellogg, W. A. (2006). Dispelling 'design' as the black art of CHI. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '06*, 521. https://doi.org/10.1145/1124772.1124853

Wong, W. L. P., & Radcliffe, D. F. (2000). The tacit nature of design knowledge. *Technology Analysis and Strategic Management*, *12*(4), 493–512. https://doi.org/10.1080/713698497

Wright, P., Blythe, M., & McCarthy, J. (2006). User experience and the idea of design in HCI. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *3941 LNCS*, 1–14. https://doi.org/10.1007/11752707_1

Wulf, V., Müller, C., Pipek, V., Randall, D., Rohde, M., & Stevens, G. (2015). *Practice-Based Computing: Empirically Grounded Conceptualizations Derived from Design Case Studies*. https://doi.org/10.1007/978-1-4471-6720-4_7

Wulf, V., Pipek, V., Randall, D., Rohde, M., Schmidt, K., & Stevens, G. (2018). Socio-informatics: A practice-based perspective on the design and use of IT artifacts. In *Socio-Informatics: A Practice-Based Perspective on the Design and Use of IT Artifacts*.

Wulf, V., Volkmar, P., Randall, D., Rohde, M., Schmidt, K., Stevens, G., … Stevens, G. (2018). *Socio-informatics*. Oxford: Oxford University Press.

Wynholds, L., Fearon, D. S., Borgman, C. L., & Traweek, S. (2011). *When Use Cases Are Not Useful: Data Practices, Astronomy, and Digital Libraries*.

Yardley, S. J., Watts, K. M., Pearson, J., & Richardson, J. C. (2014). Ethical issues in the reuse of qualitative data: Perspectives from literature, practice, and participants. *Qualitative Health Research*, *24*(1), 102–113. https://doi.org/10.1177/1049732313518373

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Conference on Human Factors in Computing Systems - Proceedings*, 493–502. https://doi.org/10.1145/1240624.1240704

Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010). An analysis and critique of research through design: Towards a formalization of a research approach. *DIS 2010 - Proceedings of the 8th ACM Conference on Designing Interactive Systems*, 310–319. https://doi.org/10.1145/1858171.1858228