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Connecting the PhD in Design: How PhDs Label Their Thesis Research

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Abstract: As design research matures, more designers pursue a PhD. In its turn, the PhD itself is changing from a solitary preparation for a career in academia toward an increasing emphasis on interdisciplinary and international experience and a greater variety of jobs. These developments call for greater opportunities for PhD candidates to build their network during the PhD. The WunderLibrary, developed in the EU-funded project DoCS4Design, aims to connect PhD candidates through a web-based platform for sharing educational and research materials and making contact. To seed the platform's ontology, the collection of tags which connect the items in it, we studied the keywords and metadata from a set of 342 PhD theses from the 6 PhD programmes in the project over the last decade. The collection of theses came with between three and six freely chosen keywords, typically provided by the authors. In this paper, we describe the process of curating the keywords and clustering the resulting data on three levels. This produced a set of 342 keywords and two levels of clustering. The raw data are openly available. We discuss data analysis and a spin-off application that uses higher-level labels to help PhD candidates describe their work.

Keywords: *doctoral education; design research; keywords; alignment; research through design*

Introduction

Design is maturing as an academic discipline, as an area of inquiry and knowledge production. One crucial indicator of this development is the growing number of PhD programs in design (Durling, 2002). The Doctor of Philosophy (PhD) degree is often defined as the study to become an independent researcher. The European Union regards the degree as the so-called third cycle of academic education, after the Bachelor's and Master's, aimed at preparing students for several research-related jobs in society and academia (European University Association, 2005), recognising that the PhD takes on different forms in across countries, universities, and disciplines. During their training, students begin the path to becoming a researcher. Such a process must be contextualised and compliant with the research traditions of the disciplinary field involved; it gets complicated when discussing PhDs in design (Durling, 2002). Indeed, research traditions of design are quite variable due to the influence of (i) disciplinary factors, (ii) contextual factors of the program, and (iii) external factors. Firstly, the disciplinary factors (i) concern that design is a methods-based discipline that thrives extensively on integrating traditions from other disciplines. Design research borrows and adapts methods



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from various other disciplines and, contemporarily, uses and creates its own (Hanington, 2003; Martin & Hanington, 2012; Van Boeijen et al., 2014).

Consequently, methods, topics, and impacts of PhD studies in design vary on several dimensions. Then, contextual factors (ii) determine the intrinsic variability of the PhD programs in different design schools and, hence, of doctoral research. For instance, PhD programs usually allow numerous diverse topics, methods and areas of inquiry in PhD research. However, the staff's expertise and contextual research culture also greatly influence the supervising capabilities and thus delimit the perimeter of the research carried out by PhD students. Also, the size of a specific school or program might influence the variety of PhD research, considering that some doctoral programs have PhD candidates in the range of one hundred while others have ten or even fewer. The organisation of the instructional offer itself is another contextual factor that highly influences the overall experience in one PhD program in design and, therefore, the variability across programs. For instance, some schools have four-year research projects with little formal education attached, while others have three-year programs which start with a full year of formal education. Finally, external factors (iii) also enhance the differences across and within PhD programs in design. Indeed, several trends (e.g., from national or EU policy) toward greater interdisciplinarity, international experience, and collaboration are in preparation for the job market (e.g., European University Association, 2010). This external impulse fits well with the disciplinary field of design, which, as mentioned earlier, by its nature, often intersects with other disciplinary areas.

Therefore, it becomes increasingly valuable for PhD candidates to exchange and build networks and experiences. In this panorama, the vision proposed by Poggenpohl (2015) of design research as a community of practice is inspiring and appropriate as it acknowledges the need to foster socially responsible collaboration among scholars and practitioners in the design field. In her words, "Design has been too insular; it is time to partner with other disciplines at the university, in practical practice settings, in entrepreneurial ways to demonstrate what we can contribute" (Poggenpohl, 2015, p. 56). Regarding the conference theme, the future of design education should foster connections (PhD) education practices and research across diverse institutions in the design field and beyond the disciplinary borders; the PhD research will shift from a solo activity to an increasingly connected one. However, this is often not a simple task due to the significant variability of doctoral design research. New PhD candidates lack the vocabulary to describe their niche and are confronted with descriptions at many levels of abstraction. As a result, they are hesitant to put up anything when asked to describe what they do in a category like 'research approach'. Even when describing one design research through selecting keywords, a widespread tool used to label research, doctoral students may struggle to overcome local institutional culture and programs.

This paper explores the value of keywords to support PhD candidates in positioning themselves in design research, finding pockets of knowledge and experiences in the community of practice of doctoral design research, and connecting to other finished and ongoing PhD works. Early-stage PhD students should be facilitated to network as they struggle with the vocabulary to describe their niche and are confronted with descriptions at many levels of abstraction. The case study of a keyword analysis conducted in the context of the DoCD4Design project is presented in the paper. The keywords of the thesis published between 2012 and 2022 at the six partner institutions were collected and analysed to understand if they describe the research fields at an institution or across institutions and if they can help PhD students connect themselves to earlier works or others with related interests. The analysis resulted in the pragmatic output of a curated set of keywords organised in clusters that serve as the content ontology for a repository of open educational resources for PhD students, which was the purpose for which the analysis was initiated in the first place. More importantly, in this process, the serendipity characterising Research Through Design helped us better understand the emerging research features described through the used keywords (e.g., the design field, the object of design, or methods, among others), leading us to another relevant output that is a structure to support PhD students in describing their researches through keywords.

The Context of DoCS4Design and the Rationale for Analysing Keywords

All the above sketches a diverse and ambiguous landscape where the PhD curricula transition from a solo effort executed in relative isolation toward a more networked development. Here, overcoming the undefinedness inherent in diversity is a challenge. When someone says they are doing a PhD in design, that statement is pretty unspecific for someone not in the same institute as the speaker. The project DoCS4Design was funded by the Erasmus+ program in 2020 and formalised the network composed of six established PhD programs in design at universities in Europe and the United States (i.e., Aalto University, Carnegie Mellon University, Imperial College London, Illinois Institute of Technology, Politecnico di Milano, TU Delft) to clarify a landscape of diverse practices and to foster exchange, experimenting with possible ways to develop a community of practice of PhD students and advisors (Stappers et al., 2022). The first project phase entailed the mapping of practices and the creation of a glossary to align the diversity of jargon, resulting in the

publication in 2022 of the document "PhD in Design - A Map and Glossary" (Stappers & van Boeijen, 2022)¹. We identified various structures and languages by studying and comparing our six PhD programs. Our PhD programs differ, e.g., in duration, responsibilities, formalities, and opportunities, and we use different jargon. This variety holds for programs but also for research approaches, themes, and methods. For instance, when describing how PhD research topics are chosen, we identified a series of factors that constrain and drive it: the expertise and interest of the PhD student; the expertise and interest of the advisors; the available committed industrial and societal parties; the opportunities to gain operational funding for carrying out the studies; the research agenda of the institute, department or group; a larger project in which the candidate is embedded; the agenda and financial support of funding institutes; and the contextual research culture. Notably, we could not fit the research agendas from the six schools into a single structure: some schools defined the research topics by the expertise of chairs, others by alignments with national scientific agendas (Stappers & van Boeijen, 2022).

However, one commonality among these schools is that they all offer open access to their repositories of PhD theses, which are accompanied by keywords that could facilitate cross-linguistic communication. Since our next step in the DoCS4Design project entailed the development of a repository of open educational resources (OERs), and given the availability of such data, we initiated the research on keywords with the primary practical objective of constructing the content ontology of this repository. The effort of keywords' collection, analysis and organisation into a curated dataset was aimed at creating a set of content tags that would enable efficient organisation and retrieval of OERs related to the PhD in design within the platform. This initiative was prompted by the need to establish an effective initial network of connections between content tags, leading to the use of curated keywords from previous PhD theses as the foundation for the content tagging system.

Framing the Use of Keywords in Design Research

Before analysing the keywords of the doctoral theses, we questioned how keywords function in the broader research and design research context to understand better the possible characteristics of the dataset we were about to analyse. Library systems and major publishing organisations, such as the ACM, have created standardised taxonomies of keywords (e.g., Dewey Decimal, IEEE). While these taxonomies have the advantage of being systematic and unambiguous, allowing users to locate what they expect to find, they are often inadequate for new interdisciplinary fields, such as design, where many research topics are out of the box, or in emerging areas which have not yet been mapped with consolidated keywords. Besides, in design research, it is not trivial to determine which is the box (or whether a box exists) since using keywords is often relatively free, and single words carry quite different loads for different contexts. Indeed, in conferences (e.g., DRS, IASDR), academic journals (e.g., Design Issues, International Journal of Design) and university repositories, we find that there is not a single well-defined system of keywords; contributors are invited to include words which function like hyper-short summaries or advertisement tags. The journal Design Studies, instead, proposes an intermediate model for keyword selection between structured and unstructured ones; authors can choose up to five keywords from the journal's set list with the possibility to add one keyword that is not included in the list (Design Studies, 2020). The list² used as a keyword classification system includes, among others, keywords describing disciplinary areas (e.g., product design, service design, graphic design), the design process (e.g., design processes, design methods, decision making), design outputs (e.g., prototypes, drawings), approaches to design (e.g., eco-design, participatory design). Rather than an organised taxonomy, the keyword list provided by Design Studies appears as a selection of uncategorised keywords that represent several topics of interest for the journal, leaving space for authors to select them freely and allowing them to expand the list by adding one keyword.

The freedom that characterises using keywords in design research might be a double-edged sword. On the one hand, it responds well to the breadth of design research topics, methods, approaches, theories, and areas, providing space to value the variety that characterises the discipline and a more comprehensive positioning in such a vast landscape. On the other hand, it challenges the possibility of establishing a shared understanding of how design research is structured and defining a precise positioning within it. The downside of an entirely free keyword selection model might become problematic under two perspectives if the aim is to build a community of practice across PhD in Design programs. First, to build effective collaborative environments, especially in plural contexts, alignment and mutual understanding are crucial factors for effective interactions. If people use words that are hard to link with each other, they might believe they are dealing with very different matters, missing out on the possibility of discovering something quite relevant for them – even if called by another name. Second, the freedom in choosing keywords is especially problematic for PhD

¹ For more information about the programs, "PhD in Design - A Map and Glossary" can be downloaded at the website www.docs4design.eu.

² The entire Design Studies keyword list can be view at this link https://www.elsevier.com/data/promis_misc/jdstkey.pdf

students as they often must position their research in the broader context of design research that, also due to this free-contents-labelling, is very hard to position per se. The model adopted from Design Studies, being intermediate between unstructured and structured models, might represent a third way that contemporarily provides more defined guidelines and broadens the pre-determined scaffolding system (i.e., the given list). Nevertheless, this system does not entirely solve the disadvantages of the two keyword selection models. First, it pushes authors to conform to a standard list of keywords, which helps to position but might discourage plurality and diversity in how languages are used, and research cultures are depicted. Second, it does not provide a solid structure for keyword selection to represent one academic research most accurately. The above considerations prepared us for the set of keywords we found with the collected theses. Indeed, similarly to other design research publication venues, the keywords to label PhD theses were freely selected by PhD students and, therefore, derived from an unstructured keywords definition process. Their word usage varied in syntactic ways (e.g., singular versus plural, adjectives versus nouns, spelling) and semantic ways, whether they related to method, content, domain, detail or overall research.

Method and Results

As mentioned above, the analysis of the PhD theses' keywords started to serve the pragmatic aim of building an ontology of contents labels for the Wunderlibrary, a repository of OERs related to the PhD in Design across the DoCS4Design institutions. Emphasising this fact is to remind the reader of the scope of this analysis: the methods adopted in the case study presented had a design purpose and not a theoretical construction one. Specifically, our design problem was to design a relational structure of keywords intended as labels to describe one research in design. Also, given the widespread diffusion of the unstructured selection model in design research, we assumed that the keywords' information structure should have been a network rather than a tree. Finally, we adopted a bottom-up approach, making the relational structure of keywords emerge from data.

Hence, the data of 342 PhD theses from the six different schools between 2012 and 2022 were gathered, including general data about the publication, such as school, author, year of publication, URL, and content data such as keywords, titles, and abstracts. The number of dissertations varied greatly between schools, with some having only a few and others having over a hundred. However, some data was incomplete and required fixing. Keyword information, for example, was sometimes missing, and how school libraries collected them varied. To address this, missing keywords were suggested by the representatives from the programs in the research team. The vast majority of the keywords supplied were in English; those few that were not have been excluded from the dataset. A first analysis of the keywords showed that the co-occurrences between exact keywords, as listed by authors, would have been too poor to build a good network; hence, we decided to initiate a process of curation of the dataset, identifying groups of keywords that would have worked as a single-node in the counting. Starting from this initial dataset, the authors started the curation process consisting of three main steps of check:

1. **spelling check** comprises correcting typos and spelling mistakes, deleting not-English words, resolving US/UK spelling and singular/plural forms, deleting punctuation, writing the acronyms in their extended form;
2. **representativeness check** comprises deleting or modifying too specific keywords and unrepresentative ones for design (e.g., name of cities, Countries, companies), deleting too generic keywords (i.e., designers, designing, design);
3. **consistency check** comprises splitting too long keywords into representative ones, checking the consistency of keywords, and ensuring that the variations of the keyword were included (i.e., plural-singular, acronyms-extended, synonyms, UK-US spelling).

Then, we grouped the provided keywords into a first clustering, which reduced the number of 'raw keywords' from 1432 (i.e., level-4) to 774 clusters represented by a 'curated keyword' (named level-3 below because two merged cluster levels were constructed). Table 1 shows some examples of level-3 and level-4 keywords.

Based on that curated set, we analysed the metadata (i.e., dissertations' titles, abstracts, and keywords) to build a keyword-to-keyword and keyword-to-thesis network. The curated keywords were used to scrape the theses' metadata (i.e., titles, abstracts, and keywords). In this way, theses would receive links from (1) keywords supplied by the author of the thesis and (2) keywords supplied by other authors but occurring in the metadata of this thesis; this might increase the connectivity in the network. Each curated keyword became a single node of a network, and its presence in dissertations' contents data was counted. The presence of two curated clusters in the same contents data of one dissertation was counted to define and dimension the arcs in the network. A third researcher aggregated the (level-3) keywords into 50 clusters with a level-2 keyword, and these into 11 clusters at level-1. The labels of the level-1 clusters are listed in Table 2, together with how many PhD theses at each program used a keyword from those clusters. Some clusters appeared at all six programmes, others only at 3.

Table 1. Examples of level-3 keywords (highlighted in light blue) of level-4 keywords.

Level-3 keywords clusters	Level-4 keywords
3d compression	3d compression
accelerometer	accelerometer
	accelerometers
accessibility	accessibility
	design for all
	design for disability
	inclusive design
	design for disability
	inclusive design
	universal design
	universal design
accessories	accessories
	accessory
acomodation	temporary accommodation
	temporary living
action research	action research
action tendencies	action tendencies
	action tendency
active packaging	active packaging
activity theory	activity theory
actor-network theory	actor-network theory
adaptation	adaptation
adaptive mediations	adaptive mediation
	adaptive mediations
advanced design	advanced design
aesthetics	aesthetics
	beauty
	digital aesthetic

Table 2. Top-level keyword clusters and how frequently these were used at programmes 1) Aalto; 2) Carnegie Mellon University; 3) Illinois Institute of Technology; 4) Imperial College London; 5) Politecnico di Milano; 6) TU Delft.

Level 1 Clusters	Examples of keywords within each cluster	Theses using keywords in that cluster							
		1	2	3	4	5	6	Total	Programs
types of design	e.g., service design, product design	29	4	3	9	82	52	179	6
method	e.g. interviews, research through design	25	5	4	8	63	57	162	6
values	e.g., sustainability, human-centered	18	2	1	1	37	59	118	6
quality	e.g., perceptual, emotional, social qualities	11	1	3	1	29	38	83	6
technology	e.g. 3D printing	2	1	1	2	15	18	39	6
object	e.g., chairs, toilets, cars	11	0	1	6	38	36	92	5
context	e.g., hospitals, sectors	15	3	0	4	33	34	89	5
design	e.g., ideation, marketing	8	2	1	0	10	9	30	5
theory	e.g., psychology, mathematics	2	0	2	1	14	11	30	5
people	e.g., children, nurses,	6	0	0	0	8	10	24	3
activity	e.g., cycling, eating	0	1	0	0	6	3	10	3

For the curated set, ambiguities of keywords were resolved by inspecting the titles and abstracts. For these clusterings, the third researcher used his background knowledge and domain expertise in the meaning of terms. Therefore, homonyms may conflate different meanings for some keywords, for instance. This was deemed acceptable because (1) the quality of assignment of the original keywords by authors was judged to be somewhat ad hoc, and (2) the intended use of the network instead of a tree as seen in previous ontologies and works was meant to be associative and suggestive, not strict and prescriptive. The current analysis was used to construct the initial ontology for the Wunderlibrary (Figure 1).

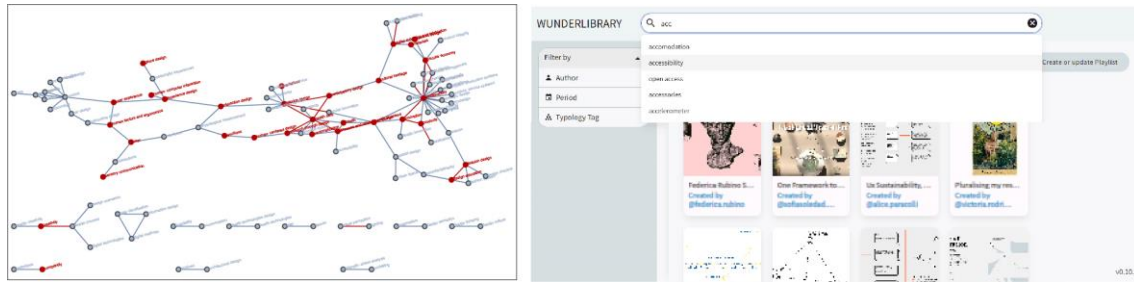


Figure 1. On the left, the graph shows 112 combinations of 101 curated keywords listed by at least two theses (grey) or more (red); keywords in red are part of at least 25 combinations. The whole graph contains 2916 combinations and 748 keywords. On the right is the Wunderlibrary prototype, where, using the search bar, users can display level-3 keywords as content tags.

Discussion

It was observed in the dataset that self-chosen keywords tend to result in disorganised and heterogeneous categorisation while employing broader, high-level clusters produced more generalised but identifiable content groupings (i.e., the top-level clusters). However, it should be noted that due to inherent ambiguities in keywords, clusters should be considered as suggestions rather than rigid prescriptions. While this approach shows promise regarding a suggestion-driven seeding strategy for the Wunderlibrary, it may not be suitable for establishing the repository as an authoritative data source. For the users of the Wunderlibrary, the keywords are triggers to consider individual items in the repository. Moreover, in the living platform, new tags input by users may add to or even overwhelm these initial keywords. The process of curating and clustering exercise led to several results and insights. One was the contents tag structure to nurture the Wunderlibrary prototype (see Figure 1). If we view the keywords not as a representation of the content of the theses but rather as an indication of what the authors deemed interesting for others to discover, it can provide ideas for PhD candidates on potential discussion topics. This is evident in the top-level clusters, which include method, topic, result, and impact. As a result of this analysis, we discovered that keywords selected freely to describe the thesis often inform about recurrent features of the research, which are the top-level clusters identified through our clustering effort (summarised in Table 3). Considering these dimensions may be beneficial, but not imposing them strictly since not all the areas identified by top-level clusters are necessarily relevant to describe each research. For instance, if none of the keywords provides information about a particular aspect, that lack can also effectively communicate that the author is unsure or uninterested. As a community of practice, we need to find ways to effectively communicate our work and its categorisation, but there is a great deal of ambiguity and local variation in terminology. As designers, we should not be too apprehensive, but it is crucial to acknowledge such variation and create opportunities to foster alignment, exchange, and mutual understanding to enhance cross-pollination across local contexts. Also, we discovered that many keywords are mainly used in only one or two programs. An example is the "CULTURAL HERITAGE" keyword, which was intensely used only at Politecnico di Milano and at Aalto University. The frequencies in Table 2 also show very high values for the largest two programs (TU Delft and Politecnico di Milano), so local habits may dominate quantitative statistics. One of the limitations of this analysis is that keywords have their constraints, especially with such an unbalanced dataset. Utilising abstracts or the complete content of the theses could yield more robust results, especially using text mining techniques to scrape the data, as has already been done in other studies on design research (Blackler et al., 2021). A separate analysis is being pursued if content analysis of the metadata (title, abstract) of the theses can provide more linkage; the findings will be reported on the project website (docs4design.eu) in Spring 2024.

A second use of the keyword collection was creating low-threshold vignettes to introduce one's research at a conference, course, or convention. One of the universities had used vignettes for its courses where around 30 participants, mainly unaware of each other's research, created them to break the ice. On the vignette, candidates would put their name, research title, and a short description of their methods or approach, goals, and maybe a text and a figure. One observation was that new candidates had difficulty coming up with short descriptions of aspects like 'research method' or 'criteria', even though these were items on which they would like to find partners. The keyword collection offered the opportunity to renew the vignettes, using the level 1 cluster names as fields and explaining them with a word cloud of level 2 clusters, as shown in Table 3. Figure 2 shows one example of a new vignette used during several inter-university online training events. Although we did not evaluate them formally, our experience suggests that supporting answers with a word cloud of earlier-used terms lowered the threshold for the participants to put down a sensible discussion starter.

Table 3. Research features are often described with the free selection of keywords emerging from the clustering.

RESEARCH FEATURES	SUGGESTIVE EXAMPLES OF KEYWORDS	WHY INTERESTING TO FIND PEERS IN THIS ASPECT
CONTEXT, SITUATION, OR SECTOR	health, context, branding, e-commerce, nature, marketing, waste management, developing countries, consumer markets, energy studies, transport services and systems, infrastructure, waiting areas, galleries, libraries, archives, museums, co-housing, cities, archives, galleries, libraries, archives, museums, mobility, cultural heritage, digital modeling and fabrication, manufacturing, theatre, public procurement, digital transformation, emerging markets, trains, physical environment, domestic energy use, entrepreneurship, military, automation, geography, sports, modernity, gardens, physical activity, transitions	PhD students working in an application area may find it useful to connect on this level, especially for funded projects.
RESEARCH METHOD	prototype, measurement, craft, narratives, teamwork, immersion, scalability, tradition, reframing, empathy, visual mapping, systems thinking, data visualisation, design thinking, interdisciplinary, living labs, methods, sensemaking, innovation processes, consumer research, design guidelines, design process, redesign, co-design, practice research, complexity management, design collaborations, representation, history, design studies, evaluation framework, design research methods, design scenarios, assessment, visualisation, design parameters, product lifecycle management, conceptual design, data analysis, modeling, fuzzy front-end, design methods, techniques and tools, decision-making, creativity, design challenges out-up-and-deep-scaling, design approaches, optimization, future vision, knowledge transfer, problem-driven approach, trends, design support, helping, futures, methodology, design methodology, research through design, design anthropology, exhibitions, crowdsourcing, transdisciplinarity, design strategies, citizens participation, self-reflection, idea generation, design analysis, design creativity, problem solving, metaphors, questionnaires, storytelling, construction, anticipation, case studies, stimulus, innovation, experiments, forecasting	PhD students in design (and related fields like architecture) express need for guidance in research methods; design research builds on diverse traditions.
OBJECT	aircrafts, textiles, food, batteries, toilets, cars, robots, furniture, hand made, fashion, system, social media, collections, interfaces, collaborative services, footwear, industry, software, accessories, product characteristics, city identity, vessels, business, consumption, production systems, buildings, housing, packaging, product-service systems, interactions, plants, behavior change, monitoring system, materials, paintings, urban spaces, design features, smartphones, object brands, seats, games, energy, interiors, products	Many design research projects often have impact goals, resulting in concrete solution proposals focused around a product category as a desired outcome.
TECHNOLOGY	new media, sensors, informatics, smart materials, virtual reality, virtual environments, personal design, machine learning, infrastructures, wearable technologies, smart materials, robotics, information and communications technologies, big data, electronics, composites, augmented reality, technology, digital technologies, smart textiles, assistive technologies, health technologies, technologies	Many design research projects explore or develop emerging technologies or practices.
DISCIPLINES OR THEORY BESIDES DESIGN	frameworks, mental models, awareness, ontology, symbolism, design frameworks, product semantics, theory, interpretations, actor-network theory, activity theory, cyber-physical systems, positive design, supply chains, positive psychology, business models, pragmatism, conceptual models, business models, practice theory, psychology, taxonomy	Design research often builds on models and theories from several other disciplines.
RELATED TYPE OF DESIGN	social innovation, industrial design, fashion design, product design, information design, user-driven innovation, cross-cultural design, design innovation, transition design, entrepreneurial design, collaborative innovation, empathic design, interior design, do-it-yourself design, human-centered design, participatory design, lighting design, aircraft design, design management, temporality-based design, multi-sensory design, service design, bio-inspired design, health technologies design, data-driven design, graphic design, spatial design, organisational design, product and service development, experience design, innovation management, communication design, strategic design, interface design, user-centered design, environmental design, business innovation, fashion method design, automotive design, contextual design, service innovation, furniture design, types of design systems design, critical design, global design, game design	Many research projects consider particular (emerging) design practices and participate with or develop methods for those practices.
VALUES, CRITERIA	safety, culture, home, impacts, communities, sustainability, social change, ritual, mending, lifestyle, function, social action, cultural context, personal information, circular economy, variety, empowerment, human factors and ergonomics, eco-efficiency, globalisation, maintenance, repair, overhauls and upgrades, slow fashion, sustainable patterns of production and consumption, hygiene, obsolescence, diseases and related health problems, interculturality, decoloniality, values, social consequences, natural resources, translation, personality, social inclusion, sustainable energy, relational aesthetics, well-being, usability, bordering, engagement, performance, everyday life, health	Some design research often is explicitly human-centered or technology-oriented.

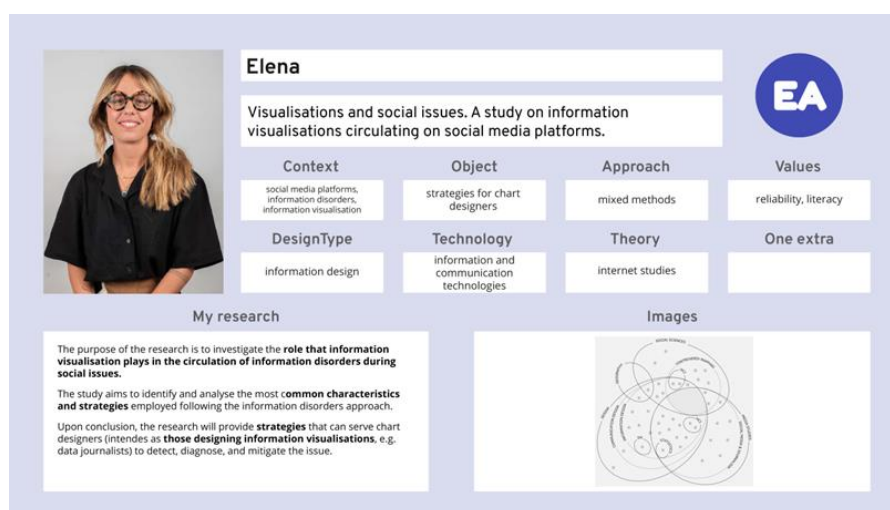


Figure 2. A vignette is used for inter-institutional PhD training events; each field is a level-1 keyword, and the instruction on how to fill it in is shown in the word clouds in Table 3. As a result, participating candidates were confident to put tentative discussion-starters in each field.

Conclusion

An increasing number of talented people, both from design expertise and not, are pursuing a PhD in design. In a world that asks them to be increasingly interdisciplinary and internationally experienced, PhD candidates benefit from finding counterparts in their research group, school, or international network and, simultaneously, position their research in a discipline that is hard to grasp and confine. These connections may include study topics, research or design methods, and other factors. We found that existing keyword practices in cataloguing theses are of limited use, as they are frequently 'attached' to a finished research paper according to criteria arbitrarily established by the author. However, keyword-selection praxis is not negligible since it allows the elements of doctoral research that the PhD candidate considers the most exciting or relevant to describe it to emerge. As the future of PhD education increasingly emphasises networked learning (European University Association, 2010), with candidates engaging in interdisciplinary collaboration and building academic connections, the ability for new candidates to swiftly identify prior work, active research groups, and connect with peers in related fields is crucial. Keywords serve as a means to succinctly encapsulate research directions; however, novice researchers often lack a standardised vocabulary, and the field lacks a unified descriptive system. Therefore, loosely aggregating keywords and suggesting descriptive language proves valuable, as illustrated by our initial experiments with the Wunderlibrary and using vignettes during network meetings.

The limitations and opportunities that emerge from the practice of free keyword selection reinforce the need to create opportunities for doctoral design students to practice concisely explaining their work and labelling it to relate effectively to their community of practice. That community of practice is the design research community and design as a disciplinary field: young researchers can fine-tune their keyword selection skills by attending conferences or publishing articles in scholarly journals (Davis et al., 2023). Nevertheless, our intuition was that exercising keyword selections and research labelling might become an aspect that PhD candidates practice within and throughout a PhD program. Concerning DoCS4Design, social interaction across our schools became one way to do that. This might be replicated or proposed within and across different institutions and might be relevant for others in several contexts. We hope that more insights into how PhD students can label their work will help them develop their academic networks early on: keywords may break the ice.

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