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Mental models of the organisation of scholarly information across the Academy: disciplinary similarities and differences

Hye Lim Joy Nam, BA, MA, MSc

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Abstract

Since the early 2000s, scholarly information seeking has been shaped by the rise of commercial search technologies such as Google Scholar and the adoption of simplified discovery interfaces in academic libraries. Whilst these systems simplify access, they also risk promoting assumptions of universality that overlook the disciplinary and institutional contexts in which scholars work. Although research in information practice, mental models, and disciplinary cultures has addressed aspects of this issue, limited attention has been paid to how researchers themselves conceptualise the organisation of scholarly information across different disciplines.

This thesis explores this gap through a qualitative study of forty researchers in chemistry, history, law, and medicine at two UK universities. Drawing on semi-structured interviews, cognitive mapping, and observation, the study examines how scholars perceive the organisation of knowledge in their disciplines and how these understandings shape their approaches to discovery. The findings indicate that mental models are better understood as adaptive structures shaped by disciplinary enculturation, institutional settings, personal trajectories, and sociomaterial practices rather than as stable internal representations. These disciplinary mental models influence how scholars find, interpret, and evaluate information, and point to substantial variation in expectations of authority, relevance, and organisation.

Conceptually, the thesis develops a multidisciplinary theoretical framework for examining disciplinary mental models as a link between cognition, practice, and culture. Empirically, it provides new qualitative evidence of cross-disciplinary, cross-institutional differences in how researchers conceptualise knowledge in their fields. Practically, it highlights the limitations of system-centred, universalised approaches to discovery and suggests that more effective information systems will need to account for the diversity of academic thought and practice.

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Author's Declaration

"I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution."

Signed: Hye Lim Joy Nam

Glossary

Cognition / cognitive / conceptualisation: Used throughout this thesis in an interpretive sense rather than a scientific one. The terms stand for the interior world of thought and meaning through which scholars make sense of their disciplines, not for the neurobiological or systematic processes studied in cognitive science. Where the thesis moves between "cognition" and "conceptualisation", this is deliberate, as the two are continuous: cognition is conceptualisation—a situated process of meaning making—in context. See Chapter One, Key Concepts for additional information.

Cognitive mapping (method): This is an elicitation technique used in this study, in which participants were invited to draw their discipline. Rooted in the library ethnography and UX tradition of drawing exercises rather than to the experimental tradition of cognitive science.

Contact zone: Pratt's (1991) concept for social spaces where cultures meet under conditions of asymmetrical power, adapted in this thesis as an analytical lens for the encounter between scholars' disciplinary frameworks and the organising logic of information systems. See also: *Transculturation*.

Disciplinary mental model: This is the central object of this study. Scholars' conceptualisations of the structure and organisation of knowledge in their field. Disciplinary mental models are not treated as biological or fixed properties of expert minds; they are dynamic, learned, shared, and enacted within disciplinary communities. Expressed empirically in the four "shapes" identified in Chapter Four. See also *Mental model* and *Shapes*.

Discipline / specialism: "Discipline" refers to the broad institutional and intellectual category (chemistry, history, law, medicine); "specialism" to the narrower research area within or across disciplines (e.g. physical chemistry, oral history, sociolegal studies). The findings show that specialisms are often the operative unit of scholarly identity and cognition.

Discovery system / discovery layer: Library search platforms that integrate catalogue records with journal articles, book chapters, and external resources behind a single search interface, modelled on commercial web search.

Epistemic culture: Knorr-Cetina's (1999) term for the socially and materially embedded practices through which a knowledge community produces and validates knowledge. Distinguished in this thesis from disciplinary mental models, which operate at the level of the individual scholar.

Ethnographish: Lanclos and Asher's (2016) term for short-term, goal-oriented library studies that borrow ethnographic methods without the full ethnographic programme of extended immersion.

Exploratory: Used in this thesis in an interpretive rather than a preliminary sense: the study explores what participants themselves believe, perceive, and articulate about knowledge in their disciplines, rather than testing hypotheses against predefined categories. This orientation is grounded in Charmaz's (2025) constructivist grounded theory and resonates with Clarke's (2005) situational analysis. See Chapter One, Methodological Orientation, and Chapter Three.

Holistic paradigm: Polkinghorne and Given's (2021) framework encompassing methodological holism (social phenomena as central to explaining human activity) and ontological holism (social phenomena as having properties and agency beyond the individuals who constitute them). The theoretical orientation underpinning this study.

Information behaviour: Following Bates (2018): all instances where people interact with their environment in ways that leave some impression on them, adding to or changing their knowledge. In this thesis, the term is used when referring to the research field and its literature, in which "information behaviour" has been the historically dominant term associated with the cognitive, individual-centred tradition of research (Savolainen, 2007). See also *Information practice*.

Information practice: The umbrella term of the social constructionist tradition in information research (Savolainen, 2007; McKenzie, 2003), foregrounding the socially and contextually embedded character of people's interactions with information, rather than the individual cognitive processes emphasised by "behaviour". In this thesis, the term is used when describing what the participants do, consistent with the study's framing of disciplinary mental models as learned, shared, and enacted. See also *Information behaviour (IB)*.

Information grounds: Fisher and Naumer's (2006) term for social settings in which information is exchanged spontaneously, though the setting was not designed for that purpose (e.g. pubs, common rooms, conference corridors).

Mental model: In the inherited HCI and LIS sense: an individual's internal representation of a system or process, which guides their beliefs, expectations, and practices (Johnson-Laird, 1983; Norman, 1983). The term operates in three related senses in this thesis: mental models of systems (the sense reviewed in Chapter Two, from which this study departs); mental models of disciplinary knowledge (the central object of this study); and mental models of the organisation of scholarly information (the bridge between the

two—the expectations scholars carry, grounded in their disciplinary frameworks, about how information is and should be arranged in libraries, archives, institutions, or digital systems). The argument of the thesis is that the second shapes the third, which in turn helps explain much of what scholars experience in the first. "Model" is used as a metaphor, a heuristic for naming the structured representations scholars carry, rather than as a scientific method. See Chapter One, Key Concepts.

Organisation of scholarly information: Both the formal infrastructures (catalogues, databases, classification schemes) and the wider institutional and intellectual arrangements (curricula, departments, research groups, funding structures) through which knowledge is structured in academia.

Shapes (of disciplinary mental models): The four situated representations of disciplinary knowledge identified in this study: the networked, molecular structure in chemistry; the torch-lit dark room in history; the cyclical, patient-centred model in medicine; and the hierarchical, inverted tree in law. These emerged from participants' own drawings and accounts. They are not universal typologies but situated phenomena, continually transformed within particular disciplinary and institutional contexts.

Sociomateriality: The perspective that material objects, spaces, and technologies are constitutive of, rather than incidental to, social practice and thought (Huizing and Cavanagh, 2011).

Third place: Oldenburg's (2023) term for informal social settings--pubs, cafés, dining halls, common rooms--where community is sustained outside home and the formal workplace.

Transculturation: Within Pratt's (1991) contact zone framework: the process by which the less powerful party in an asymmetrical encounter selects, adapts, and repurposes materials from the dominant culture. Used in this thesis to describe scholars' workarounds and adaptations of information systems that do not reflect their disciplinary frameworks.

1 Introduction

This thesis investigates how scholars in different academic disciplines conceptualise and engage with the organisation of scholarly information. It explores the mental models that shape these engagements—the cognitive frameworks through which researchers perceive, structure, and navigate their information environments. In a period when digital discovery systems and search tools have become central to scholarly work, this study examines what these mental models look like, how they are formed, how they vary across disciplinary contexts, and how they shape scholarly interactions with information.

The universalising tendencies of contemporary search and discovery technologies sit uneasily alongside the disciplinary diversity of academic research. Whilst these systems promote a seamless and standardised experience, the epistemic cultures and working practices of academic disciplines remain distinctive. Through a comparative, qualitative investigation of four disciplines at two UK universities, the study considers how disciplinary mental models shape scholars' engagement with discovery systems, and how recognising such diversity might support more contextually aware approaches to the design and delivery of scholarly information.

1.1 Context and problem space

Since the early 2000s, the landscape of scholarly information seeking has undergone a significant shift. The release of Google Scholar in 2004 placed a specialised search engine for academic materials directly alongside—and, in some eyes, in competition with—academic libraries (Oh and Colón-Aguirre, 2019, p. 876). Libraries began developing computer-based catalogue systems in the late 1960s and early 1970s to provide users with online access—by 1981, termed Online Public Access Catalogues (OPACs) (Wells, 2021). Over time, OPACs evolved into "discovery systems" and "discovery tools" (Caplan, 2012), which meant to centralise the library search experience by expanding beyond local holdings to include journal databases and external applications (Barton and Mak, 2012). Drawing on retrieval techniques and design principles from commercial search engines, discovery systems commonly replace complex search functionalities with a single, Google-style search box (Prescott and Erway, 2011; Oh and Colón-Aguirre, 2019).

This evolution is part of what Dempsey (2020, pp. xxi–xxii) describes as "a complex network ecosystem of offerings from libraries and third-party providers" in which "discovery often happens elsewhere" beyond the library. Users now move fluidly between Google Scholar, ResearchGate, Wikipedia, reading

lists, and library systems in a single workflow. As discovery shifts from a model of information scarcity to one of abundance (Dempsey, 2020), library discovery layers have become one service among many, not the primary entry point.

Yet this convergence with web-search technologies such as Google has fundamentally altered user expectations, popularising the expectation that discovery should be comprehensive, immediate, and straightforward—that entering a few words into a single query box will retrieve relevant materials in ranked order (Barton and Mak, 2012; Oh and Colón-Aguirre, 2019). In striving for this simplicity, discovery systems may inadvertently flatten the distinctive information practices and mental frameworks of users, particularly in academia, where scholars in different fields face pressure to conform to the currently prevailing search system logic as they conduct their research.

Scholars have observed that, whilst such interfaces simplify and streamline users' interactions with library resources, they also mask or flatten the underlying bibliographic structures and metadata on which those resources are organised (Borgman, 2010; Rikowski, 2011; Vaughan, 2011). In a similar vein, Introna and Nissenbaum (2000), van Dijck (2010), and Noble (2018) each highlight in different ways how search engines are not neutral or universal mediators of information but systems whose design and ranking practices can present a seemingly uniform search experience that obscures underlying biases, hierarchies, and contextual differences among both sources and users.

Research in the digital humanities has repeatedly argued that scholarly engagement with digital resources is shaped by established disciplinary practices, and that interfaces and research tools are most effective when they are designed to support those practices rather than impose uniform workflows. Unsworth (2000) argued that computing tools should build on methods already familiar to humanists, whilst Whitelaw (2012, 2015) advocated for "generous interfaces" that provide richer, more exploratory environments suited to diverse user needs. Crymble (2016) similarly emphasised the need to align digital infrastructure with disciplinary approaches to working.

This thesis addresses the tension between the universalised logic of contemporary discovery systems and the disciplinary diversity of scholarly practice. By foregrounding disciplinary variation, it interrogates the extent to which universalised search paradigms, epitomised by Google and mirrored in library discovery systems, serve—or fail to serve—the diverse user needs and scholarly practices across different subject communities. The migration of scholarly discovery into networked environments and the adoption of minimalist interfaces by libraries have created an implicit universalism at odds with the disciplinary diversity of academic research. Whilst much research examines information behaviour and information system usability (see Chapter Two), far less attention has been paid to the cognitive frameworks, or the

mental models, by which scholars in different disciplines conceptualise the organisation of knowledge and approach the navigation of library and scholarly resources. This study explores that gap.

This thesis was prompted in part by an internal, unpublished study at the Bodleian Libraries, which noted differences in how researchers from different disciplines engaged with library collections.

1.2 Research aim, questions, and objectives

The overall aim of the study is to examine how researchers in four disciplines at two UK universities understand and perceive the organisation of knowledge in their fields, and how these mental models shape their engagement with library and other information resources.

To pursue this aim, the research is guided by the following questions:

1. How do researchers' mental models of the organisation of knowledge vary across disciplines?
2. How do these differences influence their methods for discovering and selecting collection items?
3. How might insights into these mental models inform the design of library search and discovery interfaces?

In order to answer these questions, the study sets out four objectives:

1. To develop qualitative case studies of disciplinary practices among researchers at the University of Glasgow and the University of Oxford.
2. To offer a holistic view of how researchers interact with both physical and digital collections, bridging a divide in the literature between the usage of physical and digital information resources.
3. To examine researchers' preferences for search interfaces, focusing on how disciplinary knowledge structures shape their needs.
4. To provide recommendations for designing library systems that support diverse disciplinary approaches to organising and accessing knowledge.

These questions and objectives require an exploratory, cross-disciplinary approach to understand how scholars conceptualise, navigate, and articulate the structure of knowledge in their fields. Because disciplinary mental models remain largely unexamined in the literature, the study develops a new interdisciplinary framework to address these questions, which is outlined in Chapter Three.

1.3 Research gap

Although a substantial body of work exists on information behaviour and practice (Wilson, 1999; Spink and Cole, 2006; Spink and Heinström, 2011; Ruthven and Kelly, 2011; Ford, 2015; Case, Given, and Willson, 2023), much of it has moved from system-oriented to more social and contextual approaches without yet fully examining the cognitive frameworks that shape scholarly practices. This trajectory has been productive as it has yielded rich accounts of information practices as embodied and socially situated (Orlikowski, 2007; Olsson and Lloyd, 2017; Olsson *et al.,* 2018; Veinot and Pierce, 2019), of the perceived horizons of sources within which people seek (Sonnenwald, 1999, 2005), and of the affective and everyday aspects of information experience (Kuhlthau, 1991; Savolainen, 1995; McKenzie, 2003, 2006). However, in turning away from the cognitivism of early systems research, the field has also set aside the question of how people internally represent and conceptualise information, leaving the mental models concept stranded in its original system-oriented paradigm. Recent calls for holistic approaches (Polkinghorne and Given 2021) suggest a way of recovering that question without reverting to a systems approach: a holistic lens to mental models would treat them not as individual schemas to be tested against system designs, but as situated, embodied, and socially constituted frameworks shaped by disciplinary culture, expressed through practice, and continually redefined. It is this holistic reconceptualisation of mental models that the present study develops.

Furthermore, disciplinary studies of information practices have provided valuable insight into how particular individuals and groups use resources, but they tend to focus on single occupations or career levels (e.g., Brown, 2002; Cole *et al.*, 2007; Jamali and Nicholas, 2008; Willson and Given, 2020) and offer limited understanding of cross-disciplinary, socio-cognitive dynamics. As a result, relatively little is known about how disciplinary cultures influence the ways scholars conceptualise information environments or how these conceptualisations affect their use of discovery systems.

Work on mental models within library and information science has largely centred on students and on their understandings—often framed as incomplete or inaccurate—of search engines, online databases, and other digital tools (Westbrook, 2006a; Cole *et al.*, 2007; Zhang, 2008b, 2008a; Given and Willson, 2014). Comparative analyses of mental models across academic disciplines remain rare, and disciplinary variation is seldom addressed explicitly in user experience research for libraries, which typically examines universal or individual preferences rather than collective differences.

Scholarship on disciplinary pedagogy (e.g., Donald, 2002; Kreber, 2008; Gurung, Chick and Haynie, 2009) and epistemic cultures (Knorr-Cetina, 1999; Becher and Trowler, 2001) highlights the differences in how disciplines structure knowledge and cultivate ways of thinking. However, this literature focuses

mainly on teaching and the transmission of knowledge and disciplinary habits, rather than on how disciplinary enculturation has ultimately shaped the cognition and mental models of researchers themselves.

These overlapping gaps suggest a shared need: greater attention to disciplinary mental models as a bridge between cognition, practice and culture in academic research. Very little work has yet examined, in a cross-disciplinary and institutionally grounded way, how scholars think about and conceptualise the organisation of scholarly information and how these mental models influence their expectations of search and discovery systems. The purpose of the present study is to address this underexplored area by employing a qualitative, exploratory approach to investigate disciplinary similarities and differences in scholars' mental models at two UK universities. The following section provides a brief definition of the main concepts in the thesis title, offering context for the review of the literature in Chapter Two.

1.4 Key concepts

The title of this thesis, "*Mental models of the organisation of scholarly information across the Academy: disciplinary similarities and differences"*, brings together several key concepts. Briefly defining these terms will help orient the reader before they are explored in depth in the literature review (Chapter Two).

Mental models are the internal representations that individuals form of systems or processes, which guide their beliefs, expectations, and behaviours (Johnson-Laird, 1983; Norman, 1983). Within information behaviour research, mental models have been used to illuminate how people conceptualise specific search systems or the online information environment more broadly (Rieh *et al.*, 2010; Khoo and Hall, 2012; Zhang, 2012; Kodama *et al.*, 2017).

Because the term carries different meanings, it is worth stating how it is used in this thesis. The term operates in three related senses: mental models of systems, mental models of disciplinary knowledge, and mental models of the organisation of scholarly information. The first, mental models of systems, is the sense derived from HCI and LIS research referring to users' understandings of particular tools. This is the sense reviewed in Chapter Two and the one from which this study departs. The second, mental models of disciplinary knowledge, is the central object of this study, and refers to the internal frameworks through which scholars conceptualise the structure and organisation of knowledge in their fields. The third, mental models of the organisation of scholarly information, bridges the previous two; it refers to the expectations scholars carry, grounded in their disciplinary frameworks, about how information is and should be

arranged in libraries, archives, institutions, or digital systems. The argument in this thesis is that the second shapes the third, which in turn helps explain much of what scholars experience in the first.

Although the concept of mental models originates in cognitive science and human-computer interaction (HCI), this study uses it in a fundamentally different way. The focus here is not on how accurately scholars' cognitive representations map onto system architectures, or the deficit framing common in HCI mental models research, but on how scholars' conceptions of knowledge within their disciplines are something learned, shared, and enacted within disciplinary communities. The study is, in this sense, less a cognitive study than a cultural one, as it seeks to understand scholarly life from the bottom up, from the perspectives of researchers themselves, examining how they make sense of knowledge, navigate information environments, and situate themselves within their academic communities in UK higher education.

A note on the word "cognitive" is also necessary. Throughout this thesis, "cognitive" and "cognition" are used in an interpretive sense rather than a scientific one: they stand for the interior world of thought and meaning through which scholars make sense of their disciplines, not for the neurobiological processes studied in cognitive science. The study's use of cognitive mapping derives from library ethnography and UX tradition, in which drawing exercises are used to elicit how people experience and navigate their environments, and is closer to Jameson's (1988) concept of cognitive mapping—the situated attempt to represent a totality exceeding direct perception, whether a city or, in this case, a discipline—than to the experimental tradition. Disciplinary mental models are not treated as biological or fixed properties of expert minds; they are described in this thesis as plural and dynamic. Where the thesis moves between "cognition" and "conceptualisation", this is deliberate. In the interpretive sense adopted here, the two are related: cognition is conceptualisation in context.

Furthermore, the word "model" itself also deserves explanation. In a scientific context, a model implies generality and stability, which sit uneasily with this study's emphasis on the positioned, specific, and dynamic. The term is retained for three reasons. Firstly, it maintains continuity with the body of research on mental models this thesis engages with. Secondly, it remains close to the empirical findings: participants produced structured, almost spatial representations such as trees, cycles, networks, and rooms. Established LIS alternatives such as Sonnenwald's (2005) information horizons and Lloyd and Wilkinson's (2016) information landscapes capture something different. Both foreground practices of seeking and becoming informed; neither names the internal structures of disciplinary knowledge that participants externalised in their drawings, for which "model" is a more accurate descriptor. Thirdly, the term is used here as a metaphor, a heuristic for naming the structured representations scholars carry, rather than a scientific method. The models described in this thesis are not universal but situated

phenomena inhabited and continually transformed within particular disciplinary and institutional contexts.

The *organisation of scholarly information* refers both to formal infrastructures and to the wider institutional and intellectual arrangements through which knowledge is structured in academia. In the library context, this includes early OPACs and successively developed discovery services that integrate catalogue data with journal articles, book chapters, and external resources (Wells, 2021). Beyond the library, universities and departments organise knowledge through curricula, subjects, departments, research groups, and funding structures, which shape how information is produced, stored, and transmitted (Becher and Trowler, 2001; Fry & Talja, 2007). Scholars internalise these disciplinary and institutional patterns, developing mental frameworks for grouping and navigating material within their fields. These internal cognitive maps—shaped by disciplinary cultures and local institutional contexts—are thus an integral part of the "organisation" of scholarly information as conceived here.

Across the Academy signals the scope of the research. Rather than focusing on a single subject area, this study spans four disciplines that span the arts and humanities, social sciences, and sciences. It also takes place in academic settings, within two UK universities, situating its inquiry within real institutional settings whilst maintaining a comparative lens. This framing responds to calls for more empirically grounded, cross-disciplinary research on scholarly information-seeking (Warwick, Terras, Galina, *et al.*, 2008; Gooding, Terras and Berube, 2019).

Finally, the emphasis on *disciplinary similarities and differences* reflects the comparative orientation of this project. Scholarship in the digital humanities has signalled how existing disciplinary practices shape researchers' engagement with digital resources and that interfaces and research tools could be designed more effectively to support those practices rather than impose uniform workflows (Unsworth, 2000; Whitelaw, 2012, 2015; Crymble, 2016). There is also a significant body of literature in information behaviour that deals with differences in information practices, mostly in single disciplines (e.g., Makri, Blandford and Cox, 2008; Chassanoff, 2013; Gordon *et al.*, 2018) or groups of disciplines (e.g., (Brown, 1999; Francis, 2005; Given and Willson, 2015), but relatively few studies focus on in-depth disciplinary comparisons. This study focuses on the distinctive mental models that scholars bring to information seeking, by comparing patterns across academic disciplines in specific institutional settings to identify where shared approaches exist and where more nuanced, discipline-sensitive support may be required.

1.5 Methodological orientation

Because disciplinary mental models remain an underexplored phenomenon, this research employs a qualitative, exploratory design**,** grounded in four disciplinary case studies. The term "exploratory" is used here in a specific sense: the study explores what participants themselves believe, perceive, and articulate about knowledge in their own disciplines, rather than testing hypotheses against predefined categories. It does not signify that the research is preliminary but reflects a methodological commitment consistent with constructivist grounded theory (Charmaz, 2025) that is open to participants' meanings and categories that emerge from their accounts. It seeks to capture scholars' perspectives in depth and to situate them within their institutional and disciplinary contexts. To build a richer picture of how participants articulate and make sense of the organisation of scholarly information, the study employs multiple methods**,** including semi-structured interviews, cognitive mapping exercises, and observation. It takes an interpretive, inductive approach, recognising that mental models are socially and contextually shaped and dynamic, rather than fixed entities.

The empirical work implementing this study's design took place from May to September 2023 at the Universities of Glasgow and Oxford, with pilot studies conducted in Glasgow in April 2023. The method was developed and refined, incorporating an observational component into the interviews, as the spatial and material aspects gained greater focus throughout the study, reflecting the iterative and grounded nature of the research.

Given the novelty of the topic, the research also develops a new, holistic theoretical framework to guide the analysis rather than relying on an existing model. Together with an explanation of this framework, Chapter Three presents details of the case study design, data generation, and data analysis.

1.6 Scope of study

This study focuses on 40 academic researchers working in four disciplines at two UK universities. It examines how these scholars conceptualise the organisation of scholarly information within their own disciplinary contexts and how such mental models shape their approaches to discovery. The analysis is therefore grounded in the lived experiences of established researchers rather than students or other user groups.

Several areas lie beyond the scope of the project. It does not include students, postgraduates, subject librarians, university administrators, or system designers. Nor does it investigate non-scholarly search contexts, other types of institutions, or global comparisons. The findings are accordingly not presented as universally generalisable but as situated insights into disciplinary mental models within two specific institutional settings. By defining these boundaries, the study seeks to provide a clear and manageable focus whilst offering situated, in-depth evidence that may stimulate further research on disciplinary mental models in other contexts.

1.7 Contributions of the study

This thesis presents an original investigation of disciplinary mental models, introducing a neglected dimension into debates about information seeking and systems design.

This study makes four interrelated contributions. Empirically, it offers new qualitative evidence on how researchers in four disciplines at two UK universities conceptualise the organisation of scholarly information. By focusing on scholars rather than students and by comparing across disciplinary boundaries, it addresses a gap in the existing literature on information practice and mental models.

Conceptually, the study brings together insights from information practice research, mental model theory and scholarship on disciplinary culture to frame disciplinary mental models as a valuable lens for understanding scholarly discovery. Rather than assuming universal cognitive structures or practices, it argues that disciplinary enculturation shapes how researchers think about, navigate and evaluate information environments.

Practically, the study does not seek to prescribe or redesign systems. Instead, it highlights that prevailing approaches to library and discovery system design have generally prioritised universal or individual preferences and have seldom taken disciplinary mental models into account. By surfacing the existence and diversity of such mental models, the research offers situated insights that can inform future thinking about how disciplinary nuance might be recognised in the design of systems and delivery of scholarly information.

Culturally, the study offers a bottom-up account of scholarly life in UK higher education, showing how disciplinary cultures are carried by individual scholars and expressed in their conceptions of knowledge, their information practices, and the spaces in which they work.

1.8 Outline of the thesis

This thesis is organised into seven chapters that present the conceptual, methodological, and empirical components of the research. The structure moves from establishing the theoretical foundations of the study to presenting and discussing its findings and implications.

Chapter Two reviews three primary bodies of literature that inform the study. It begins with mental models, the central concept of the study, tracing its origins in cognitive science, its application in LIS, and the point at which sustained attention to it lapsed. A short contextual section then outlines how scholarly information is organised, as this is the object of the mental models examined in the study. The chapter then turns to information behaviour research, following the field's evolution from system-oriented models through the social and contextual turn towards practice-based approaches, and situating this study's terminology within that trajectory. The fourth section examines scholarship on disciplinary cultures and boundaries, from studies of academic tribes and epistemic cultures to work on how disciplinary thinking is taught, transmitted, and bounded. The chapter concludes by drawing the three strands together to articulate the gap this thesis addresses: the absence of research connecting scholars' internal representations of knowledge to the cultural and practical life of disciplines.

Chapter Three provides a detailed overview of the methodology employed in the study. It begins with a theoretical framework—derived from the holistic paradigm in LIS, library user experience and ethnography, as well as the concept of the *contact zone* from critical literary studies—developed specifically for this study. It then describes the research design, which involves multiple methods and four case studies, and explains how data were generated and analysed, all within a qualitative, context-aware, iterative approach. Finally, it discusses ethical considerations and methodological limitations.

Chapters Four to Six discuss the findings, presenting themes emerging from the data in three separate chapters, starting with the strongest explanatory factor underlying disciplinary mental models. Chapter 4 begins with the key findings: the different forms of scholars' mental models across chemistry, history, law, and medicine. The rest of the chapter explains and supports how these shapes were identified by exploring how external factors—universities, disciplines, collections, and systems—shape scholarly mental models of knowledge.

Chapter Five explores the individual factors, including educational background, career trajectory, and specialism, that shape scholarly mental models across the four cases. It examines researchers' motives for

choosing and staying in their discipline, the training and education they received, the nature of their daily work, and how they self-identify in relation to their academic discipline and community. It also touches upon how specialisms and ways of thinking and reasoning can extend beyond conventional disciplinary boundaries, reflecting participants' lived experiences and grounded perspectives.

Chapter Six introduces social, spatial, and material aspects of scholarly mental models. It begins by exploring the role of physical, everyday spaces in disciplinary thinking. Then, it moves into spaces beyond the office or laboratory—specifically, field sites—that reconfigure mental models iteratively as disciplinary knowledge is extended into real-world contexts. It also discusses material objects and the everyday tools that both reflect and shape scholarly work and modes of thinking, as well as the informal social aspects of academic work—such as chats over coffee and in the pub, conversations at conferences, or exchanges on social media—that also play a role in shaping disciplinary mental models. The chapter concludes by discussing disciplinary variation in culture, collaboration, and spatial layout, grounded in institutional context.

Finally, Chapter Seven presents a discussion of the key findings, examining the various shapes that mental models take across the four case studies and the three distinct aspects that influence them (external, internal, and sociomaterial factors). It also discusses the relationship between mental models and information systems, arguing that information systems should be viewed as an integral part of users' information worlds and life worlds, rather than as a binary opposition between users and information systems, thereby reinforcing the need to consider the disciplinary contexts in which users are embedded. Furthermore, it examines how informal networks in academia offer modes of determining relevance and credibility in a more transparent, community-based manner, in contrast to opaque, contextless algorithmic rankings. It may be beneficial for systems to consider a community-determined approach to relevance, as determined by disciplinary communities, to facilitate access to relevant material. The limitations of the study and future research directions are also laid out.

1.9 In closing

This chapter has outlined the background, aims, and scope of the study. It has traced how, since the early 2000s, library discovery has been reshaped by the rise of commercial search technologies and minimalist interfaces, and how this shift risks an implicit universalism in scholarly information seeking. Against this backdrop, the chapter has introduced the research aim, questions, and objectives, clarified the key

concepts in the title—particularly of mental models and the organisation of scholarly information—and previewed the qualitative, case-study approach adopted in the study.

The thesis proceeds from the premise that disciplinary cultures and institutional contexts shape how scholars think about, navigate, and evaluate information environments. In a time when simplified discovery systems and algorithmic search engines dominate, assumptions of simplicity and uniformity risk obscuring the disciplinary knowledge structures that continue to shape scholarly engagement with information resources. By investigating the mental models through which scholars in four disciplines at two UK universities conceptualise the organisation of scholarly information, the study offers situated insights into a dimension of academic practice that has so far received little attention. In doing so, it seeks to deepen understanding of how disciplinary cultures influence scholarly engagement with information systems and to open new paths for research on the links between cognition, practice, and the infrastructures of discovery.

With this context in place, the thesis now turns to the literature on mental models, information behaviour and practice, and disciplinary cultures, together with background on how scholarly information is organised, to show how existing research has shaped, and left gaps in, our understanding of disciplinary mental models, laying the conceptual groundwork for the empirical work that follows.

2 Literature review

2.1 Introduction

Chapter One traced the changing landscape of libraries since the 2000s, when the emergence of Google Scholar and other innovations in search technologies began to reshape information seeking. Shifting from the library side to the user perspective, Chapter Two offers an overview and synthesis of existing scholarship in this problem space—namely, how universalised search paradigms fail to meet the varied needs and practices of different scholarly communities—in order to identify the research gap.

The library discovery layer was developed in response to innovations in the commercial technology sector—particularly the World Wide Web and advances in information retrieval—and was accompanied by large-scale digitisation projects as libraries sought to adapt to changes in the private sector and provide access to users online (Borgman, 2010; Rikowski, 2011; Vaughan, 2011). Whilst these developments simplified the search experience, the adoption of discovery layers that mirrored minimalist commercial interfaces came at a cost. Some of the nuance was lost for users, as the complexity of bibliographic and archival organisation became increasingly obscured behind a single search box, risking the assumption that search is universal and imposing a one-size-fits-all model (Introna and Nissenbaum, 2000; van Dijck, 2010).

The implications of changing tools and technologies on scholarship have been widely discussed across library and information science (LIS), human–computer interaction (HCI), and digital humanities (DH) (Blandford and Attfield, 2010; Warwick, Terras and Nyhan, 2012). Scholars have reflected critically on how commercial search regimes shape research, highlighting the need to design tools that better reflect scholarly practices and contexts, and empower users (Unsworth, 2000; Marchionini, 2006; Warwick, Terras, Huntington, *et al.*, 2008; Whitelaw, 2015). Despite this attention on user needs, gaps remain in our understanding of how scholars' sociocultural and cognitive backgrounds shape information practices. Foundational information behaviour studies tended to emphasise individual differences (e.g., Marchionini, 2006; Nicholas *et al.*, 2006, 2010; Rowlands *et al.*, 2008), a tendency that persists in much of the literature. Although there is now a substantial body of research on disciplinary information practices, these studies often describe patterns of scholarly behaviour (Ellis and Haugan, 1997; Research Information Network *et al.*, 2009; Catalano, 2013; Georgas, 2014; Fu, Lomas and Inskip, 2021) rather than interrogating the underlying cognitive or epistemic frameworks that drive disciplinary variation. More specifically, there is limited understanding of the role of academic disciplines and mental models in shaping scholarly expectations of search. Identifying disciplinary nuances in the ways researchers

conceptualise and navigate information is critical for developing more effective library discovery systems.

Three different fields of scholarship address this problem from different angles: mental models, information behaviour and practice, and disciplinary culture and teaching. Mental models research has explored people's understanding of tools and systems (Thatcher and Greyling, 1998; Zhang and Chignell, 2001; Zhang, 2008c; Maceli, 2019; Han *et al.*, 2020; Norton, Bloodworth and Nielsen Ott, 2024), but few studies mention disciplinary practices or the perspectives of academic researchers. Information behaviour studies have examined scholarly practices in individual disciplines (Gorman, 1995; Joseph, 2001; Duff and Johnson, 2002; Cole *et al.*, 2007; Jamali and Nicholas, 2008; Bronstein and Solomon, 2021), but investigations into cross-disciplinary variation or the cognitive drivers underpinning practice have been limited. Studies of academic disciplines have focused on pedagogy (Kreber, 2008; Gravelle and Fisher, 2012; Bager-Elsborg, 2019; Huber and Morreale, 2023), culture (Knorr-Cetina, 1999; Becher and Trowler, 2001; Trowler, Saunders and Bamber, 2013; Fry *et al.*, 2016), and practice (Ithaka S+R, 2012, 2013, 2014, 2014, 2017b, 2017a, 2018, 2019b; Given and Willson, 2018), but not on the lived experience and ways of thinking actually held by scholars.

Although each of these bodies of literature highlights a different aspect of the problem, there is no study systematically linking them, despite existing overlapping gaps across these three strands that address the missing explanatory factor this thesis addresses: disciplinary mental models. These mental models, cultivated through discipline-specific pedagogies and embedded in cultural contexts, shape how scholars think, and how they seek and use information.

This chapter reviews three bodies of literature that inform the study, together with a short contextual section. It begins with mental models research, which offers a way of investigating how individuals internally represent knowledge and systems. A brief section then provides background on the object of these models, the systems and structures through which scholarly information is organised. The chapter then turns to information behaviour and practice research, which offers a way of investigating what scholars do with information and the social contexts of that activity. The final strand examines scholarship on disciplinary cultures and boundaries, which offers a way of investigating the communities and epistemic traditions within which scholars are formed. The chapter concludes by assessing the limitations of each perspective taken alone, and by arguing that the phenomenon this thesis investigates, disciplinary mental models, is visible only where the three are brought together.

2.2 Mental models

The concept of *mental models* (MM) offers a useful framework for examining the less visible cognitive structures that guide how individuals understand and interact with information. This section first traces the conceptual development of MMs across relevant fields before turning to its empirical applications in LIS research. In doing so, it establishes the theoretical foundation for the present study's focus on disciplinary MMs as a key factor shaping scholarly information practices.

2.2.1 Conceptual developments

The notion of *mental models* has its roots in several disciplines, including psychology, cognitive science, and human–computer interaction (HCI) (Kodama *et al.*, 2017). Early conceptual precursors can be found in theories of the *schema* in psychology. Bartlett (1932, p. 201) defined a schema as "an active organisation of past reactions, or of past experiences", emphasising the role of memory in shaping understanding. Piaget (1953) developed the idea in an individualistic direction, proposing that children construct mental structures by integrating new information into existing schemata or by altering them to accommodate their own experiences. Vygotsky (1978), in contrast, conceived of schemata in children's cognitive development as a fundamentally social phenomenon, formed through interaction and cultural mediation.

Cognitive scientists in the 1980s, however, would trace the origins of MMs more directly to Craik (1943), who argued that individuals create internal small-scale representations of reality that mirror external structures and relations. These internal models not only represent the external world but also provide functional guidance and predictive ability, enabling people to test possibilities, make decisions, and anticipate future outcomes. Building on these ideas, the present study defines a *mental model* as a cognitive structure grounded in experience and memory that maps relationships between concepts and supports navigation of information environments.

Cognitive scientists in the 1980s developed MM theories around the notion of a correspondence between the external environment and internal representations, drawing on the metaphor of the mind as an information-processing machine (Marchionini, 2008). Johnson-Laird (1983), for example, used linguistic and semantic analysis to explain MMs in relation to human reasoning, and suggested that mapping MMs onto computer programs could be a means to make cognition explicit. Around the same time, other

researchers sought to capture and test people's MMs of systems, technological artefacts, and physical phenomena, with several such studies published in the edited volume *Mental Models* (Gentner and Stevens, 1983).

In this volume, Norman (1983, p. 7) distinguished between four related constructs: "the *target system*, the *conceptual model* of that target system, the user's *mental model* of the target system, and the *scientist's conceptualization* of that mental model". He explored the relationships between these elements, laying the groundwork for his influential book, first published in 1988 and later revised as *The Design of Everyday Things* (2013). Norman's work helped popularise the concept of MMs within HCI and design communities, where it became central to discussions about usability and user experience. Building on this foundation, subsequent research in HCI and usability studies applied the MM framework to practical concerns of system design, focusing on how users conceptualise and engage with technologies (Interaction Design Foundation, 2002; Krug, 2005; Nielsen, no date).

Borrowing from cognitive science, the concept of MMs was extended in cognitive anthropology and organisational studies to encompass collective, shared, and team-based forms (Quinn, 2005; Jones *et al.*, 2011). Senge's *The Fifth Discipline* (1990) popularised MMs in management studies by linking them with organisational learning and leadership, sparking interest in their role in group psychology and dynamics (Banks and Millward, 2000; DeChurch and Mesmer-Magnus, 2010). Research on *team mental models* expanded as a way to measure and enhance organisational management and performance (Cooke *et al.*, 2000; Langan-Fox, Code and Langfield-Smith, 2000; Mohammed and Dumville, 2001; Davison and Blackman, 2005a; Mohammed, Ferzandi and Hamilton, 2010; Paoletti, Reyes and Salas, 2019; Uitdewilligen *et al.*, 2021). As Jones *et al.* (2011) argue, this shift from an individual to a collective focus in MM research reflects a growing acknowledgment that cognition has a social dimension and that decision-making occurs across scales, from individual to societal.

2.2.2 MM in LIS literature

Borgman (1982, 1986a) provided some of the earliest LIS applications of MM theory, showing that user training grounded in MM development could significantly improve performance in Boolean search tasks. Her studies suggested that users with more accurate conceptual models of retrieval systems were able to engage more effectively with complex search processes. Unlike broader trends in MM or IB theory, however, LIS scholarship has remained largely systems oriented, asking whether users hold complete or accurate MMs of information systems and applying the concept as a UX tool, in similar ways to design

research (Ring, Ellis and Reeves, 1994; Soper and Mitra, 2013; *How to Use Mental Models in UX Design*, 2025; Nielsen, no date).

A recurring theme in MM research is the distinction between novice and expert users, with studies consistently showing that experts possess more coherent and adaptable MMs. For instance, Holman (2009) and Li (2007) found that domain expertise—defined as in-depth knowledge of a particular subject area—is linked to more complete and structured MMs, particularly when users navigate complex system features such as controlled vocabularies or advanced search functions. More recently, Furlough and Gillan (2018), compared video game players with varying levels of experience and found that novices showed fewer procedural and abstract connections in their MMs of a game than highly experienced players. Novices also tended to rely on natural language concepts, whereas experts drew on domain-specific terminology.

With the rise of the Internet and digital discovery platforms, empirical studies of MMs in LIS have focused on users' understandings of online tools and systems (Makri *et al.*, 2007a; Zhang, 2008a, 2008c, 2010; Holman, 2009, 2011). Much of this research examines how people conceptualise search engines, academic databases, and library interfaces, often using typologies to categorise users' approaches. For example, Thatcher and Greyling (1998)'s investigation of MMs of the internet found six categories of MMs and suggested these can expose gaps in users' understanding of the systems they use; Westbrook (2006b) identified postgraduate students' models of IT tools as linear, networked, or storm-like; and Han *et al*. (2020) found nine categories of novice users' MMs of databases, showing how cognitive models evolved through iterative use. Although these studies yielded valuable insights into how users' MMs can vary and evolve with experience, they generally treated users in isolation from their broader contexts. By concentrating on the Internet or online platforms as self-contained environments, this body of work has tended to leave out the physical, social, and institutional settings in which IB unfolds.

At the same time, work exploring use of online tools has also tended to frame users' MMs in terms of misalignment with system design. Misunderstandings of indexing, ranking, or access rights are often interpreted as evidence of incomplete or inadequate MMs (Makri *et al.*, 2007a; Zhang, 2008c, 2008a, 2010; Holman, 2009, 2011; Maceli, 2019). For instance, Khoo and Hall (2012) found that HCI students evaluated a library catalogue against Google, expecting similar features and functionality; whilst the authors interpreted this as naïve, this finding points to how users' MMs are grounded in everyday experience and other familiar online environments. Similarly, Cole *et al.* (2007) reported a mismatch between students' intuitive ways of organising topics and the hierarchies of thesauri, framing this again as a deficiency in user understanding rather than a limitation of the system. This system-centric orientation

casts the users' MMs as flawed. The present study takes the opposite stance: it treats MMs as meaningful cognitive and contextual phenomena focusing on how disciplinary cultures shape them and what they, in turn, can reveal about the diverse ways scholarly communities engage with information.

A further limitation of LIS research on MMs is its uncritical adoption of frameworks derived from commercial UX (Seale, Hicks and Nicholson, 2022). Studies have used MMs as diagnostic tools to evaluate user-system fit, mirroring consumer technology design, whilst overlooking the institutional and ideological assumptions behind these methods. As Seale, Hicks, and Nicholson (2022) note, UX practices imported into libraries tend to prioritise efficiency and satisfaction in ways that obscure the distinctive aims of scholarly information environments. In this sense, LIS studies risk reinforcing system-centred notions of usability, treating user understandings as comprising shortfalls rather than as situated perspectives. Recent LIS scholarship has begun to challenge the uncritical adoption of commercial UX assumptions, instead urging approaches that foreground users' situated, lived contexts. This includes Seale, Hicks, and Nicholson's (2022) call for a critical turn, Wilkinson's (2022) critique of the imported authority of UX in the field, Lanclos and Asher's (2016) comments on the instrumentalisation of library ethnography and UX for short-term institutional ends, and Hegarty and Boyd's (2023) broader critical LIS framing. These themes will be discussed further in the theoretical framework in Chapter Three.

It should be noted that much of the literature on mental models in LIS dates from the 1980s to the early 2010s. This reflects not an oversight in the present review but a trajectory in the field itself: after an initial wave of system-oriented mental models research, LIS scholarship largely turned toward social and practice-based approaches, and the concept received comparatively little sustained attention thereafter. Recent studies that do employ the concept (e.g. Han et al., 2020; Furlough and Gillan, 2018) remain largely within the system- and deficit-oriented paradigm. The relative scarcity of recent work in recent years on mental models and of the work connecting them to disciplinary knowledge is precisely the gap this thesis addresses.

As a perspective for investigating this study's topic, mental models research offers pathways into how individuals internally represent knowledge and systems, and elicitation methods such as visual techniques for externalising those representations. Its limitations for present purposes are twofold. Firstly, it has remained largely system-oriented and student-focused, framing users' MMs as more or less accurate approximations of a given system's design—a deficit framing this thesis rejects. Secondly, it treats the knower in isolation, saying little about where MMs come from, how they are shared within communities, or how they are shaped by training, culture, and material context. A study of disciplinary mental models

cannot proceed from this literature alone as it requires perspectives that supply the social and cultural dimensions lacking in this tradition.

2.3 The organisation of scholarly information

Because this thesis investigates scholars' mental models of the organisation of scholarly information, some background is needed on what that organisation consists of and how it has developed. This section is therefore contextual: it describes the structures through which scholarly information is arranged, namely classification, description, and discovery. It does not attempt a comprehensive review of knowledge organisation but establishes the object of the mental models examined in this thesis, and shows that this object is layered, varied across domains, and far from neutral.

2.3.1 The knowledge organisation tradition

Library classification and standardised subjects

The dominant instruments for organising library collections are numerical classification schemes, which arrange knowledge into hierarchical classes that determine intellectual description and, often, physical location (Broughton, 2015; Joudrey and Taylor, 2017). The Dewey Decimal Classification divides knowledge into ten classes subdivided by decimals; the Library of Congress Classification, which was developed for the Library of Congress's own collection, uses alphanumeric notation across twenty-one classes; the Universal Decimal Classification offers a faceted alternative allowing for compound subjects (OCLC, no date; Library of Congress, 2014; UDC Consortium, no date). Subject access is also provided through controlled vocabularies such as the Library of Congress Subject Headings, which supplement classification with standardised terms and cross-references between them (Broughton, 2012). Svenonius (2000) argues that systems of this kind answer to specific objectives against which their design choices can be evaluated.

These schemes are not neutral instruments. Hjørland (2008) argues that knowledge organisation always reflects particular theoretical and domain perspectives, privileging some views of a subject over others. Bowker and Star (1999) show that classification systems embed the values and assumptions of their makers, and that once embedded in working infrastructures these choices become largely invisible, except

to those whose experience the categories fit poorly. In a similar vein, Olson (2002) argues that library classification standards and subject headings reflect historical cultural biases, marginalising or excluding certain groups and topics.

Cataloguing and metadata standards

Description of informational entities follows content standards that determine what is recorded about an item, and encoding standards, which govern how it is structured for machine processing (Joudrey and Taylor, 2017). The Anglo-American Cataloguing Rules (AACR2) was the dominant content standard for decades before being succeeded by Resource Description and Access (RDA) (Oliver, 2010). Current information organisation is also informed by conceptual models such as the Functional Requirements for Bibliographic Records (FRBR) and the IFLA Library Reference Model (Riva, Le Boeuf and Žumer, 2017). Records have been encoded since the 1960s in MARC format, developed at the Library of Congress to enable catalogue records to be exchanged between institutions (McCallum, 2002). The Library of Congress's BIBFRAME initiative proposes replacing MARC's record-based structure with a linked-data model in which bibliographic relationships are expressed as linked entities (Library of Congress, no date). Alongside these, general-purpose metadata schemes such as Dublin Core support description across repositories and disciplines (Zeng and Qin, 2022; ISO, no date), whilst identifiers such as DOIs for outputs (Paskin, 1999) and ORCID for researchers (Haak et al., 2012) increasingly anchor scholarly objects and their creators within networked infrastructures.

Archival description

Archives are organised on a fundamentally different principle. Where library classification arranges items by subject, archival arrangement follows *respect des fonds*: records are kept with other records of the same creator, and in the order in which the creator maintained them, on the reasoning that there is inherent meaning in the relationship between a record and the activity that produced it (Millar, 2017). Description proceeds hierarchically, from fonds through series and files to item level, as codified in the General International Standard Archival Description (International Council on Archives, 1999) and, in North America, in Describing Archives: A Content Standard (Society of American Archivists, 2022). Encoded Archival Description provides the corresponding XML structure for machine-readable finding aids (Library of Congress, no date).

Because archival materials are described by provenance rather than subject, and description often stops well above item level, finding relevant material requires understanding the creating entity rather than searching by topic. Historians' search practices reflect this, favouring names and contexts over subject keywords (Duff and Johnson, 2002). Chapters Four and Seven return to this distinction, which helps

explain the friction historians in this study reported with keyword- and subject-driven discovery interfaces.

2.3.2 From catalogue to discovery

The environment in which scholars now encounter these organising structures has been transformed over the past three decades. The card catalogue gave way to the online public access catalogue (OPAC) (Borgman 1986b, 1996) and, in the early twenty-first century, the term discovery system emerged to describe catalogues that borrow search technologies of the commercial web (Wells, 2021). From around 2009, web discovery services such as Primo, Summon, and EBSCO Discovery Service became available to academic libraries, merging catalogue records, journal articles, and other resources into a single central index searched through one search box (Vaughan, 2011; Breeding, 2015).

This convergence on the single search box has attracted sustained critique. Marchionini (2006) argues that systems designed around short, transactional queries cannot adequately support the exploratory and iterative forms of inquiry that characterise much scholarly research. Whitelaw (2012, 2015) contends that minimal search interfaces impoverish users' engagement with collections, advocating instead "generous interfaces" that surface context, structure, and browsability. Others have shown that the apparent neutrality of search is illusory: relevance ranking embeds judgments that are invisible to users (Introna and Nissenbaum, 2000), search is a socially embedded technical practice (Gregory *et al*., 2020), and the design of metadata and discovery interfaces can systematically limit the visibility of less-represented scholarship (Shirazi, 2022). Thus, the discovery layer does not simply provide access to an organised collection but reorganises the collection in the act of presenting it in response to a query, flattening hierarchies into a ranked list and hiding contextual information.

Furthermore, beneath the surface of discovery systems, bibliographic infrastructure has been shifting from record-based standards towards linked-data models, so that scholarly information is organised less as a catalogue of discrete records than as an interconnected web of relationships between entities (Library of Congress, no date; Zeng and Qin, 2022). The growth of open access has increased the means by which a given work can be reached (Piwowar et al., 2018), whilst the FAIR principles extended expectations of findability and interoperability to research data (Wilkinson et al., 2016). Yet the sources scholars use differ in coverage and in how they index and rank material (Visser, van Eck and Waltman, 2021). The result is not a single organisation of scholarly information but several overlapping ones, which scholars must learn to navigate.

In sum, the organisation of scholarly information is layered, changing, and not neutral. Each layer embeds assumptions about what knowledge is, how it should be arranged, and who it is for. It is against this backdrop that the scholars in this study form and negotiate the mental models examined here. It should be noted that this study's data collection concluded in 2023, before generative artificial intelligence came to shape scholarly research processes (Busch, Hausvik and Nielsen, 2025). The organisation and mediation of scholarly information have continued to evolve since; the implications of this timing, and the opportunities it creates for future research, are discussed in Chapter Seven.

2.4 Information behaviour and information practice

The foundational body of research on which the present study is based, is in the fields of information behaviour (IB) and information practice. This section starts by defining the concept of IB, then identifies some of the key models from the field, traces the discourse on IB in social contexts and the emergence of the practice framework, and finally explores key empirical studies of IB in academic disciplines. In general, this section highlights how shifts in IB and practice literature place users and complexity back into the centre of our understanding of information seeking.

2.4.1 Models of information behaviour

Information behaviour (IB) is a term used to describe the various ways in which human beings respond to and interact with information. It also designates a subdiscipline within information science that seeks to understand people's relationship with information (Bates, 2018). Ford (2015, p. 27) observes that the field is continually evolving and has "embrace[d] more complex and wide-ranging views of the interactions between people, organizations and information"; accordingly, researchers and professionals have not limited themselves to a single definition of IB. As a central, orientating concept, IB has been defined in more specific terms, such as "the study of how people need, seek, give and use information in different contexts, including the workplace and everyday living" (Pettigrew, Fidel and Bruce, 2001, p. 44), and as the "generation, acquisition, management, use and communication of information, and information seeking" (Ingwersen and Järvelin, 2005, p. 259). Grounded in a holistic theoretical framework, which will be explained in more detail in Chapter Three, this study adopts Bates' (2018, p. 2074) definition of IB as

> …all instances where people interact with their environment in any such way that leaves some impression on them—that is, adds or changes their knowledge store…These changes can also reflect complex interactions where information combines with pre-existing knowledge to make new understandings, or enables the individual to deduce or induce new thoughts and ideas.

This definition is extended here to include not only interactions between people and their environment, but also interactions among people themselves.

Research on scholarly IB has evolved substantially over the past several decades, reflecting broader shifts in information science from system- and channel-oriented approaches to more person-centred and context-sensitive ones. A clear illustration of this transition is the shift from Shannon's (1948) mathematical theory of communication, dominant in the post-war years, to Dervin's (1983b, 1983a) sense-making theory, which sought to "humanise" communication and information systems by conceiving of information seeking as a situated process. The 1980s and 1990s saw the development of influential user-centred models, including Bates' (1989) "berrypicking" model, which proposed that information seeking typically follows non-linear paths, and Kuhlthau's (1991) "information search process" which incorporated the affective and cognitive dimensions of information seekers. The increasing complexity of models over time reflects a broader disciplinary shift that places user perspectives and contexts at the core of IB research.

Alongside these theoretical developments, empirical research into scholarly information practices has expanded steadily since the early twentieth century (Wilson, 1994; Bawden and Robinson, 2022). Early studies focused on the information needs and uses of academics and professionals in STEM disciplines, employing primarily quantitative methods (Bawden and Robinson, 2022). In the 1960s and 1970s, attention widened to include students in higher education (Tucker, 1961; Oppenheim, 1962; Bowyer, 1963) and social scientists (Line, 1971; Wilson, 1994). From the 1980s onward, both user groups and research methods diversified, with increasing attention directed to the arts and humanities, leading to significant studies on humanists' distinctive engagement with libraries, archives, and print materials (Corkill, Mann and Stone, 1981; Stone, 1982; Watson-Boone, 1994; Case, Given and Willson, 2023). Since the 2000s, research has also examined the growing use of online resources (Blandford, Rimmer and Warwick, 2006; Nicholas *et al.*, 2006, 2009, 2010; Huntington, Nicholas and Jamali, 2007; Rowlands *et al.*, 2008; Warwick, Terras, Galina, *et al.*, 2008; Warwick, Terras, Huntington, *et al.*, 2008; Nicholas, Rowlands and Jamali, 2010).

These developments marked a shift from a narrow focus on efficiency and information retrieval to a broader recognition of how academic communities interact with information. The next section turns to

several key IB scholars, considering their models in chronological order and showing how each framework built on earlier work, shaping the conceptual development of the field.

The first of these scholars, Dervin (1983a, 1998), challenged the positivist search for universal patterns of human behaviour across time and space by proposing an alternative approach that conceptualises IB as sense-making: a frequent, dynamic, and situational process. Adopting a constructivist perspective, Dervin (1983a) describes sense-making as the human need to "construct ideas to bridge gaps as a means of dealing with ever-present discontinuities in reality". The "gap" here refers to an information need or question that arises as people attempt to make sense and move through time-space (Dervin, 1983a). The sense-making model consists of three elements: *situations*, or the "time-space contexts in which sense is constructed"; *gaps*, the discontinuities and information needs individuals encounter; and *uses*, the purposes to which newly constructed sense is applied, often conceptualised as the ways in which information helps or hinders (Dervin, 1983a).

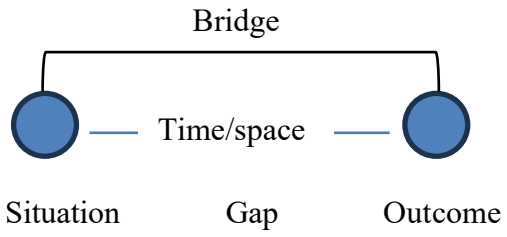


Figure 2-1 Dervin's (1983a) sense-making theory, modelled by Wilson (1999)

As shown in Figure 2-1, Wilson later elaborated on this tripartite model by introducing a fourth element, the *bridge*, and by replacing *uses* with *outcomes*, thereby emphasising how information behaviour involves building informational bridges to reconcile the situation with the outcomes of the sense-making process.

Dervin's sense-making model thus introduced a situational and constructivist approach that redefined information behaviour as a dynamic process of bridging gaps in context. As a user-centred framework, it explains how people deal with uncertainty and navigate changing situations to realise desired outcomes. Although not an IB model in the strict sense, it has nonetheless been highly influential in shaping the field

(Bates, 2018). Building on this foundation, other scholars proposed alternative models that further expanded the scope of IB research. The next was Ellis (1989a), whose work in the late 1980s offered a process-oriented account of information seeking grounded in empirical studies of researchers.

Ellis (1989a) proposed a model that identified common behavioural elements of scholarly information seeking. Based on an empirical study of social scientists' information practices, the model (Figure 2-2) describes a set of activities that do not necessarily occur in sequence but recur across searches.

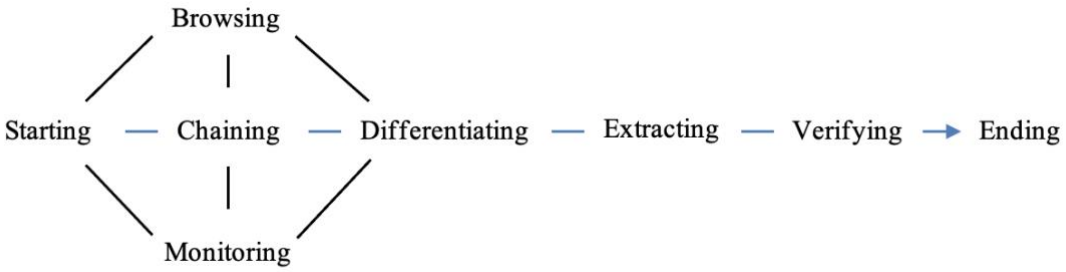


Figure 2-2 Ellis' (1989a) model, illustrated by Wilson (1999)

It consists of six main "characteristics", intended to "underpin recommendations for information retrieval system design and evaluation" (Ellis, 1989a, p. 178): *starting*, or the activities associated with initiating a search for information; *chaining*, the practice of following citations or other referential links between sources; *browsing*, semi-directed searching in an area of potential interest; *differentiating*, using differences between sources as filters of quality or relevance; *monitoring*, keeping up to date with developments in a field by tracking particular sources; and *extracting*, or systematically working through a particular source to locate material of interest.

The model proved influential and was subsequently applied and expanded in later studies. For example, Meho and Tibbo (2003) revised Ellis's model based on data collected from sixty social science faculty in fourteen different countries, whilst Bronstein (2007) applied it to a study of twenty-five Jewish studies scholars in Israel. Although the model does not account for contextual or causal factors, it provides what Wilson (1999) describes as a "micro-analysis" of the information-seeking process and stands as an early example of a model derived from empirical findings about a specific social group.

Ellis's framework, derived from close observation of scholarly practice, highlighted the recurring stages of information seeking and the non-linear ways in which users progress through them. Soon thereafter, Kuhlthau (1991) expanded the scope of inquiry by turning to the cognitive and affective dimensions of information seeking. Kuhlthau's (1991) "information search process" (ISP) model elaborates on the

stages and tasks of information seeking by integrating the associated feelings, thoughts, and actions (Figure 2-3). Drawing on Kelly's (1955) personal construct theory, which examines the affective features of experience, Belkin's (1980) anomalous state of knowledge (ASK) hypothesis, which addresses the user's sense of uncertainty, and their own empirical studies of student behaviour, Kuhlthau (1991, p. 366) formulated a model that combines three "realms" of the search experience: "the affective (feelings), the cognitive (thoughts), and the physical (actions)".

Stages in ISP	**Feelings common to each stage**	**Thoughts common to each stage**	**Actions common to each stage**	**Appropriate task according to Kuhlthau model**
1. Initiation	Uncertainty	General/Vague	Seeking Background Information	Recognize
2. Selection	Optimism			Identify
3. Exploration	Confusion/ Frustration/ Doubt		Seeking Relevant Information	Investigate
4. Formulation	Clarity	Narrowed/Clearer		Formulate
5. Collection	Sense of direction/ Confidence	Increased interest	Seeking Relevant or Focused Information	Gather
6. Presentation	Relief/Satisfaction or Disappointment	Clearer or Focused		Complete

Figure 2-3: Kuhlthau's (1991) ISP model

The ISP comprises six sequential stages. *Initiation* occurs when "a person first becomes aware of a lack of knowledge", often accompanied by "uncertainty and apprehension". In the *selection* stage, a search topic and approach are identified. *Exploration* involves investigation and orientation and may be marked by "confusion, uncertainty, and doubt". *Formulation* represents the "turning point of the ISP when feelings of uncertainty diminish and confidence increases" as the person gains clarity and focus. *Collection* follows, during which relevant information is gathered through interaction with information systems. Finally, *presentation* marks the end of the process, accompanied by either satisfaction or disappointment depending on the perceived success of the search. Whilst some stages overlap with Ellis' behavioural characteristics, Kuhlthau's model is distinct in its sequential structure and explicit, detailed expression of the affective and cognitive dimensions of information seeking, elements that Ellis' framework does not address.

Kuhlthau's integration of thoughts and feelings into IB marked an important expansion of the field beyond purely procedural, behavioural, or strategic models. Pioneering this growing complexity in the realm of theoretical models even before Kuhlthau, Wilson developed a series of models from the 1980s onwards, which synthesised earlier approaches and offered broader frameworks for understanding the contexts, drivers, and outcomes of IB. One of Wilson's (1981) first models is shown in Figure 2-4. This model of "factors influencing needs and information-seeking behaviour" captures personal factors—physiological, affective, and cognitive—as well as the social and environmental contexts in which an information need arises. It also illustrates the barriers that may hinder information-seeking activities. Wilson later described this diagram as a "macro-model", suggesting that personal, social, and environmental factors interact to shape IB. A subsequent version incorporated Ellis' model in the area of "information-seeking behaviour", thereby embedding Ellis' micro-level activities within a broader framework.

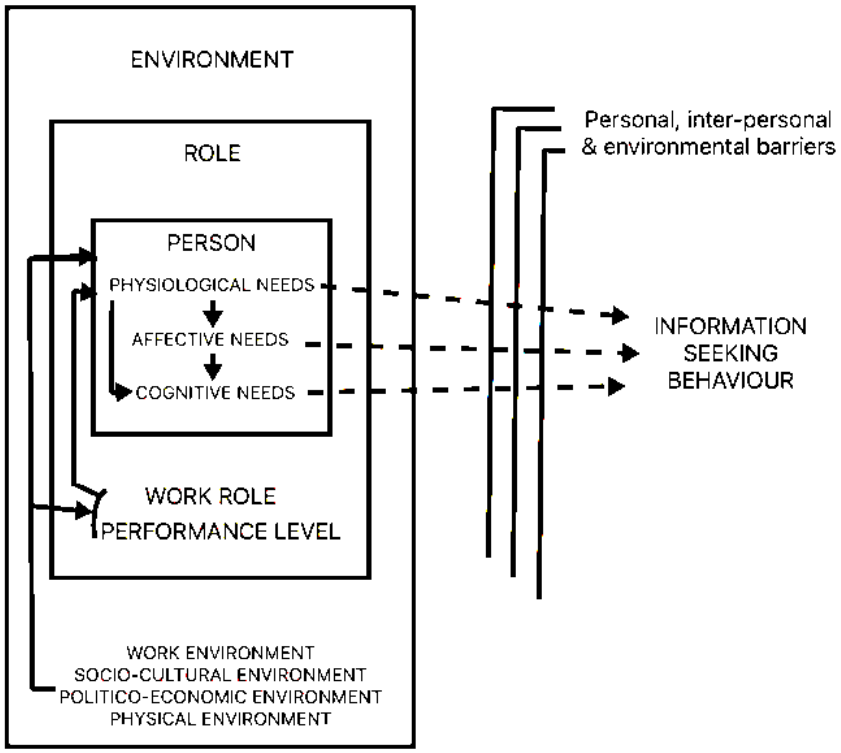


Figure 2-4 Wilson's (1981) model of "factors influencing needs and information-seeking behaviour"

In the following decade, Wilson (1997) revised and extended this work, producing a "general" model of IB that integrated insights from psychology, consumer research, health communication, decision-making

studies, and systems design (Figure 2-5). To account for the stage between the "person-in-context" and the decision to seek information, Wilson introduced "activating mechanisms" to explain sources of user motivation, drawing on cognitive theories from psychology.

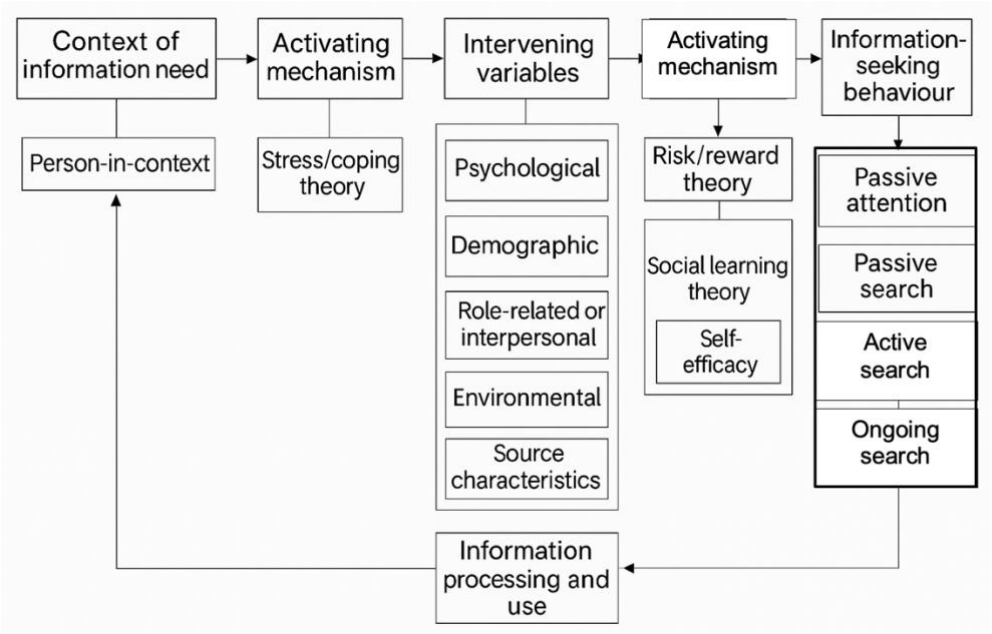


Figure 2-5 Wilson's (1997) "revised general model of information behaviour"

The "intervening variables" (previously called "barriers") were also expanded to five categories, with the "personal" now including psychological and demographic factors, and the characteristics of information sources being recognised as potential barriers. Unlike the 1981 model and Ellis' framework, which only deal with active search, Wilson's 1996 model encompasses active, passive, and ongoing forms of IB, as well as information processing and use, which feed back into the "person-in-context". Like Dervin's sense-making model, it is concerned with motivating factors and information needs but goes further in mapping a chain of causal links between the individual, context, intervening factors, modes of behaviour, and the processing and use of information.

Together, the models developed by Dervin, Ellis, Kuhlthau, and Wilson illustrate how IB research developed conceptual richness over the late twentieth century. Each added layers of complexity to the

study of IB, from Dervin's situated sense-making, to Ellis's processual stages, to Kuhlthau's integration of affect and cognition, and finally to Wilson's broad frameworks synthesising layers of context and activating/intervening mechanisms. These contributions moved the field beyond concerns over efficiency and retrieval and began to highlight explanatory factors underlying information practices, although they were still treated information seeking as an individual or generalised process. From this point, the field began to turn toward more social and contextual approaches, shifting attention from individuals to the collective settings in which information practices are embedded.

2.4.2 IB and social context

The sociocultural turn in IB research brought greater attention to the ways information practices are shaped by communities and shared environments rather than by individuals on their own (Case, Given and Willson, 2023). Ideas that earlier scholars had discussed primarily in theoretical terms were increasingly applied in empirical studies, leading to new sociocultural understandings of IB. The significance of this shift was evident in the emergence of the "Information Seeking in Context" conference in 1996, whose inaugural papers addressed, for example, job-related IB, the nature of context, and the everyday information practices of groups such as older adults and adolescent girls (Riley, 1999; Bates, 2018).

Out of this context, several influential concepts emerged in the 1990s and 2000s, including Hjørland and Albrechtsen's (1995) domain analysis, Savolainen's (1995) everyday life information seeking, Chatman's (1999) information worlds, Sonnenwald's (1999, 2005) information horizons, McKenzie's (2003, 2006) information practice, and Fisher and Naumer's (2006) information grounds. These concepts reposition IB within broader social and cultural contexts, offering alternative ways to understand how people engage with information environments.

Hjørland and Albrechtsen's (1995) *domain analysis* theory marked a significant shift in perspective by emphasising that understanding IB requires examination of the expert domains in which users operate. Rather than treating information needs as purely individual or universal, domain analysis situates them within the intellectual, social, and institutional structures of domains, defined as "thought or discourse communities, which are parts of society's divisions of labor" (Hjørland and Albrechtsen, 1995, p. 400). They argued that certain forms of language and communication, patterns of cooperation, knowledge organisation, information systems, and information retrieval practices are products of the work of such domains and therefore cannot be studied in isolation from them (Hjørland and Albrechtsen, 1995, p. 400).

By highlighting the domain as a unit of analysis, Hjørland and Albrechtsen's approach provides a socio-cognitive methodological basis (further discussed in Chapter Three) for examining how expert and disciplinary communities construct, organise, and engage with information in ways that reflect their collective intellectual and cultural norms. Whilst domain analysis foregrounded the role of the domain, Savolainen (1995) shifted the attention to everyday contexts, emphasising how information seeking is embedded in the routines of ordinary life outside work.

Savolainen (1995) proposed a framework for studying *everyday life information seeking* (ELIS), focusing on people's "nonwork" information needs in areas such as health, hobbies, or shopping. Drawing on sociological theories, Savolainen argued that IB is shaped by the "way of life" of individuals, which reflects their habits, values, and available resources. Savolainen also introduced the notion of the "mastery of life" which refers to strategies for coping with everyday challenges (Savolainen, 1995, p. 266). This was significant because much empirical IB research up to that point had concentrated on professional or academic contexts, privileging structured, work-related tasks. In contrast, ELIS highlighted on informal and unstructured ways of engaging with information in the course of daily life, drawing attention to the lived contexts in which IB is embedded. ELIS expanded the scope of IB research by legitimising non-institutional forms of information seeking as worthy of study and, in doing so, helped shift the field toward a more holistic understanding of IB encompassing both formal and informal experience.

Hartel's research extends ELIS into the realm of "serious leisure" (Hartel, 2006). In an ethnographic study of twenty gourmet cooks, interviewed in their homes and their culinary resources documented photographically, Hartel (2006) showed that cooking as a hobby entails substantial information activity: enthusiasts browse, seek, compare, and produce their own planning documents and culinary journals; and, as these materials accumulate, they come to manage "personal culinary libraries" (Hartel, 2010). This work established hobbies and pleasurable pursuits as legitimate and information-rich sites of enquiry within a field whose attention was focussed largely on problem-based contexts. Hartel (2011, p. 3271) further argues that serious hobbies constitute distinct "social worlds" with particular individuals, activities, and modes of organisation, and suggests that hobbies can encompass informational patterns comparable to those of academic disciplines. The present study takes up that comparison from the other direction, examining how disciplinary communities generate their own distinctive relationships with knowledge and information.

About a decade after Hjørland and Albrechtsen articulated their domain-analytic approach, Savolainen (2007) revisited the "umbrella concepts" of information-seeking literature. In a review, Savolainen (2007)

described the social constructionist term “information practice” as a critical alternative to the individualistic and cognitive tendencies generally associated with the term “information behaviour”. Central to this reorientation was McKenzie’s (2003, 2006) theory of *information practice*, developed from a qualitative study of pregnant Canadian women. McKenzie’s research revealed that everyday information seeking and exchange often occurred in “less-directed”, “incidental”, and networked ways, highlighting how information acquisition is not always the result of intentional searching but may emerge from chance encounters and social interactions. Later work by Olsson and Lloyd (2017) and Olsson et al. (2018) extended this practice perspective by developing the concept of *embodied information practice*, which emphasises that IB is social, material, and corporeal.

This shift in terminology, from “behaviour” to “practice”, is significant because, as Savolainen (2007) explains, the two terms carry different assumptions: the first foregrounds individual cognition and the latter foregrounds the social, shared, and everyday nature of what people do with information. The present study, with its emphasis on disciplinary communities and sociomaterial contexts, aligns with the practice orientation, whilst retaining, as explained in Chapter One, the concept of mental models as the cognitive dimension that information practice approaches have set aside.

Contributing to the sociocultural and practice-oriented turn in IB research, Chatman (1991, 1999) examined how social norms and boundaries shape what information is considered accessible, relevant, or even worth seeking within particular communities. Based on investigations of specific social groups—janitors and prisoners, among others—Chatman (1991, 1999) developed the theory of *information worlds*, which describes socially bounded environments where members share norms that regular the flow and value of information. In this framing, IB cannot be understood separately from the cultural and normative contexts that determine what counts as useful or credible knowledge. Like the concept of information practice, Chatman’s information worlds reflect a community-based framing of IB, an orientation that is shared by Sonnenwald’s information horizons (1999, 2005) and Fisher and Naumer’s (2006) information grounds, considered below.

Sonnenwald’s information horizons (1999, 2005) similarly emphasise the socially situated nature of information seeking. Sonnenwald proposed that within any given context and situation, individuals perceive a “horizon” of information, or an array of resources, people, tools, and systems they regard as available to them in that moment. These horizons, like Chatman’s small worlds, are socially constructed and vary across contexts and communities. The framework shares this study’s commitment to situated, socially shaped understandings of information seeking, and its use of participant-generated maps precedes the visual elicitation employed here. Information horizons differ, however, from the concept of

disciplinary mental models developed in this thesis. Whilst information horizons map the perceived field of available sources, disciplinary mental models are concerned with the internal representation of knowledge in a field—how a discipline is conceptualised—rather than focusing on sources or particular acts of seeking. Nevertheless, the two are complementary: a scholar's disciplinary mental model may shape which sources appear within their horizon and engagement with those sources may, in turn, shape the disciplinary mental model.

Fisher and Naumer's (2006) concept of *information grounds* highlights how information sharing can occur spontaneously in social, time-bound settings that are not necessarily designed for information exchange. Such *grounds*, which can range from community centres to waiting rooms, illustrate how people can encounter and circulate information informally through momentary social interaction. This attention to place and environment has since been extended to IB research through related concepts such as *information environments* (Veinot and Pierce, 2019), which emphasise how spatial conditions shape access to and interpretation of information, and *information landscapes* (Lloyd and Wilkinson, 2016, 2019), which conceptualise information practices as shaped by both physical and sociocultural features. More recently, Lee and Ocepek (2022) have underscored the importance of space in framing the contextual and embodied aspects of IB, showing how spaces can shape what kinds of IB are possible or prioritised.

The concepts of domain analysis, ELIS, information practice, information worlds, and information grounds extend the field beyond the foundational models of Dervin, Ellis, Kuhlthau, and Wilson. Whereas those models described the processes, motivations, and contexts of individual IB, the practice-based and sociocultural approaches that followed emphasise that IB is enacted within communities, embodied through lived experience, shaped by everyday contexts and habits, and influenced by spatial, material, and environmental conditions. Investigating IB through this broader lens has yielded more complex and nuanced accounts of information seekers, recognising them as socially, temporally, and materially situated agents whose practices are shaped by collective norms, values, and changing contexts. What is known so far, then, is that the field comprises a rich body of models, theories, and empirical studies that have shifted from system-centred to holistic perspectives of information as practice, embedded in social, cultural, and physical settings. The next subsection turns to studies of IB in academic disciplines, where domain- and community-specific perspectives have been influential and which provide the central focus for the present study.

2.4.3 IB in disciplinary contexts

As noted in Section 2.4.1, early IB studies were primarily concerned with STEM fields before gradually extending to the social sciences and the humanities. Some studies examined information practices within a single discipline, including chemistry, history, law, and clinical medicine (Makri, Blandford and Cox, 2008; Crymble, 2016; Gordon *et al.*, 2018; Blasingame *et al.*, 2025), whilst others focused on broader metadisciplines such as the humanities or the social sciences (Gould, 1988; Gould and Pearce, 1991; Ellis, Cox and Hall, 1993; Folster, 1995; Buchanan *et al.*, 2005; Sheeja, 2010; Al-Shboul and Abrizah, 2014).

In the 2000s and 2010s, the Research Information Network (RIN) and Ithaka S+R commissioned a series of reports on an unprecedented scale and scope on scholarly practices across the academic disciplines that serve as a reference point for the present study. The RIN studies investigated the life sciences (Research Information Network and British Library, 2009), the physical sciences (Meyer *et al.*, 2011), and the humanities (Bulger *et al.*, 2011) in the UK. Thereafter, Ithaka S+R conducted another series of large-scale studies across ten disciplines primarily based on institutions in North America: chemistry (2013), history (2012), art history (2014), religious studies (2017c), agriculture (2017a), public health (2017b), Asian studies (2018), civil and environmental engineering (2019a), Indigenous studies (2019b), and languages and literature (2020).

The three RIN reports (2009–2011) on the life sciences, physical sciences, and humanities provided a comparative study of disciplinary information practices in the UK. Each report was based on multiple case studies, ranging from animal genetics, neuroscience, and systems biology (Research Information Network and British Library, 2009) to corpus linguistics, philosophy, and digital projects such as the *Digital Republic of Letters* (Bulger *et al.*, 2011), to astrophysics, nanoscience, and chemistry (Meyer *et al.*, 2011) Collectively, the reports offered a snapshot of scholarly IB during a moment of transition from print to digital resources, as search engines and remote access via personal devices became widespread. Across disciplines, researchers combined traditional strategies such as citation chaining with newer methods like using email alerts to monitor new publications. Physical scientists tended to bypass physical libraries in favour of digital access, except when consulting textbooks (Meyer *et al.*, 2011), whilst humanities scholars continued to rely on print collections supplemented by online tools (Bulger *et al.*, 2011). In contrast, life scientists often restricted themselves to a relatively narrow set of resources, citing lack of time as a reason for favouring convenience and speed over breadth (Research Information Network and British Library, 2009). These findings pointed to a hybrid information environment, but one in which disciplinary communities enacted distinct approaches to discovery and use.

A closer look at search practices further illustrated these contrasts. Life scientists relied heavily on Google, describing it as the "ultimate enabler" (RIN and British Library, 2009, p. 36), and used relatively simple strategies that reflected both time pressures and the minor role of information seeking in their workflows. Physical scientists showed uneven patterns: in some fields, such as gamma-ray burst astrophysics, advanced specialist systems enabled efficient discovery, whereas in others, such as nuclear physics, keyword search was relatively unimportant because of the small number of core journals (Meyer *et al.*, 2011). Humanities scholars, by contrast, spent considerable time refining search terms to account for inconsistent spelling and metadata, especially in historical databases (Bulger *et al.*, 2011). This persistence contrasted with their use of comparatively simple analytic tools, underscoring that sophistication in searching did not map directly onto sophistication in technologies. Overall, the RIN reports surfaced fundamental disciplinary differences in information seeking and complexity (Meyer *et al.*, 2011). these findings are valuable illustrations of how disciplinary communities enact distinct approaches to information seeking. At the same time, the reports are primarily descriptive: whilst they hint at contextual factors, they do not delve into the epistemic or cognitive frameworks that underpin these practices. In this sense, the RIN studies surface disciplinary variation without fully explaining or examining its drivers—a limitation that parallels the later Ithaka S+R reports.

The Ithaka S+R report series (2012–2020) extended the comparative study of disciplinary practices beyond the RIN reports, drawing on in-depth interviews with researchers and research support professionals in ten disciplines, including history (Ithaka S+R, 2012), chemistry (Ithaka S+R, 2013), art history (Ithaka S+R, 2014), agriculture (Ithaka S+R, 2017a), public health (Ithaka S+R, 2017b), religious studies (Ithaka S+R, 2017c), Asian studies (Ithaka S+R, 2018), civil and environmental engineering (Ithaka S+R, 2019a), indigenous studies (Ithaka S+R, 2019b), and languages and literature (Ithaka S+R, 2020). Based primarily in the US with some coverage of the UK and Canada, the studies captured a wide range of subfields, institutional contexts, and career stages. Echoing some of the themes from the RIN reports, the Ithaka findings highlighted continued reliance on commercial search services, citation chaining, peer networks, and conferences, complemented by automated alerts, social networking platforms, and idiosyncratic discovery strategies. They also documented new and different challenges in scholarly practice such as accessing non-Western sources, navigating vast, fragmented online information environments, and supporting interdisciplinary research in subjects such as religious or Asian studies.

As in the RIN studies, the Ithaka reports revealed both similarities and differences across disciplines. In general, scholars blended formal discovery tools with ad hoc, informal strategies, and relied heavily on personal networks and serendipity. Important differences also emerged: historians, art historians, and language and literature scholars relied heavily on archives, print collections, and primary sources (Ithaka

S+R, 2012, 2014, 2020). Their research practices were shaped by the organisation and availability of these materials, and they valued serendipitous discovery and the materiality of sources. Scholars in these disciplines often developed highly individual search strategies, especially when navigating dispersed or inconsistently catalogued collections (Ithaka S+R, 2012, 2014, 2020).

The information needs of scholars in the sciences and applied fields (chemistry, public health, civil and environmental engineering, agriculture) tended to focus on secondary sources, datasets, and grey literature such as government reports and policy documents (Ithaka S+R, 2013, 2017b, 2017a, 2019a). There was some anxiety around the comprehensiveness of literature searches, as scientific information seeking was often framed as systematic and all encompassing. Chemists, for example, expressed concerns about the comprehensiveness of their literature searches, reporting that reliance on keyword and targeted searching limited the scope of their discovery and contributed to anxiety about missing important sources (Ithaka S+R, 2013). Public health and engineering scholars turned to informal networks to access scattered or politically sensitive information (Ithaka S+R, 2017b, 2019a). Researchers in these subjects tended to adopt simper or more standardised information seeking practices, with higher reliance on Google Scholar or domain-specific databases, as well as on collaboration and professional networks.

Asian studies and Indigenous studies scholars faced challenges around non-Western and multilingual sources. They highlighted mismatches between their conceptual frameworks and the cataloguing systems of libraries and archives, which sometimes forced them to “work around” institutional structures (Ithaka S+R, 2018, p. 11). This reflects broader issues of biases in discovery systems and illustrates how disciplinary or area-based research communities may need to negotiate institutional and geopolitical barriers and adapt their IB (Ithaka S+R, 2018, 2019b).

The Ithaka S+R studies provide a rich account of scholarly practices across a wide range of disciplines, highlighting contrasts: humanities disciplines emphasising primary and print sources; sciences and applied fields focusing on data, comprehensiveness, and collaboration; and area and indigenous studies underscoring institutional and geopolitical barriers to access. However, as with the earlier RIN reports, these studies say little about the underlying epistemic cultures and cognitive frameworks—briefly but explicitly noted in the Asian studies report—that shape disciplinary variation. Why historians persist in iterative, granular searching whilst scientists prefer rapid, streamlined search methods, or why applied subjects depend on grey literature yet struggle to obtain it, remains underexplored. Large-scale, cross-disciplinary investigations like those of RIN and Ithaka S+R provide valuable insights into scholarly practices but offer limited explanatory power. Addressing this gap requires closer attention to the conceptual frameworks and epistemic assumptions that shape how scholars engage with information.

Information behaviour and practice research offers a second way into the study of disciplinary mental models: empirically grounded accounts of what scholars do with information and the types of information they use. Further, in its social and practice-oriented turn, it developed a vocabulary for the contextual, communal, and embodied character of that activity. Its limitation is that the field largely focuses on documenting what scholars do, describing scholarly practices in detail whilst leaving unexamined the disciplinary conceptual frameworks scholars use to navigate information. Disciplinary variation is repeatedly documented in this literature, by the RIN and Ithaka reports among others, but described rather than explained. The cognitive dimension that mental models research supplies is precisely what this perspective lacks.

2.5 Disciplinary cultures, boundaries, and teaching

If disciplinary communities shape how researchers construct and share MMs of information, then it is also essential to consider how these communities are formed and sustained. Scholarship on disciplinary culture and pedagogy examines how fields transmit intellectual traditions, norms, and practices through scholarly activity and teaching. This body of work provides an important backdrop for the present study, as it highlights how disciplinary cultures shape the cognitive and practical frameworks through which scholars engage with information. This section first defines what is meant by "discipline", then considers research on disciplinary culture and boundaries, and finally examines studies of disciplinary teaching.

2.5.1 Disciplinary culture and boundaries

Disciplines refer to structured fields of knowledge characterised by distinctive methods, conceptual frameworks, epistemological assumptions, and communication norms (Becher and Trowler, 2001; Hounsell and Anderson, 2008). As such, they function as cultural systems that determine what counts as valid knowledge, shape research practices, and inform knowledge dissemination.

One of the earliest and most influential contributions to the discourse on disciplinary culture was Snow's (2008) "two cultures" thesis, originally delivered as a Rede lecture in 1959, which highlighted the cultural and communicative gulf between the sciences and the humanities. Snow's provocative framing of disciplines sparked ongoing debate about the nature and boundaries of disciplinary knowledge (Burnett, 1999; Levin, 2003; Kemp, 2009; Leavis, 2013; Massey, 2019). Later commentators, such as Massey

(2019), expanded on this discussion by examining how historical shifts in funding and collaboration in higher education have shaped conceptions of disciplinarity across fields.

A subsequent strand of scholarship sought to capture the diversity and identity of disciplines through a metaphor. Becher and Trowler's *Academic Tribes and Territories* (2001) characterised disciplines as distinct "tribes" with their own values, traditions, and "territories" of knowledge. In later work, Trowler *et al*. (2013) revised this frame to reflect a more complex academic landscape marked by interdisciplinarity, internationalisation, and institutional change, whilst still recognising the enduring influence of disciplines in structuring academic life.

Building on these perspectives, Knorr-Cetina (1999) introduced the concept of *epistemic cultures* to describe the socially and materially embedded ways in which knowledge is produced, validated, and communicated. Through comparative ethnographies of molecular biology and high-energy physics, Knorr-Cetina revealed that disciplines differ not only in methods and subject matter but also in their foundational ways of reasoning, valuing evidence, and attitudes towards knowledge and its production. This approach underscored the importance of examining how disciplinary backgrounds shape information practice and revealed the depth of cultural variation that underpins scholarly work.

Whilst this work characterises disciplines by what distinguishes them, there is scholarship that examines the boundaries themselves and how knowledge moves across them. Star and Griesemer (1989) introduced the concept of *boundary objects*, or abstract or concrete objects that are "plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star and Griesemer, 1989, p. 393). They enable cooperation between social worlds that do not share a single view of the objects they work with. Library catalogues and discovery systems can be understood as boundary objects, serving many disciplinary communities whilst being read differently by each. This perspective frames disciplinary boundaries not only as divisions between tribes but as sites where shared information structures meet divergent ways of knowing, a theme to which Chapter Seven returns.

Scholarship on academic disciplines has shifted from viewing them as static, and discrete entities to conceiving of them as more fluid, culturally embedded, and shaped by broader socioeconomic and technological factors. Despite the growth of inter-, multi-, and cross-disciplinarity, disciplines remain important organising categories in academia. In this thesis, disciplines are defined as culturally and institutionally structured subject areas that are evolving and context sensitive. The next section turns to literature on disciplinary teaching and learning to explore how these cultures are formed and

transmitted—an essential consideration, given education strongly influences scholars' thinking and the MMs they carry of their disciplines.

2.5.2 Disciplinary teaching

A substantial body of higher education literature argues that critical thinking and learning are discipline-specific rather than generic. Education scholars have studied how different disciplines foster distinct cognitive skills, often through comparative studies. The present study underscores how disciplinary training cultivates distinctive ways of thinking, providing a foundation for understanding variations in how knowledge is conceptualised and practiced across fields.

Donald's *Learning to Think: Disciplinary Perspectives* (2002) represents the culmination of twenty-five years of research into how ways of thinking, teaching, and learning develop across eighteen disciplines in Canada, the UK, the US, and Australia. Through close analysis of "model" or exemplary courses in subjects including physics, engineering, chemistry, biology, psychology, law, education, and English literature, Donald (2002, p. 29) studied course materials and conducted interviews with professors to identify key concepts and the cognitive processes required in each discipline. Using concept mapping, Donald identified conceptual structures embedded in curricula, uncovering distinctive disciplinary patterns: the sciences tended to have hierarchical and highly interconnected conceptual arrangements (2002, pp. 16, 40); the social sciences organised ideas around "pivotal concepts" (2002, pp. 16, 180); whilst the humanities presented looser, linear, or less cohesive structures (2002, pp. 16, 244–45). Importantly, Donald explicitly drew on the psychological notion of *schema*—"a data structure of generic concepts stored in memory and containing the network of relationships among the constituent parts" (2002, p. 15)—to interpret how disciplines organise knowledge, thereby linking pedagogy with cognitive frameworks. In doing so, Donald led early theorising about the development of disciplinary thinking and offered a framework for understanding how students may construct conceptual models as they are socialised into their subjects.

In *Learning to Think*, Donald also (2002, pp. 279–82) went on to characterise disciplinary thinking along a set of continuums: structured to less structured, deductive to inductive, convergent to divergent, and "objective empirical" to discourse-based modes of reasoning. Science subjects such as physics and engineering emphasised deductive problem-solving supported by strong conceptual schemas (Donald, 2002, p. 127), whilst the social sciences and humanities fostered more varied, inductive, and discursive forms of reasoning, often underpinned by weaker schemas (Donald, 2002, p. 272). Donald's work is thus

an important forerunner, linking cognitive structures with disciplinary pedagogy and highlighting the schemas that shape how scholars engage with and organise knowledge.

Building on this foundation, pedagogical frameworks such as Meyer and Land's (2006) theory of *threshold concepts* and Middendorf and Pace's (2004) *Decoding the Disciplines* model made explicit the tacit steps of disciplinary thinking that students must learn. *Threshold concepts* are described as transformative ideas that act as gateways into a discipline's ways of knowing which, once grasped, reconfigure understanding and enable learners to thinking like members of the discipline (Meyer and Land, 2006; Meyer, Land and Baillie, 2010). Similarly, *Decoding the Disciplines* advises instructors to identify the "bottlenecks" in disciplinary learning, making explicit the hidden cognitive steps that underlie expert practice (Middendorf and Pace, 2004; Pace, 2017). Both approaches extend Donald's earlier work by recognising that disciplinary education is not only about learning content but also about internalising distinct cognitive processes and ways of knowing.

The notion of *signature pedagogies*, first articulated by Shulman (2005), adds another dimension to the study of disciplinary teaching and learning by proposing that each discipline has characteristic forms of instruction that induct students into the reasoning patterns, skills, and values of their subject. Whilst Shulman's essay "Signature pedagogies in the professions" narrowly focused on professional education (law, medicine, etc.), Gurung, Chick, and Haynie (2009) extended the concept beyond the professions to academic disciplines, highlighting how teaching practices in areas such as psychology, history, and biology cultivate disciplinary "habits of mind". Their more recent volume (Chick, Haynie and Gurung, 2023) reinforced this perspective, noting both continuity and adaptation in how signature pedagogies function in contemporary contexts, including digital environments and interdisciplinary spaces. Other recent studies have applied the concept to specific domains such as music education (Creech, Zhukov and Barrett, 2022), nursing (Crookes, Else and Lewis, 2020), and arts and design (Kan and Khoo, 2025), underscoring its relevance across diverse fields. This body of work emphasises that pedagogy is not simply a matter of instructional technique but a means of transmitting disciplinary ways of knowing and practice, embedding students into the intellectual traditions of their subject areas.

Kreber's edited volume *Disciplinary Ways of Knowing, Thinking, and Doing* (2008) foregrounded how disciplines define and value knowledge, and the kinds of cognitive processes they expect students to master. Drawing on faculty perspectives across English, law, and physics, Kreber illustrated how disciplinary thinking is anchored in different forms of information: in English, "everything…emerges from a text"; law depends on "assimilating information"; and physics requires "being able to look at a mathematical equation and…see the underlying physics to it" (Kreber, 2008, pp. 12–13). These contrasts

point to distinctive cognitive processes underpinning each discipline: law and the physical sciences rely on hierarchical frameworks in which foundational principles are synthesised and applied, whilst English foregrounds inductive reasoning that begins with textual details and extends outward into a broader interpretive discourse.

Hounsell and Anderson's (2008) contribution to the same volume, on "ways of thinking and practicing in biology and history", reinforced and expanded these insights. Their interviews with history lecturers revealed "a very strong commonality" in the "habits of mind" they sought to develop in students which included recognising history as socially constructed and contested, critically evaluating evidence, situating events in wider contexts, and adopting multiple perspectives. In contrast, biology lecturers highlighted habits of mind oriented towards systematic observation, classification, and the linking of experimental results to broader concepts. Whilst historical reasoning emphasised interpretation and contextualisation, biological reasoning involved integrating empirical data into established taxonomies and theoretical models, reflecting a tendency toward cumulative knowledge building and strong methodological structure.

These works resonate with Hyland's (2004) work on disciplinary writing and rhetoric as a means of inducting students into disciplinary modes of reasoning, as well as with Knorr-Cetina's (1999) concept of "epistemic cultures", where knowledge is produced and validated through socially embedded logic and practice. They also extend Donald's (2002) analysis of disciplinary schema, echoing the "habits of mind" advanced in signature pedagogy research (Shulman, 2005; Chick, Haynie and Gurung, 2023). This strand of scholarship underscores that disciplinary learning is not only about acquiring subject knowledge but also becoming initiated into particular epistemological cultures, intellectual values, and reasoning practices.

Scholarship on disciplinary cultures offers a third perspective into disciplinary MMs: an account of the communities, pedagogies, and epistemic traditions within which scholars are formed, and thus of where distinctive ways of thinking come from. The discourse on disciplinary culture and pedagogy makes clear that significant differences exist in how scholars are socialised into the norms, values, practices, and cognitive styles of their fields. Its limitations for this study are twofold. Firstly, its empirical focus has been on teaching, curricula, and students, or how disciplinary thinking is instilled, rather than on how it operates in the daily information practices of established researchers. Secondly, it works primarily at the level of the collective: epistemic cultures, tribes, and signature pedagogies; it leaves open how disciplinary enculturation is internalised by individual scholars and expressed in their engagements with information. It names the shaping force but not the shaped representation. The following section

synthesises the literature reviewed in this chapter to identify gaps across and between these bodies of work, and to define how the present study will address those gaps.

2.6 Intersecting gaps

The preceding review has examined three strands of scholarship (MMs, IB and practice, and disciplinary culture and pedagogy) that together provide important insights into how scholars seek and conceptualise information. Yet across these bodies of literature, key gaps remain. This section identifies those gaps and shows how they intersect, thereby identifying the problem space addressed by the present study.

First, studies of MMs within LIS have largely concentrated on students and on their understandings of the Internet, search engines, or online databases, often characterising them as incomplete or inaccurate. These investigations rarely extend to comparative analyses across academic disciplines. As a result, little is known about how disciplinary cultures shape scholars' mental representations of knowledge systems. Though MM research has informed library UX, where user-centred methodologies have reshaped design and service delivery, these approaches rarely consider disciplinary variation. Instead, they tend to prioritise universal or individual preferences and perceptions.

Second, research on IB and practice has developed from individualistic, system-oriented models to more social and context-oriented approaches, including studies of disciplinary contexts. Whilst this work illuminates scholarly practice, it often falls short of examining the underlying motivations or cognitive frameworks that shape those practices. Disciplinary IB studies, moreover, tend to focus on single occupations or academic levels, leaving limited understanding of cross-disciplinary, socio-cognitive dynamics.

Third, scholarship on disciplinary pedagogy and epistemic cultures has highlighted significant differences in how disciplines structure knowledge and cultivate ways of thinking. However, this body of literature has concentrated on teaching and student learning, paying less attention to how disciplinary pedagogy and enculturation shapes the cognition, MMs, and the lived experiences of researchers themselves.

Each, taken alone, is insufficient for investigating disciplinary mental models, and their insufficiencies are complementary. Mental models research attends to internal representation but isolates the knower from community and context; information behaviour and practice research attends to activity and context but brackets internal representation; disciplinary cultures scholarship attends to community and formation

but stops short of the individual scholar's cognition and information practices. Each perspective's limitation is another's contribution: the cultural literature explains where models come from, the mental models literature provides the concept and methods for studying them, and the practice literature situates them in what scholars actually do. The phenomenon this thesis investigates—the internalised, culturally constituted frameworks through which researchers conceptualise disciplinary knowledge, and their consequences for information practice—exists at the intersection of the three. This is why the study's theoretical framework, developed in Chapter Three, is deliberately integrative: it is a response to the structure of the gap itself.

The gaps identified across these three strands point to elements in the others that could help address its limitations. The lack of explanatory attention to cognitive frameworks in IB research can be supplemented by insights from MM studies, which foreground how users conceptualise information systems, and by disciplinary scholarship, which situates those cognitive processes within established modes of education and training. Conversely, the missing disciplinary element in MM scholarship could be addressed by drawing on disciplinary IB studies and work on disciplinary cultures, thereby linking mental representations to concrete practices and institutional contexts. Finally, research on disciplinary pedagogy and culture could in turn benefit from the perspectives of IB and MM scholarship to better account for how disciplinary training and socialisation is experienced, perceived, and applied by scholars beyond their student years. in this way, the three bodies of literature are interdependent, and their intersections highlight a shared gap: the need to pay greater attention to disciplinary MMs as a bridge between cognition, practice, and culture in academic research.

Greater attention must therefore be paid to how scholars think, conceptualise, and frame work in their disciplinary worlds. At the same time, the social and context-oriented dimensions of scholarly cognition need to be more drawn out, particularly in relation to disciplinary settings. Attending to these interplays underscores the complexity of scholarly IB and reintroduces much needed nuance into our understanding of users and their expectations of search. This is the central gap in the literature. Because it has not yet been systematically investigated, the present study addresses this gap by applying a novel, interdisciplinary theoretical framework designed to examine the problem holistically. Chapter Three outlines this framework in detail and explains how it is applied in the study.

2.7 Conclusion

This chapter identified the research gap by reviewing what has and has not been written about differences in researchers' MM across academic disciplines. It has shown that three relevant bodies of literature (MM, IB and practice, and disciplinary culture and pedagogy) approach different aspects of the problem, yet their respective gaps are interconnected. Although disciplines remain meaningfully distinct categories in academia, MM research does not address disciplinary nuance fully. Similarly, whilst IB research has shifted towards social and context-sensitive approaches, it pays insufficient attention to the cognitive dimension. At the same time, scholarship on disciplinary culture and teaching emphasises how scholars are trained and socialised into distinctive traditions but says little about how these processes end up shaping actual researchers' MM. Investigating disciplinary MMs, therefore, offers a way to address gaps in all three fields, connecting cognitive, cultural, and practice-oriented perspectives, and to better understand scholars' expectations of search.

The following chapter sets out the methodology through which this study investigates disciplinary MMs and explores their role in shaping scholarly information practices.

3 Methodology

This chapter describes the methodology used in this study. It sets out to explain the nature of the study both on a theoretical level, as a philosophical endeavour, and on a practical level, as a specific set of strategies based on a particular research perspective. As this is the first study in LIS to investigate researchers' mental models across disciplines, the purpose of the study is to explore participants' own understandings and articulations of disciplinary knowledge, following their accounts where they lead rather than imposing existing categories or hypotheses. This orientation is grounded in Charmaz's (2025) constructivist grounded theory, which treats qualitative enquiry as an open-ended and iterative process, engaging with participants' perspectives and building theory from their accounts. This also resonates with Clarke's (2005) situational analysis, which extends grounded theory by mapping the situations, social worlds, and discourses within which meaning is created. The commitment these approaches share to studying a phenomenon from the standpoint of those who live it is reflected in every aspect of this study's methodology, from the open-ended cognitive mapping prompt to the participant-led structure of the interviews and responsiveness of the research design to emerging themes such as spatiality.

This chapter begins by identifying the research problem and defining the research questions that arise from it. It then describes and justifies the philosophical approach and the theoretical framework that underpin the research and shape the methods used in the study. Based on the theoretical framework and research problem, it describes and justifies the research strategy and design used to achieve the aims of the study, including the use of multiple methods, inclusion of case studies based at the Universities of Glasgow and Oxford, and the choice of disciplines. Subsequently, it explains in more detail the data generating methods employed to explore researchers' mental models and disciplinary practices, which consist of semi-structured interviews and a visual technique used to elicit mental models. Then, the qualitative approaches used to analyse the data are explained. Finally, the chapter closes with the ethical considerations and the methodological limitations of the study.

3.1 Research questions

Chapter Two reviewed studies on scholarly information behaviour and practice, mental models research, and disciplinary teaching and culture, and identified a notable gap: we understand how scholars are taught and how they engage with information across disciplines, but not *why*—what knowledge structures underlie their practices? What do their mental models look like? Shifting the focus from what scholars *do*

to how they *think*, this study harnesses the theory of mental models to find explanatory power in disciplinary difference. Thus, the present study investigates how researchers understand and perceive the organisation of knowledge within their own disciplines, paying particular attention to how their mental models impact their use of library and other information resources.

The research is guided by the following questions:

1. How do researchers' mental models of the organisation of knowledge vary across disciplines?
2. How do these differences influence their methods for discovering collection items?
3. How might insights into these mental models inform the design of library search and discovery interfaces?

To address these questions, the study sets out four key objectives:

1. To develop case studies of disciplinary practices among researchers at the University of Glasgow and the University of Oxford.
2. To offer a holistic view of how researchers interact with both physical and digital collections, bridging a divide in the literature between usage of physical and digital information resources.
3. To examine researchers' preferences for search interfaces, focusing on how disciplinary knowledge structures shape their needs.
4. To provide recommendations for designing library systems that support diverse disciplinary approaches to organising and accessing knowledge.

These research questions necessitate exploration of how scholars conceptualise, navigate, and articulate the structure of knowledge in their disciplines. As disciplinary mental models are an unexamined phenomenon, this study puts forward a novel interdisciplinary theoretical framework to address the research questions rather than using an established framework. The following section explains it in detail.

3.2 Theoretical framework

In seeking insights into academic researchers' mental models of knowledge in their own disciplines, the study explores scholars' mental models in their own words, based on their own perspectives, and rooted in their specific sociocultural contexts. It does not test or apply a theory or model but rather seeks to "inductively develop…a theory or pattern of meaning" (Creswell and Creswell, 2018, p. 8). The

philosophical approach to understanding phenomena in this way is what Pickard (2013, p. 11) calls "empirical interpretivism", a research paradigm that "deals with investigation in natural settings of social phenomena". This approach entails particular assumptions about what constitutes reality and what we can know of it, which in philosophical terms pertain to ontology, or "what things are", and epistemology, or "how we gain knowledge about things" (Silverman, 2019, p. 5).

The interpretivist view is linked to a relativist ontology which holds that "realities are multiple, constructed and holistic" (Pickard, 2013, p. 12). Interpretivism is concerned with the understanding of meaning and "seeks to understand the entire context, at both the macro- and micro-environmental level" in order to reach this understanding (Pickard, 2013, p. 13). Its epistemological stance is subjectivist, whereby "the inquirer and the 'object' of inquiry interact to influence one another" and "only time- and context-bound working hypotheses…are possible" (Lincoln and Guba, 1985, p. 37).

In addition, this study also adopts a social constructivist stance, related to the interpretivist view and subjective epistemology, which emphasises the social dimension of meaning making. As the term suggests, constructivism posits that meaning is not discovered or created, but *constructed*, as we engage with the world and objects in it, things which Crotty (1998, pp. 43–44) describes as "our partners in the generation of meaning." Building on this, social constructivism holds that "subjective meanings are negotiated socially and historically" and are "formed through interaction with others…and through historical and cultural norms that operate in individuals' lives" (Creswell and Creswell, 2018, p. 8). Based on the social constructivist perspective, understanding emerges through interaction between the researcher and participants, and is shaped by cultural, disciplinary, material, and sociotemporal contexts.

Developing this qualitative approach in more depth, Charmaz's (2025) constructivist grounded theory positions knowledge as co-constructed through sustained interaction with participants and iterative engagement with data. It emphasises participants' voices whilst also recognising the researcher's interpretive role, encouraging flexible, reflexive analysis that remains closely tied to lived experience. As an inductive, qualitative inquiry inspired by Charmaz' grounded theory, the study is less concerned with making generalisations about disciplinary cultures than with drawing out detailed first-hand perspectives in conversation with individuals who have in-depth knowledge of their fields. A grounded approach is embedded in all aspects of the study, from the research design to data generation and analysis, and the study builds conceptual understanding inductively from empirical data, aligning with the grounded theory tradition.

Existing paradigms

Chapter Two traced the various strategies scholars have employed to study human information behaviour and cognition, which revealed broad theoretical shifts. Information science and information behaviour studies moved from a system-centred to a person-centred approach, and their methodologies followed suit; studies gradually shifted from quantitative methods to qualitative ones (Wilson, 1994). In addition, Hjørland (2002) identified theoretical developments in psychology that successively influenced information science: behaviourism, cognitivism, and the socio-cognitive view. Behaviourism is associated with empiricism and the natural sciences, and focuses on observable responses to stimuli; cognitivism is an individualist and rationalist view of the mind and its mechanisms; and the socio-cognitive perspective is concerned with social and cultural context (Hjørland, 2002, pp. 262–63).

In favour of the socio-cognitive approach, Hjørland (2002, p. 268) wrote that cognitivism could only offer to "psychologize the epistemological issues (to study knowledge by studying the individual)"—a common approach at the time of his writing—but "what is needed is the socio-cognitive view, which tends to epistemologize psychological issues (to see individual knowledge in a historical, cultural, and social perspective)". Concepts influenced by the latter view such as Hjørland and Albrechtsen's (1995) domain-analysis and Savolainen's (1995) information practice heralded a holistic approach in information science which emphasised situation and context (Case and Given, 2016, pp. 46–50). Going even beyond Savolainen's or Hjørland's social epistemology, Huizing and Cavanagh (2011, p. 16) proposed a "new practice movement" that includes both human and nonhuman agencies, and therefore takes into account "the social role of objects, sociomateriality, and social epistemology".

Taking its cue from this shift from behaviour- to practice-based approaches, mental models are seen as phenomena embedded in and shaped by a dynamic ecosystem of people, objects, and systems. Furthermore, mental models and information practice are closely intertwined, as mental models shape information practice and, in turn, information practices shape mental models. These interactions, which bridge the gap between notions of individual (Piaget, 1953) and social (Vygotsky, 1978) knowledge construction in psychology, exist in the overlapping domain between the cognitive constructivist and the socio-cognitive approaches in information science (Talja, Tuominen and Savolainen, 2005). Seeking to understand the interplay between the individual and collective dimensions of mental models and information practice translates to a study of "the dialectical relationship between the individual and the socio-cultural milieu" (Talja, Tuominen and Savolainen, 2005, p. 85) which is based on the premise that

> Individual development derives from social interactions within which cultural meanings are shared by a group and eventually internalised by the individual. It is assumed that individuals construct knowledge in interaction with the environment and that in the process both the individual and the environment are changed. (Talja, Tuominen and Savolainen, 2005, p. 85)

Terms such as "development", "interaction", and "process" in this characterisation of the socio-cognitive viewpoint by Talja, Tuominen, and Savolainen highlight the active and transformative nature of knowledge formation. Moreover, the present study aligns itself with the "social practice approach" proposed by Talja and Hansen (2006, p. 126), which considers "a mutually shaping relationship to exist between information and collaboration practices and the tools developed for the purposes of communication and knowledge sharing…Thus, work and collaboration practices, and information and communication technologies (ICTs) are co-constituted." This work-oriented take on the interactions described by Talja, Tuominen, and Savolainen highlights the co-constitutive dynamic between people, ICTs, and social practices in a specialised domain.

The growing recognition of the importance of sociocultural, material, and technological factors in information practice has prompted the move towards a more holistic understanding of the human being as a situated, embodied, and complex agent, acting in a dynamic environment with an agency of its own, and shaped by changing sociotemporal contexts. As discussed in Chapter Two, the theory of mental models has also shifted from a focus on an individual's cognition interacting with a single system, studied in isolation, to a notion that attempts to factor in the situated, collective aspects of human thought and action. The current concept of mental models is thus transdisciplinary, touching upon sociological and organisational factors, and mental models research concerns itself not only with trying to understand individual thought structures but also with collective, shared modes of understanding.

Towards a holistic paradigm

In 1981, Wilson (1981, p. 6) had already visualised the relationships between people, objects, and systems in his model of the "universe of knowledge". Wilson's early diagram (Figure 3-1), which was subsequently updated, illustrates the full context in which information practice occurs; it includes "all knowledge-related objects, events and phenomena", and "the complex interactions of the physical and abstract universes" (Wilson, 1981, p. 5). On the left is the "user's life-world", or "the totality of experiences centred upon the individual as an information user", which includes smaller spheres of work and other social groups with which the user associates; in the middle are "information systems" which include the "mediator" (a person) and "technology"; and on the right are "information resources"

(Wilson, 1981, p. 6). The arrows represent the user's means of action, or "search paths", when seeking information and the subsequent events this may cause.

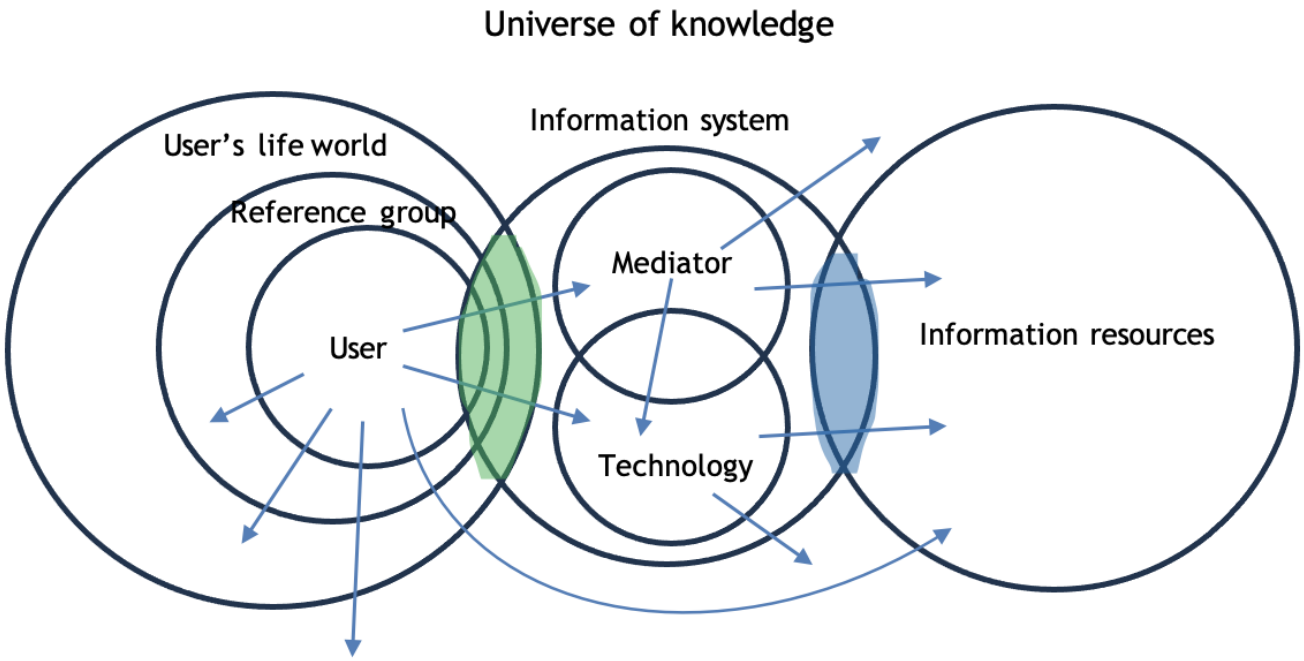


Figure 3-1 "The information user and the universe of knowledge" (Wilson, 2019)

In the context of the present research project, mental models are considered to exist in the overlapping area between the user's life-world and the sphere of information systems (highlighted in green in the diagram), as they have a mediating function between the user and the information systems used to access knowledge, and are formed through interactions between the user, the user's reference groups, and the user's life-world. The overlapping area between information systems and information resources (highlighted in blue) is seen to be the organisational structure imposed by information systems onto existing knowledge, a structure with which the user comes into contact by means of information systems, and which may also shape mental models.

Other IB concepts from the past few decades that account for complex information environments such as Wilson's include: Chatman's (1991) small worlds, Davenport and Prusak's (1997) information ecology, Sonnenwald's (2005) information horizon, Fisher and Naumer's (2006) information grounds, and Burnett and Jaeger's (2011) information worlds. Despite a widening of perspectives in information science, Robinson and Bawden (2014) argued in 2014 that the importance of a holistic approach for information science had been acknowledged by authors in the field, but that it had not been put into practice. In 2021, Polkinghorne and Given (2021, pp. 1261–71) also noted that "holism" has become more of a rhetorical device than an applied approach.

But what does it mean to apply a holistic paradigm to information science research? To give the notion of a holistic paradigm more substance, Polkinghorne and Given explain what methodological and ontological holism are, and how they might be applied to research design. Methodological holism "emphasizes the centrality of social phenomena in explaining human activity", whilst ontological holism "emphasizes the *existence* of social phenomena", acknowledging

> …a belief in the existence of social phenomena, not solely as aggregates of individual people's choices, but as concepts with properties of their own. This means believing that culture, social norms, and macrosocial arrangements such as capitalism have distinct characteristics, and even forms of agency. (Polkinghorne and Given, 2021, p. 1266)

Considering diverse social phenomena and micro- and macroscale "arrangements", each with their own characteristics and influence, could help identify and highlight multiple agencies (or lack thereof), as well as subtle and complex relationships. This complements Huizing and Cavanagh's (2011) "new practice movement" which considers nonhuman agency and the social role of objects.

Polkinghorne and Given describe how a holistic perspective could enrich each step of research design in information science. This would entail research questions that examine whole individuals embedded in structures and systems, multi-method approaches that try to "articulate experience in context", analyses that highlight complexity and recognise the researcher's subjectivity, and representations of results that showcase rich descriptions in context (Polkinghorne and Given, 2021, p. 1267). Importantly, they argue that information science is a field "rooted in studies of phenomena that are social, such as libraries, archives, systems of knowledge organization and information retrieval, and socially-situated norms of information behavior that we document and work to explain" and that therefore the research field itself "is to some extent fundamentally holistic" (Polkinghorne and Given, 2021, p. 1268).

Summarising their suggestions for holistic information research, they conclude:

> One common purpose for holistic rhetoric is to call for more expansive and inclusive approaches. In this vein, we emphasize the importance of acknowledging the existence and functioning of social structures, which have properties and agency beyond those of individual people. We encourage greater methodological diversification. Particularly, we call for more widespread use of interpretivist qualitative approaches such as hermeneutical approaches and critical, humanities-informed approaches, which provide lenses with which to perceive and understand the presence and influence of power relations and social structures. (Polkinghorne and Given, 2021, p. 1269)

Polkinghorne and Given's proposition that holistic research should engage critically with "the presence and influence of power relations and social structures" coupled with the idea that social phenomena have

their own characteristics and agency, suggest a different reading of Wilson's (1981) "universe of knowledge" model. If the arrows were to be interpreted not as "search paths" but as directions of influence, the arrows in the universe of knowledge would point in both directions to signal mutual influence between human and nonhuman entities, based on Polkinghorne and Given's holistic framework. Qualitative and interpretivist approaches, as well as the use of diverse methodologies, could help identify what social structures and subtle power relations are at play between the different elements in the universe of knowledge.

Contact zone

In the context of this holistic paradigm, what does it mean to study specific instances of mental models and their connections to information practice in academic libraries? Highlighting the multifaceted, connective role of libraries, Lanclos wrote:

> Libraries are portals today—as they have always been—to content, to information. They are also increasingly locations that provide access to people and tools and places for the creation of something new. As locations for collaboration—among students, among staff, among community members—libraries stake a claim to something new, and something terrifically difficult to quantify. (Lanclos, 2016, p. 21)

As portals to information, people, and tools, and as locations for creation and collaboration, libraries—in whatever form they take, whether study spaces, stacks, search interfaces, collections, or librarians—are a point of contact for individuals, groups, and their mental models on the one hand, and information systems, organisational structures, mediating tools and technologies, and information resources on the other.

A term that could help conceptualise these relationships is that of the "contact zone", first coined by Pratt (1991) in the context of literary and cultural studies, with particular reference to colonial encounters. Later applied in the museum context by Clifford (1997) and to lesser degree in the library sphere by Elmborg (2006), it was originally used to describe spaces of intercultural interaction and negotiation. Pratt (1991, p. 34) defines contact zones thus:

> I use this term to refer to social spaces where cultures meet, clash, and grapple with each other, often in contexts of highly asymmetrical relations of power, such as colonialism, slavery, or their aftermaths as they are lived out in many parts of the world today.

Rather than utilising a binary postcolonial framework of coloniser versus colonised, or metropole versus colony, or viewing conceptual boundaries as closed and cultures as discrete entities, Pratt uses the notion of the contact zone to designate a metaphorical site of linguistic and cultural encounters which play out in the context of power asymmetries.

In the essay titled "Arts of the contact zone" wherein this concept is described, Pratt (1991) also introduces the term "autoethnographic text", defined as "a text in which people undertake to describe themselves in ways that engage with representations others have made of them", illustrated through indigenous writing practices in the Andes during the period of Spanish colonisation. Autoethnographic texts are not independent forms of expression but "a selective collaboration with and appropriation of idioms of the metropolis or the conqueror. These are merged or infiltrated to varying degrees with indigenous idioms to create self-representations intended to intervene in metropolitan modes of understanding" (Pratt, 1991, p. 35). Thus, texts written by the colonised people, which may have been viewed as poor imitations or erroneous interpretations by the dominant group, are newly perceived as products of agency, selection, and negotiation.

This process of creative selection and negotiation, even in the face of conflict and power imbalance, is described as "transculturation":

> Ethnographers have used the term transculturation to describe processes whereby members of subordinated or marginal groups select and invent from materials transmitted by a dominant or metropolitan culture. The term, originally coined by Cuban sociologist Fernando Ortiz in the 1940s, aimed to replace overly reductive concepts of acculturation and assimilation used to characterize culture under conquest. While subordinate peoples do not usually control what emanates from the dominant culture, they do determine to varying extents what gets absorbed into their own and what it gets used for. Transculturation, like autoethnography, is a phenomenon of the contact zone. (Pratt, 1991, p. 36)

The concepts of acculturation and assimilation in linguistic and cultural studies were linear and binary modes that focused on one dominant entity in opposition to a subordinate one. However, Pratt argues that in a contact zone, boundaries are porous, and the mode of exchange is "transcultural", meaning there are multiple, malleable entities shaped by different factors exercising agency in multiple directions as they come into contact.

Applied to the present research project, which aims to conceptualise practical and cognitive phenomena in complex environments, it is useful to consider not only a transdisciplinary but also a transcultural approach, because the latter can operate in a way that is at once narrow and complex. Trying to understand mental models of the organisation of knowledge through a transcultural lens would enable the study of a specific phenomenon in a specific setting whilst also acknowledging that the universe of knowledge of which it forms part is "constituted through transformations and entanglements that follow from contacts and relationships between various agents, concepts and institutions" (Michaels and Mittler, 2019), with different levels of power and influence.

Mental models bear some similarities with Pratt's autoethnographic texts: they are both products of iterative processes of making sense of the world. They are representations created by selectively combining elements from the external (possibly hierarchical) environment with already existing tools and structures of understanding. Mental models are also formed in the process of negotiating between others' representations and one's own. They are not isolated, but embedded and embodied phenomena that can adapt as people engage with specific elements in specific contexts.

Therefore, the present study views people, objects, systems, technologies, spaces, and institutions as each having their own agency and as being continuously, mutually transformed. The point of contact between them and mental models constitutes a contact zone, a dense point of exchange in a specific time and space involving co-production, transformation, and entanglement.

User experience and ethnography in libraries

Beyond the holistic paradigm and the contact zone, this study is inspired by research approaches from anthropology and design—in particular, that of user experience (UX). The term "user experience" has no single established meaning, but it has become widely used in various fields and professions, particularly in the human–computer interaction (HCI) and design communities (Forlizzi and Battarbee, 2004; Hassenzahl and Tractinsky, 2006). Derived from various disciplines in the sciences and social sciences, including user-centred LIS research (Seale, Hicks and Nicholson, 2022), the concept of UX emerged as "a countermovement to the dominant, task- and work-related 'usability' paradigm" (Hassenzahl and Tractinsky, 2006). It sought to move away from a narrowly focused, system-oriented perspective to one that was more open to the complexities of users and their experiences (Hassenzahl and Tractinsky, 2006). A human-centred paradigm developed which was concerned with the "meaning which the product,

system or service should offer to people" and which gave importance to people's perceptions, contexts, expectations, intrinsic motivations, and emotions (Krippendorff, 2004; Giacomin, 2014).

The notion of "experience" has taken hold in higher education as well, in the form of the "student experience" (Priestner and Borg, 2016, p. 2; Bell, 2018; Seale, Hicks and Nicholson, 2022, p. 15). According to Priestner and Borg (2016), a focus on student experience by administrative bodies in higher education came about due to various factors: financial motives, competition with other universities, and shifts in expectations of service. In addition, the choices afforded to people by "new technology, online retail and social media" have increased expectations of the quality and range of products and services, and of people's ability to "influence and interact with service providers" (Priestner and Borg, 2016, p. 3). These changes in expectations, coupled with the growing importance of the user experience and the student experience in driving product and service design improvements, have had a significant impact on libraries as well.

In the library context, UX developed both as a research approach and practical method aimed at learning "*what is* rather than how we think things *should be* or how people *should behave*"—in other words, a shift in mindset from assuming librarians are more knowledgeable than library users, to regarding users' insights as valuable opportunities to learn and discover what can be improved (Priestner and Borg, 2016, p. 3). Certainly, the introduction of UX methodology was not the first instance of a desire to understand users, as discussed in Chapter Two. However, efforts to gather information on library users have commonly employed surveys and questionnaires, and primarily quantitative approaches to understanding library use (Wilson, 1994; Priestner and Borg, 2016; Case, Given and Willson, 2023). In contrast, library UX refers to a methodological approach that borrows elements from ethnography, anthropology, usability, and service design (Priestner, 2021) as a means of "eliciting qualitative data about user behavior, and more importantly as an avenue to transforming institutional practices and increasing the role of library voices in shaping such practices" (Lanclos, 2016, p. 21).

The term "library UX" has been used interchangeably with "library ethnography" to describe a methodology that aims to capture details of people's experiences of library tools, resources, and spaces. Ethnography is "a collection of qualitative methods that focus on the close observation of social practices and interactions", according to library anthropologists Asher and Miller (2011, p. 3). It aims to learn about the meanings people ascribe to particular processes or situations, and "allows the researcher to tell a group's story from the point of view of participants by deeply examining the context in which activities occur" (Asher and Miller, 2011, p. 3).

Lanclos (2016) has been a major proponent of an "ethnographic agenda" in libraries, advocating the need to capture voices and stories in context:

> They [ethnographic techniques] provide ways for researchers to gain insight into the logics behind people's behavior by situating their choices in broader social and cultural contexts. Via ethnographic work, we gather stories, we gather what anthropologists call "ethnographic authority" – the authority to speak that is grounded in "being there", in effective representations of our users' realities, because we did the work. Stories can be ambiguous and powerful. Stories can encourage us to learn more. Stories taken together, can begin to reveal patterns. […] Interpreting such qualitative data is risky, and opens us up for uncomfortable moments, debates, and possibilities that we might be wrong. I would argue that it is less important to accurately predict changes, for example, than to be able to recognize what is a change, as it is happening, and not be so locked into "The Way We Do Things" that it's impossible to respond to changes. (Lanclos, 2016, p. 22)

Lanclos encourages libraries to tune into people and their stories to keep a pulse on ever-changing library culture. Lanclos identifies a need to situate people's behaviour and choices in their broader sociocultural contexts to better understand the reasoning behind what they do and, by extension, how they shape library culture. Libraries need to be flexible and responsive to the patterns revealed in users' stories, even if such an open approach may be "risky" and challenging. Ethnographic work and UX methods, which Lanclos (2016, p. 21) views as "a subset of ethnographic practices", allow for a richer, more "effective" representation of a library's community.

Further, libraries should not be viewed as separate systems but as part of an interconnected information landscape:

> For libraries to be visible to their communities, discovery cannot depend on prior knowledge of specialized systems. Rather, those specialized systems should become natural extensions of the networks people bring with them to university, and build and extend while they are there." (Lanclos, 2016, p. 23)

The ethnographic approach does not start from the system, but from the people who use them as part of their existing networks; thus, UX and ethnographic methods are less about educating and guiding library users about current systems and more about allowing the users to inform the shape of the information system over time according to their needs and contexts, in a kind of symbiotic relationship.

Quantitative data has its place as well, but Lanclos bases the importance of qualitative approaches stemming from ethnography in their ability to build "relationships" and "connections":

> Quantitative data and research agendas that yield such data can provide paths towards a stronger voice for libraries in higher education, and more effective policies on behalf of library users. Qualitative approaches point the way to building the relationships necessary to demonstrate and further develop the important role of academic libraries within higher education. Libraries cannot build relationships by counting things. Rather, connections emerge from work, with collaboration, from being embedded into the work of higher education. This is work that has always been done within libraries, and it is more important than ever to make that visible and explicitly connected. (Lanclos, 2016, p. 24)

A deeper understanding of library culture and library users gained through qualitative methods will help underscore the importance of libraries in relation to "the work of higher education" and bring to light how people, academic libraries, and the broader HEIs are interconnected. This is the complex and holistic perspective that the present study is inspired by.

Despite its glowing potential and growing popularity, library UX has been critiqued by various scholars, including Lanclos herself. There is an ongoing discussion about the complex relationship between UX and the various disciplines and commercial interests from which it has developed (Seale, Hicks and Nicholson, 2022). There is also a critical debate about how current practices, which often involve short-term, project-based, and goal-oriented library studies, fall short of the long-term and open-ended nature of the full ethnographic programme; such practices have been described as "ethnographish" by Lanclos and Asher (2016). Nevertheless, Lanclos and Asher (2016) acknowledge that "Ethnographish projects have yielded real insights into student and faculty behavior." They note that the use of methods borrowed from ethnography has led to real changes and policy discussions in libraries, but that this has not managed to bring about "a different way of seeing", a "decrease in reliance on quantitative methods of data collection" or a "dedication of full-time staff hours to ethnographic data collection and analysis" (Lanclos and Asher, 2016).

The present study has, like many ethnographish library projects, finite goals and a relatively short timeframe for data collection and analysis. However, the holistic theoretical framework that is being applied here makes space for an ethnographic vision—for a "less directed", exploratory, and comparative investigation that trusts in qualitative methods to yield real insights, as called for by Lanclos and Asher. Despite practical limitations, it seeks to understand researchers' disciplinary mental models through their own words whilst keeping the method as open-ended as possible. The use of methods borrowed from library UX and ethnography will enable a deeper, richer exploration of people's multifaceted experiences and relationships with libraries, information resources, their disciplinary communities, and universities.

This research aims to draw upon UX- and ethnography-based approaches to identify patterns in people's stories that hold explanatory power for their practices and choices that will, ultimately, help libraries bring information systems and resources closer to their users.

Implications of the theoretical framework

Based on existing paradigms in IB, UX, and ethnography in libraries, and the concept of the contact zone, this theoretical framework builds up to a holistic perspective for information science that can provide new, context-oriented insights on IB that considers multiple factors, agents, and structures, as well as their interactions. Rather than seeing human practice, and cognition as purely individual or universal, the holistic paradigm emphasises specificity, embeddedness, as well as co-production and co-constitution. Change, complexity, entanglement, and negotiation are also key to the theoretical perspective in the present study.

Applied to the present study, following a holistic approach would entail:

- employing an interpretivist, qualitative, and critical approach
- seeing the universe of knowledge as contextual and fluid, not objective and fixed
- a dynamic understanding of information resources and systems that includes both digital and analogue forms
- an emphasis on the socio-cognitive aspect of mental models, information practice, and academic disciplines
- aiming to understand mental models of individuals and groups based on their subjective views and experiences in specific socio-temporal contexts
- focusing primarily on people, not on systems design, although the results will inform/benefit design
- sensitivity to power relations and social structures in libraries, disciplines, and universities
- Acknowledging and identifying multiple agencies

Furthermore, Pratt's concept of the "contact zone" provides a vital theoretical lens. Applying the contact zone to the present study, it is understood as the space where scholars' mental models of their disciplines encounter the evolving structures embedded in libraries, universities, and technologies. These encounters can reveal points of friction as well as points of transcultural negotiation, where multiple agents select, reinvent, and co-create conditions on the ground.

Taken together, the theoretical framework integrates the holistic and interpretative principles of qualitative research with insights from information behaviour and practice research and UX, whilst also leveraging the contact zone concept to interrogate how scholars operate within, and sometimes against, the architectures of academic knowledge organisation. This approach allows for a fuller understanding of disciplinary knowledge as something that is experienced, conceptualised, and practised. The theoretical framework therefore informs a holistic approach to research design, which emphasises complexity, reflexivity, and context at each stage of the research process.

3.3 Research design

Building on the holistic theoretical framework outlined in the previous section, which emphasises an interpretivist, qualitative, person-oriented, and context-sensitive interdisciplinary perspective, the research design sets out the strategies used to investigate disciplinary mental models. It explains and justifies the use of multiple methods, as well as mental model elicitation techniques and case studies, to ensure the study design remains consistent with the theoretical framework established above.

3.3.1 Multiple methods

Investigating disciplinary mental models is a complex task, as these are internal conceptual structures that scholars may not have consciously examined previously. This study acknowledges several challenges:

a. Scholars may never have reflected explicitly on their own cognitive frameworks and may have difficulty expressing them.
b. Mental models may be expressed in varied forms, including visual, spoken, written, and practiced.
c. Disciplinary knowledge may be shaped by embodied, social, material, temporal, and environmental aspects.
d. The concept of "knowledge" varies widely across disciplines, encompassing formal/informal, academic/professional, and theoretical/applied understandings.

Addressing these multifaceted challenges within a holistic framework that attends to the complexity of researchers' sociocultural contexts is best supported by a multimethod, fully qualitative strategy (Brewer and Hunter, 2006). As Pickard (2013) argues, combining methods can offer a richer, more holistic, and

context-sensitive understanding of the phenomenon. The theoretical framework establishes a dynamic and subjective lens designed to surface, rather than reduce, the complexity of researchers' lived experiences, whilst grounded theory (Charmaz, 2025) emphasises knowledge as co-constructed through interaction between the Researcher and participants. Accordingly, this study adopts an open-ended and flexible multimethod approach that encourages participants to express their thinking in diverse forms whilst also allowing emerging insights to shape the research design, as occurred with the inclusion of the observational method. Drawing on practices from anthropology, library UX, and information science, it combines visual, verbal, and observational techniques to address each of the challenges listed above:

- **Visual methods**: Introduced in response to (a), (b), and (c), visual methods allow participants to express complex or abstract ideas in imagery, supporting intuitive and holistic reflection. They promote different ways of seeing, invite reflexivity, and can generate rich, embodied data (Weber, 2008; Hartel and Thomson, 2011; Hartel and Savolainen, 2016; Hartel, 2014; Hartel *et al.*, 2017).
- **Verbal methods**: Open-ended interviews address (a), (b), (c), and (d), allowing participants to explore the personal, interpersonal, disciplinary, and institutional dimensions of their scholarly practice in conversation with the Researcher. Rooted in symbolic interactionism, such interviews construct meaning collaboratively rather than merely extracting facts (Hollway and Jefferson, 1997; Rubin and Rubin, 2005; Kvale, 2007).
- **Observational methods**: In response to point (c), the need for observational techniques emerged during the data generation process, as the spatial and material aspects of disciplinary mental models became increasingly evident. Observations were therefore necessary to capture how physical and environmental factors shape researchers' mental models, with workspaces providing particularly valuable contextual insights (Gibson and Kaplan, 2017; Veinot and Pierce, 2019; Lee and Ocepek, 2022).

The visual elicitation technique drew on established practices from LIS and library UX (Lanclos, 2013; Priestner, 2021; Fu, Lomas and Inskip, 2022). The visual technique was integrated into the verbal one, whereby a visual task was introduced early in the interview as an icebreaker and a catalyst for deeper reflection and discussion. The techniques were complementary, helping participants articulate complex or abstract ideas in more than one format, and allowing the Researcher to probe participants' reasoning behind their representations. This dual visual-verbal approach helped stimulate participants' meta-cognitive awareness of their own disciplinary practices and also helped bridge conceptual gaps between the Researcher and participants, enhancing the co-construction of meaning between Researcher and participant, which is core to the interpretivist foundation of the study.

Together, these methods support a participant-centred, context-sensitive approach to eliciting disciplinary mental models, following the theoretical framework. The combination of visual, verbal, and observational techniques enables a multifaceted, holistic investigation of mental models, allowing for rich, layered accounts of disciplinary knowledge to emerge. These methods will be discussed in greater detail, but first the next section will present the case studies used for analysis, which offer a means of grounding the methodological approach within specific disciplinary settings.

3.3.2 Case studies

This investigation is based on case studies of different academic disciplines. As Liamputtong (2020) notes, case study research is often surrounded by conceptual confusion. However, a definition provided by Luck et al. (2006, p. 104) describes it succinctly as "an intensive, detailed, in-depth study, examination, or investigation of a single unit—the case—where the focus is on the particular". Both Luck et al. (2006) and Stake (2008) emphasise that a case study is defined more by the choice of case than by the methods used. The case is understood as a system bounded by time, place, or activity, and these boundaries help limit the scope of data generation.

In this study, the "case" is the academic discipline. By conducting multiple case studies, the research allows for comparison between disciplines, which facilitates the exploration of underlying mechanisms, the testing of emerging ideas, and the generation of theoretical insights (Hesse-Biber, 2017). Qualitatively driven case studies, in this context, aim to produce rich descriptions of disciplinary life and provide a deeper understanding of the social and cognitive processes that shape knowledge within bounded disciplinary contexts.

The study takes the category of "discipline" as its unit of analysis, recognising the limitations and tensions at this level of granularity. Disciplines can be defined broadly (e.g., social sciences) or narrowly (e.g., sport psychology), each approach carrying trade-offs in specificity and comparability. As Becher and Trowler observed, "To see the whole is to see it in breadth, but without access to the particular vision: to see the part is to see it in depth, but in the absence of the general overview" (2001, p. 73). The discipline was selected as a mid-range analytical frame that balances depth and breadth.

Four disciplines were selected as case studies: History, Law, Chemistry, and Medicine. These disciplines were chosen for several reasons: each has an existing body of literature on information practices, and together they represent a broad range of academic inquiry spanning the humanities, social sciences,

natural sciences, and medical sciences. The focus on traditional disciplines rather than interdisciplinary or multidisciplinary fields reflects the study's aim to compare disciplinary communities with distinct and established research strategies, terminologies, and epistemic cultures (Knorr-Cetina, 1999).

The decision to focus on four cases was both methodological and pragmatic. From a methodological perspective, case study research values deep engagement with each case (Stake, 2008; Yin, 2018), and the effectiveness of qualitative case studies comes from prioritising analytic depth over representativeness (Hesse-Biber, 2017). A smaller number of cases allows for richer inquiry, and selecting four disciplines offers a manageable scope for in-depth data collection, whilst still enabling meaningful comparisons across cases. In a pragmatic sense, the study sought to compare disciplines rather than universities and grouping the two institutional contexts within each disciplinary case ensured that attention could be paid to similarities and differences across institutions whilst maintaining a disciplinary frame of analysis.

The study was conducted at two UK universities: the University of Glasgow and the University of Oxford. Both universities provide a wide range of undergraduate and postgraduate degree programmes, supported by robust research cultures (*University of Oxford - Admissions*, no date; *University of Oxford - Research*, no date; *University of Glasgow - Study*, no date; *University of Glasgow - Research*, no date). A key point of divergence between the two institutions lies in their pedagogical and organisational models. The University of Glasgow relies primarily on a lecture-based model, supplemented by seminars, tutorials, and laboratory sessions (*Teaching style, assessment and credits*, no date). In contrast, at Oxford, the tutorial system forms the foundation of teaching, offering small group or one-to-one sessions in which students engage closely with faculty or college tutors; these sessions are combined with lectures, seminars, and lab work, depending on the course (*The Tutorial System*, no date; *University of Oxford - Personalised learning*, no date).

Academic staff at both universities contribute to teaching and research, though the career structures differ. At Glasgow, staff have titles such as Lecturer, Senior Lecturer, Reader, and Professor reflecting levels of academic progression, and there is a purely teaching-focused career track in addition to the more standard research and teaching track (*Academic appointment & promotion policy*, no date). Oxford, meanwhile, maintains similar academic posts (Associate Professor, Reader, Professor), but scholars typically hold dual roles: they serve as members of a faculty whilst also acting as college tutors within their respective colleges (*Academic posts at Oxford*, no date). These institutional and structural variations in teaching and career progression shape not only how disciplines are administered and taught but also how academic life is experienced by both staff and students.

Each university differs slightly in how it structures disciplines. Glasgow groups disciplines into colleges at the broadest level (e.g., College of Social Sciences), schools at the intermediate level (e.g., School of Law), and subjects as the smallest unit (e.g., Law), whilst Oxford employs divisions (e.g., Social Sciences Division) and departments or faculties (e.g., Faculty of Law) as its overarching academic structure (*Divisions and Departments*, no date; *University of Glasgow - Subjects A-Z*, no date). Both universities organise disciplines in four comparable groups: humanities, social sciences, physical and life sciences, and medicine. The scope and diversity of the subjects they offer, however, vary. These differences reflect regional or linguistic emphases—for example, Glasgow offers Scottish Literature and Celtic & Gaelic courses whilst Oxford includes Asian and Middle Eastern Studies. Medical specialisms also vary, with several subjects lacking direct equivalents across the two institutions. Glasgow, for instance, offers Dentistry, Nursing, Sports Science, and Veterinary Medicine, which Oxford does not. Conversely, Oxford's medical departments include Primary Care Health Sciences, Surgical Sciences, Paediatrics, and Women's & Reproductive Health, areas without direct counterparts in Glasgow. A complete list of courses is provided in Appendix I. Organisational and structural distinctions also exist within each of the four disciplinary cases, which is explained in more detail below.

History

At Glasgow, History is located within the School of Humanities, under the College of Arts. Research strengths span fields such as gender history, global history, Scottish history, and war studies. These are supported by dedicated research centres, including the Centre for Gender History, the Beniba Centre for Slavery Studies, the Centre for Scottish & Celtic Studies, and the Scottish Centre for War Studies & Conflict Archaeology (*History Research Centres*, no date). History in Glasgow is located on University Gardens in the University's Gilmorehill campus, and the department is distributed across multiple buildings tailored to different specialisms: medieval, modern, and Scottish history (*Graduation 2025 - University of Glasgow Campus Map*, no date). These buildings accommodate both teaching and research activities, as well as faculty offices. Students and faculty in the History Department benefit from both central and subject-specific library support via the main University Library and the Archives & Special Collections (*Special Collections subject guides - History*, no date). Glasgow has College Librarians dedicated to subjects within each college, and there is a dedicated College Librarian assigned to support enquiries in History (*Library - Subjects - History*, no date).

At Oxford, History is housed within the Humanities Division and is one of the largest history faculties in the UK offering over 100 course options across British, European, African, Asian, American, global, and

transnational history (*Faculty of History - BA in History*, no date). The department's research centres are organised around a range of themes such as the Oxford Centre for Byzantine Research, the Centre for History of Science, Medicine & Technology, and the Centre for the History of Childhood (*Faculty of History - Research Centres*, no date). The History Faculty building, which contains administrative offices and teaching spaces, is located on George Street, whilst the Oxford Centre for the History of Science, Medicine and Technology is housed separately on Banbury Road in north Oxford (*Faculty of History - Facilities*, no date). The department has a dedicated History Faculty Library based in the Radcliffe Camera, which is part of the Bodleian Libraries (*Faculty of History - Facilities*, no date). Historical research is also supported by the special collections in the Bodleian, which hold rare books, manuscripts and archives, and other historical materials in multiple formats (*Special collections*, no date). Oxford has three History librarians providing specialist support for different geographies and specialisms (*Subject librarians*, no date).

Law

Law at Glasgow is both a subject and a School, situated in the Stair Building (*University of Glasgow - School of Law*, no date). It offers undergraduate degrees in common and Scots law as well as postgraduate degrees (*School of Law - Undergraduate*, no date; *Taught degree programmes A-Z - Law (LLM)*, no date). Law research is centred around a range of themes from theory to empirical sociolegal research, and the School has a number of research groups focused on areas such as Corporate and Financial Law, Intellectual Property, and International Law and Security (*School of Law - Research Groups*, no date). Law students and faculty have a dedicated law library, or "Law Workshop", in the Stair Building, a print collection on Level 7 of the main University Library, and a dedicated College Librarian (*Library services for law students*, no date; *College Librarians*, no date).

The Faculty of Law at Oxford is part of the Social Sciences Division and is primarily housed in the St Cross Building, which hosts lectures and seminars, and contains academic administration. Most academic staff, however, are based in their colleges rather than in the St Cross Building (*Faculty of Law - St Cross Building*, no date; *Faculty of Law - About us*, no date). Research activity is facilitated by ten Research Groups and five Institutes and Centres, including the Law and Technology Research Group, the Centre for Socio-Legal Studies, and the Institute of European and Comparative Law (*Faculty of Law - Research Groups*, no date). The St Cross Building also holds the Bodleian Law Library, and legal resources are also found in college libraries, notably All Souls College (*Faculty of Law - Libraries*, no date). Law is supported by a subject librarian (*Subject librarians*, no date)

Chemistry

Similar to Law, Chemistry at Glasgow is both a subject and a School based in the Joseph Black Building on the Gilmorehill campus (*School of Chemistry - How to find us*, no date). The School combines teaching and research, with facilities that include cutting-edge equipment and dedicated support services (*School of Chemistry - About the School*, no date). Library provision is supported through the University Library, which offers subject-specific books and journals in the Chemistry Branch Library in the Joseph Black Building as well as a dedicated College Librarian (*Library - Chemistry Library*, no date; *College Librarians*, no date). Glasgow's research is organised around six themes including *Chemical Biology and Precision Synthesis, Chemical Photonics, Complex Chemistry, and Energy Conversion and Storage, and there is additionally a centre for chemical education research* (*School of Chemistry - Research*, no date). The School is also part of WestCHEM, a chemistry research consortium for the West of Scotland (*School of Chemistry - About the School*, no date).

Oxford's department of Chemistry is located across five sites in the university's Science Area: the Chemistry Research Laboratory, the Chemistry Teaching Laboratory, the Inorganic Chemistry Laboratory, the Physical and Theoretical Chemistry Laboratory, and the Rodney Porter Building (*Department of Chemistry - Getting here*, no date; *Access Guide - Department of Chemistry*, no date). Lectures, practical lab work, maths and physics classes, and supervision are provided by the department, whilst tutorial teaching is organised in colleges (*Department of Chemistry - FAQs*, no date). Teaching and research are supported by extensive laboratory infrastructure and the Bodleian Libraries—in particular, the Radcliffe Science Library—and a dedicated subject librarian (Vetrugno, 2025). Research activity is organised into eight themes which include *Chemistry at the Interface with Biology and Medicine; Energy and Sustainable Chemistry;* and *Theory and Modelling in the Chemical Sciences, and a* significant proportion of research falls within chemical biology and medicinal chemistry (*Department of Chemistry - Research themes*, no date).

Medicine

Medicine represents the broadest case in this study, as its organisation differs significantly between Glasgow and Oxford. The subject encompasses a wide range of research areas which are classified differently across institutions, reflecting both local contexts and institutional traditions. Despite these

variations, Medicine holds a central place within both universities, not only as a major area of teaching and research but also as an administrative unit in its own right, constituting a separate division or college within each university structure. Because it is such a central subject for both institutions, Medicine was included in this study as a case despite the challenges it poses as a wide-ranging example.

At Glasgow, Medicine officially sits within the School of Medicine, Dentistry & Nursing. Research in the subject of Medicine focuses on clinical, surgical, and palliative areas spanning Child Health, Dermatology, and Molecular Pathology (*School of Medicine, Dentistry & Nursing - Research*, no date)**.** However, there are other schools and subjects within the broader College of Medical, Veterinary & Life Sciences that relate to Medicine but are organised separately such as the School of Cancer Sciences, School of Cardiovascular & Metabolic Health, and the School of Infection & Immunity which are dispersed across various university and hospital sites (*University of Glasgow - Subjects A-Z*, no date)**.** Clinical teaching and research is primarily based in the Wolfson Medical School Building on University Avenue, the New Lister Building at Glasgow Royal Infirmary, and the Teaching & Learning Centre at the Queen Elizabeth University Hospital (*School of Medicine, Dentistry & Nursing - About us*, no date). Other facilities include the Anatomy Facility and a Forensic Medicine & Science unit (*School of Medicine, Dentistry & Nursing - Forensic Medicine and Science*, no date; *School of Medicine, Dentistry & Nursing - Anatomy Facility*, no date). There is a dedicated college librarian, but no medical library (*College Librarians*, no date)**.**

At Oxford, Medicine comprises the whole of the Medical Sciences Division, which covers biomedical and clinical research and teaching. It is made up of 16 departments including the Nuffield Department of Clinical Medicine, the Radcliffe Department of Medicine, and the Department of Oncology (*Medical Sciences Division - About Us*, no date). The Division offers undergraduate and graduate medical degrees; most undergraduate teaching takes place in the Medical Sciences Teaching Centre whilst postgraduate teaching and research is facilitated via the Medical Sciences Graduate School and the Medical Sciences Doctoral Training Centre (*Medical Sciences Division - Medicine*, no date; *Undergraduate courses - Medicine*, no date; *Medical Sciences Division - Graduate School*, no date). The Division is physically organised across two main sites: the Science Area in central Oxford, which hosts pre-clinical teaching and biomedical departments, and Headington two miles east of the city centre, which comprises medical research institutes and two hospitals (*Medical Division - Departments, Networks & Clinical Trial Units*, no date; *Hospitals*, no date; *Access Guide - Old Road Campus*, no date). Specialist library support is provided by the Bodleian Health Care Libraries which comprises four library sites across the Oxford University hospitals and the Old Road Campus (*Libraries*, no date); there are also dedicated clinical and pre-clinical medical librarians (*Subject librarians*, no date).

The table below summarises key differences across the four cases.

	Glasgow	**Oxford**
History	Located in multiple buildings across University Gardens. Research covers Scottish, Medieval, and Modern History. Main library support via the University Library and Archives & Special Collections.	Faculty based in one building on George Street, with staff distributed across colleges and centres. There is a dedicated History Faculty Library housed in the Radcliffe Camera.
Law	Based in the Stair Building. Facilities include a dedicated Law Library (Law Workshop), a Moot Courtroom, and a section of the University Library.	Housed in the St Cross Building. The Bodleian Law Library, located in the same building, is a significant resource. Academic staff offices are mostly in colleges.
Chemistry	Based in the Joseph Black Building. Research structured into six themes. Subject-specific library provision via University Library.	Department located across multiple Science Area sites. Research organised into eight themes. No dedicated chemistry library but support via Bodleian Libraries.
Medicine	The School of Medicine, Dentistry & Nursing is distributed across university buildings and hospitals. The School is focused on clinical medicine but the broader College comprises areas of biomedical research such as cancer science and infection & immunology.	Medicine delivered via the Medical Sciences Division which is divided across two locations (city centre and Headington). Training provided via Medical Sciences Teaching Centre, Graduate School, and Oxford University Hospitals NHS Trust. Dedicated library support via Bodleian Health Care Libraries.

Table 3-1 Summary of key differences between cases

3.4 Data generation

This section outlines the approach taken to generate, record, and manage data in the study. The term “data generation” is used instead of “data collection” to reflect the active role of the researcher in creating meaningful insights through engagement with participants. The term is adopted from Mason (2017, pp.

21–22), who explains that researchers do not simply retrieve data that already exist, but rather generate it through interaction with their sources. The data generated consist of audio recordings, their transcripts, fieldnotes, and drawings. The activities and techniques involved in the process—sampling and recruitment, data elicitation methods, and the recording and management of data—are presented here in the order in which they were undertaken.

3.4.1 Sampling and recruitment

As discussed in Section 3.2.2, the case studies were conducted at two UK research universities: the University of Glasgow, where the Researcher is primarily based, and the University of Oxford, a collaborating partner in the project. These sites were chosen both because they formed part of the collaborative doctoral programme and because their different disciplinary structures allowed for a more nuanced exploration of disciplinary mental models than a single-site study could provide.

The recruitment of participants required more than administrative permission at both institutions. Consistent with the study's ethnographic and qualitative orientation, the researcher sought appropriate means of gaining access to the everyday professional lives of social actors (Atkinson, 2014, p. 176). This was pursued by engaging with subject librarians at both universities. These individuals were not seen as gatekeepers but as valuable sources of knowledge about researcher availability, communication habits, and disciplinary cultures. Their advice informed a feasible and sensitive recruitment plan. Where such contacts could not be made, administrators were consulted for guidance on effective engagement with relevant departments. This early stage of relationship-building was essential for navigating institutional frameworks and developing a recruitment approach that was both respectful and contextually appropriate. These connections played a key role in ensuring successful access and meaningful engagement with potential participants across both university environments.

This study engaged individuals recognised as experts in their fields and actively involved in academic research. Accordingly, the participant sample focused on scholars beyond the postgraduate stage, including postdoctoral researchers, research fellows, lecturers, associate professors, and full professors. A purposeful sampling strategy was used to identify participants likely to provide detailed insights into the topic. As Patton (2015) observes, such individuals are often "information rich" and "illuminative", representing useful examples of the phenomenon under investigation. Within each disciplinary case, maximum variation sampling (Patton, 2015; Creswell and Poth, 2017) was employed to ensure diversity

in participant backgrounds and experiences whilst also enabling the identification of shared patterns across cases.

In terms of sample size, there is no single accepted standard in qualitative research (Dworkin, 2012; Marshall *et al.*, 2013). Whilst approaches such as theoretical sampling (Glaser and Strauss, 1999) and redundancy sampling (Lincoln and Guba, 1985) are widely recommended, they require iterative processes not always feasible within time and funding constraints. Practical considerations often shape decisions around sample size, especially where review boards require estimates in advance (Patton, 2015).

The target sample size was guided by comparable qualitative studies in the field. For example, Fry (2006) interviewed 9–10 academics per discipline; Foster and Ford (2003) included 9–14 participants per metadiscipline; Talja (2002) recruited 10–12 researchers per discipline; and Lönnqvist (2007) conducted 24 interviews across four disciplines. Following this precedent, the present study sought to interview 10 academics for each case, yielding a total of 40 participants evenly distributed across the four disciplines and the two institutions (Appendix II). The intention was not to generate quantifiable or generalisable findings, but rather to obtain rich insights into scholarly mental models and disciplinary cultures in accordance with the holistic theoretical framework.

Recruitment was primarily carried out via email and remained flexible throughout. Where possible, subject or college librarians assisted in identifying suitable candidates or distributed calls for participation through internal channels such as listservs and newsletters. In cases where this was not feasible, the Researcher contacted academics directly. Snowball sampling (Liamputtong, 2020) was also used, whereby initial participants recommended additional contacts.

Fieldwork was conducted in three phases over four months in 2023. Timing was based partly on librarians' advice and partly on the Researcher's availability. The first phase ran from early May to early June in Oxford; the second from June to August in Glasgow; and the third from late August to late September back in Oxford. The initial phase involved conducting one or two interviews per week to allow time for familiarisation with the field. During the later phases, the number of interviews increased to between two and four per week as the Researcher grew more familiar with the methods and the disciplines, and to meet the target.

Two pilot interviews were conducted in April 2023, shortly after ethics approval was granted. These involved a postdoctoral researcher in Chemistry and an honorary research fellow in History at the University of Glasgow. The full protocol was tested in these sessions, and minor adjustments were made based on the feedback received before moving into full recruitment.

3.4.2 Methods for generating data

The methods used to generate data consisted of semi-structured interviews, cognitive mapping, and observation. Each of these methods was designed to elicit participants' perspectives on disciplinary knowledge structures in a flexible and participant-centred manner. The combination of verbal, visual, and observational methods aligns with the study's interpretivist and exploratory framework and appropriately addresses the research challenges outlined in Section 3.3.

Interviews

Semi-structured interviews were the main method of data generation. They allowed for flexibility in questioning and provided space for participants to reflect on their research practices and disciplinary perspectives. Interviews were designed in line with Flick's (2007) view of qualitative interviews as both interactive and adaptable. Rather than following a rigid script, the interview design was iterative and responsive to the study's ongoing progress (Rubin and Rubin, 2005; Flick, 2007).

The interview guide was developed from the study's research questions and the literature reviewed in Chapter Two, centring on participants' perceptions of their own fields, research practices, and work cultures. Questions were designed to elicit, in participants' own words, their path into and identity within their discipline; how they conceptualise the organisation of knowledge in that field; their practices of seeking and evaluating information; and their experiences of the systems, collections, and spaces used for their work. The guide was piloted with two participants at the University of Glasgow and questions were refined after the first few interviews, leading to the addition of questions related to the setting or environments in which researchers worked as well as the closing question. Consistent with the study's interpretive orientation, the guide was treated as a flexible scaffold rather than a script, and its purpose was to open themes for participants to explore, not to standardise responses.

Within each interview, a consistent opening protocol was used, after which participants were asked to draw and then to discuss their drawings and lead the conversation wherever possible. Follow-up questions were often shaped by the participant's responses rather than drawn in order from the guide. Not every question was therefore asked of every participant. This was a deliberate methodological choice as the

study's aim was to understand how each scholar perceives and articulates their disciplinary world in their own terms, and imposing a uniform question set would have constrained the participant-led accounts. Comparability across the dataset was maintained at the level of underlying conceptual patterns rather than identical questions, supported by the consistent opening protocol and the cognitive mapping exercise completed by all participants except for one. Across the study, the guide also evolved in response to what earlier interviews surfaced: most significantly, the recurrent appearance of physical spaces and objects in participants' drawings and accounts led to new questions about participants' work environments and the addition of an observational component partway through fieldwork, as described further below.

Each participant took part in a single interview, arranged following an initial email invitation. Interviews were open-ended and guided by a flexible protocol (see Appendix III), with follow-up questions tailored to participants' responses. This design enabled consistency across interviews whilst also allowing the exploration of new or unanticipated themes. The aim was to foster free-flowing conversations shaped by the participants' own experiences and language. Such an approach is highly adaptable, enabling topics to be covered in depth within a limited timeframe, especially when rapport develops between interviewer and participant (Asher and Miller, 2011).

Interviews typically lasted around one hour, with some extending to 90 minutes. Most were conducted in participants' offices, though a few took place in alternative venues suggested by the Researcher and/or selected by the participants, when they expressed they did not have an adequate workspace for a private interview. All interviews were audio-recorded with participants' consent and transcribed in full.

Cognitive mapping

As an entry point to the interviews and to supplement the verbal data, participants were invited to complete a cognitive mapping task. Cognitive mapping is the internal process by which individuals acquire and organise information into structured mental representations, enabling them to interpret and navigate their environment and experiences (Stea, 2017). As a research technique, it invites participants to externalise this internal map as a visual sketch and to discuss their experiences through it, illuminating lived practices and contexts that might otherwise remain tacit (Lanclos, 2013). A precedent for this approach is Hartel's iSquare method (Hartel, 2014; Hartel *et al.*, 2017), an arts-informed technique able to elicit conceptions of abstract phenomena, surfacing perceptions that verbal methods alone cannot. The mapping exercise in this study—a method also common in library user experience (UX) research (Priestner, 2021; Fu, Lomas and Inskip, 2022)--extends this approach from the concept of "information"

to the broader terrain of disciplinary knowledge, inviting scholars to externalise how they conceptualise the structure of their fields.

The task prompt was: “Please draw your discipline.” Participants were given six minutes and three differently coloured markers to complete the drawing on an A3 sheet of paper, changing colours every two minutes. This sequence allowed the Researcher to observe the order in which concepts were introduced. The prompt was intentionally broad and open to interpretation. In some cases, participants sought clarification, but responses were kept deliberately vague in order to maintain the open-ended character of the task.

Cognitive mapping provided a visual entry point for participants to express abstract or complex ideas about their disciplines. The drawings were followed by the interview, where participants were asked to elaborate on the meaning and structure of their maps. This approach helped stimulate reflection and offered insight into the ways participants conceptualise the organisation of knowledge in their fields.

Observation

Interviews and cognitive mapping sessions were conducted at the University of Oxford and the University of Glasgow. Participants were encouraged to choose locations where they felt most comfortable. Most sessions took place in participants’ offices or departmental meeting rooms. In one case, the interview was conducted in a participant’s home, at their invitation. The choice of interview sites was meant to minimise participant burden and create a relaxed and familiar atmosphere for data generation. These environments also offered contextually rich insights into participants’ working environments.

Whilst the spatial aspect was not initially a focus of the study, its significance emerged progressively during the course of data generation. As interviews unfolded, it became increasingly apparent that the physical, environmental, and material dimensions of participants’ spaces played an important role in shaping their practices and academic identities. This realisation was not pre-planned but arose organically through the grounded and emergent nature of the research process. What began as a logistical consideration developed into an analytical lens. Space, in its various forms, became so salient that it ultimately provided the foundation for Chapter Six. This unanticipated but central focus on spatiality constitutes one of the original contributions of this thesis, demonstrating the value of flexible, responsive methodological approaches in qualitative research.

Fieldnotes and memos

Fieldnotes played a crucial role in documenting both descriptive and reflective insights. According to Brodsky (2008), fieldnotes are essential for recording observations, participant behaviours, and environmental cues not captured in audio recordings. They also serve as a personal journal for the Researcher, capturing evolving thoughts, interpretations, and reactions during fieldwork.

Reflective fieldnotes were kept throughout data generation, capturing both logistical issues and the Researcher's own responses to interview dynamics. These included notes on non-verbal cues, the interview setting, and interactions that influenced the tone or direction of the session. Fieldnotes were written immediately after each session to ensure accuracy and depth. They included two sections: observations (e.g. setting, gestures, tone) and reflective commentary (e.g. Researcher impressions, dilemmas, and emerging themes). These notes supported the analytic process by facilitating coding, memoing, and theory development.

3.5 Data analysis

The analysis in this study was guided by a holistic framework and a constructivist grounded theory approach (Charmaz, 2025) adapted to the specific constraints and aims of the project. This approach prioritised participants' voices and experiences, keeping the Researcher close to the empirical data and allowing concepts and patterns to emerge directly from the data rather than imposing predefined categories. Consistent with the interpretivist framework of the research, analysis was iterative and evolving. To remain immersed in the data, the Researcher delayed engaging with the wider literature during analysis. At the same time, the study was shaped by the concept of disciplinary mental models introduced in Chapter Two. As such, the analysis did not follow a wholly inductive, pure grounded theory method, but instead applied grounded theory strategies to generate situated insights.

The relationship between data generation and analysis requires comment. Constructivist grounded theory envisages analysis proceeding concurrently with data collection, each informing the other (Charmaz, 2025). In practice, this study operated on three levels. First, informal analysis was continuous throughout fieldwork: reflective notes were made immediately after each interview, emerging patterns were noted, and these ongoing reflections directly shaped the evolving nature of the study, most notably in the recognition of space as a significant theme and the consequent adaptation of methods mid-fieldwork. Second, formal coding began after data collection was complete, partly reflecting practical constraints:

transcription and detailed notetaking for forty interviews consumed much of the condensed fieldwork period. Third, the formal analysis was itself conducted iteratively rather than as a single synchronic exercise. Transcripts and cognitive maps were coded in the order in which the interviews had been conducted. Because participants from different disciplines and institutions were interwoven across the fieldwork period, coding in this order meant that the disciplinary cases were compared continuously as the framework developed, in the manner of constant comparison (Charmaz, 2025). Earlier transcripts were revisited and re-coded as categories evolved, ensuring that the developing framework was applied consistently across the data. Theoretical saturation was evaluated once all interviews had been coded and compared, at which point no new categories were emerging from the data.

A departure from Charmaz's approach should be acknowledged. Constructivist grounded theory pairs concurrent analysis with theoretical sampling, and recruiting additional participants as indicated by the emerging theory. This study did not do so. The sample of forty, separated by discipline and institution, was determined in advance because the comparative case study design required a balanced sample across the four disciplines, an aim incompatible with open-ended, theory-driven recruitment. Theory was instead built inductively from the complete body of interviews, cognitive maps, and observations. This is an aspect in which the study is inspired by constructivist grounded theory rather than a procedural replication of it: it adopts Charmaz's epistemological position, her emphasis on participants' meanings, and her core analytical practices of constant comparison and iterative re-coding, whilst adapting the sampling logic to the requirements of a structured comparative design.

The cognitive maps were analysed qualitatively, element by element. Each component of a drawing--shapes, lines, and annotations—was treated as a codable unit, in the same way that each line of the interview transcripts was coded. As the drawing exercise took place within the interview and participants explained their cognitive maps as they drew, each drawing was analysed alongside the corresponding passage of transcript, with the verbal account used to interpret the visual elements and vice versa. Codes generated from visual and verbal data were integrated into a single coding framework rather than maintained separately, allowing themes to be built from both sources together. The circumstances of the drawings' production were also treated as data: instances where participants declined to draw or produced word-only cognitive maps were coded and analysed as meaningful responses, as discussed in Chapters 6 and 7. Observational data from field notes were brought into the same framework, allowing participants' accounts of their spaces and practices to be compared with what was directly observed.

In the coding process, a factor was treated as influential where it emerged consistently across participants' accounts and drawings: where its presence corresponded to recognisable differences and similarities in how knowledge was conceptualised and articulated within and across the disciplinary cases. Factors were

treated as not influential, or less influential where no such patterns emerged. This differentiation was itself a product of constant comparison: candidate influences suggested by early interviews were compared against the accumulating body of data, and those that did not hold across cases were set aside or reframed. The factors presented in Chapters Four to Six are accordingly those that showed prominently this comparative testing. Section 7.1.3 discusses those that did not.

Initial and focused coding

The first stage involved initial coding (Charmaz, 2025, pp. 108–138), during which the researcher conducted line-by-line analysis of the interview transcripts and their own memos. In some cases, *in vivo* codes, drawn directly from participants' own words, were used to preserve their original meanings (Charmaz, 2025, p. 134). At this stage, the researcher avoided imposing predetermined categories, staying close to the data and remaining open to the emergence of patterns.

This was followed by focused coding (Charmaz, 2025, pp. 139–148), in which the most significant and frequent codes were selected and the data organised into stronger categories through a process of constant comparison across codes and transcripts. A tactile approach was adopted in this stage: codes were printed, cut, and physically sorted by theme. This hands-on, visual method encouraged closer engagement with the material and facilitated the identification of thematic clusters (Figure 3-2). As the iterative coding process stabilised, it resulted in 35–40 provisional categories developed from the initial codes (Figure 3-3).



Figure 3-2 Physical sorting of codes

Basic unit	Communication	Information resources	Information access	Information relevance	Information organisation	Academia vs practice	Theory vs application	COVID
Knowledge exchange	Teamwork	Training/ mentorship	Career	Roles	Community	Motivation	Method	Place/space
Structural	Dissemination/publication	Approach	Aim	Own discipline	Other disciplines	Nature of discipline	Specialisms	Education
Personality	Inter/multidisciplinarity	Funding	Information behaviour	Big picture	Collaboration	Research initiation	Social impact/value	Values/culture

Figure 3-3 Categories that emerged from the data

Axial and theoretical coding

Following initial and focused coding, a stage of axial coding was undertaken to explore relationships between categories and subcategories (Charmaz, 2025, pp. 149–151). For Strauss and Corbin, axial coding involves reassembling data that were broken up during initial coding by identifying links between rigid categories (Strauss and Corbin, 1990, pp. 96–115). Charmaz (2025, pp. 149–151) is critical of this rigid approach, viewing it instead as a flexible device that helps explore relationships between categories.

In this study, axial coding was used in Charmaz's flexible sense: categories were arranged into diagrams to visualise connections, with lines drawn to indicate conceptual links across categories and subcategories. These diagrams evolved as the analysis progressed and played a central role in shaping the interpretation of data. Examples of these visualisations are below (Figures 3-4, 3-5, 3-6).

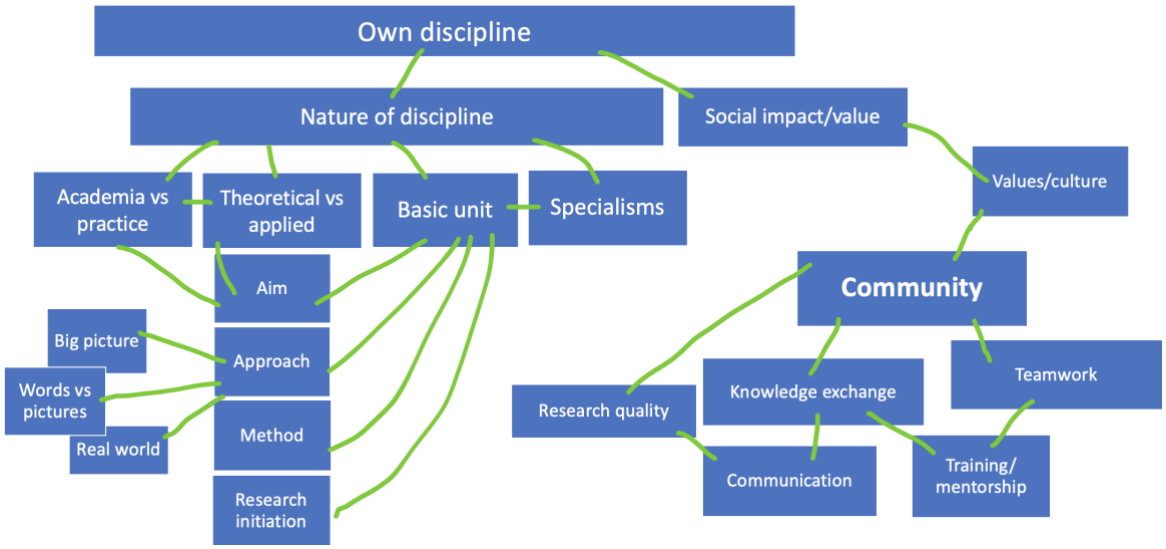


Figure 3-4 Relationships between categories, clustered around "own discipline" and "community"

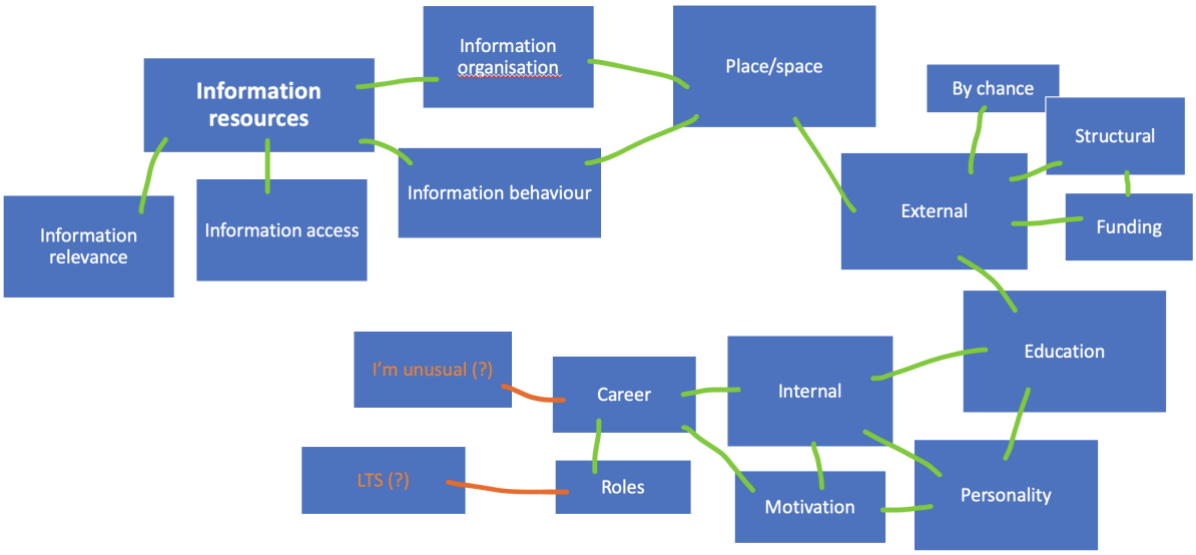


Figure 3-5 Relationships centred around categories "external", "internal", and "information resources"

Finally, a composite diagram was developed to bring together all categories and subcategories and show their relationships in a single conceptual framework. The model evolved as coding and analysis progressed, but Figure 3-6 represents a working map of the major categories and connections underpinning the study, clustered around the focal point of the study: scholars' mental models.



Figure 3-6 Working map of categories and their relationships

Whilst Figure 3-6 presents the categories and their relationships as a map, Table 3-2 shows how each was grounded across the four disciplinary cases. The table follows the hierarchy in Figure 3-6, but reflects the final coding framework, so a small number of codes were merged, renamed, or added as the analysis progressed.

Two patterns stand out, and the first is that the codes were largely shared. The major categories, and many subcategories, appeared across all four disciplines. The variation lies in how they were expressed rather

than whether they appeared, and this is clearest at the subcategory level. Academia versus practice was high only in law. Information access was high in history and law but low in chemistry. Information anxiety was slightly higher in history than in other cases.

The second is that the codes marked as absent are also informative. Teamwork did not appear in history or law but was present in chemistry and medicine. Values/culture did not emerge as a category in chemistry whilst it did in the other three cases; social impact was absent in history, whilst it was more explicitly expressed the other fields, particularly in law. A summary of the salience of the different categories and subcategories by disciplinary case is outlined below.

Salience key:

- High: Prominent; strongly and consistently patterned in this case
- Medium: Present; appeared, but less central or less consistent
- Low: Marginal in this case
- None: Absent in this case

Category / subcategory	Chemistry	History	Law	Medicine
Own discipline	High	High	High	High
—— Nature of discipline	High	High	High	High
—— Academia vs practice	Low	Low	High	Low
—— Theoretical vs applied	Medium	Low	Low	Medium
—— Basic unit	Medium	Medium	Medium	Medium
—— Aim	Medium	Low	High	High
—— Approach	High	High	High	High
—— Method	High	High	High	High
—— Research initiation	Low	Low	Medium	Low
—— Specialisms	High	High	High	High
Internal factors	Medium	Medium	Medium	Medium
—— Career	Medium	Medium	Medium	High
—— Roles	Medium	Low	Low	Medium
—— I’m unusual or in between	Low	Low	Low	Low
—— Education	Medium	High	High	Medium
—— Personal qualities	Medium	Low	Medium	Low
—— Motivation	High	Medium	High	Medium
External factors	Medium	Medium	Medium	Medium
—— Place/Space	High	Medium	High	Medium

Category / subcategory	Chemistry	History	Law	Medicine
—— Structural	Low	Low	Low	Medium
—— Funding	Medium	Medium	Low	Medium
Information resources	Medium	Medium	Medium	Medium
—— Information access	Low	High	High	Medium
—— Information organisation	Medium	High	Medium	Low
—— Communication	Medium	Medium	Medium	Medium
—— Dissemination/Publication	Medium	High	High	Medium
—— Information anxiety/overload	Low	Medium	Low	Low
—— Information finding	High	Medium	High	Medium
—— Information processing	Medium	Medium	Medium	Medium
Community	Medium	Low	Low	Medium
—— Collaboration	High	Medium	High	High
—— Teamwork	Medium	None	None	Medium
—— Knowledge exchange	Medium	Medium	Low	Medium
—— Values/Culture	None	Low	Low	Low
—— Social impact/contribution	Low	None	Medium	Low
Cross/inter/multidisciplinarity	High	Medium	Medium	High

Table 3-2 Salience of category by discipline

Theoretical saturation and theory construction

The Researcher analysed all collected interview transcripts and materials through a grounded theory-inspired iterative process; theoretical sufficiency was reached when the categories were well developed and sufficient depth had been achieved within the scope of the project (Charmaz, 2025, p. 212-214). An iterative process of constant comparison provided analytic depth to each of the four cases and ensured that categories remained grounded in the data. Throughout the analysis, the Researcher produced both descriptive notes and conceptual memos throughout the analysis stage (Charmaz, 2025, p. 163-165). Descriptive memos summarised the data, whilst conceptual memos distilled key insights, thereby helping to “bridge the gap between coding and conceptual development” (Charmaz, 2025, p. 163-165). In addition, diagrams were created and refined alongside the memos to conceptualise relationships and support the development of grounded theory.

From this process, three major themes emerged that together form an explanatory framework for understanding mental models: individual/internal factors, external factors, and spatial/material factors.

These themes provide the foundation for the three subsequent chapters, which present the study's findings in detail. Before turning to the findings, it is necessary to address the ethical dimensions and the methodological challenges that arose during the study, as these informed the conduct of the research and the practical methodological choices made.

3.6 Ethical considerations

Because the study relied on human participants, ethical considerations were central throughout. Key concerns included informed consent, confidentiality, data protection, participant welfare, and the responsible use of incentives. Approval was obtained from both relevant ethics committees in March 2023 (University of Glasgow: 100220071; University of Oxford: R86262/RE001).

Procedural safeguards: Participants received clear information about the study before agreeing to take part, through a Participant Information Sheet and Consent Form outlining the study's purpose, selection criteria, methods of data generation, data use and storage, confidentiality measures, and participants' rights. They had sufficient time to review the documents, ask questions, and provide informed consent, which was obtained in writing. Data were managed in accordance with ethical guidelines and data protection standards: physical materials were kept in locked spaces, digital files were stored on password-protected and encrypted university systems, and consent forms were stored separately from research data to protect identities.

Participant welfare: The study focused on participants' work-related experiences, not on personal or sensitive information. Nonetheless, it was recognised that the combination of details such as job title, department, and institution could indirectly identify individuals. To reduce this risk, participants were assigned numerical identifiers (e.g., P1, P2, P3) in transcripts, analysis, and reporting. Modest financial incentives in the form of gift vouchers were offered, advertised during recruitment, and distributed at the end of each session. These acknowledged the time and insight offered by participants and supported equitable participation across different backgrounds and circumstances. Given their modest amount, they were not expected to influence responses. To further minimise burden, participants were encouraged to choose interview times and settings that were most convenient for them, and care was taken to foster a respectful, comfortable environment.

Researcher positionality: The Researcher's positionality shaped the research process in various ways. As a student and researcher, she occupied both insider and outsider roles, belonging to academia but not to the disciplines studied. Her background as an ethnic minority woman with a multidisciplinary

education informed her perspective, and rather than attempting to eliminate these influences, the Researcher sought to acknowledge and reflect on them critically. Conducting the research within the Researcher's own academic institutions required additional care to uphold privacy and professional boundaries. Reflexive practice was embedded throughout, supported by training in research integrity and detailed notes on participant dynamics, emotional responses, and the Researcher's own influence on the interactions.

Working with more senior academics led to particular dynamics, marked by both curiosity and vulnerability. As the interviewer, the Researcher approached participants with openness and a willingness to learn, whilst also recognising her relative inexperience. Differences in institutional affiliation and levels of familiarity with each site further shaped these interactions. Together, these positionalities and ways of relating to participants were explicitly acknowledged as part of a commitment to reflexivity, ethical integrity, and transparency throughout the project.

3.7 Methodological challenges

This study employed a combination of semi-structured interviews, cognitive mapping, and observational data to explore scholars' perspectives across disciplines. Whilst this multimethod approach added richness and allowed for multiple angles into disciplinary mental models, it also presented several methodological limitations.

In the cognitive mapping activity, variation in responses was an important feature of the study, reflecting the exploratory and holistic orientation of the framework. The prompt "draw your discipline" was intentionally open to interpretation, and participants approached it in diverse ways: some sought clarification, others depicted what felt most accessible to represent, and some expressed uncertainty or discomfort. These differences provided insights into the multiple ways participants articulated their disciplinary thinking and the strategies they used to externalise mental models. In one instance, a participant (P30) declined to draw, but this itself highlighted the limits of the method and was balanced by a lengthier interview and observation, underscoring how the use of multiple methods enriched the dataset and offered a more nuanced picture of disciplinary mental models.

In the semi-structured interviews, participants were allowed to guide the conversation, which often resulted in valuable and unexpected insights. This naturally led to variability across interviews, as follow-up questions were shaped by each participant's responses. Such variability is consistent with the exploratory nature of the study and reflects the holistic theoretical framework set out earlier in the

chapter, which prioritises understanding participants' perceptions and experiences in their own terms. Analysis therefore focused on the mental models that emerged from these conversations, rather than on the comparability of specific questions, making the semi-structured format appropriate for the aims of the research. Rigour was maintained through the use of a consistent opening protocol and grounded analysis, ensuring that the insights derived from participants' accounts were comparable at the level of underlying conceptual patterns.

In the observational component, the importance of this method only became clear during the research process, so greater emphasis was placed on this method in the mid- to later stages, resulting in some inconsistency across the dataset. At the same time, it was important to meet participants in spaces where they felt most comfortable, which often meant going to them in their preferred locations. For some—particularly early career researchers who worked in shared or temporary workspaces—it was necessary to arrange suitable meeting rooms, whilst many medical researchers preferred to meet in spaces within their building, hospital, or medical library. These choices sometimes limited access to everyday work environments, yet they also reflected a balance between respecting participants' comfort and remaining attentive to the environmental surroundings that could shed light on their work practices and mental models.

Recruitment also presented challenges, particularly in ensuring that participants reflected the study's focus on disciplinary researchers. Some participants were later identified as being on the Learning, Teaching and Scholarship (LTS) track—a purely teaching-focused track mentioned in Section 3.3.2—at the University of Glasgow, a distinction not apparent from job titles. To address this, additional screening questions were introduced to exclude LTS staff, whose teaching and pedagogical research fell outside the scope of the study. Recruitment in medicine proved especially difficult, particularly among clinicians, so a broader range of biomedical, lab-based, and clinical researchers from across the medical division or college were included, rather than concentrating on a single medical subject. This contrasts with the more narrowly defined subject areas in chemistry, history, and law.

The study's aim to explore and compare mental models across disciplines must be understood within a holistic framework that recognises the complexity of these models. As Norman (1983) has argued, mental models are often tacit, only partly available to individuals themselves, and can only be externalised through partial, interpretative means such as language, visualisation, or observation (Norman, 1983). In accordance with qualitative research traditions, the data generated here was not "discovered" but co-constructed through the interaction between participants and the Researcher. The framing of prompts, the asking of questions, and the interpretation of responses were shaped by the Researcher's positionality, which was critically reflected upon, not disregarded. Rather than constituting a limitation, this interaction

highlights the situated nature of the findings, which should be viewed as illustrative insights into disciplinary thinking. By combining multiple methods, the study offers a richer and more nuanced picture than a single or quantitative approach could, whilst acknowledging that such insights are necessarily interpretative rather than definitive representations of mental models.

3.8 Summary

This chapter has outlined the methodology used to investigate researchers' mental models of disciplinary knowledge. It set out the theoretical framework underpinning the study—an interpretivist, qualitative, and holistic framework grounded in a constructivist approach—and explained how data were generated using a multimethod design combining semi-structured interviews, cognitive mapping, and observation appropriate to the study of disciplinary mental models. Analysis was guided by principles of grounded theory (Charmaz, 2025), following the immersive processes of coding, theoretical saturation, and theory building.

Although the iterative development and application of this qualitative methodology presented challenges, it enabled a more holistic and reflexive engagement with disciplinary mental models. Ethical considerations and methodological limitations were addressed by examining how the rigorous, yet flexible design reflected the contextually grounded, exploratory analytical framework. Together, these methodological choices provided the foundation for capturing the nuanced ways in which scholars conceptualise, experience, and navigate knowledge within their disciplines.

4 Extrinsic factors: how disciplines, universities, collections, and systems shape mental models of knowledge

4.1 Introduction

The present study's theoretical framework is centred on a holistic and contextualised explanation of researchers' mental models of knowledge. Human–computer interaction studies do not always account for users' lived experience or the contextual factors that shape their practice beyond the interaction with the system interface. Yet academic information extends beyond online platforms, encompassing multiple layers of context in a scholar's life world that influence how knowledge is conceived and organised. The goal of this research is to gain a better understanding of those factors and how they relate to researchers' mental models of information. Accordingly, this chapter examines not only the information systems that mediate scholars' interactions with knowledge, but also the wider disciplinary and institutional environments in which these systems are embedded.

This chapter begins with the study's key findings—the shapes of disciplinary mental models—before presenting the evidence that led to them, starting with the most influential aspect: the extrinsic. It examines four extrinsic factors that shape scholarly mental models: the discipline, the university, the collection, and the system. First, each discipline encompasses a fundamental body of knowledge that scholars are expected to learn and apply in their research. Disciplines also define distinctive methodological approaches that encourage particular ways of thinking and problem-solving. Materials such as bibliographies, textbooks, handbooks, and other reference works—often produced by learned and professional societies—offer insights into what each discipline considers foundational, and how that knowledge is organised and transmitted.

Second, the institutional structures of universities also shape how scholars experience and conceptualise knowledge organisation. Each university imposes its own hierarchical categorisation of academic disciplines and subdisciplines, often reflected in the physical and administrative arrangement of departments. These structures influence how scholars interact, identify with their disciplinary communities, and understand the boundaries of their fields.

Third, libraries and archives maintain systems of resource classification and organisation that affect how scholars conceptualise and seek knowledge. The Universities of Glasgow and Oxford each operate

distinct library systems that reflect their institutional histories and practices. Archives likewise maintain structures of knowledge organisation reflecting specific organisational needs and development, shaping how scholars navigate their information environments and, consequently, their mental models of knowledge organisation.

Finally, the information systems through which researchers access scholarly materials possess their own internal logic and affordances. These systems shape user interactions and influence how information is discovered, evaluated, and accessed. Specialist databases beyond general search tools such as Google or library discovery layers provide clues about how disciplinary expectations are embedded in search systems and how these, in turn, influence researchers' information practices.

These extrinsic contexts form the foundation for the disciplinary "shapes" of knowledge presented at the beginning of the chapter, each emerging directly from the empirical patterns described here. These four extrinsic contexts reveal that researchers' mental models of knowledge are shaped not only by cognitive or individual factors but also by the broader disciplinary, institutional, and technological environments in which scholarly work takes place. The findings presented in this chapter—as well as those in Chapters Five and Six—culminate in the identification of distinctive disciplinary shapes of knowledge that represent, visually and conceptually, how multiple contextual factors influence researchers' ways of thinking about, organising, and engaging with information.

4.2 Shapes of disciplinary knowledge

The empirical findings of this study reveal that the four disciplines examined—chemistry, history, law, and medicine—structure knowledge in distinctive ways. Participants' drawings and interviews suggest that each discipline embodies a characteristic form through which knowledge is organised and understood. These disciplinary "shapes" reflect both the intellectual logic of the field and the contextual conditions that support it. They also represent the culmination of how external, individual, and sociomaterial factors—explored across Chapters Four to Six—intersect within scholars' mental models of knowledge.

The mental model in **chemistry** is based on the periodic table of elements, which are the building blocks of atoms and molecules, the fundamental units of study utilised by chemists. On this basis, knowledge at larger scales takes on a networked structure, as scholars make sense of phenomena in the world via molecular diagrams, modelling physical structures and reactions, and by drawing connections between

chemistry's subfields (physical, inorganic, organic, theoretical, computational, synthetic) and other scientific disciplines that facilitate the production of knowledge.

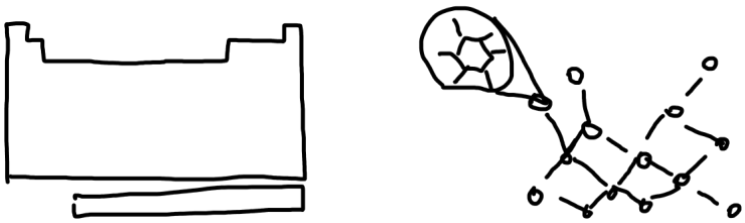


Figure 4-1 Mental model in chemistry, drawn by Researcher

The mental model in **history** resembles a dark room illuminated by a torch, where historians use fragments of information to critically (re/de)construct and (re)interpret the past. Knowledge is built by being immersed in the space, observing closely, identifying gaps, and connecting sometimes disparate, unexpected elements to build an understanding of the past. Although the room is a space of discovery, it is confined by specific criteria such as time period and geography.



Figure 4-2 Mental model in history, drawn by Researcher

The mental model in **law** is shaped like a pyramid or an (inverted) tree, reflecting its hierarchical taxonomy. Knowledge is built upon a classification scheme of laws, providing a framework for classifying and addressing new legal issues. The building blocks of case law are court precedents and statutes. This foundational organisation of knowledge, based on statutes and precedents, supports the construction of tight-fitting, precise logical arguments that minimise legal ambiguities.

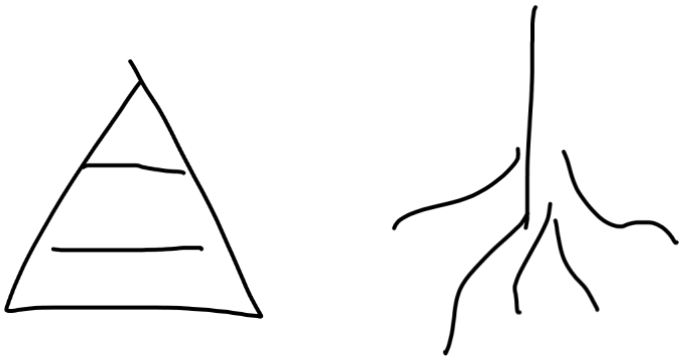


Figure 4-3 Mental model in law, drawn by Researcher

The mental model in **medicine** is a cyclical loop centred around the patient, where research problems start and end with the patient. Clinical researchers consider the lifecycle of a patient and/or a disease, and the medical interventions at different stages of the cycle. Biomedical researchers consider similar questions but approach these on a more fundamental, microscopic scale. Knowledge production follows an iterative feedback loop where discoveries continuously fuel new areas of research that could improve or enhance understanding of human health.

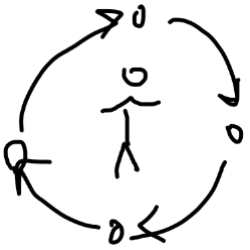


Figure 4-4 Mental model in medicine, drawn by Researcher

Mental models across the four disciplines reveal differences in how knowledge is organised and applied. Chemistry's periodic table, history's illuminated room, law's inverted tree, and medicine's patient-centric cycle each reflect and reinforce the methodologies and modes of reasoning in these fields. These different shapes of knowledge illustrate the varied mental frameworks of scholars across disciplines. They provide clues into why and how scholars approach information seeking differently across disciplines, which will be covered in more depth in the discussion in Chapter Seven.

The remainder of this chapter, along with Chapters Five and Six, explains how these disciplinary mental models emerged from the study's analysis of the various influences shaping scholars' conceptions of knowledge. Chapter Four, as outlined above, focuses on external factors: disciplines, universities,

collections, and systems. Chapter Five examines individual and personal factors, whilst Chapter Six explores mental models through spatial and material dimensions.

4.3 The disciplines

4.3.1 Chemistry: chemical elements and molecular structures

At a fundamental level, knowledge in chemistry is centred on the periodic table of elements, and on molecular and atomic structures. As P6 (Oxford inorganic chemist) explained, 'I think about chemical schemes all the time, chemistry equations. Of course, we are trained that way.' Repositories of data are designed to find information according to chemical structures, compounds, and elements, and much of the thinking is expressed through structural diagrams. As P25 (Glasgow physical chemist) noted:

> …that's like the foundation of what we do and how we understand all concepts in chemistry. Just understanding the periodic table. And then everything else in organic and inorganic chemistry is all going to come back to it. But then, in general, I would say because our degrees are accredited by the Royal Society of Chemistry, so there's a lot of content that we need to put in, which is based on their kind of outline, framework. (P25, Glasgow physical chemist)

There is a central framework of general knowledge in chemistry informed the Royal Society of Chemistry that shapes chemists' early mental models. Chemistry is traditionally subdivided into inorganic, organic and physical chemistry and categorised according to method or application (e.g., computational), although, as P2 observed, all of these boundaries became blurred when conducting research:

> Organic, inorganic [chemistry] are both material; it's sometimes really hard to draw the line. You know, what's inorganic, what's organic? If you have metal, that counts as inorganic. It could be organic based, and then you build some metal [from the material]. It's not inorganic or organic. I just feel like there is no clear definition when it comes to real research. (P2, Oxford organic chemist)

The interconnected nature of chemistry's subfields was visually depicted by Oxford inorganic chemist P6 and Glasgow organic chemist P13, illustrating subdisciplines and other scientific disciplines as nodes in a network. These visualisations reflect how chemists conceptualise subfields as separate but porous entities that are interconnected with other scientific fields:

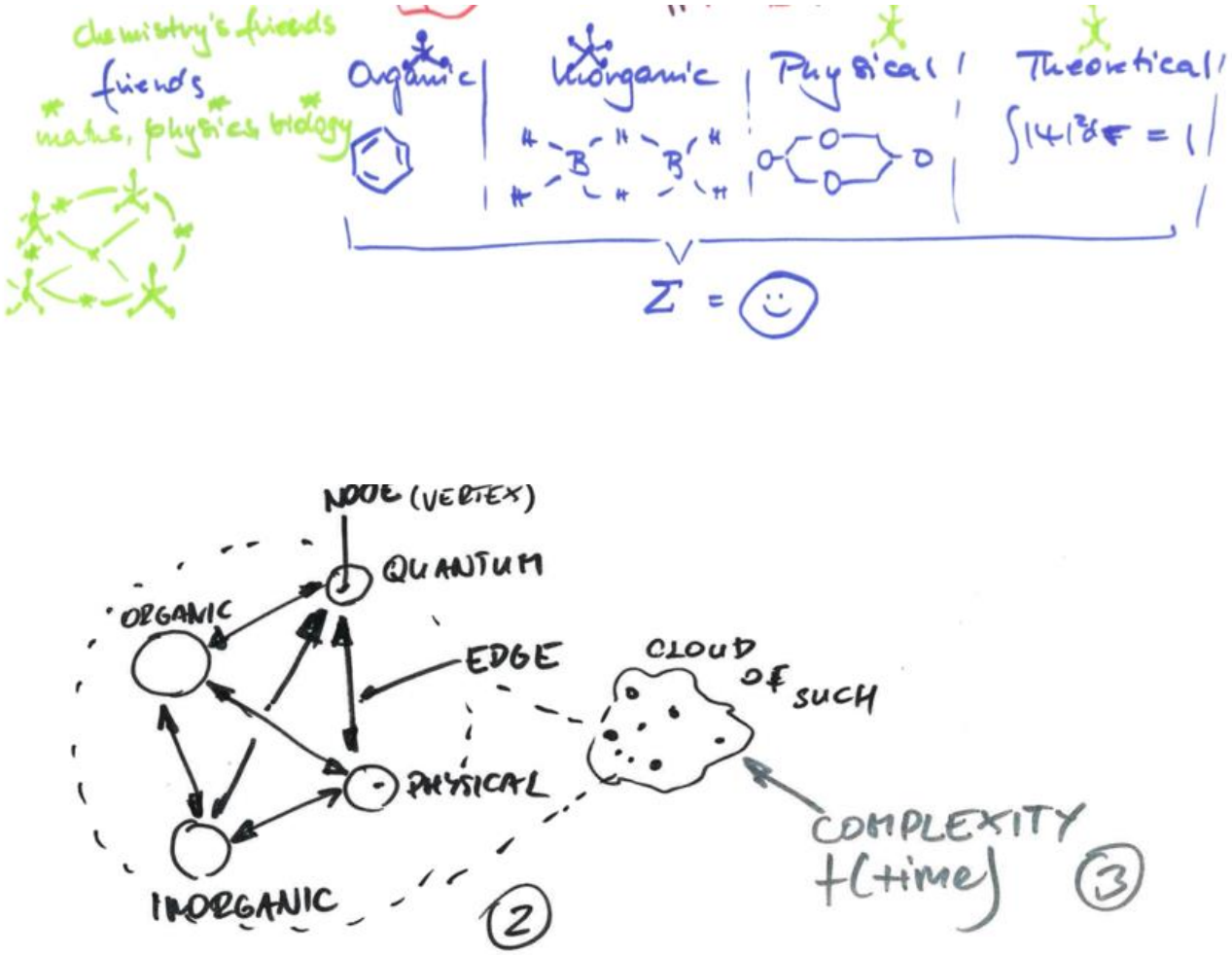


Figure 4-5 Excerpts from drawings of chemistry by P6 (above) and P13 (below)

Networks and nodes featured not only in P13's drawing but also in P1's (Oxford physical chemist) visual rendering of their field. P1 included networks in their drawing to explain how they conceptualised the fundamental structures of substances:

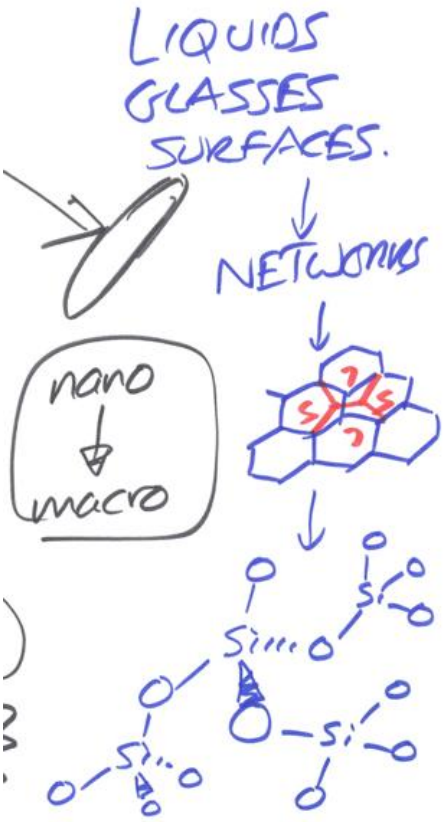


Figure 4-6 Part of drawing of chemistry by P1

Built upon a fundamental knowledge of chemical elements, the structural and conceptual notion of "networks"—networked chemical structures, networked fields of study, networked scientific knowledge—was a recurring theme in discussions with chemists in both Glasgow and Oxford.

Chemistry participants' drawings and perceptions of their fields suggested chemical knowledge is fundamentally organised around the structures and properties of molecules, with knowledge systematically conveyed through the periodic table and structural diagrams. Visualisations by chemists highlight the porous yet structured nature of chemistry, depicting connections between subfields and scientific disciplines such as biology and physics, and underscoring chemistry as an interconnected system built on the foundation of the periodic table of elements.

4.3.2 Medicine: a patient-centred, cyclical knowledge base

Medicine places human and animal health at its centre, as participants' depictions of their discipline showed, in which people/patients were a central feature. Researchers investigated internal and external, micro- and macroscopic factors affecting human and animal health.

Some medical researchers (P3, P18, P22, P24, P34) in this study described their research as a "cyclical" process centred on the human and animal body, as reflected in their drawings. Studies sought to improve understanding of why and how health conditions develop across diverse patient groups and to develop novel interventions, testing, defining, and redefining the boundaries of medical knowledge iteratively.

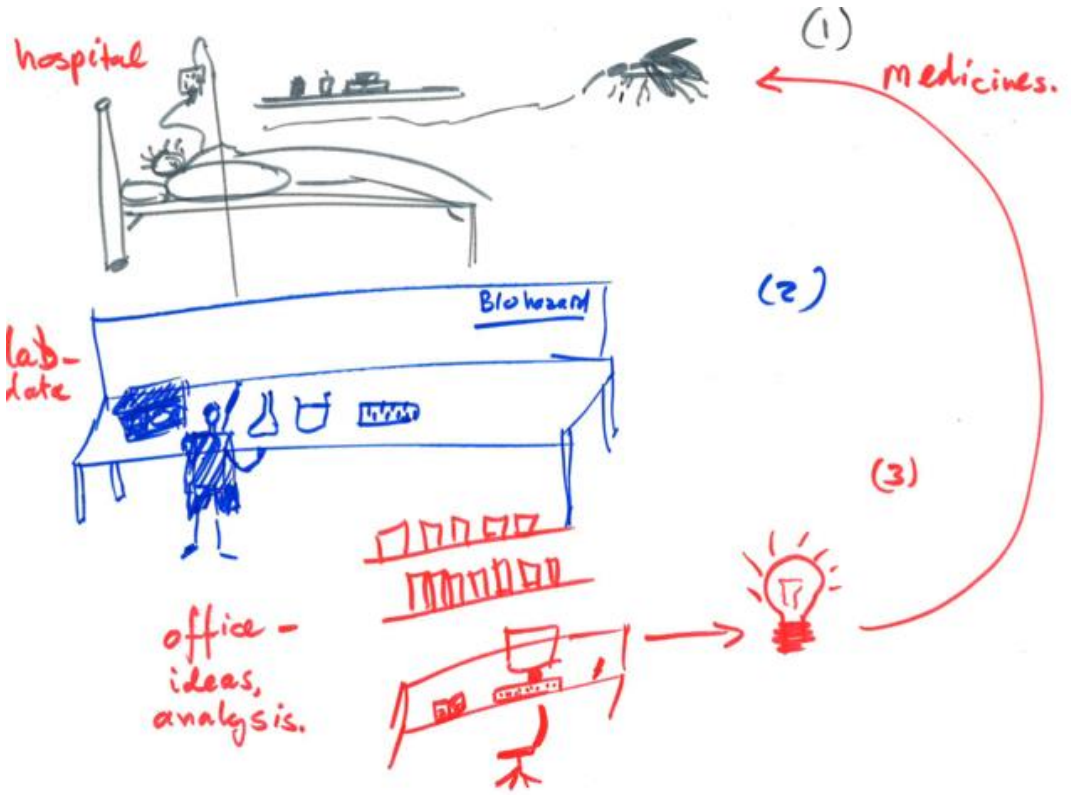


Figure 4-7 Glasgow biomedical researcher P22's drawing of their discipline

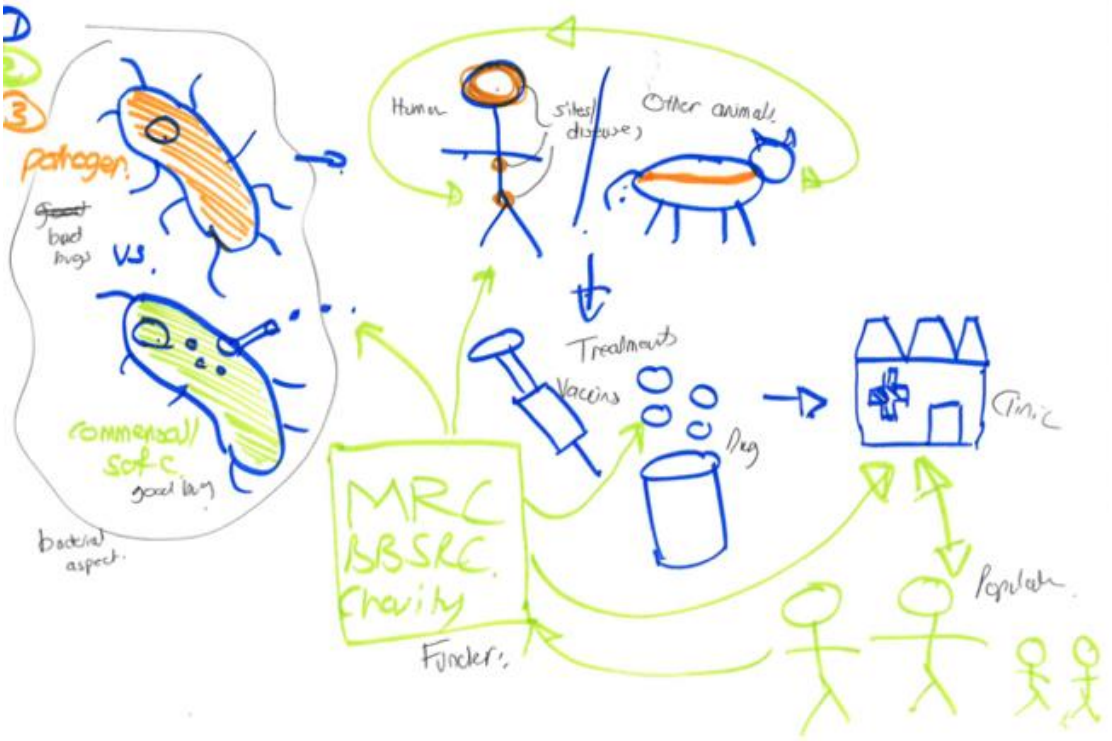


Figure 4-8 Glasgow biomedical researcher P18's drawing of their discipline

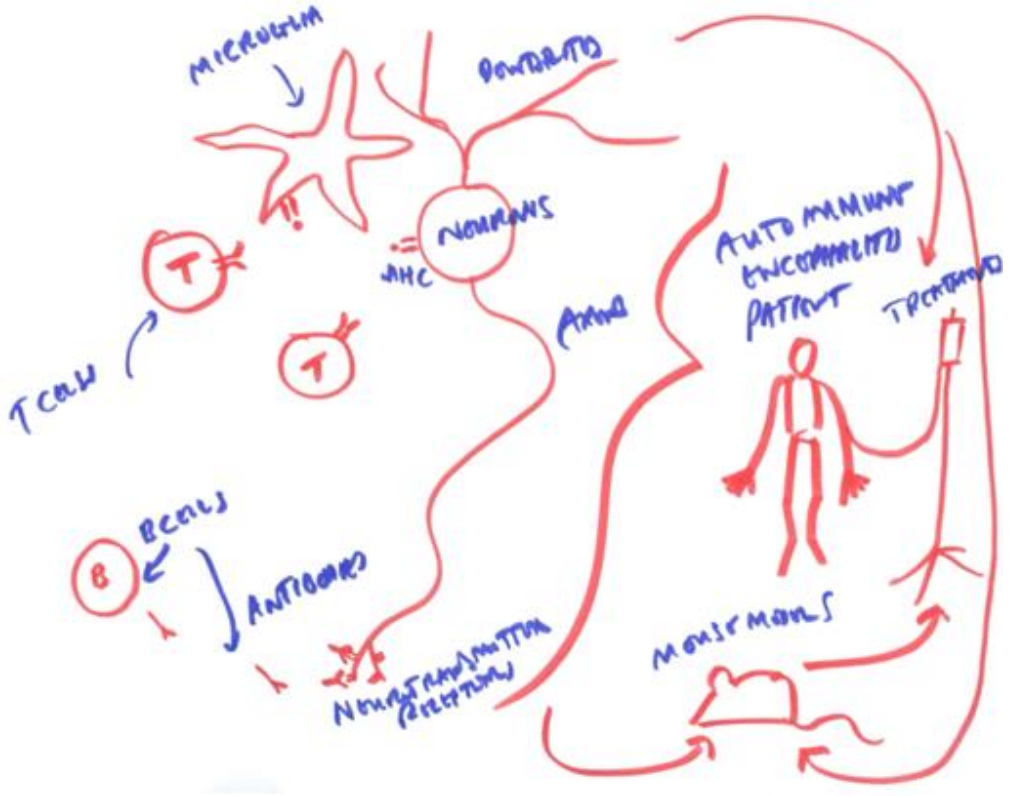


Figure 4-9 Oxford clinical researcher P3's drawing of their discipline

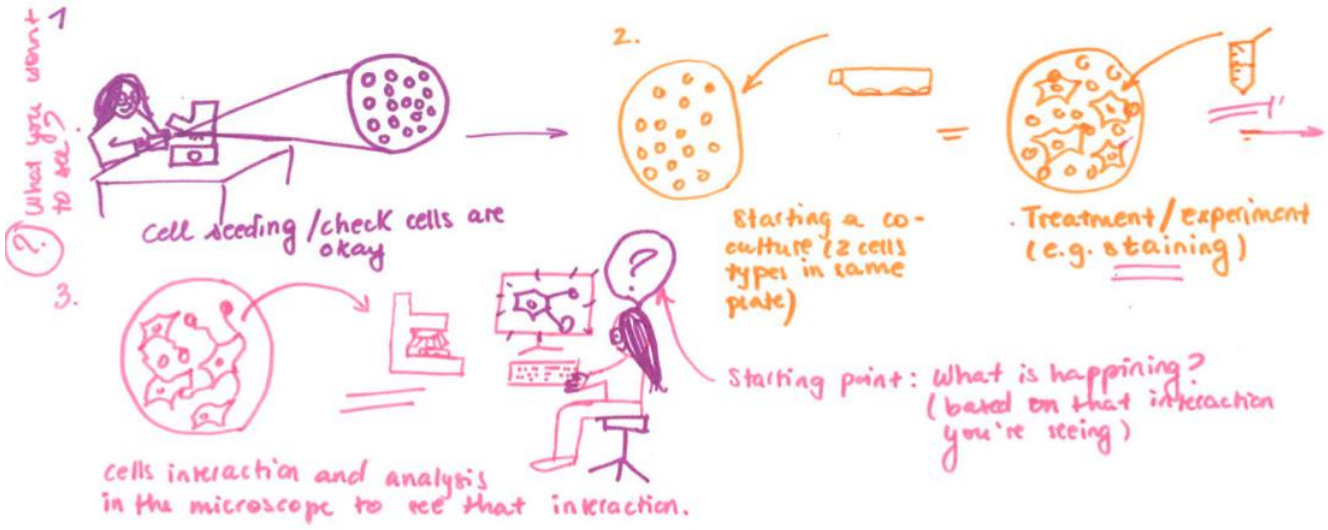


Figure 4-10 Glasgow biomedical researcher P24's drawing of their discipline

For clinical researchers in particular, the research problem was generated by the patient:

> But certainly, for the, for the field that I've ended up in, it's quite patient focused and that, that generates the problem lists that you can go on to find knowledge to address, I guess. (P3, Oxford neurology researcher)

For P34, the production of new knowledge was about constantly seeking new angles and interdisciplinary perspectives for developing novel kinds of interventions that could lead to a breakthrough:

> I want to know how to break the cycle. You know, [through] more new perspectives. That's the thing—people say, oh, we can try these drugs, but also other people will say, oh, you know, gut microbiome is probably another way out. So, I want to know, I want to know all these new things because they could be helpful for my research. (P34, Oxford primary care researcher)

The "cycle" on P34's mind was the lifecycle of a disease, and all the variables that could be tested along the way to "break" it. P34 was investigating one type of intervention and how it played out, across the patient's and the disease's lifecycle. Experiments started with the patient and ended back at the patient, where the cycle began again.

P24 noted this difference as they transitioned between fields, from biomedical engineering to cancer science: "For this other thing [biomedical engineering], it was like I wanted to give an explanation of what is happening in nature. So, now, it's different. I'm pursuing a purpose to be used in medicine." To

them, being involved in cancer research carried a tangible purpose—to improve human health—going beyond theoretically understanding how things work, which underlies fundamental scientific research. P24's drawing (Figure 4-10) of their discipline also conveys how an experimental process begins with a question and ends with a new question, which starts the experimental cycle again.

Based on participants' responses, medical knowledge is viewed as cyclical and iterative, with research leading to new discoveries and interventions that are tested and continuously improved. It is not only a cyclical loop in the research process but also in patient-centric thinking, with research questions arising from the patient and the disease and ultimately circling back to the source of those questions.

4.3.3 History: glimpses into a dark room

Historians in this study described how they gather and interpret fragmentary historical records. Historians "end up trying to make sense of quite big things on the basis of a very small number of documents" (P30, Glasgow modern historian). This process of historical research is what P30 likens to "shining a torch around a dark room":

> And the visual metaphor that I came up with for explaining this is that...you can't reconstruct a sense of the design of a large and complex mosaic from a couple of tiny tiles here and there. But if you're shining a torch around a dark room, although you're only illuminating a little part of it here and there, you can at least get some kind of sense of the size and shape of the room. And that's what I was trying to do with that very scant documentary record. (P30, Glasgow modern historian)

Piecing together the "scant documentary record" required a critical reading of the content and context. P9 (Oxford modern historian) explained how it was not only about reconstructing an idea of the dark room from the extant records but also questioning why they are there and what this means:

> But you know, archives are equally constructed documents. So, when we think about archives, we actually need to think about, well, why is it that this document has been preserved? Whose kinds of voices or whose voices tend to get preserved in colonial—in, in archives? …All of those documents are equally constructed for a purpose in the same way that, you know, oral history narratives are constructed narratives, and our job as a historian is sort of to deconstruct them… (P9, Oxford modern historian)

For history participants, making sense of the "dark room" is often an open-ended endeavour that does not lead to a single process or answer but unfolds as a dialogue, with other historians and with the public, as shown in P4's (Oxford modern historian) depiction of History:

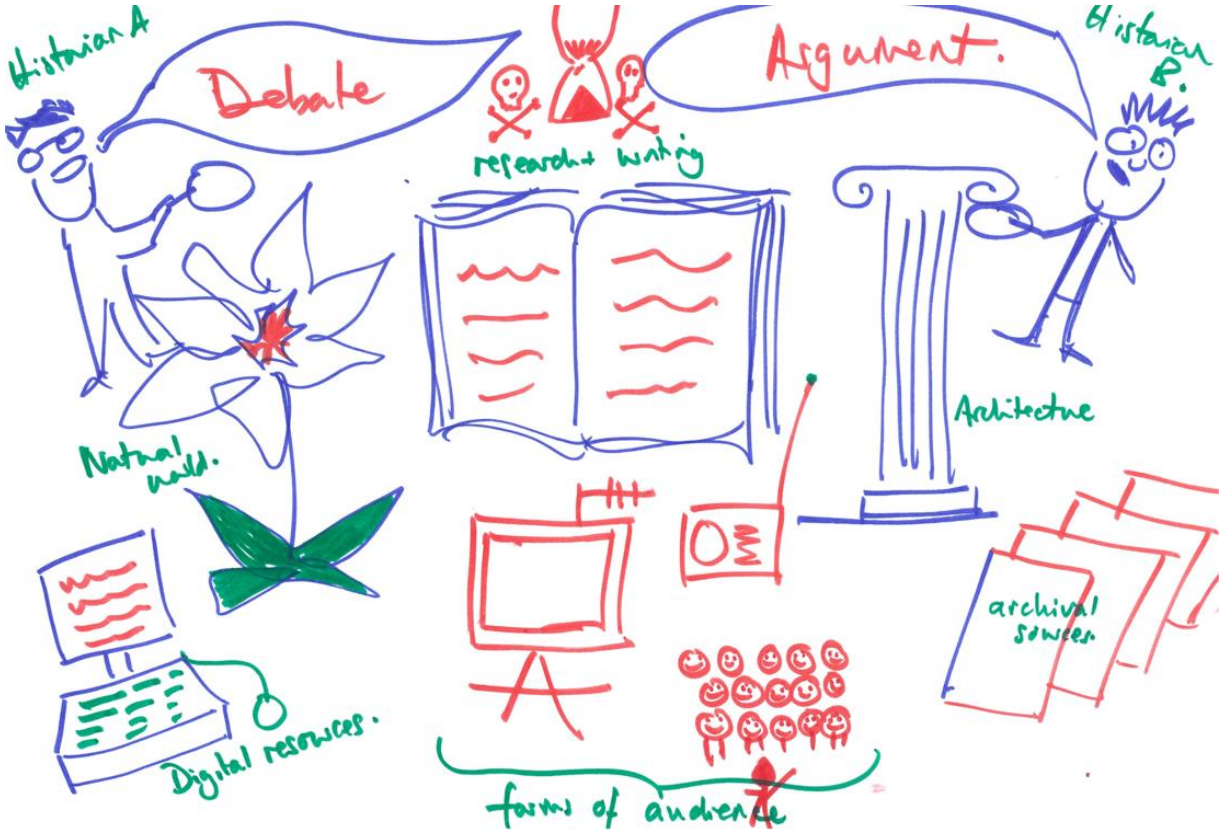


Figure 4-11 P4's (Oxford modern historian) drawing of their discipline

P4, P7, P9, and P27, P33 highlight how historical research is about shining different kinds of light on existing records and narratives, and uncovering aspects of history that haven't yet been explored, a process which can lead to different interpretations of the past—seen in the "debate" and "argument" in P4's drawing of their discipline (Figure 4-11). This use of different perspectives and narrative deconstruction is only possible through a deep immersion in sources. P7 elaborates:

> Somebody asked me once what was my methodology. And I said, saturation in empiricism. Essentially, I read everything I can get my hands on. And then I work out, as I've said, the kinds of questions, the kinds of concepts—that's my way of doing it... (P7, Oxford early modern historian)

P7 describes how their methodological approach is inductive, where questions and concepts arise from the empirical evidence. Historical methodology is also explained as "saturation in empiricism" by P26 (Glasgow medieval historian), whilst P30 (Glasgow modern historian) described it as a "mystical" sense of understanding arising from "listening" to the evidence:

> I mean, the sort of mystical skills, if you like. The sort of, the listening and the imagination, you know, it's being able to sort of, have that, what are they actually saying? You know, never mind all the stuff that, that you think they might be saying, but what's there? And, you know, can you imagine yourself to be here? What's it—What was it like to come across a preacher on a Sunday afternoon, you know, in the open air? Why did you stay and listen? (P26, Glasgow medieval historian)

In contrast to the structured problem-solving in chemistry, and the patient-centred reasoning in medicine, historians work critically with fragmentary evidence to piece together a clearer picture of the "dark room" of the past, but they also build narratives creatively, intuitively, and in dialogue with the sources, opening a space for multiple interpretations, rather than looking to provide a single answer.

4.3.4 Law: hierarchical taxonomies

Legal knowledge is underpinned by a hierarchical taxonomy of subjects, the "building blocks" of which are research are cases, statutes, and precedents (P38, Oxford private law scholar). This taxonomy is shaped like a pyramid or inverted tree, where subjects branch out from the general to the specific:

> …one branch would be private law. That would be one branch for criminal law, one branch for public law. Above everything would probably be constitutional law because we have this idea that there is a pyramid. So, you go from the more general, more important norm, which is the Constitution. And then you go down… (P12, Glasgow private law scholar)

This legal classification scheme was seen as the "backbone" of legal research by researchers—and even of society, according to P38, a scholar of English law. Even though English law was centred on building arguments using legal cases which are not organised taxonomically in the same way, the mental models of scholars of English law were still largely hierarchical, and fixed.

P11 (Glasgow private law scholar) explained the significance of the legal taxonomy, in relation to law as a discipline, as a practice, and to society:

> I think it's [legal taxonomy] a really important thing internally to keep as a discipline. To be informing the rest of the university or the rest of society what we are contributing. We know what the law is, hopefully, and where it is, so internally, we need to keep it taxonomically well organised… How do we—where do you organise that and put that? What's similar? So that then it helps us when you knock at the door and say, this issue is before us, how do we decide? (P11, Glasgow private law scholar)

Just as chemists might apply their foundational knowledge of periodic elements and reactions to conduct their research, legal scholars referred to the existing structure of law to make sense of new issues and offer others advice in navigating the vast and complex "sea of law" (P11, Glasgow private law scholar). Not only that, but P11 found that this is how law stays internally and externally accountable, reinforcing P12's (Glasgow private law scholar) observation that the taxonomy is so well established that legal academics "believe in it".

Whilst historians' mental models of methodology were more inductive and amorphous, allowing sources to give rise to new concepts and questions, legal research was almost the reverse. Legal academics had a robust mental framework from the outset and built tight logical arguments by selecting sources to support their arguments, using a "deductive" rather than inductive approach:

> I suppose that in any article that you might be writing, you would be selecting the materials that are relevant to the problem that you're trying to address, for example, so… I think what you end up doing is arguing for the relevance of particular things? That's part of the...task. So, you might say, well, let's look at this area of law because it might be helpful in these following ways. (P8, Oxford public law scholar)

> So, you really, well, you need to really have an understanding of what law means, what its fundamental structures and concepts are in your head, and then you need to know how to apply those to...concrete issues that you come across. (P14, Glasgow international law scholar)

Based on the legal taxonomy, legal scholars were able to determine "how to classify an issue" and identify what areas of the law were relevant in order to properly analyse a situation and arrive at an argument or decision (P11, Glasgow private law scholar).

Law has an established taxonomy of subjects, and scholars not only commit this hierarchy of legal subjects to memory—just as chemists might memorise the periodic table—but also apply this classification system to new cases and issues to make sense of them. This was communicated visually in participants' drawings of their subject discipline and also described verbally as a "pyramid" and "branches" stemming out from a tree.

4.4 The university

The previous section showed differences across disciplines. This section will show that universities are environments that shape the mental models researchers adopt of their disciplines. The physical organisation of disciplinary departments and administrative structures at the Universities of Glasgow and Oxford (see 3.2.2) influence not only how disciplines evolve (and vice versa), but also how individual scholars conceptualise and approach their fields. This section highlights how the divergence in institutional organisation between these two universities reflects and contributes to researchers' conceptions of their disciplines. One key distinction between the University of Glasgow and the University of Oxford consists in that Oxford operates within a collegiate system, a feature absent at Glasgow. This structural difference plays a role in how disciplines are organised and experienced by scholars.

4.4.1 History

At Glasgow University, the History department is structured around period and geography. Scholars and research groups are divided into the subfields of medieval history, modern history, and Scottish history, housed within a row of buildings along University Gardens. As early modern historian P15 explains, these are the "conventional" categories of the discipline of history and scholars still "see themselves somewhat tribally", holding onto their subdisciplinary identities, but because geographical divisions cut across the chronological, P15 and colleagues "spent quite a lot of time walking up and down University Gardens". The spatially distributed institutional organisation encourages specialisation within specific historical subfields, but at the same time the clustering of history buildings and the proximity of researchers' offices to each other facilitated engagement across the department. The history department is also organised around research themes such as Scottish & Celtic Studies, American Studies, Gender History, and War/Conflict Studies, among others, areas that cut across chronological and geographical boundaries (*History Research Centres*, no date).

In contrast, the faculty of History in Oxford University operates within a single department building, but the collegiate system means that scholars are more often embedded within individual colleges. Most interviews with historians were conducted in participants' college offices, where they conducted their research as well as taught tutorials with students. Thus, whilst the central History faculty provides a unifying framework for the discipline, much of the intellectual and teaching activity occurs within the colleges, something reflected in historians' official roles, such as "Fellow of the College and University

Lecturer" (P5, Oxford modern historian). This dual structure reinforces the college as a locus for independent research and interdisciplinary exchange; it is more decentralised than Glasgow's structure. Oxford's department is also organised around research projects and centres such as Environmental History, Defining the Global Middle Ages, Centre for European History, and Centre for Intellectual History (*Faculty of History - Research Centres*, no date; *Faculty of History - Research Projects*, no date), which provide bases for collaboration and more granular views of subdisciplinary association compared with Glasgow.

4.4.2 Medicine

Both Glasgow & Oxford medicine are organised by institutionally designated specialisms such as population health, primary care, and cancer science. However, medicine is structured very differently across the two universities.

In Glasgow, the physical and conceptual organisation of research fields and buildings complicates the identification of what constitutes a "medical researcher". For example, a research field designated as "infection and immunity" is housed in a building separate to that of "medicine", leading to a fragmented definition of "medical" scholarship. At Glasgow, the discipline is strongly associated with undergraduate clinical training for aspiring medical and veterinary doctors, nurses, and dentists. Medicine falls within the School of Medicine, Dentistry and Nursing, which is part of the broader College of Medical, Veterinary, and Life Sciences (MVLS). This College also encompasses non-clinical research areas such as Cancer Science and Infection and Immunity, but these are organised into distinct Schools under the MVLS college umbrella.

This nested structure with separate clinical and non-clinical specialisms reflects Glasgow's emphasis on clinical training as the official definition of "Medicine", with non-clinical research classified under other non-explicitly medical areas. This shaped the mental models of medical scholars in an interesting way where one participant questioned their eligibility to participate in the present study and commented: "I'm not based in the medical faculty. I don't have a medical degree. I don't work with patients. I work for patients, I would like to think. […] So, I'm a lab based, and now office based, scientist. So, is that... Am I a medical researcher? It depends on the definition, simply." (P22, Glasgow biomedical researcher).

Oxford, in contrast, has a broadly named Medical Sciences Division which houses a variety of departments and research institutes. Compared with other disciplines, medicine is an entire division in itself with a wide range of specialisms, and departments and clinical work spread across multiple

campuses and hospitals. This spatial fragmentation shapes a mental model of medicine as an expansive and highly specialised discipline, whose compartmentalisation is felt keenly by some:

> My personal opinion is that the structure of the university doesn't lend itself to much collaboration… They're very...to a fault, I think, overprotective of their spaces… I think Oxford, because of how it's structured, ends up reinforcing this. Maybe not...originally by design. But yeah, I think now it's reinforcing a specific mindset. (P36, Oxford biomedical researcher).

Clinical work, which is heavily research-oriented and separated across two campuses, reinforces the institutional diversity of medicine at Oxford. Although there is a unified conception of medicine under the umbrella of the Division, this fragmentation fosters specialised, research-oriented mental models among medical scholars across subdisciplines, diverging significantly from Glasgow's more clinically oriented framework of medicine, where non-clinical research is not explicitly designated as "medicine" in the institutional context.

4.4.3 Chemistry

In Glasgow, the chemistry department is primarily housed within a single building. Some newer specialisms—in digital chemistry, for example—are based in a different building, the Advanced Research Centre, signalling conceptual shifts and growth within the discipline into new areas of study. This centralised layout fosters a cohesive and holistic view of chemistry, where scholars from organic, inorganic, and physical chemistry constantly interact. Such proximity encourages interdisciplinary collaboration and a shared sense of identity within the department.

In Oxford, chemistry is physically organised across five sites, as described in Chapter Three, divided according to the subdivisions of organic, inorganic, and physical and theoretical chemistry, and including teaching and research laboratories. For chemistry, the distribution of the discipline across multiple buildings reinforces the historical distinction between subfields, which Oxford physical chemist P1 explains, still holds: "Oxford is unusual in the sense that the three sub-departments historically were very separate, and it's still kind of true". This, in turn, reinforces distinct identities among subfields, even if, in practice, much of chemistry research overlaps, suggesting that both research practice and administrative organisation and history shape chemists' understanding of how their discipline is organised.

4.4.4 Law

In both universities, law is housed within a single department. In Glasgow, the department's physical consolidation reflects a cohesive disciplinary identity. In strong contrast to Medicine, Law is highly centralised, with many scholars' offices in the same building with teaching, seminars, and workshops taking place there. Interviews did reveal, however, that a substantial proportion of scholars work frequently from home, highlighting how legal research is often a solitary endeavour in contrast to chemistry or medicine.

In Oxford, whilst law is also nominally centralised in a single building which hosts lectures and seminars, the collegiate system shaped how scholars perceived and engaged with the discipline. Most legal scholars in this study conducted their teaching and research activities within their college offices rather than the faculty building. This decentralisation underscores the role of the college in fostering a sense of individual autonomy and intellectual independence, shaping a mental model in which the discipline is experienced more through individual scholarship.

Overall, these examples illustrate the manifold ways in which institutional structures both reflect and shape researchers' mental models of their disciplines. There are multiple points of contrast between Glasgow and Oxford: centralisation versus dispersion, clinical versus research emphases, physical layouts (a single building versus multiple sites), the existence of a collegiate system, and the multi-layered organisational frameworks underpinning each faculty. These differences in the arrangement of disciplines, and even within the same discipline, are closely bound to how scholars conceptualise and conduct their work. Furthermore, this variation suggests that academic disciplines are neither monolithic nor purely intellectual: they are both products and agents of their institutional contexts.

By examining how history, medicine, chemistry, and law are configured across these two universities, this study underscores that the structure of a university can play a pivotal role in shaping not only the practical realities of research and teaching, but also the underlying conceptions of disciplinary identity.

4.5 The collections

This section explores how researchers' mental models of knowledge are influenced by the publication landscape, personal collections, as well as by library and archive collections. It highlights how varying levels of standardisation, resource organisation, and resource availability impact the ways researchers internalise and navigate information landscapes. In doing so, it reveals the interplay between existing collections—be it personal, commercial, library, and/or archival, and the interplay between physical and digital environments—in shaping contemporary academic practices.

4.5.1 Specialist resources

The findings of the present study suggest scholars' mental models of academic knowledge are shaped by key information resources utilised for teaching and practice. Reference materials such as bibliographies, indices, research guides, and textbooks play a crucial role in shaping knowledge acquisition and application in each field. These tools serve as starting points for acquiring general knowledge as well as a sense of how knowledge is organised in the field, which is then expanded upon through further research and exploration.

Chemistry

Chemists described how existing knowledge was seen to be based on a hierarchy of generalist, high-impact factor journals at the top, down to specialist, lower-impact journals at the bottom. Oxford organic chemist P2 depicted this visually:

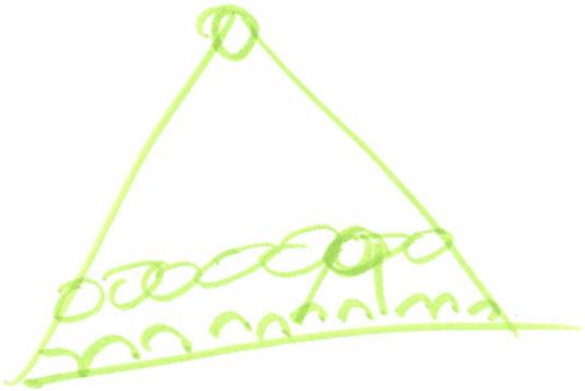


Figure 4-12 Excerpt from Oxford organic chemist P2's drawing

Journals at the bottom were numerous but "they can be really reliable, good, you know, specialised journals, and then certain [journals] that cover, you know, two of these or three of these can get higher up and then finally will be a, a journal about everything". These top-tier "journals about everything"—*Nature*, *Cell*, and *Science*—were regarded highly across the sciences, and even had an acronym: "NCS, we call them. Everyone wants to publish in NCS" (P2, Oxford organic chemist). This impact-based metric system of literature in the sciences, which was meant to signal quality, wide readership, and high citation counts, shaped how some chemists filtered their reading.

Chemists P20 and P21 for example discussed how this metric was utilised to navigate the ever-growing body of publications:

> Over the years, the number of journals increased dramatically. To follow 100% everything is practically impossible […] So, you prioritise the most important, and by most important, it's the most reputable sources first, because of higher impact within the specific field in chemistry, in my case. So, I prioritise this, so I have a list of 20 to 30 journals, for example. Beyond that, [it] becomes hectic and…a bit chaotic. You might miss something like that, yes, but the chance that it's something very important diminishes rapidly after that. (P20, Glasgow inorganic chemist)

> Well, so I sort of have created my own priority list, which is just based on, I guess, like the, the opinion with which I regard the journal. So there's a lot of talk about something called impact factor, which I guess you know. And I have to say, I mean, impact factor is a surrogate for quality. Like, we're not supposed to say that; we're not supposed to think that. But there's a reason that papers in *Science* get cited as much as they do, and that's because they tend to be really good papers. So, yeah, I think that that's the kind of way I organise the hierarchy. (P21, Glasgow organic chemist)

For chemists, the body of knowledge was constantly growing, but the "most important" information could be identified effectively by relying on journal impact factors and the implicit knowledge in their disciplinary communities that NCS were top quality publications. There was an implicit trust expressed by P21 in the ability of this metric system to control for quality and determine what is relevant in the field currently. Ultimately, information was ranked according to both external criteria and personal judgment. As seen in the quotes, P20 and P21 had each created their own lists of journals to follow based on impact factor and then by relevance to their specialism.

Checking who cites their own work was a strategy Glasgow organic chemist P23 used to screen for relevant information, and reading and writing reviews for the field was also a way to "get a lot of citations" and "to position yourself somewhere so people know, OK, you work with this stuff, because you wrote a big review about it".

When it came to personal collections, few chemists kept print materials in their offices—reflecting their preference for online articles—apart from textbooks for teaching and foundational knowledge, copies of journals where they had published a paper, and students' theses, which one chemist (P6, Oxford inorganic chemist) reported referring back to, to see what literature previous students had cited. Oxford physical chemist P1's case was different in that they liked to spatially arrange literature in print. P1 discussed how they would "chase references back", print the articles out, and spread them out across their office. Reading and organising articles physically was how they would "build up a picture" of a new field and "quickly...get a map" (P1, Oxford physical chemist). Whilst some chemists described a hierarchical understanding of the chemical publication landscape, others viewed chemical knowledge as positioning oneself or their topic in relation to others' work and building a networked picture of their knowledge of a topic.

History

Whilst chemists showed a stronger preference for online access to information, historians tended to have extensive personal collections of physical books in their offices. Scholars relied heavily on bibliographies, handbooks, and other reference materials to navigate their research, which some preferred to keep and use in print form. Reference materials were often organised chronologically and according to geographical area. Structured databases like the *Bibliography of British and Irish History* (Institute of Historical Research and Brepols, no date) provided critical entry points:

I'm primarily a British historian. I'm very, very well served with the Bibliography of British and Irish history, which the Royal Historical Society puts together… The researching aids that haven't made it onto that, many of which are next door [adjacent office storage room], you know, *Handbook of Manuscript Diaries*, *Handbook of Working Class Memoirs*, the *Dictionary of Labour Biography*, the *Dictionary of National Biography*, various of these, which are quite sort of specialist stuff. (P4, Oxford modern historian)

There's also some bibliographies that are online, which I'm going to forget the name of now, because I tend to just have a, have it saved as a tab. So, I just click on that. But it's like the *Brepols Bibliography of Medieval...Medieval Bibliography* or something? And there's the *Bibliography of British and Irish International Bibliography,* or something like that. (P29, Glasgow medieval historian)

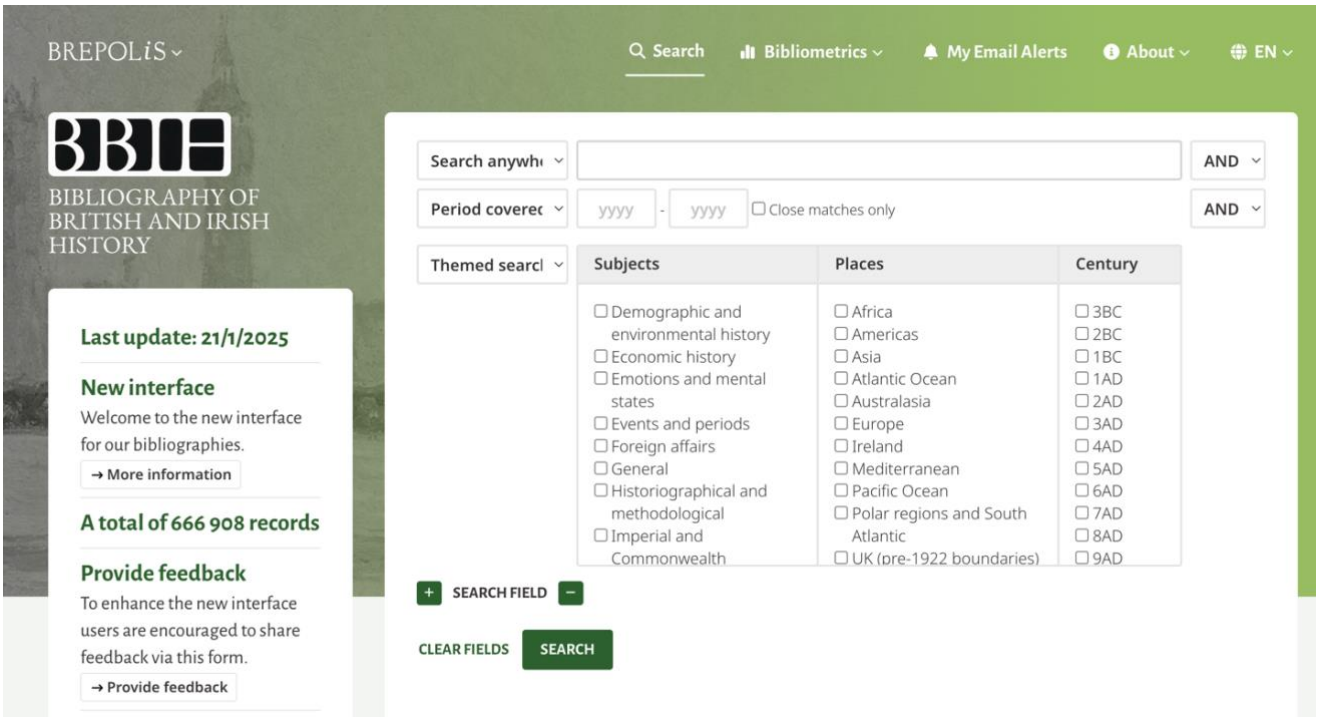


Figure 4-13 Screenshot of *Bibliography of British and Irish History* main page (Institute of Historical Research and Brepols, no date)

Key categories used to search across bibliographies and handbooks were subject, place, and time period. In some cases, these reference materials organised information primarily according to individuals' names, such as the dictionaries of biographies mentioned by P4 which were sorted alphabetically. P7, also an early modern Oxford historian of Britain, discussed using indices to find information on specific people:

> So, for example, there was something called the Index of Dedications which listed the dedications of books to particular individuals, and you could go through and say, oh, right, I'm going to look at, I know, Henry the Eighth, look and see the list of, of books. (P7, Oxford early modern historian)

Medieval historians mentioned reference materials such as the edited volumes of *Patrologia Latina* and *Monumenta Germaniae Historica*, which organise primary sources chronologically and by document type, as well as using catalogues and databases organised by place, institution, and persons. P29 highlighted the importance and availability of catalogues for their specialism:

> So, that's a hard copy catalogue of Medieval Cartularies of Great Britain and Ireland by G.R.C. Davis, just for record, that has a big, big list of all the manuscripts, so I could look up Oxford in the...in the bibliography, for example—index— and find all the cartularies that are currently in Oxford… And it's organised by institution, so Benedictine Abbey, for example…there was this project a while ago that created basically a database of charters… It's called the *People of Medieval Scotland*. So that's kind of one of the key resources for that. (P29, Glasgow medieval historian)

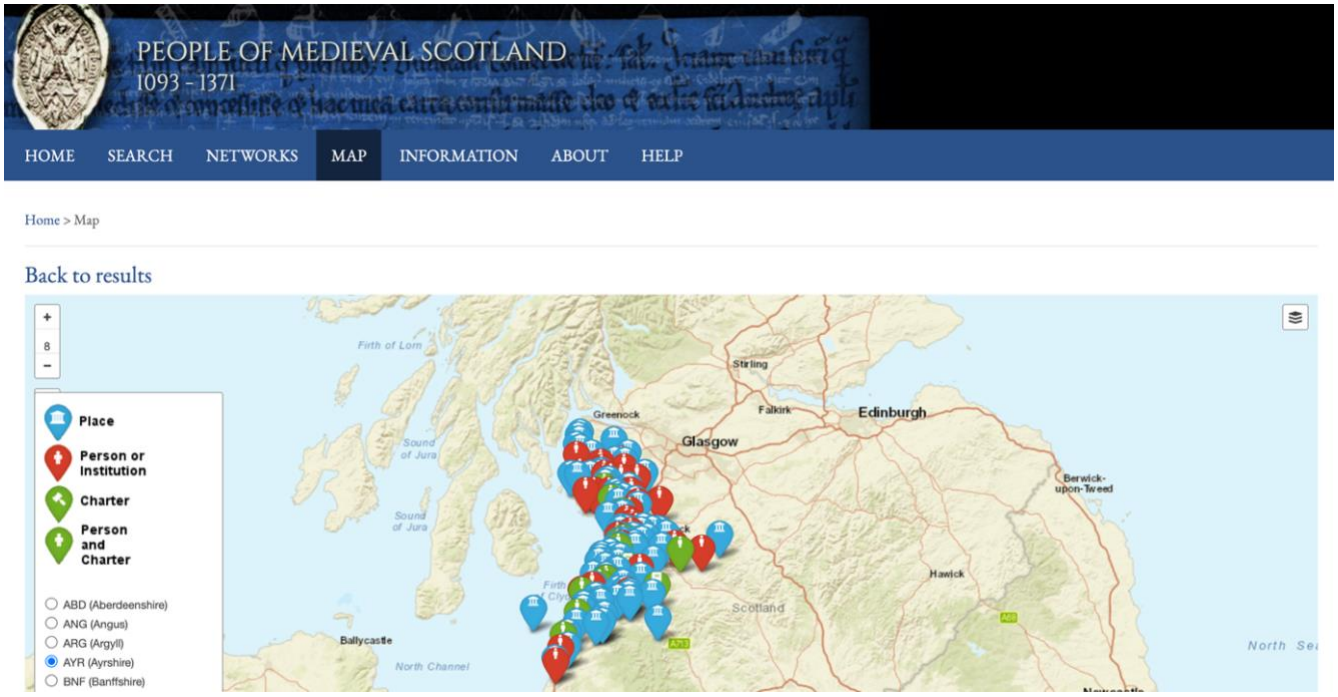


Figure 4-14 Screenshot of *People of Medieval Scotland* (Beam et al., 2019)

Historians discussed using print catalogues, handbooks, and bibliographies quite heavily. Where they existed, digital databases were, likewise, important reference points. Their mental models were shaped by the organisation of these reference materials—often categorised by place, person, institution, and time period. Historians themselves were also involved in creating reference materials and databases reflecting and perpetuating those same categories and mental models. This suggests historians' mental models and expectations of information organisation are centred around the questions who, where, and when, and figuring out the what, why, and how are based on the sources that are found.

Law

Legal research relies on mostly centralised databases of sources as well as academic and practitioner reference texts which are organised by subject and by case. Scholars trace back precedents and build arguments upon cases and decisions that came before, contributing to the growth of a structured, regulated, and slowly evolving legal body of knowledge.

P39, an Oxford scholar of English law, explained how, apart from "reading cases…and trying to place them in the puzzle of where they fit in our overall model", legal arguments are built through "legal archaeology", a tracing back of historic cases, which is efficiently aided by practitioner texts, which are organised by subject and case:

> …I mean, a practitioner text…to give an example, I use one called *Lewin on Trusts*, which has been in publication since the 1830s, so it's, it's almost 200 years of accumulated information. So, every year, people review it, and they look at what the most important decisions are, and they add them to the book, and get rid of ones which are no longer relevant. …they're kind of like maps that tell you where these information points are. And then, when you go to those information points, when you go to the individual cases, what you can see is the judge in that case will have been referred to other cases, earlier cases, in making their decision… So, you can sort of, it's like legal archaeology. You can sort of keep tracing it back to the, the original case where this idea came from. (P39, Oxford private law scholar)

Texts such as *Lewin on Trusts* provide legal scholars with a tightly regulated body of information recurrently reviewed and updated by experts in the field. P39's mental model is informed by the structure of such texts, which help build mental "maps" of information.

Arranging sources according to the level of relevance to one's own specialism was another way in which one legal scholar explained they ordered their personal library. P40, also an Oxford scholar of English

law, described how their own collection of books was organised with their specialism at the centre, branching out into other related subjects, because subjects "run into each other" in ways only a specialist might know.

Medicine

In contrast to legal knowledge, which requires reaching back in time, medical knowledge evolves rapidly and is comparatively forward oriented. Scholars often disregard older sources as irrelevant to current practices, prioritising the recency of the research.

In medicine, books may be valued for their foundational knowledge, but the field's rapidly evolving nature requires reliance on research articles to keep up with the most current developments. Glasgow cancer researcher P24 explained:

> Well, in a book, it's good to look for the basics… But then once you want to know how this research has developed, then I will move to articles. Because that will give you the most recent [online] sites. (P24, Glasgow cancer researcher)

Unlike in law and history, where scholars reach back in time for precedents or historical sources, and monographs which can stay relevant no matter their age, medical researchers' mental models were constantly reaching forward in time and trying to envisage where the next breakthrough would come from.

Medical knowledge was vast and fast-moving, and researchers were under pressure to stay on top of the most relevant and timely data:

> …because we care about more recent literature other than anything else, we usually don't even cite literature from before 2010, because they are old. You don't want to know what's the number of…for example, number of babies that were born in 2005. It's not helpful to inform any of your current policies. So, if you follow the recent literature well enough, you are able to know most of them. (P37, Oxford global health researcher)

While this can be overwhelming for less experienced scholars, who have a narrower view of the field, as well as for more experienced researchers, who have more administrative and managerial duties to contend with, collaborative practices help mitigate the challenges. Scholars discussed how they shared new information they had found with members of the research groups and the importance of sitting on review panels and reading reviews of the field to get a good grasp of the literature.

Medical researchers' mental models were thus malleable, open to epistemic shifts, expecting existing paradigms to be overturned with the next breakthrough, but also wired to be highly collaborative and open to input from the group. These patterns across the four disciplines unfold within and are further shaped by the library environments researchers rely on.

4.5.2 Libraries

Across chemistry, law, history, and medicine, libraries influence how scholars interact with, structure, and access knowledge, to varying degrees. University libraries play a particularly significant role in shaping the mental models of historians.

Libraries are organised differently in Glasgow and Oxford, where Glasgow has one Main Library, three branch libraries, and three additional sites that cater to specific subject areas such as chemistry and law. In comparison, Oxford has a network of over 100 libraries, ranging from college libraries to the group of 26 libraries under the Bodleian Libraries which cover a range of geographical and subject-based foci. Thus, the impact of having one primary library in Glasgow plays out differently in scholars' mental models compared to those of Oxford scholars, who work with a decentralised library system—possibly part of the reason why scholars preferred to purchase books and keep extensive collections of books in their personal offices, even more so than in Glasgow.

Physical libraries

Researchers in chemistry and medicine described how physical libraries and librarians provided critical access points for developing mental models of scholarly information. P1, a chemist in Oxford, reflected on the formative influence of physical libraries during their doctoral studies and the importance of harnessing the knowledge of librarians to access the digital library:

> What I'm trying to get them [students] to do there is to realise there is an expert out there on accessing the information that goes beyond a Google and so I get them to go and talk to [a librarian] because [the librarian] actually knows about, you know, how to search properly and…those kinds of skills that I would have developed...I guess naturally, by physically having to go to the library. (P1, Oxford physical chemist)

Librarians' expertise offers scholars a structured framework for navigating complex information systems and using digital library interfaces and databases effectively, thereby influencing scholars' understanding of scholarly information organisation and reinforcing existing assumptions of the "proper" form of knowledge.

Medical researchers also highlighted the value of physical libraries as spaces for discovery and learning. Glasgow biomedical researcher P18, a senior scholar, recalled the tactile and interactive nature of browsing journals during weekly visits to the library:

> We used to go as a group to the library every week. There was something special about browsing the journals, flipping through the pages, and seeing what was new. It gave you a tactile connection to the research—something you don't get when you just scroll online. Back then, it felt like you could keep up with the field in a more personal way. (P18, Oxford biomedical researcher)

Whilst formative experiences navigating information in their fields may have involved print materials, the "personal" and "tactile" connection to research was no longer current practice for P18 as sources had moved online.

P3, a clinical neurology researcher in Oxford, described how engaging with a systematic review librarian enhanced their understanding of online resources:

> I've just been doing a systematic review with one of my PhD students. And for that she…engaged one of the specialist health sciences systematic review librarians to show her how to design the appropriate search criteria and stuff. So that was quite illuminating, and I learned a bit vicariously from that. …'cause I think when you are close to a problem, you can sort of assume that the search terms you'll use will pick up everything. But actually, if people haven't indexed stuff correctly, by broadening that out and, you know, really thinking, ah, when I say "treatment", should I also include an analogy for "treatment"…to bring things up that you wouldn't have expected otherwise. (P3, Oxford neurology researcher)

Liaising with a subject librarian who is already attuned to the needs and expectations of medical researchers shaped their understanding of medical information whilst also reinforcing existing disciplinary conventions of the systematic review method. Compared to other medical researchers, P3, an early-career Oxford clinical researcher, showed less confidence in their ability to search for relevant information. Along with P24, a Glasgow biomedical postdoctoral researcher who also appeared to be using relatively simple strategies, P3 relied on keyword search as an active strategy and automated Google alerts as their passive strategy for searching. Thus, the techniques learned through a subject librarian familiar with medical databases and their functionality—albeit indirectly—broadened their approach.

The spatial and conceptual organisation of physical libraries was most deeply embedded in historians' mental models. Library organisation offered a transparent and comprehensible framework for accessing knowledge that search engines could not.

For some historians, the organisation of library collections provided critical context to research in their field. P9, an Oxford modern historian, articulated the irreplaceable value of browsing physical bookshelves:

> So really, I think nothing replaces sort of actually going down and having a look at the bookshelf and that really gives you a sense of the field as well and how it's changed. (P9, Oxford modern historian)

For P9, the structured arrangement of books provided important context and insight into the evolution of academic subjects and fields. Similarly, Glasgow early modern historian P15 described in detail how their deep familiarity with their library's layout informed their mental models and research practices:

> I think social history is in floor six. Economic history is in floor six. History of ideas is mostly on floor nine and ten. Cultural history is all over the place, because depends how you define it. And it shows up in the way, you know, my itinerary around the library… A good student is one that I think will be able to cope with whatever structure you have in a library and learn to use it to best effect. (P15, Glasgow early modern historian)



Figure 4-15 University of Glasgow Library Directory. Image taken by Researcher.

P15 had committed to memory the structure of the library and had combined the spatial and organisational layout of the library to be able to draw up an "itinerary" of where to go, both conceptually and physically. Although the participant did not think the placement of resources ideal for their own purposes given how scattered they were, P15 used the university library's organisation as a mental scaffold to find what they needed.

Digital libraries

Many scholars found digital access to resources useful and convenient across all disciplines. Some participants in history and law, however, struggled with or were critical of library discovery layers for mimicking Google's simple interface, thereby obscuring the depth and structure of academic collections. Glasgow historian P30 (mid-career scholar) found that:

> The problem with discovery layers is that they hide the structured organisation of collections. You lose the depth and rigour that libraries are supposed to provide. It's like trying to do serious academic research with a tool that's designed to mimic Google. (P30, Glasgow modern historian)

In P30's view, libraries are "supposed to" make the "depth and rigour" of knowledge structures more apparent and provide a different point of entry to sources than Google, surfacing their expectations of how libraries should work. This sentiment underscores P30's perceived tension between the convenience and apparent simplicity of digital systems and the structure and context required for "serious academic research". This critique is echoed by Oxford historian P9 (early-career scholar) who, as above, discusses the importance of contextualising sources by browsing library shelves, and Glasgow historian P29 (early-career scholar), who expressed anxiety about missing important sources due to limits of one-off queries using a search box:

> Some libraries have maybe more clunky search engines that, I don't know, don't tend to—or you have to be very precise about the shelfmark, how you put it in. So, it can be quite hard to find it. So, if I don't find a result, I'm not always confident that's because it's not there. I'm assuming it's because I just can't seem to find it. So, I do tend to give up, I suppose. (P29, Glasgow modern historian)

The precision required when searching on library interfaces was challenging to P29, an early-career lecturer who perceived library search as unsystematic and opaque. Whilst historians did mention using Google Scholar for its ease of use and accessibility, they voiced the strongest criticism of discovery interfaces and the search process. They also expressed the most anxiety about missing sources if using the wrong keywords or search strategies, especially when it came to locating primary sources. Given that historical primary sources are often unique, rare, and scattered across national and international institutions, Google's generalist, and decontextualised queries were less compatible with a complex heritage landscape where finding resources depended on contextualised knowledge. Sources in some cases were discoverable only by using exact terminology or shelfmarks, based on bespoke cataloguing conventions that varied from repository to repository. History participants' experiences with digital

libraries revealed the greatest gaps between their expectations and beliefs of how libraries should work and what the libraries actually delivered.

The anxiety caused by opaque library systems and search results caused Oxford legal scholars P8 (senior scholar) and P40 (senior scholar) to feel inadequate at searching. P8 for example, commented:

> the other thing I use quite a lot now is, is the library catalogue. So SOLO, the Oxford library catalogue, which always used to just be the library catalogue, so you would get the books that were in the library, but now it's got journals and other sort of online sources and so that can be quite helpful. Though again, it always seems to return a huge amount of stuff, and that can be a bit...a lot of which is not what you were looking for, and it can be a bit irritating… Even if I'm looking for something quite specific, and I think I've put in quite specific search terms, it still seems to dredge up quite a lot of stuff. Maybe I'm just not very good at this, I don't know. (P8, Oxford public law)

Like P8, who expressed lack of confidence in getting to relevant information efficiently, Oxford legal scholar P40 also described how "I get lost very easily and I probably am not efficient at searching", turning to subject librarians for assistance navigating the online library system. Whilst increasingly, sources have moved online and digital collections have grown, these legal participants' approaches have not grown in sync, turning instead to subject librarians who are better acquainted with their needs and expectations.

These examples indicate how libraries and librarians play a part in shaping scholars' understanding of how physical and digital collections are organised and designed, therefore enhancing their ability to navigate to the sources they require, although some researchers expressed feeling lost or lacking confidence in the digital realm. Participants in history and law had mental models more attuned to tangible, stably and hierarchically organised physical libraries relative to digital libraries. In law, senior scholars discussed stronger doubts in their online skills compared to more junior legal scholars, whilst senior researchers in chemistry seemed more confident than junior scholars in navigating scholarly information. Researchers in history and law appeared to lack confidence in their ability to find information the most, reaching for help from librarians to supplement their mental models where they did not align with how they perceived the library search interface should work.

University libraries, whether physical or digital, remain integral to academic research, shaping researchers' mental models of knowledge organisation. For chemists and medical researchers, libraries and librarians provided critical training in structured search strategies, whilst for historians, the physical

layout of libraries offered contextual, structured insights into academic subjects. Legal scholars, however, highlighted the challenges of navigating general systems such as Oxford's SOLO, which is more like Google, compared with databases such as Westlaw which are optimised for specialist use.

4.5.3 Archives

Whilst libraries apply to all scholars, archives primarily relate to the work of historians. Archives played a significant role in shaping historians' mental models of knowledge as those who engaged with archival materials had to be closely acquainted with the hierarchical and contextual organisation of archives. The archival principle of original order—or the "organization and sequence of records established by the creator of the records" ("Original order," no date) also influenced their expectations and experiences with historical materials.

Historians demonstrated extensive knowledge of the archival repositories relevant to their fields. P4 (Oxford modern British historian), P7 (Oxford early modern British historian), P29 (Glasgow medieval British historian), and P30 (Glasgow modern global historian) all described a range of repositories they had used or knew to contain materials relevant to their research, ranging from the United Nations High Commission for Refugees Archive to the National Archives. This familiarity underscored the importance of knowing where collections are held and how they are organised. It also highlighted how historians' mental models of historical knowledge are shaped by the institutions that mediate access to these sources.

Oxford early modern historian P7 noted how physical and thematic organisation varied across countries and institutions. Furthermore, the comprehensiveness and accessibility of archival catalogues were "hit or miss":

> There are—there are, for the most part, there are catalogues. And some of them are very good and full and some of them are not, so sometimes it's hit or miss… They're usually chronological, actually. I mean, within certain themes… In the Huntington [Library], it's actually, the collections are within the donor or the person who purchased them, or the collection associated with that. So, you would get, for example, Hastings manuscripts, which were all those that were purchased *en bloc* that related to the Hastings family… You have to go to each one of the collections to see if there's anything in them that might be of value. (P7, Oxford early modern historian)

These differences in cataloguing practices reflect institutional decisions that shape researchers' access to and interpretation of materials, further reinforcing the importance of understanding archival organisation.

There were also factors beyond archival organisation such as geographical dispersion that shaped perceptions of knowledge organisation. Glasgow medieval historian P29, for example, explained how Scottish manuscripts, previously held in monasteries and cathedrals, became scattered after the Reformation, requiring historians to track sources across institutions and over time, adding temporal and geographical complexity to their mental models of knowledge.

Archivists are crucial mediators between researchers and archival materials. In many cases, archivists were the only guides available to assist researchers to locate materials. Economic historian P33 highlighted their dependence on archivists, particularly in private archives where inventories were often incomplete or inaccessible:

> Sometimes you don't even know what's there… Often, in private archives, you don't have access to any kind of inventory, so you're almost completely dependent on the archivist. (P33, Oxford modern historian)

Not only did some archives have no findings aids or inventories, P33 recounted difficulties communicating exactly what material they were looking to archivists because the terms used in private business archives did not match the terms and concepts they were accustomed to using in academia and added to this was the challenge of communicating concepts in different languages. Scarcity of archival information was also experienced by P27:

> One of the files I looked at in the British Library was just named for one of the [country name] kings…and that's it… So, it wasn't until I actually sat down and started flipping through the pages that I began to get a sense of, oh, okay, so this is what the British government was interested in. (P27, Glasgow modern historian)

P27 noted the frustrations of working with archives labelled in a historical context that did not align with their expectations. Moreover, archivists themselves sometimes did not have granular knowledge of their collections, and so historians needed to spend time sifting through boxes or files:

> Sometimes the archivists themselves won't have spent a lot of time in files and they don't know. So sometimes you're just handed this massive digital repository or a box, and you've just got to dig through it. (P27, Glasgow modern historian)

Whilst archivists provided researchers guidance to navigate their collections, they did not necessarily have detailed information on all records, some of which were labelled according to different conventions from the past. Some archives lacked finding aids altogether, requiring researchers to work closely with archivists to identify and access the materials they were hoping to find.

Digitised archival materials such as those provided by the Bodleian Library and the British Museum were valued by historians for their convenience but seen as partial representations of collections, as noted by P15 and P30. Participants noted that digitisation reframe what is visible and searchable, prompting hybrid strategies: “not everything relevant is digitised, so you end up spending a lot of time manually sifting through vast amounts of extraneous material” (P15, Glasgow early modern historian). P7 (Oxford early modern historian) and P29 (Glasgow medieval historian) found it important to engage with archives in both digital and analogue formats as online views supported scoping whilst in-person consultation remained essential for grasping materiality, scale, and contextual detail.

In sum, uneven cataloguing, digitisation, and access conditions required historians to shape their expectations and methods according to each repository. Archival principles (e.g., original order), local cataloguing conventions, archivists’ guidance, and gaps in finding aids influence researchers’ mental models of where evidence is found, how it connects, and what kinds of questions can be asked.

How collections shape mental models

This section has shown that scholars’ mental models are produced alongside the collections they use, including personal libraries, specialist databases, academic libraries, and archives. Chemists and medical researchers are oriented towards current literature filtered through journal impact factors and personal research interests; historians build chronological and geographical mental models from specialist databases, bibliographies, libraries, and archival materials; legal scholars build “maps” of precedents supported by practitioner texts and legal databases. In each case, the structure of collections helps set up pathways for inquiry.

Libraries and librarians mediate these pathways. For some chemists and medical researchers, training in search strategies and early engagement with physical libraries shapes a structured view of the literature. Historians’ reliance on the order to physical libraries and archives provides a spatial understanding of knowledge that situates historical materials within specific contexts. Legal scholars’ experiences highlight the friction between general search platforms and specialist tools, bringing subject librarians into the loop to bridge systems and disciplinary expectations.

Overall, how resources are organised and described across physical shelves, catalogues, specialist databases, and digitised and physical archives conditions scholars’ expectations of knowledge organisation. Differences in standardisation, spatial organisation and description, and digitisation do not

only enable access but also play a role in contouring the mental models scholars use to seek and make sense of information.

4.6 The systems

Across the four disciplines, scholars discussed using a mix of general and specialist search tools to find information. There were heavy users of Google and Google Scholar in all four disciplines, but many also relied on specialist databases commonly used in each discipline such as WestLaw for law, PubMed for medicine, structure databases for chemists, and archival catalogues for historians. These shaped scholars' expectations of how knowledge is organised and how it should be found, in digital form.

Whilst the experience of searching in centralised, and standardised systems leads to stronger links between mental models and systems, and is linked with a greater confidence in one's search skills and in the systems scholars use, a scattered information landscape poses challenges to scholars as they do not align with their mental models, and the uncertainty in being able to locate relevant sources is tied to a lack of confidence in one's own search skills and a scepticism of systems and their trustworthiness—particularly notable in the case of historians and sociolegal scholars.

Scholars continuously adapt their mental models to align with the systems available to them. To effectively retrieve information, they must often tailor their thinking to fit the structure and logic of these systems. The more frequently a database is used, the more deeply its organisation becomes embedded in the user's mental framework. In some fields—particularly chemistry and law—information systems have been intentionally designed to reflect the specific conceptual categories and practices of the discipline, facilitating a closer alignment between system design and scholarly thought.

Disciplines are ordered below by the degree to which scholars' mental models align with the systems they use, from greatest to least alignment: chemistry, law, medicine, and history.

4.6.1 Chemistry: structure search and standardised language

Chemists have several databases developed specifically to facilitate their work and the ways in which they already think and communicate. Chemistry databases were designed to integrate the common

language of chemists, whether in visual, mathematical, or string-based form. There are chemical databases that allow searches for chemicals by name, formula, visual structure, or by chemical reaction, among other ways to filter literature catering specifically to chemists. There are also databases for computational chemists who submit mathematical models and other modes of research output with appropriate means of searching. For chemists looking for information to organise their experiments, there are chemical databases developed to deliver the information they need efficiently along every step of the research process, including information on experimental procedures, reaction conditions and yields, as well as information on chemical suppliers for ordering experimental materials.

Chemistry communication is built on a common scientific language that is understood universally. The ways in which molecules are symbolised verbally and visually, and the names of reactions are understood by all chemists. Chemical database interfaces incorporate this standardised chemical language and provide efficient means to search for molecules and atoms, which are the basic units of study upon which the discipline is built, according to participants. Chemical databases such as Reaxys (Elsevier, no date), PubChem (National Center for Biotechnology Information, no date), or SciFinder (American Chemical Society, no date) provide a variety of query methods and search fields for molecule, substance, and reaction searching via the input of computer facilitated drawing, compound ID, molecular formula, analysis technique, and physical properties, among other query options.

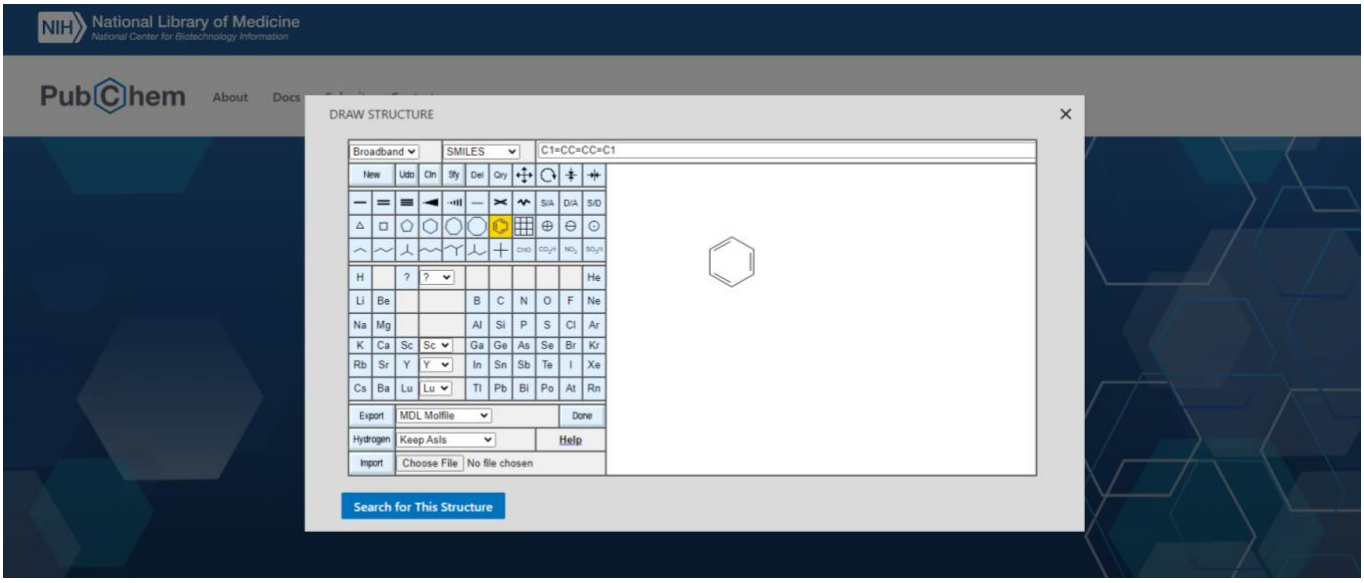


Figure 4-16 Screenshot of computer-facilitated structure drawing on the PubChem database (National Center for Biotechnology Information, no date)

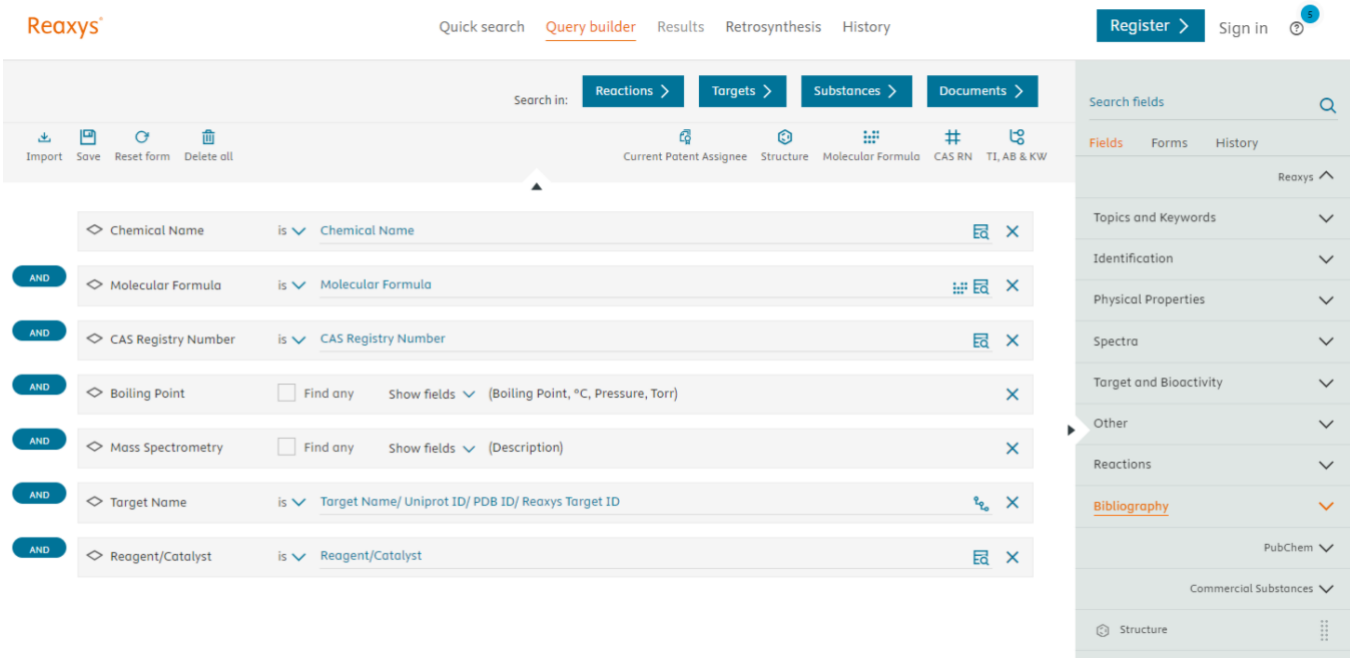


Figure 4-17 Query building on Reaxys database using custom search fields (Elsevier, no date)

The use of unique and standardised chemical terms and names allows chemists to narrow down their search results efficiently, even when using general search engines such as Google:

> Google is pretty good for us… Google Scholar, you just search whatever keywords you are looking into. Usually, the keywords are very scientific and specialised, so, Google will give you straight away, you know, usually research articles that you're looking for. (P2, Oxford organic chemist)

Using "very scientific and specialised" search terms, P2 could easily find relevant information even through a general tool like Google. Furthermore, chemists could input precise computer-generated images of molecular structures into specialised databases to find what they needed, as described by P21:

> So, it's called structure searching, so you don't input words, you input structures. And, yeah, you can search it, and you can do similarity searches and things like that. (P21, Glasgow organic chemist)

For chemists looking to solve issues related to a particular molecule, the impetus for their search was goal oriented, translating into a narrow, specific search that the system was able to facilitate easily. P13 explained:

> So, if you're doing...if you're having a particular problem, for example, this reaction doesn't work, right? Chemists use Reaxys databases which allow you to first look...input a molecule of interest, decide if it's a component of the reaction, reagent, or product. And then based on this, it will spit out—you have, for example, papers whenever this molecule has appeared as a product… Usually what we care about is, in, in the field of organic chemistry, are their reaction conditions, because the problem—product is already defined. (P13, Glasgow organic chemist)

P13's approach to searching specifically addresses the means to achieve an end—the "reaction conditions" leading to a determined product. Thus, information is effectively narrowed down by selecting which component of the production process the researcher is interested in investigating, the "reaction, reagent, or product", features encoded in their mental models of experimental research. Ultimately, the results deliver actionable information for application in experiments (P2, P13, P23).

Structure search aligns with chemists' visual, structural, and experimental mental models, supporting and reinforcing the centrality of the molecule and its structure. Literature in the field was organised around molecules, their properties, and their reactions.

Chemists who discussed structure searching (P2, P13, P20, P21, P23), were primarily organic and synthetic chemists. These five participants were or had previously worked on synthetic chemistry projects, conducting laboratory work to develop, e.g., novel drug molecules, metal compounds for energy applications, and protein engineering techniques. Thus, structure searching was perceived as aligning closely with their goal-oriented, experimental thinking and practice.

Furthermore, P20 discussed how the structure of research outputs also fed back into chemical databases, reinforcing the alignment of systems with chemistry research, from chemical compounds to experimental processes and outputs:

> We have databases for...for example, crystal structures…so, we use these databases as part of the publication process... You make a new molecule, and you try to write, to communicate how you made this molecule and what this molecule is capable of... Then you have to provide the data of the actual structure—the accurate structure and not just the hand drawing of the, of the molecule. So, this needs to go into a specific database, for example. (P20, Glasgow inorganic chemist)

Other databases existed for other specialised topics such as the one for computational chemistry:

> The computational chemists, they have also…a number of databases [where] they store the, the calculations that they do in their simulations that they do for specific molecules. (P20, Glasgow chemist)

P23 notes that chemical databases are “optimised for chemists”. Indeed, the existing forms of chemical communication, practice, and modes of thinking are supported by specialist databases, which allow for text-based and visual searching, along with other chemistry-specific search filters which reflect the categories of thinking that chemists employ in their research. Thus, the system aligns with chemists’ linguistic and conceptual expectations, providing an efficient interface between chemistry users and scholarly information. Some major chemistry databases have been developed by disciplinary and professional bodies that understand discipline-specific needs and ways of thinking and have been able to build in features into their systems, such as ChemSpider (Royal Society of Chemistry, no date) of the Royal Society of Chemistry and CAS SciFinder (American Chemical Society, no date) of the American Chemical Society.

4.6.2 Law: statute and case

The key databases legal scholars commonly work with are also designed to align with the needs and expectations of legal scholars, making them easier to understand and use. Legal academics reported working with certain systems so frequently that they have inscribed the system’s structure into their mental models.

Legal databases are built on a common language and structure familiar to legal academics because they are organised by case and legislation. WestLaw UK (Thomson Reuters, no date), for example, a popular database among UK legal researchers and practitioners, is designed around these categories, as seen in the first two menu items on the top left on the Westlaw UK webpage.

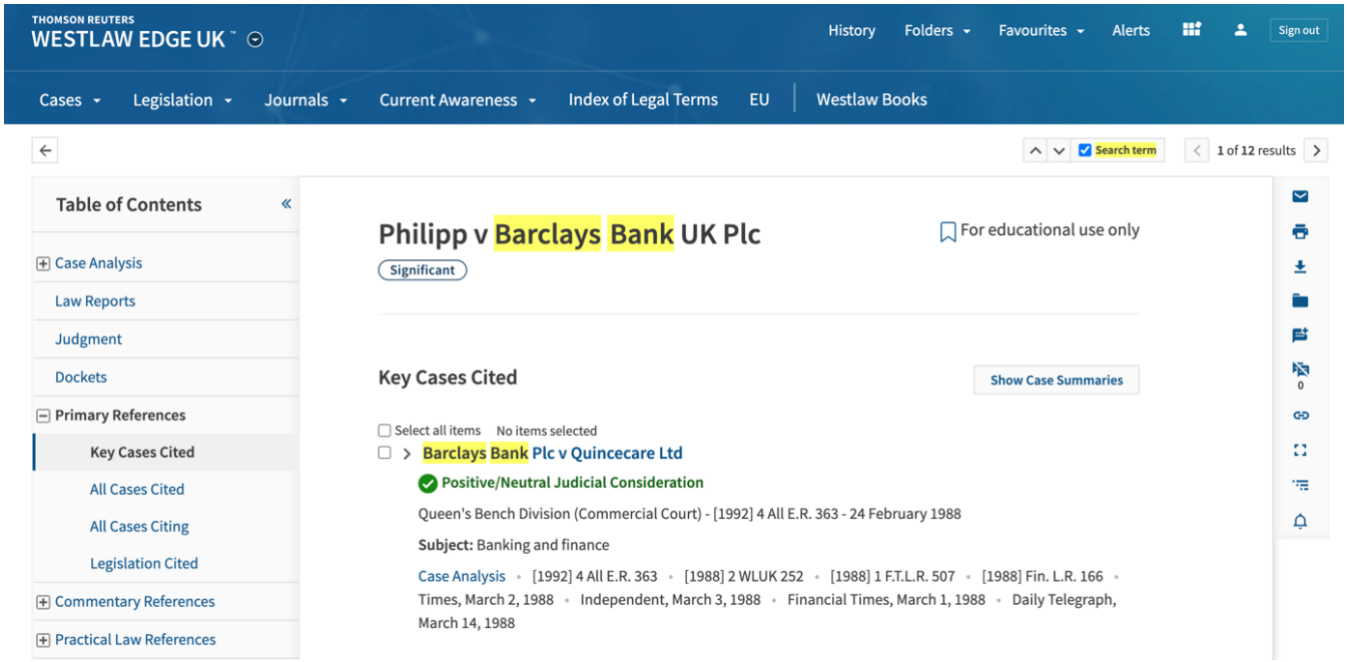


Figure 4-18 Screenshot of Westlaw UK (Thomson Reuters, no date)

Although there are geographical distinctions between legal systems within the UK as well as different "building blocks" among different areas of law, where statutes regulate some areas of law such as criminal and constitutional law, and cases dominate in contract and trust law—the basic units on which legal argumentation is built for scholars working on UK law are cases, statutes, and precedents, or "what previous judges have said or previous scholars have said" about a legal issue (P39, Oxford private law scholar).

These building blocks of legal research look different for scholars working in other specialisms such as international law, which requires sources such as international treaties (P14, Glasgow international law scholar), and commercial law, which may involve financial and economic data (P16, Glasgow commercial law scholar). For most law academic across Glasgow and Oxford, however, analysing cases, statutes, and precedents were the norm, categories on which major legal databases are built.

There is an applied element to legal scholarship where scholars put forth their ideas on current issues that require practical solutions. This requires normative argumentation based on what the researcher sees as the single "correct" interpretation:

> And what I'd say is, in contract law, a contract has one meaning. And when there's an argument about whether or not one party is in breach, the court is asked to determine the meaning of the

> contract… I want people to read it [my work] and think that I'm correct in what I say. I also think I'm right about the arguments I'm making about how the law should be. So, if and when the right case comes up, I want barristers who are arguing it to look at it and submit it to the court, and I want the judges who have to decide what the law of England is or should be to say, well, we're very convinced by [P38]'s argument, and therefore, we're going to resettle the law in a certain way. (P38, Oxford private law scholar)

Arguments about "how the law should be" are based on threading together evidence—precedents in a particular area—and extrapolating from these a general principle that can help address a specific legal issue:

> A lot of the time, what we're trying to do is to figure out what the law is on a particular issue, because…there's not a single book you can look into, and it will give you the answer… What you've got instead are hundreds of thousands of different individual cases which are specific to the facts in that particular case, so you have sort of hundreds of thousands of separate...information points… So, you can sort of look at, you know, 20 of them and extrapolate from that a general principle. (P39, Oxford private law scholar)

The identification and tracing back of relevant cases is facilitated efficiently by existing legal databases such as Westlaw (Thomson Reuters, no date) and LexisNexis (LexisNexis, no date) which link together related primary (cases and legislation) as well as secondary (commentary in books and journals) sources:

> Well, we're lucky in the sense that we have this website called Westlaw, which is a big legal database, and there's a tab on Westlaw for each case that collates all the journal articles. So if I'm reading [name of legal case], I can then click on the case analysis box…and it will just tabulate every article that references that case… (P38, Oxford private law scholar)

Scholars of English law who reported spending a considerable amount of time on Westlaw (Thomson Reuters, no date) described aligning their thinking with the organisation of the system. When asked if Westlaw's organisation makes sense, P38 responded: "…maybe not like *ab initio*. Maybe not to the uninitiated, but my mind's in it now. And so, I know how it works." (P38, Oxford private law scholar)

P8 described Westlaw (Thomson Reuters, no date) as a key source of information because it could map out the precedents of a case and provide updated statutes, thus "doing a lot of work for you" and "saving a lot of time" (P8, Oxford public law scholar), emphasising how much the system is synchronised with their thinking and research processes:

> I spend most of every day on Westlaw… So, Westlaw is a big law database that has UK case law and statute, and I like it because it a couple of useful features, so it provides you with updated versions of statutes. So obviously, statutes get amended over time, and if you just look for the free one on the government website, it doesn't always give you the updates. And so, it's quite useful to see how a provision has changed over time, and it gives you all that in a little map. And with cases, it's got a feature where you can click and see which cases have cited the case you're reading. So, you can start mapping out how the precedent has developed over time. It also has pretty good coverage of journals, so you can get those sources through that too. (P8, Oxford public law scholar)

Legal scholars were typically taught to use Westlaw and LexisNexis as part of their undergraduate studies, forming the basis of how they expect legal knowledge to be organised and presented. Some scholars thus perceived Westlaw as an all-in-one database that streamlines legal research, pooling together past and current resources in "maps" and other features relevant to legal scholarship. Some researchers such as early career European law scholar P31 did not use legal databases because they felt EU sources were so well indexed online, in a way that matched their expectations, that information could easily be found via a simple Google search, circumventing database interfaces altogether:

> Yes. Well, there are the special databases, and there are databases for EU documents and EU cases and databases for articles, books. But how I do it—I don't even need to go that far. I Google. I immediately see what I need, and then if I can't access it through Google, I go through Oxford's system, and then I access that. But like just by putting stuff in Google, like the keywords, I'll find cases will pop up from like the EU. I don't even go into specific databases for that because on Google I will find everything. (P31, Oxford European law researcher)

Challenges: scattered resources and luck-based results

Researchers in some legal specialisations experience a significant disconnect between their mental models and the capabilities of existing information retrieval systems. Law participants in commercial law, international law, and those employing sociolegal methods described challenges to accessing sources beyond the standard legal texts—cases, statutes, commentaries, and law reports—which are often scattered across multiple organisational websites and standalone databases. Effective navigation requires familiarity with diverse online repositories, such as the United Nations and the World Trade Organisation, rather than relying solely on aggregated legal databases, requiring a shift in mental models to accommodate the structure of smaller, bespoke systems.

The perceived inadequacy of many organisational websites further compounds the complex landscape of legal organisations. One scholar indicated that the database of the European Court of Human Rights was "clunky" and difficult to navigate:

> The European Court of Human Rights has a database that's called HuDoc… I find it really clunky, and it's—I'm guessing it's quite a nightmare for someone who's looking at it for the first time. Because court decisions can be given by different levels of courts. They can be in different languages. The case might be at different stages, so it's quite hard to navigate that. (P14, Glasgow international law scholar)

This comment reflects the broader challenge: if users do not already know where to look, the systems offer limited assistance. As noted by P14, "You'd have to know...to go to a specific website for that". Consequently, the burden of information retrieval falls heavily on the researcher.

The scattering of resources across siloed systems and the myriad forms of resource classification in these systems leads to a gap between scholars' mental models and a reliance on "serendipity" in information retrieval (P40), whereby finding information is haphazard rather than systematic. P14's and P40's experiences suggest that, where systems do not align with scholars' expectations, researchers fall back on luck or chance to find what they need or leverage their preexisting knowledge of the legal landscape to access specific organisations' websites and databases. This underscores a critical gap between legal scholars' mental models, which expect structured and logical access to information in the style of Westlaw, and their actual experience. This gap was pronounced in participants whose specialisms were in interdisciplinary and non-UK law: commercial (P16), international (P14), and sociolegal studies (P40).

4.6.3 Medicine: systematic reviews and specialist thesauri

As with legal scholars, medical researchers have dedicated databases such as PubMed (National Library of Medicine and National Institutes of Health, no date). In medical research, systematic reviews serve as a standard method for synthesising existing literature on specific topics. These reviews are fundamental in ensuring that researchers are informed of all relevant findings. As part of their training, medical researchers are taught how to conduct effective searches using healthcare databases. P32, a population health researcher, described their process to conducting meta-analyses and systematic reviews as part of larger projects as well as teaching these skills to postgraduate students using a tool called Ovid (Wolters Kluwer, no date). P32 ran a detailed search scenario, narrowing results using Boolean operators and

experimental variables, expertly narrowing down and expanding the focus as needed, revealing a mental model highly attuned to the workings of healthcare databases.

Like P32, researchers with greater experience conducting systematic reviews and using data at scale—be it patient datasets or healthcare systems—showed greater confidence in searching and filtering results. P19, a health economics researcher at Glasgow, described how their experience with systematic reviews had enhanced their ability to navigate databases effectively, employing filters, Boolean operators, and truncation, among other strategies, to yield relevant results. Moreover, the use of Medical Subject Headings (MeSH) allowed researchers to utilise standardised vocabulary, reflecting a more consistent understanding of how knowledge is organised and classified across the discipline (P19, P32):

> So, you can use different techniques to search for, to either broaden your search or narrow it down. So yeah, you, you can use MeSH terms… So, [these] are terms that basically... so for example, if you're looking for opioids, opioids can be called by different names. You can call opiates… analgesics, pain killers. You know…you can call [them by] so many names. So, if you use the MeSH term for opioid, it will what we call "explode" the search to search for all these different terms instead of you having to look for all the terms. (P19, Glasgow health economics researcher)

Taught and self-taught skills in systematic searching and understanding of controlled vocabularies provided the basis for a more stable, established mental model of knowledge in the medical field.

Challenges: trust in systems and the burden of discovery

Despite the general alignment between mental models and system functionality, there is variability in researchers' experiences and search strategies, depending on their familiarity with the databases. Those with extensive experience in conducting systematic reviews and analysing large datasets exhibit greater confidence and proficiency in information retrieval. In contrast, researchers who are less familiar with systematic review methods are less confident, particularly when exploring interdisciplinary topics or conducting one-off queries (P3, P28).

Oxford clinical researcher P3, for example, discussed the limitations of search queries stemming from various factors such as incomplete indexing, use of the wrong keywords, or gaps in the literature itself, noting that it was difficult to know which of these was the cause. If a search was unsuccessful, P3 supplemented it with other mitigating strategies such as looking at reviews in the field, a strategy also employed by Glasgow clinical researcher P28. Again, the burden of finding relevant information fell on

the researcher, who was expected to know how "to use proper, appropriate keywords" (P3, Oxford clinical researcher) to navigate the system successfully.

Active information seeking, especially one-off searches that were not related to a systematic review, were particularly challenging to clinicians P3, P28, and P24, who had recently switched over from a different subject area. The vastness of the existing body of literature and the lack of time to keep up in a rapidly growing field meant that many relied on Google Scholar because of its relative speed and scope. One-off keyword searches were hit or miss; researchers had to sift through irrelevant results and alter their queries based on initial results.

In addition to terminologies, the structure of papers made a difference in participants' information seeking. One participant observed how searching for a particular topic in medical science journals was straightforward because the structure and content of articles were more familiar and thus easier to navigate, whereas journals in non-medical fields tended to use different terminologies and writing conventions, which made it more time-consuming to identify relevant information and gauge a paper's relevance (P37, Oxford global health researcher).

This highlights a crucial gap: whilst medical researchers generally trust in existing systems to deliver relevant results—especially as medical databases align with their mental models of knowledge organisation and standardisation—they are sometimes left struggling to locate relevant literature in adjacent fields due to differences in writing conventions and terminology that differ from existing mental models of knowledge in their own field.

As with law, some medical participants perceived online searching as lending itself to potentially overlooking key information, and relying on serendipity and "luck" (P24, Glasgow cancer researcher) rather than systematic investigation.

4.6.4 History: time, place, and subject

Medical researchers contend with large, centralised repositories of information in their fields; meanwhile, historians work with more scattered historical records found and accessed through a variety of different institutional and commercial search platforms. Unlike the standardised language and systematic search protocols of chemists and medical researchers, there is no standard language or research process covering the entire discipline. There are, however, categories historians commonly use that shape their mental

models of knowledge organisation. Historians identify themselves by their temporal and geographical foci—e.g., medieval historian of Britain, early modern historian of Europe—and discuss records of the past through analytical categories such as concepts, subjects, or themes, and descriptive categories such as names and demographic details.

Search habits reflect historians' categories of thought. P26, a medieval historian discussed how they would start looking for the latest research on a topic of interest:

> OK, [take] preaching. I would Google "preaching in the Middle Ages" for a start because that would give you what's been coming out in the last few years. (P26, Glasgow medieval historian)

P26's used keyword search is composed of a social practice and a historical period, categories commonly used by historians to define their work. P26 found that Google and general keyword search were a sufficiently reliable method, as relevant information appeared even if details were left out of a search query:

> The difference between when I was a graduate student and now is, authors don't matter, you know, because [if] you can't remember the name of the author, who cares? But keywords, titles, they matter. It's funny how that, you know, I still solemnly do copy down the author, but you'd think I don't need to, you know, unless it's something really confusable it'll, it'll turn up anyway. (P26, Glasgow medieval historian)

Similar sentiments were voiced by mid-career historian P30, who was generally sceptical of search platforms but still found that "Google is in some respects a blunt tool, but it's a very fast one that is often a very good starting point".

Mid-career global historian P27 also used general keywords alerts via Google's platforms to stay on top of the latest academic and non-academic information in their field:

> Well, I mean, there's, there's so much on [country]. So, I actually keep, like, I have alerts set up on Google Scholar and I have alerts set up with just Google. That's one of the tools that I use. So, every time something new is published, I'm getting alerts about it. Every time something is happening in the news, I'm getting alerts about it. And not to say I can keep up on it all because it's, it's massive. But, yeah, I mean, I'm, I'm just constantly reading. I have to be. (P27, Glasgow global historian)

Because P27 did not focus on a single time period or topic related to the African country on which their work was based, they had set up generic alerts for "anything on [country]" on Google. Unlike P26, who had used thematic and temporal keywords, P27 only used a geographical category to specify the information they wanted, although without any other parameters, this returned numerous results.

Some historians searched by name. Senior early modern scholar P7, for example, described how their search sometimes centred on historical figures but emphasised how online search stripped away contextual materials and the tangible experience of "reading through" a collection:

> I think people are being much more interdisciplinary and adventurous on the—as a result of, of the data [being online]. The real danger of things being online is that we don't actually experience the material of whatever it is… the documents won't speak to you in the same way as if you've got a collection you're just reading through. If you're just saying, right, I would like to read everything that's related to [name] or something, the danger is you'll only read those, and then you're—the other kinds of interesting materials won't be there… So, there's a lot to be said for trying to mix these two techniques, one using the search engine, but the other a form of serendipity when you've got time to read through things. (P7, Oxford early modern historian)

Historical records exist in context, so it was important for P7 to combine the targeted keyword search with the general strategy of "reading through" a collection. To P7, online access lowered barriers to engage in "more interdisciplinary and adventurous" endeavours, complementing an exploratory mental model where unexpected connections are made beyond and across collections and repositories, albeit within specific temporal, geographic, and/or subject parameters.

Challenges: lack of context and relevant criteria

Whilst there is a "serendipitous" element in online environments, historians face significant disconnects between online information and their mental models of historical knowledge stemming from the decontextualised nature of search results. The tangible organisation of physical repositories allows historians to conduct exhaustive, situated searches, a process that cannot be replicated using search engines. Participants in this study discussed relying on geographical, chronological, and subject-based organisation of knowledge, which provides a sense of context and relevance that is largely absent in digital systems.

The shift to online keyword-based searching has made finding relevant sources more difficult, as results are devoid of the structure historians expect from scholarly sources as one might find in libraries (see 4.6.2) or archives (see 4.6.3). As Oxford modern historian P9 lamented, "It's going to come up with a fairly disparate collection of results...when you just do a keyword search online, it doesn't come up in any sort of hierarchy about, you know, what is a good book to start with". This highlights a lack of differentiation in the results apart from an opaque ranking system, requiring more effort to judge where a source sits in a field, and whether it is foundational, niche, or irrelevant to their needs. The inability of

search systems to provide structured context regarding a topic as perusing physical volumes of journals might do, further complicates the research process, leaving scholars to navigate an ever-growing amount of isolated information.

Historians often resort to using analogue methods to regain some control over their research process. Participants discussed browsing library shelves or following references in known sources, reflecting a general disconnect between expectations of search inputs and outputs. Participants expressed anxiety about the "scattergun approach" of online searching and conveyed lower patience for information in online environments (P29, Glasgow medieval researcher), where both fuzzy and precise terms can return a massive number of irrelevant results (P15, Glasgow early modern historian; P30, Glasgow modern historian). Whereas the expectation when dealing with physical materials is that it takes time—to sort through items, to learn how things are ordered, to consult a specialist—in the web context, the expectation shifts to the opposite extreme in that users anticipate relevant items to appear instantaneously, without any transparent order or context, and without any human or expert assistance, and are more likely to give up and "move onto the next thing" more quickly. Such apprehensions suggest a significant misalignment between historians' mental models of information organisation and the functionalities of online information retrieval systems.

Ultimately, the degree to which scholars' mental models align with the systems they use depends on how well those systems are designed to reflect disciplinary practices, terminologies, and conceptual categories. In chemistry and law, where systems have been purpose-built around disciplinary concepts and categories, researchers described greater alignment between their thinking and the databases they use. In medicine, alignment is fostered through formal training and thesauri like MeSH, whilst history illustrates a more eclectic approach, where specialist databases, deep reading, and serendipitous discovery are used alongside general tools like Google. These variations highlight how disciplinary norms shape and are shaped by information systems over time.

4.7 Conclusion

This chapter has shown that the disciplinary mental models introduced at the beginning—the network of chemistry, the illuminated room of history, the hierarchical pyramid of law, and the patient-centred cycle of medicine—did not emerge abstractly or solely from participants' drawings. Rather, they crystallised

through a close examination of the extrinsic environments in which scholars work and interact with knowledge.

By tracing how disciplines define foundational content, methods, and conventions, it is possible to see how each subject establishes the intellectual scaffolding from which its characteristic mental models emerge. Universities reinforce (or unsettle) these forms through their physical layouts, administrative structures, and teaching cultures, prompting researchers to internalise particular ways of imagining the boundaries and relationships of their fields. Libraries and archives further shape scholarly expectations by structuring knowledge through established organisational practices, thereby shaping scholars' mental models, primarily in history. Finally, information systems—from chemistry's structure-search interfaces to law's precedent-mapping databases and history's heterogeneous archival portals—either mirror or complicate these disciplinary expectations, strengthening or straining the fit between scholars' thinking and the systems through which they retrieve information.

These extrinsic factors explain why each discipline's mental model takes the shape that it does. Chemistry's networked form emerges from a discipline whose resources, collections, and databases are tightly aligned around molecular structures and experimental processes. History's "dark room" arises from the fragmentary and dispersed nature of historical material and the open-ended nature of historians' work. Law's hierarchical pyramid is based on taxonomies and systems explicitly designed around cases, statutes, and precedent. Medicine's cyclical loop reflects the iterative, intervention-oriented logic of clinical and biomedical research.

Thus, the disciplinary shapes identified at the start of the chapter are not merely metaphors but are grounded in the material, institutional, and technological conditions explored throughout this chapter. The arrival at these forms is a cumulative result of mapping how disciplines, universities, collections, and systems structure scholars' engagements with knowledge in their fields. Subsequent chapters build on this foundation by showing how these extrinsic elements intersect with individual experience (Chapter Five) and sociomaterial dimensions (Chapter Six) to develop a comprehensive understanding of researchers' mental models of knowledge.

5 Individual factors shaping mental models of knowledge: education, collaboration, and specialisms

5.1 Introduction

The previous chapter focused on external and structural factors shaping researchers' mental models of knowledge in their fields: disciplines, universities, collections, and systems. This chapter looks at individual factors, such as personal motives, educational background, and specialisation. Academic training, specialised research interests, and collaborations further complicate and enrich the discussion of disciplinary mental models, as scholars navigate multidisciplinary and interconnected research landscapes. In some cases, strong similarities in mental models can be observed across disciplinary boundaries.

Early decisions often coincide with the formation of mental models, as scholars learn which questions are "worth asking" and which approaches align with disciplinary norms. A chemist might revel in the creative aspect of making or discovering new substances, whereas a legal scholar might focus on the social implications of judicial frameworks. Although these core drives differ, the common thread is that formative experiences, such as early interests and university studies, lay the groundwork for how participants continue to frame problems, build collaborations, and envision the societal contributions of their fields.

Across chemistry, history, law, and medicine, participants describe a dynamic interplay of personal and social contexts:

Curiosity and broader goals: For chemists (P6, P13, P23, P35), a love of fundamental science, discovery, and creating new things proves pivotal, whilst law participants (P12, P14, P17, P31, P40) highlight a desire for social justice and/or an intellectual challenge. Medical scholars (P22, P24, P28, P34) mention a deep interest in biology and human health, whereas historians (P4, P7, P15, P27) speak to a commitment to understanding the origins of social and cultural phenomena.

Family influences and early interests: P6 (chemist) and P15 (historian) reference family relocations or parental expertise as early catalysts; others (such as parasitologist P22 or chemist P10) mention influences from undergraduate studies that shaped a lifelong orientation toward interdisciplinary research.

Collaboration and specialisation: Several participants (P12, P16, P27, P30) mention interdisciplinary or comparative approaches rooted in early academic training. Such formative experiences lay the groundwork for how these scholars cross disciplinary lines in later work, as they develop expertise in specific subfields or topics that require grounding in one's own disciplinary background, whilst also reaching for interdisciplinary methodologies and collaboration.

The chapter explores participants' motives for disciplinary choice, educational background, collaboration, specialism, and the negotiation of disciplinary identities—all factors that play a critical role in understanding how scholars conceptualise knowledge within and across their fields.

5.2 Motives for choosing and staying in an academic discipline

This section considers the range of factors that lead individuals to choose particular academic fields, reflecting both personal aspirations and broader societal influences. These decisions often coincide with emergent mental models of knowledge, as early disciplinary choices establish certain ways of thinking and problem-solving. In some instances, scholars' motivations may be driven primarily by curiosity and intellectual stimulation; in others, they may be guided by a desire to effect social change or address pressing societal health concerns. This section illustrates how participants in chemistry, history, law, and medicine articulate their motives for entering and remaining in their respective disciplines.

5.2.1 Chemistry: curiosity, discovery, creativity

Participants in chemistry referred to a sense of curiosity and joy in discovery as key drivers. One participant reflected on the inherent pleasure of research: "most of us are doing it because it's really good fun, doing what we're doing." (P6, Oxford inorganic chemist)

Others described a constant desire to learn new things. P13 (Glasgow organic chemist) highlighted this restless curiosity:

> Every day for me is chasing...knowing. I, I really have a hard time personally in…not knowing… So, they tell me, I want to build a robot… Give me a moment and I will. And this is how it works for me. I always look for a chance first…I learn something. This is what I get from that stuff. (P13, Glasgow organic chemist)

P35 (Oxford physical chemist) underscored the gratification found in simply satisfying one's own curiosity:

> For us, it's very curiosity driven. And, and so, actually, the reward is, in a way…whether you satisfied your curiosity or whether you managed to answer the questions. (P35, Oxford physical chemist)

Meanwhile, P23 (Glasgow organic chemistry) pointed to chemistry's creative element:

> So in a way it's, it's actually also crafting things. That's, that's different from most of the other things you—at least at the level of studying things—because you create things. (P23, Glasgow organic chemist)

As exemplified in the quotes above, chemists' motivations ranged from a fascination with understanding the fundamental workings of the natural world to the excitement of discovery and creating something new.

5.2.2 Law: curiosity about society and justice

Whilst for some chemists, discovery and satisfying curiosity were key drivers, for many legal scholars, a commitment to social justice and enacting social change appear to be the primary motivators. In some cases, participants arrived at law after first pursuing related fields such as political science. P12 (Glasgow property law scholar) ascribed the transition from studying political science to law to the desire to study something that could engage with issues in the present, something that would enable them to "actually do things on the field".

Others articulated a direct interest in pursuing legal study as a way to contribute to social change. Glasgow international law scholar P14 emphasised:

> I was interested in human rights and justice as a passionate young person. And I thought law might be a tool to work on those issues. That's why I decided to study law. (P14, Glasgow international law scholar)

Similarly, P17 and P40 underscored the appeal of law in promoting justice:

> The idea of justice. I thought law was the way to make the world a better place. I was young and naive, but I still think that there's something to do about it. Yeah, I wanted to become a judge. That's why I studied law. (P17, Glasgow public law scholar)

> But there's also a campaigning element to it as well. So these are issues where I think there is some sort of injustice potentially happening, and that I find a very strong motivator for what I'm doing. […] I partly just want to find out the answer, but I want to find out the answer and try and bring things to people's attention if I think that there's some need for improvement or change. (P40, Oxford property law scholar)

Whilst some law participants identified social ideals as their principal motivation, others mentioned intellectual curiosity or career practicality. P31 (Oxford European law scholar) spoke of a desire for "something that was intellectually rigorous because I found school very easy…" P16, meanwhile, regarded law as a gateway to understanding how the world operates:

> I think to study law is a good way to know the world… I really like to know different countries, the cultures, not only the cultures, also, like, the real world, how it operates. (P16, Glasgow private law scholar)

By contrast, P38 (Oxford private law scholar) described more pragmatic considerations:

> Law was a pretty good option on that front because it was something new. And I thought, well, you'll get a high-paying job out of it at the end… And I... sort of first met and began to really appreciate my specific subjects while I was there [in university].

Within law, then, personal motives range from a passion for justice and a desire for intellectual challenge to career pragmatism.

5.2.3 History: curiosity about the past

Like some of the curiosity-driven chemists, historians also foreground a sustained intellectual curiosity about how social phenomena evolve, as well as an interest in interpreting varied sources. P4 (Oxford modern historian) recalled initially intending to move on from history after undergraduate study, only to be captivated by the discipline's potential and the possibility of contributing to a new approach:

> But I just really, really loved the subject. And in particular what I enjoyed was trying to think about how you might approach history in a different way… Historians, particularly in the mid-nineties…had become exceptionally good at analysing texts… And I thought more and more that

> that was largely inadequate. That in fact there had to be a more material history, as it were… And my thought was that if I investigated buildings, that would be a way of training me to understand material histories, to try and understand how you could answer different questions about how people actually lived life in the past, which was not all textual. (P4, Oxford modern historian)

P33 (Oxford modern historian) similarly emphasised the "stimulation" of historical investigation:

> I think it's just the, the stimulation of, of like, the intellectual stimulation of, of kind of investigating phenomena, really. Trying to understand things that haven't been fully understood, or that lack a historical perspective. (P33, Oxford modern historian)

This participant also recalled early indecision between science and the humanities, indicating the eventual pull of historical inquiry:

> I was a bit indecisive about whether I wanted to do something more scientific…but I was always…kind of interested in understanding the origins of phenomena…I think that's probably why I was drawn to history. (P33, Oxford modern historian)

P7 (Oxford early modern historian) recalled that a strong secondary school teacher ignited this passion, fostering skills of argumentation and critical synthesis:

> I had a brilliant history teacher at school. And I was good at it. But he was—he was superb in that it wasn't dictated notes. It wasn't just content. It was very much about argument. And different views and how you come to some kind of… conclusion, a decision that you make, based on the evidence, and I loved it. (P7, Oxford early modern historian)

According to historians' accounts, their motivations arise from a desire to understand and interpret historical phenomena and to develop new perspectives of the past.

5.2.4 Medicine: interest in life, disease, and social impact

Echoing some legal participants' motivations for social change and impact, participants in medicine cited a fascination with human health and disease, along with a drive to generate positive social impact. Some were enticed by forensics or pharmacology, such as P19 (Glasgow forensic medicine specialist), who recalled:

> …so I had a lecturer that worked in the police in Brazil…and I've always been fascinated by drugs that could kill you, basically. So, their lectures always fascinated me… And I left industry to basically study, to try to join the police. (P19, Glasgow forensic medicine specialist)

Others preferred to explore the biological underpinnings of the human body. P24 (Glasgow cancer researcher) articulated an enduring curiosity:

> All the biological part, I really liked it. The disease and everything, to understand why it's happening, why we behave as the way that we behave, why we move the way that we move… I think that's beautiful. (P24, Glasgow cancer researcher)

For P37 (Oxford global health researcher), the appeal lay in seeing more immediate, policy-related outcomes:

> I think I like things where I could directly see an impact of my work, especially related to policy-related impact or practical impact. I didn't really like mathematics or anything related to that because I couldn't see how it's useful for people's day-to-day life. (P37, Oxford global health researcher)

In contrast, P34 (Oxford primary care researcher) explained a decision to pursue public health rather than clinical work, mentioning the pressures of direct patient care:

> So, it's very stressful to deal with patients. Tight schedule, risk of life sometimes, or risk your health sometimes… In clinical settings, you see the patient every day. If you don't have a strong mind…you can't just finish your work. So that's why I chose…public health instead of clinical. (P34, Oxford primary care researcher)

Participants in medicine, as shown in the examples above, were generally drawn to their field by dual forces: an interest in understanding fundamental workings of the body and wanting to impact policy and public health.

5.2.5 How motives impact mental models

Across these four disciplines, participants articulate a diverse set of motivations for embarking on specific academic paths. Personal drivers—such as a yearning for justice, curiosity about the natural world, fascination with the past, or a commitment to improving health—suggest that the construction of disciplinary identity is far from uniform. These early motivations often influence how individuals

conceptualise their field's purpose and potential contributions, suggesting that the development of a researcher's mental model of a field is linked to the initial motives that bring them into their discipline.

Looking more broadly, these findings highlight the interplay between personal aspirations and social context. Some participants referred to a catalyst—whether an influential figure, or a social purpose. Participants' stories underscore that disciplinary identity is as much a product of context and experience as it is of innate interest. Researchers' mental models are shaped by formative influences yet continue to adapt as they encounter new methods, people, resources, and collaborative possibilities, which speak to the dynamic, deeply human processes underlying academic knowledge production and researchers' mental models.

Moreover, the motivations described above offer insight into how researchers perceive their role within society. Scholars in law, for instance, repeatedly emphasised a commitment to social justice, framing legal study as an avenue for meaningful social intervention. By contrast, chemists largely dwelt on creative problem-solving and the excitement of discovery, suggesting that their discipline fosters an identity built on experimental curiosity. Historians, meanwhile, described a preoccupation with interpretation and debate, mediating between the past and present. Finally, those in medicine showed diverging interests between direct clinical engagement and more lab-based, or public health and policy perspectives, suggesting how disciplinary identities may shift in response to ethical and emotional demands.

Overall, the origins of disciplinary choice extend beyond mere preference for a subject area, reflecting a constellation of factors—personal and social—that shape academic trajectories. These motivations, in turn, feed into the mental models researchers develop, influencing how they approach evidence, frame questions, and envision the relevance of their work.

5.3 Disciplinary training and early influences

This section focuses on how undergraduate, postgraduate, and early career experiences shape researchers' conceptual frameworks. It further considers personal qualities—such as curiosity or social responsibility—and the ways these traits influence participants' perspectives of disciplinary knowledge. Whether following a single discipline or crossing disciplinary boundaries, early academic pathways appear to influence the questions researchers find meaningful and the methods they draw upon.

Whilst most researchers in each of the four disciplines had pursued a single discipline throughout their years of study, there were those who started from a different discipline. The distinctions were most notable in medicine, where over half of the participants had pursued degrees in biology, engineering, and social work before taking on medically oriented research. There were a couple of notable distinctions in chemistry and history where scholars had obtained degrees in disciplines other than their current one, such as physics or genocide studies respectively. Legal scholars reported the fewest divergences, with one who had studied philosophy at the beginning of their studies, but a couple of participants had also worked in practice, as solicitors, before taking up academic research posts.

Single-discipline education	**Multi-disciplinary education**
Chemistry: 1, 2, 6, 13, 20, 21, 23, 25	Chemistry: 10, 35 (physics component)
History: 4, 5, 7, 9, 15, 26, 29, 30	History: 27 (genocide studies); 33 (International economic history degree based in social science department and another degree in history/political science)
Law: 8, 12, 14, 16, 17, 31, 38, 39	Law: 11 (philosophy and sociolegal studies; worked as solicitor); 40 (No doctoral degree; worked as solicitor)
Medicine: 3 (neurology, clinician); 19 (forensic medicine); 28 (physiology, clinician); 37 (global health and clinical medicine)	Medicine: 18 (biology); 22 (biology); 24 (biomedical engineering); 32 (biology); 34 (social work); 36 (biology)

Table 5-1 Participants' educational backgrounds

5.3.1 Chemistry

Chemists in this study highlight a range of formative factors. Oxford inorganic chemist P6 grew up with parents working in mathematics and chemistry, inheriting a broad scientific outlook and curiosity about the natural world, and discussing them as a source of inspiration:

> My father's a mathematician. My mother was a chemist… She would walk around with you in the world… and this is this mineral and that is this mineral… I changed my mind what I wanted to

> study five times… on the last available day I changed again, to chemistry. (P6, Oxford inorganic chemist)

P6 described themselves simply as a "chemist", resisting a narrow specialism and emphasising how chemistry naturally intertwines with other scientific areas.

By contrast, P10 and P35 were physical chemists who originally studied physics. Despite being formally in a chemistry department, P10 and P35 identified strongly with physicists. P10 noted that whilst chemistry can accommodate physicists, the reverse is less likely. Thus, whilst P6's broad view of their field and P10's and P35's posts in a chemistry department highlighted chemistry's breadth, P10's and P35's early physics training inspired an enduring self-perception as physicists. P6 collaborated on multidisciplinary projects that are difficult to pin down as inorganic, organic, or physical chemistry, whilst P10 also collaborated with other specialists on molecular imaging projects, more aligned with physicists' interests. Thus, their mental models of chemistry were fundamentally influenced by knowledge and approaches from earlier training and personal influences, shaping their positionality in relation to the disciplines in which they currently found themselves.

5.3.2 Law

Legal scholars described strong ties to social justice and a desire to understand societal structures, but their academic journeys also reflect diverse methodological grounding. P11 (Glasgow private law scholar) began in philosophy, which encouraged a logically rigorous worldview before they completed a law degree that emphasised the sociolegal perspective:

> They've got a very distinctive style there. They teach it from a sociolegal perspective. So right at the start, you're introduced to social science, like real social science, where it's studies about not just a court case, but the reasons that would prevent people from raising court cases. (P11, Glasgow private law scholar)

P12 (Glasgow private law scholar) followed an international and multidisciplinary route, studying a range of fields including political science, economics, law, and philosophy before completing a master's and a PhD in law. Over time, P12 integrated sociolegal methods and collaborated with sociologists and anthropologists on a project investigating property law in France.

Meanwhile, P16 (Glasgow commercial law scholar) emphasised comparative methodologies as an enduring interest, driven by an early desire to understand the world and society comprehensively:

> I have interest in… social science much, much more than natural science… I really like to know different countries, the cultures… how it operates. (P16, Glasgow commercial law scholar)

This motivation to understand different societies through a legal lens led P16 to use a "comparative, cross-border" approach to in their doctoral studies in commercial law, incorporating sources beyond those of a legal nature. P16, as well as P11 and P12 were exposed early on to fields and methodologies beyond those of a purely legal nature shaping their approaches to legal research in the longer run and their mental models of legal knowledge.

5.3.3 Medicine

Whilst some medical researchers in this study had studied medicine, others had an education based in the natural sciences. P22 (Glasgow biomedical researcher) studied chemistry and biology, and their subsequent research in parasitology and pharmacology exemplifies how chemistry and biology converged in their academic trajectory.

Similarly, P24 (Glasgow biomedical researcher) gained a doctoral degree in biomedical engineering prior to undertaking postdoctoral research in oncology, demonstrating how engineering principles can inform clinical or biomedical inquiries. P18 (Glasgow biomedical researcher) studied microbiology to later specialise in bacteriology.

Others like P28 (Glasgow clinical researcher) completed medical studies in a variety of geographical and institutional contexts, which broadened their perspective on clinical work and research interests. P34 (Oxford primary care researcher) had a degree in social work, which laid the foundation for future work in epidemiology and health behaviour.

For these medical researchers, their multidisciplinary educational trajectories often came together to form the basis of their current orientations in relation to medical research. This suggests mental models in medicine can variably be informed by backgrounds in clinical work or fundamental science, but these participants' experiences also speak to the expansive nature of the field, something that was particularly

evident in Oxford University's administrative structure (see Section 4.4), where medicine comprised an entire Division.

5.3.4 History

Historians described entering the field via diverse academic routes. Some historians discussed how their multilingual and cross-cultural backgrounds shaped their academic interests. P15 (Glasgow early modern historian of Europe) and P33 (Oxford modern economic historian) discussed how their international upbringing, having grown up in various European countries, fostered a multilingual skill set and later a comparative, international historical approach. P15, for example, said:

> I'm an EU citizen… I was born in [European country] my family moved to [European country] … so there is a kind of—I'm very keen on comparative history… all the European connections, intellectual and cultural. (P15, Glasgow early modern historian of Europe)

P30 (Glasgow modern global historian) emphasised how prior language study opened up opportunities for historical investigation:

> I moved into the Arabic language degree because I thought that it would be more achievable to study Arabic and then become a historian, than to study history and get Arabic later, and I think that was correct. (P30, Glasgow global historian)

P30 was trained in language and area studies which exposed them to a wide range of methodologies and disciplinary intersections early on:

> I then did a master's in Middle East studies. And again, although I mainly picked historical optional modules, it was an area studies programme. And to the extent that there were those methodological, you know, teaching of methodologies, it was the kind of hodgepodge of area studies methodologies where you have a seminar on, on history, a seminar on anthropology, a seminar on, you know, politics... (P30, Glasgow global historian)

In a similarly interdisciplinary path, P27 (Glasgow global historian) began in forensic archaeology—variously classified as an arts, social science, or hard science discipline. Unable to undertake a dedicated PhD in forensic archaeology there, P27 embarked on an interdisciplinary humanities doctorate, integrating history, forensics, and genocide studies. Over time, they moved towards archival research and oral history, demonstrating how a shift in disciplinary emphasis can arise from academic constraints and a personal inclination towards more "people-centred" methods.

Early experiences in a particular geographical region, exposure to languages, and exposure to interdisciplinary fields during their studies shaped the specialisms and methodologies adopted by the above historians; disciplinary training and early life experiences influenced their global, interdisciplinary mental models of historical knowledge.

5.4 Cross-disciplinary collaborations within and beyond academia

Participants' accounts of how their research is rooted firmly within their own disciplinary backgrounds whilst simultaneously being drawn towards and enriched by interdisciplinary collaboration. Scholars across chemistry, history, law, and medicine described how engaging across disciplinary boundaries expands their methodological approaches, enriches their knowledge bases, and fosters innovative research outcomes.

5.4.1 Chemistry: the integrative nature of experimental science

According to chemists from all subfields included in this study, the nature of chemical research requires a willingness to integrate methods from other disciplines such as physics, biology, and computational science to address a problem in innovative ways, reflecting a solution-driven approach. This interdisciplinary character ensures that chemistry remains at the cutting edge of scientific discovery, balancing theoretical innovation with experimental validation. As Oxford physical/computational chemist P1 notes,

> Everything has a crossover. So, I collaborate with people in Bath who're in the physics department, I collaborate with people here in theoretical physics… Biochemistry. Even biology, to some extent, absolutely. Materials science as well... (P1, Oxford physical chemist)

This viewpoint underscores the view that the natural phenomena that chemists study are inherently chemical, but also interdisciplinary. Thus, researchers in chemistry rely on expert collaborators from other fields to refine methodologies, particularly in analytical and physical chemistry, where computational modelling and instrumental techniques play a crucial role (P1, P10). As another Oxford physical chemist explained,

> I have collaborators from tunnelling microscopy, scanning force microscopy—surface science people—from theory and simulation, from mass spectrometry, electron microscopy, and instrument builders in industry from pharmaceutical companies, structural biologists, and so on. (P10, Oxford physical chemist)

A Glasgow organic/computational chemist likewise explained how some of their research projects required multidisciplinary teams to address complex issues:

> I did my first big project with...a consortium…between our university and a [country name] university, doing research on melanoma and looking for potential therapies to, to fight it. Then I was in [country name] for four years, working in a group that was more material science slash engineering slash organic chemistry and nanotechnology oriented. (P13, Glasgow organic chemist)

Additionally, inorganic chemists P6 (Oxford) and P20 (Glasgow) emphasised how their research areas required knowledge from other disciplines, leading to interdisciplinary collaborations that shape how research problems are approached.

These excerpts highlight chemistry's reliance on complementary expertise to enhance research quality and innovation. Such partnerships extend beyond academic disciplines to include industry collaborations, in pharmaceuticals (P21) and materials science (P20), for example. These chemists' mental models were thus shaped not only by intradisciplinary collaboration—within research groups, for example—but also by the relevant knowledge from other disciplines relating to their areas of interest.

5.4.2 History: the negotiation of discursive and empirical traditions

Historians, by contrast, engage in a fundamentally different mode of inquiry, one that privileges textual analysis, archival research, and historiographical critique, although methods and approaches are widening beyond this. Whilst history is often considered a solitary pursuit, steady shifts towards oral history, ethnographic methods, and digital humanities have encouraged collaboration. One historian described how oral history can involve international collaboration and teamwork:

> I've become quite interested in the co-production of knowledge. So, I've done a lot of audio oral history interviewing, but out of that has come a project…there's a whole team around it. You know, subtitlers, camera operators, editors, and so on…I've been really fortunate to have worked on a lot of international collaborative projects. (P9, Oxford global historian)

Historians working in architectural history or on medieval manuscripts highlighted the benefits of collaborating with experts who have practical knowledge of the object. Historians may engage with museum professionals, heritage experts, and anthropologists (P4, P29), bridging the divide between textual interpretation and material culture analysis. As Oxford modern historian P4 reflected,

> Quite a lot of architectural historians work for the National Trust or Historic England or English heritage. And they are people who are incredibly knowledgeable about the materials often in ways I can't be because they're working day to day with them. So they understand the, the, the objects, they understand the architecture in a, in, in a way that I don't get… (P4, Oxford modern historian)

P4 had also collaborated with a psychologist on a project relating to the history of dyslexia, discussing how their collaborator's perspective of archival sources and research differed from their typical approach. These remarks exemplify how historical research is enriched by expertise from beyond academia and conventional historical boundaries. In addition, the discipline's engagement with co-production of knowledge, particularly through oral histories and participatory research, illustrates how history is evolving in response to new epistemological demands, shaping scholars' mental models over time.

5.4.3 Law: doctrinal analysis and interdisciplinary expansion

Legal scholarship reflects both a strong doctrinal tradition and growing interdisciplinary, empirical approaches. Whilst some participants only engaged in doctrinal and/or theoretical analysis (P8, P11, P17, P31, P28, P39), others used both theoretical and empirical methods in their research. A Glasgow legal scholar describes the different modes of research:

> In fundamental research, you basically look at the law and write theories about that, and I find that I'm better off working alone…but in applied research—I work on collective property systems in France—so…we interview people, we meet with local authority associations… I do this research with a sociologist and a public lawyer…and we have some anthropologists as well. So, the idea is really that we need the diversity of competence. And it's not just about one field of law. (P12, Glasgow private law scholar)

Legal research can require engagement with experts in other fields, such as sociologists and scientists, especially for cross-disciplinary projects such as collective property systems, as described by P12, and environmental issues that intersect with the law (P8, P12, P40).

One Oxford legal scholar reflected on their evolving methodology, based on the necessity of more holistic approaches for their research on housing and fire safety:

> So, if I want to understand how a block of flats is working and the problems that people are encountering…in relation to fire safety…the energy policy person was looking at energy efficiency… And the law gets in the way of that, but it's not solely a legal problem. It's a political problem, a policy problem…technical problems as well…So, if I want to understand the difficulties of upgrading a block of flats, it's looking at the law…but also how that interacts with these other areas, which is why it's good, if I can, to work with people from non-legal backgrounds. (P40 Oxford private law scholar)

P40 had originally begun with more traditional methods, but expanded their methodological scope as their career progressed:

> …over the years, my work has been—my research has become much more focused on what I regard as real world problems... taking the law and thinking about how it applies in particular complex problems in society, which is quite a different kind of research than what I was doing earlier on where I was much more sort of, I don't know, just interrogating legal doctrines. (P40, Oxford private law scholar)

This statement encapsulates the challenge faced by legal academics—whilst law is traditionally analysed within its own conceptual framework, it increasingly intersects with broader social, economic, and technological issues. Interdisciplinary legal research often requires methodological negotiation, as illustrated by P40 as well as Glasgow commercial law scholar P16, who found traditional doctrinal approaches inadequate for studying capital markets, necessitating the adoption of economic analysis. These perspectives illustrate law's dual identity as a discipline grounded in a doctrinal tradition yet increasingly shaped by external disciplinary influences.

5.4.4 Medicine: the intersection of scientific and social inquiry

Medicine, perhaps more than any other discipline in this study, embodies the intersection of natural and social sciences. Medical research is highly interdisciplinary, drawing upon fields such as biology, chemistry, engineering, and public health. Glasgow biomedical researcher P18 noted, "We work really closely with chemistry…we work a lot with cell engineering… we work with colleagues in the art school…to illustrate what we do…" This reflects an epistemological flexibility wherein medical researchers synthesise diverse knowledge sources to advance both theoretical understanding and clinical application.

The collaborative nature of medical research is further exemplified by participants working in health economics, forensic science, health policy, and epidemiology. Glasgow-based health economist P19 described a multidisciplinary research environment where economists, accountants, and statisticians worked alongside medical professionals to assess healthcare interventions. Additionally, medicine's direct implications for policy and ethics require interdisciplinary dialogue, as noted by Oxford global health researcher P37. These insights underline medicine's practical, integrative, and highly collaborative nature, highlighting how the approach of societal health issues necessitates a mental model that encompasses social and practical flexibility.

5.5 Specialisms

All participants had developed expertise in specific subfields or niche topics. Such specialisms can cut across conventional disciplinary boundaries and enable new kinds of inquiry that draw on multiple subject areas. For some scholars, specialisation strengthens their sense of disciplinary identity, whilst for others, it becomes a bridge to wider interdisciplinary dialogues. In this way, specialisation can simultaneously consolidate disciplinary mental models and broaden scholars' perceptions beyond the contours of their fields.

5.5.1 Chemistry: expanding boundaries through specialised expertise

In chemistry, researchers frequently transition toward interdisciplinary domains because of their specialist knowledge. Oxford physical chemist P1 explains:

> I actually liked physics more, which is why I ended up being a physical chemist and practically being a physicist in some ways. I publish a lot in physics journals because chemistry, physics, biochemistry, maths, etcetera—they're really just undergraduate labels...but when you get into the world of research, those labels don't have great meaning anymore. (P1, Oxford physical chemist)

P1 underscores how chemistry overlaps with other scientific disciplines, making interdisciplinary collaboration a natural extension of research maturation and specialisation rather than a departure from it. A Glasgow organic chemist discusses how career trajectories often evolve affinities to other disciplines:

> Inside of chemistry there are, there are so many subfields. So, it's not only these three… For each area of chemistry, you can have so many fields of research as well... Inside of chemistry, you get mixed up and have mixes with other things and then you also move to biology or physics, depending on, on which area you are [in]. So for us, we're, we're probably closer to biology, I think. (P23, Glasgow organic chemist)

Similarly, P2, another organic chemist, described how interdisciplinary research was their way forward in innovating new techniques:

> I'm already working on very, you know, interdisciplinary area, which gives me more satisfaction. Oh yeah. I can't cope with pure chemistry… We're developing technology to sequence, you know, information rich biopolymers. One of them is DNA. (P2, Oxford organic chemist)

P2's research combined organic chemistry with biology and nanotechnology, which they hoped would provide them with potentially new approaches that would produce "disruptive technology" and "come up with really new ideas".

These chemists suggest how specialisation and a narrowing of research interests simultaneously push researchers beyond traditional disciplinary boundaries, fostering interdisciplinarity through their research questions and collaborative interactions.

5.5.2 History: Specialist subjects leading to interdisciplinary perspectives

Historians also find their specialisations can draw them towards interdisciplinary perspectives. Oxford modern historian P4 recounted:

> I'm very interested in interdisciplinary approaches. Often if I pick up on something in a field that I don't think historians have picked up on, I try to bring it in and say, wouldn't it be interesting…to think about…I don't know, acoustics? How do buildings sound, as well as how do they look? …can we think about how, thinking about the material world more generally, what philosophers and anthropologists have been writing about that might be a useful way of us responding? (P4, Oxford modern historian)

P15, an early modern historian at Glasgow, highlighted how pursuing economic history encouraged thinking beyond traditional historical analysis:

> Economic history, I came to that very early because that was one of the fairly early quantitative aspects of history where one could check political history and social history against what's available about demographic change. In other words, population structures, nature of class structure… And things like productivity, how do people make livelihoods, and so on. (P15, Glasgow early modern historian)

Whilst showing some caution about using concepts from outside of history, historian P15 discussed having previously drawn upon sociological and quantitative concepts to understand history from a distinct perspective. They subsequently moved into intellectual history, cultural history, and book history, demonstrating multiple "changes in perspective" throughout their academic career.

P33, a modern historian at Oxford, reflected on their own academic trajectory, discussing how social sciences may have shaped their approach to historical research:

> I did my PhD in social sciences, so the Economic History department in the Faculty of Social Science. …I don't know if that may have changed something, or the approach, or how I go about doing my research. (P33, Oxford modern historian)

P33 also went on to explain that the kinds of scholars who are interested in their research 'tend to be people outside, or closer, to economics and social science' rather than mainstream history. This shows not only how their academic institution viewed this branch of history but also the approaches P33 was trained in and the audience of their research.

These examples suggest that specialisation in history and the identification of emerging topics can encourage the integration of perspectives from other disciplines to generate new knowledge, sometimes shifting existing frames or approaches to historical knowledge.

5.5.3 Law: Challenging doctrinal rigidity through specialised interdisciplinary pursuits

Several legal scholars described engaging in both traditional doctrinal methods and less conventional, interdisciplinary research. Oxford law scholar P40 remarked:

> I don't really fit into any boxes because I've done lots of different things…for the past 10–15 years, I've been driven by a problem and thinking, well, in order to understand that problem, what,

> who do I need to ideally work with? …There's one project that…I'd love to find a legal geographer to work with… (P40, Oxford private law scholar)

Similarly, Glasgow-based legal researcher P14 investigating the role of youth in peace processes underscored their use of interdisciplinarity arising from specialised interests:

> …we're looking at…what role youth play in building peace and communities. So…we've done surveys and…semi-structured group discussions with youth groups. And lots of knowledge exchange activities with practitioners… It doesn't involve much Law, so it's interdisciplinary in the sense that it involves political science, international relations, and education, I would say. (P14, Glasgow international law scholar)

Here, P14 differentiates between traditional Law—something that they engage in as well—and their collaborative project on peacekeeping processes which employs social science methodologies and documentary analyses of international instruments such as United Nationals monitor frameworks that resemble legal documents.

P38, a legal scholar at Oxford reflected on how their own research and view of their subject area had outgrown traditional disciplinary structures:

> I see connections between subjects that perhaps not everyone would traditionally see. I mean, presumably they just adopt some sort of standardised law library categorisation, but…I think that I kind of run subjects in together slightly, and make associations in my mind between certain subjects that probably only suit the way I view the law… (P38, Oxford private law scholar)

Whilst P38 is firmly rooted in legal doctrine, they also see gradients between different subjects related to their specialism as their area of expertise grows and deepens.

These reflections reveal how certain specialisations in law can serve as a gateway to interdisciplinary exploration and collaboration with experts in other fields, challenging traditional notions of legal scholarship and pushing the boundaries of existing research frameworks.

5.5.4 Medicine: Interdisciplinary problem-solving and career development

Medical researchers describe their advanced specialisations as inherently interdisciplinary. A Glasgow-based medical researcher observed:

> Science, here at Glasgow…tends to be a little broader. You know, you tend to be a little less constrained—rather than, you're a clinician, or you're a vet. You know, science is just about answering the scientific questions… But that, that's just about putting the right infrastructure and meetings in place where people can come together and, you know, get those cross-disciplinary things going. I mean, we, we manage it with engineering and chemistry and things. (P18, Glasgow biomedical researcher)

When it came to pathogen research, for P18, it was important to remove the disciplinary "silos" and to have the infrastructure in place to connect experts from different fields to pursue the goal of "answering the scientific questions" effectively.

Another experienced medical researcher discussed the internal tension of specialising in one specific topic versus developing broader expertise:

> …there may be a few [medics] who say, you know, I'm a stroke doctor. And they would not touch diabetes and the kidney… And that may be, for their own research career…really, really useful. …if you're really an expert in one area…you will be known by funding bodies…you will be known in the community as the go-to person when it comes to whatever. Whereas if you have a bit of a broader portfolio, it may be personally very satisfying. It may also be good for certain roles where you need to integrate a larger team or oversee a larger team to have a bit of knowledge here and there, but it may be a little bit more difficult [career wise]. (P28, Glasgow clinical researcher)

As a clinician and researcher with experience in multiple subject areas, P28's birds-eye view drawing of their subject area reflected this. The interdisciplinarity in their career arose out of personal interest and necessity, which they described with mixed emotions.

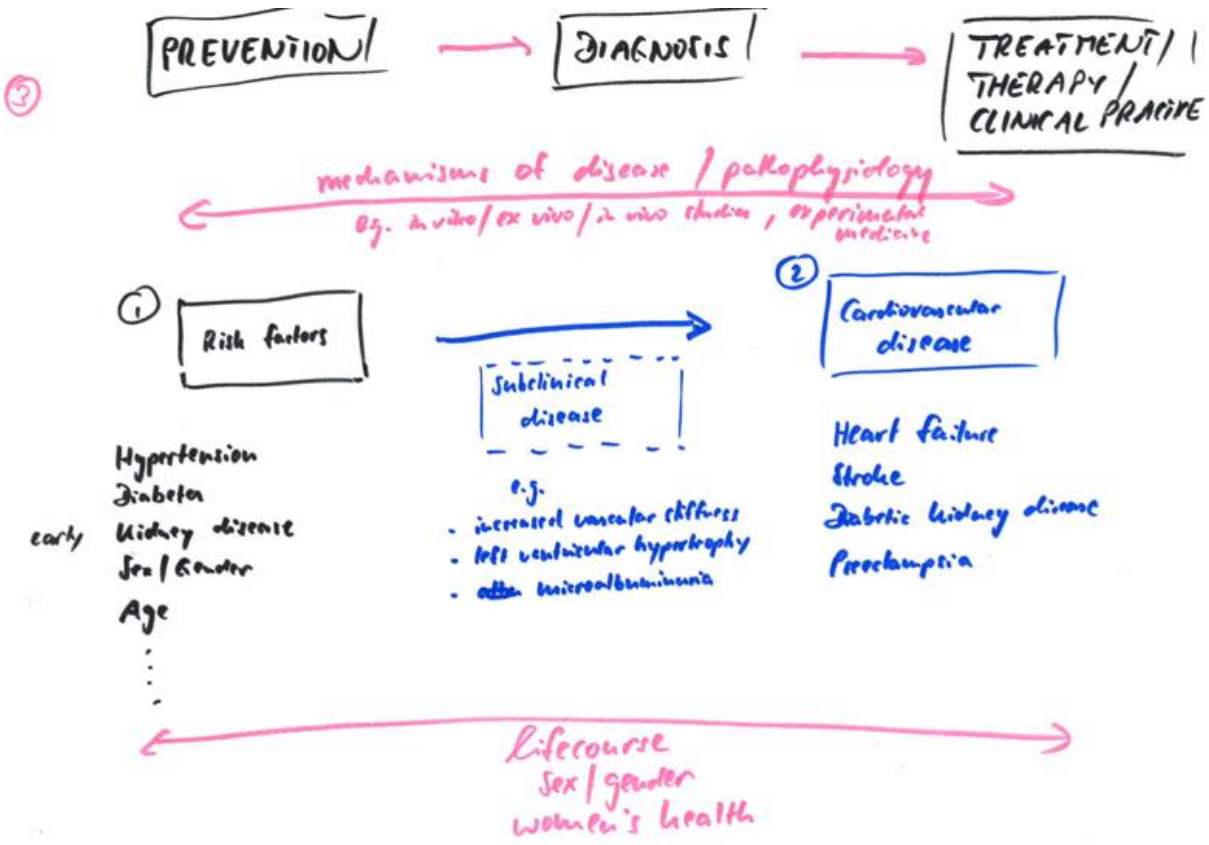


Figure 5-1 Glasgow clinical researcher P28's drawing of cardiovascular medicine

Having a broader portfolio was rewarding but came with a sense of uncertainty because it meant it would be harder to fit into a single specialist identity.

In medicine, therefore, expertise development can prompt interdisciplinary dialogues, enabling more effective problem-solving, whilst also raising questions about career trajectories and disciplinary belonging.

Sections 5.4 and 5.5 bring to light how disciplinary specialisation and cross-disciplinary collaborations can propel scholars to draw on other relevant disciplines whilst also reinforcing disciplinary knowledge boundaries. In chemistry, history, law, and medicine, scholarly maturity is marked not only by disciplinary depth but also by the ability to navigate and integrate diverse intellectual traditions. These complex, interwoven research landscapes shape not only the kinds of mental models scholars develop of their disciplines but also their self-perceptions and positionalities in relation to the discipline itself, which is discussed in the following section.

5.6 Nested identities

One way these positionalities become visible is through the layered forms of belonging scholars describe in their everyday research lives. P14, an international law scholar, discussed the ways in which knowledge is disseminated in their disciplinary community both formally and informally:

> So, like in the school, we have a work in progress seminar series… Then, in international law, we have a working group. So again, you can present your work there or go and listen to the presentations of others… Yeah, I think these are—and then, yeah, informal chats, like, over coffee. (P14, Glasgow law scholar)

P14 moves through different concentric layers of community, from general (school) to specific (working group), and from formal (seminar series) to informal (chats over coffee). Concentric layers of belonging are also suggested in the way P29, a medieval historian, responded to a question about whether historians share a distinctive approach to research:

> I suppose when you're talking to people from other disciplines, you feel like a historian, like there is a unique historian identity. But then when you're in a room of historians, you feel suddenly your identity changes because you're a medieval historian, and the medievalists, we have a way of doing things. And then when you're in a room of medieval historians, you know, you're a charter person. And that charters is how we do things. And then, it kind of keeps going. (P29, Glasgow medieval historian)

P29's response highlights a nested conceptualisation of identity, in which disciplinary belonging is progressively refined and redefined depending on context. P29 was unsure about how to answer at first, explaining how the fluid nature of disciplinary identity made it difficult to pin down what is "unique" about historical thinking. For P29, disciplinary affiliation was a shifting phenomenon that was both *relational*—as it is formed in the process of encountering and interacting with other academics—and *relative*—in the sense that your identity changes as you compare what you do with what others are doing.

This notion of disciplinary fluidity was evident across the four cases. Historians in this study, for example, tended to consider themselves as "unusual" due to the interdisciplinary nature of their research. P5, an intellectual historian, remarked:

> Well, the first thing to say is that I'm unusual in the sense that I don't actually have one field. (P5, Oxford modern historian)

P5's career trajectory spanned political and social theory and historiography, reinforcing their sense of being positioned between traditional disciplinary boundaries. Similarly, P33, a postdoctoral researcher in economic history, described feeling caught between distinct research traditions:

> I guess I'm kind of in the middle. Somehow in the middle of different, different approaches and different ways of doing things, which is sometimes actually kind of problematic because it's—you, you don't really quite fit into any kind of research tradition or research field. (P33, Oxford modern historian)

This perception was not exclusive to history. Medical researchers, too, encountered tensions in their disciplinary identities. P22, a parasitologist, discussed their own sense of being an outsider:

> It's a smallish community, yes. Everybody knows each other by name and, and pedigree and so forth… He got his initial training by Professor So-and-so back in, in the 1980s and whatever. I, I didn't, of course. Yeah. I parachuted in from outer space. (P22, Glasgow medical researcher)

Even after a long career, P22 continued to describe themselves as "the odd one out here", underscoring the enduring nature of perceived disciplinary boundaries. Even during recruitment, P22 revealed their doubts about qualifying as a "medical researcher" in email exchanges because they did not engage in clinical studies. Thus, there were interesting tensions between their notion of what constitutes a "medical researcher", their own background, and how they saw themselves in relation to the rest of their specialist community.

Similarly, some legal academics struggled with conventional disciplinary frameworks. P40 explained:

> I don't fit into any obvious box... If there are boxes that you try and put people in, I don't really fit into any boxes because I've done lots of different things. (P40, Oxford private law academic)

P40, who had dipped in and out of legal practice, emphasised that they were unconventional in the way they had landed in academia as well as in the way they conducted their research. Unlike more traditional legal academics, P40 reached for any methods or sources from within or beyond the legal realm that would aid in the analysis of a contemporary legal issue. Although sociolegal research has grown substantially, P40 explained how this was not the case when they started out in academia and that everything they knew in relation to social science methods had been self-taught. For all these reasons, P40 had an image of themselves as unusual.

This sentiment resonated in chemistry, where disciplinary affiliation shifted depending on institutional context. P35, a physical chemist, discussed their movement between chemistry and physics departments:

> I was actually a postdoc at [UK university] in the chemistry department. But then my [name of fellowship] was in a pure physics lab. And then my stay in this research institute at [US university] was pure physics, so I sort of feel comfortable in both environments. I mean... I am definitely neither by training nor by interest a traditional chemist. (P35, Oxford physical chemist)

Despite their official affiliation with chemistry, P35 did not perceive themselves as a "traditional chemist", reinforcing the idea that disciplinary identity is not solely a matter of institutional positioning but also personal experience and training. This ambiguity was also reflected in P10's discussion of the chemistry-physics boundary:

> There's a lot of physicists in chemistry, very few chemists in physics. Because, as I said, I think chemistry is very inclusive. So, so, it's, it's very easy to make an impact with a physics education in chemistry—or, it's possible—whereas with chemistry education to make an impact in physics, [it's] not, because physics asks different questions. (P10, Oxford physical chemist)

P10's reflection highlights how disciplines operate differently in terms of inclusivity and research orientation. Whilst chemistry is perceived as "inclusive" and inclined to unite various approaches, physics maintains stricter boundaries regarding what constitutes legitimate research, so whilst they identified more as a physicist because of their education, they worked as a physical chemist.

These complex self-perceptions and positionalities also became apparent during the drawing task designed to visualise disciplinary knowledge. Some participants struggled to depict their disciplines, questioning the very premise of a singular disciplinary affiliation. Historian P30 (Glasgow global historian) refused to draw, expressing discomfort with representing their discipline in a static way. Meanwhile, P27 (Glasgow global historian) found the task difficult due to their interdisciplinary knowledge base, ultimately producing an image that focused on methods, depicting oral history fieldwork and archival research.

The findings here suggest that academics across disciplines engage in a continual negotiation of their disciplinary identity, shaped by educational background, institutional context, career trajectory, collaboration, and broadening methodologies. Whilst some retain strong disciplinary affiliations, others experience persistent uncertainty about where they belong. As academic disciplines continue to converge and evolve, traditional models of disciplinary identity may no longer suffice, requiring more flexible frameworks that account for the complex, shifting nature of scholarly self-identification. Whilst institutional structures may still impose disciplinary labels, the experiences of these scholars suggest that disciplinary identity remains dynamic and context dependent.

5.7 Ways of thinking that cut across disciplines

What emerges from participants' accounts of their varied disciplinary motives, training, specialisms, and collaborations throughout this chapter is that despite their apparent differences, chemistry, history, law, and medicine share some underlying cognitive structures. Three models emerge as common ways of approaching knowledge: transactional models, "reductionist" thinking, and a bottom-up approach. These shared conceptual frameworks indicate that in some cases scholars across these disciplines employ similar cognitive strategies to structure, interpret, and apply knowledge, albeit within their own disciplinary contexts.

5.7.1 Transactional models: mapping knowledge through economic frameworks

A transactional approach to knowledge appears prevalent among scholars in fields with economic dimensions, such as commercial law, equity law, economic history, and health economics. Scholars described knowledge in their fields as a structured web of agents and interactions, which they mapped through diagrams.

For instance, one Oxford law scholar conceptualised legal cases in terms of transactions:

> If I'd brought a copy of a case, a Supreme Court judgment I was reading, you'd see red and yellow and highlighting and little diagrams. You know, you need to sort of pin down the web of transactions in your mind, and I like to sort of actualise that. (P38, Oxford private law scholar)

A Glasgow law scholar employed a visual representation to conceptualise agents and their relationships in commercial law:

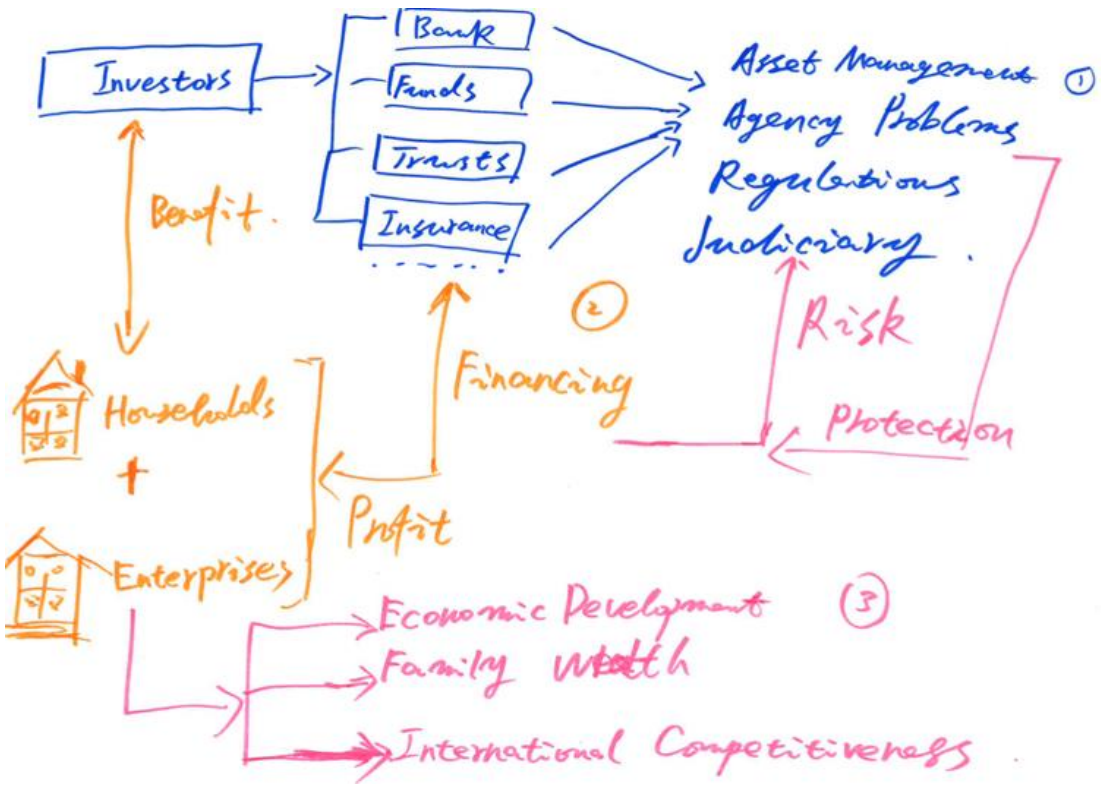


Figure 5-2 Commercial law scholar P16's drawing of their discipline

This way of conceptualising the field resonates with that of P33, an economic historian, who depicted economic transactions in their drawing and P19, a health economist, who similarly mapped hospital funding models.

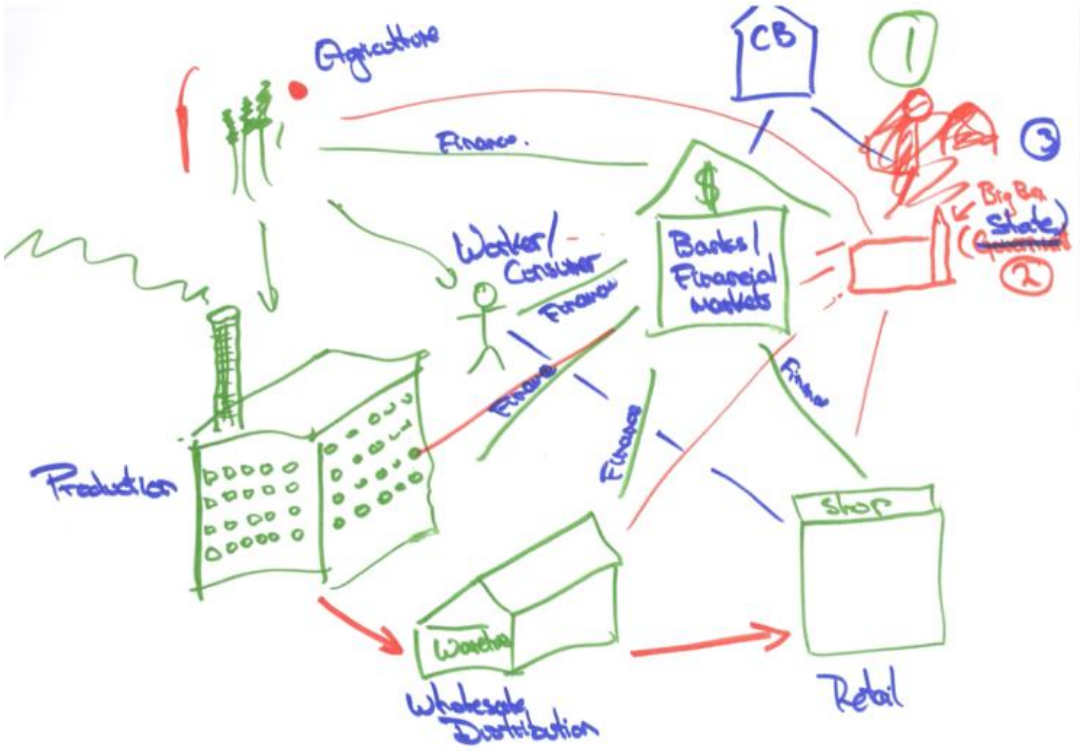


Figure 5-3 Oxford modern historian P33's diagram of transactions between economic agents

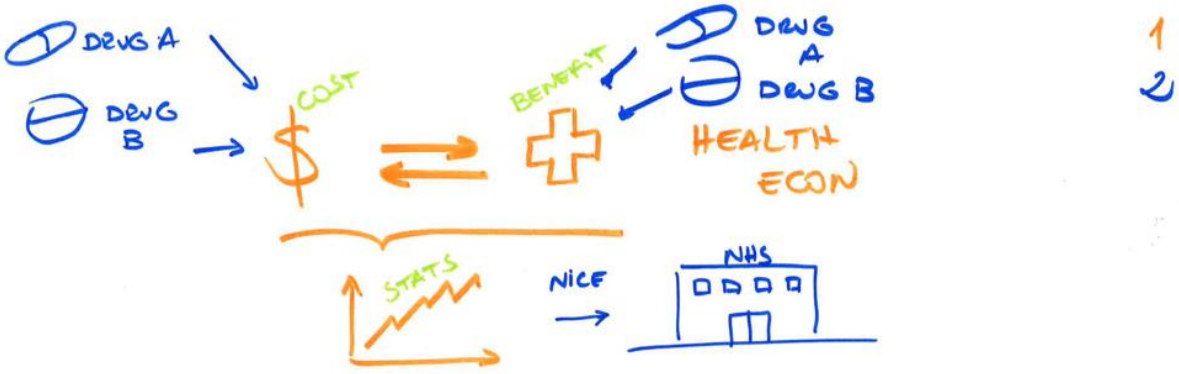


Figure 5-4 Glasgow medical researcher P19's visualisation of health economics

This shared cognitive approach suggests that disciplines engaged with investigating economic and systemic interdependencies rely on mental models that structure knowledge as webs of transactions.

5.7.2 Reductionist thinking and abstraction: unpacking complexity in chemistry, medicine, and law

Some scholars in chemistry, medicine, and law demonstrated a shared inclination toward "reductionist" thinking, wherein complex phenomena are broken down into very basic components or principles for analysis. This approach allows researchers to construct systematic, logical models that progress from fundamental principles to broader applications.

Physical chemist P35 described their approach as a "mathematical reductionist kind of thinking" that enables them to distil scientific principles through step-by-step reasoning. They elaborate:

> I have a reductionist way of thinking…you build your, your perception of what's happening, your model of what's happening on, on a very kind of step by step, you know, A leads to B leads to C. It needs to be kind of in terms of as simple principles and as simple assumptions as possible. (P35, Oxford physical chemist)

Similarly, medical researcher P36 illustrated this mindset in biomedical investigations, stating, "Even though we have big ideas, at the end of the day, we try to answer questions that boil down to yes or no, [and] trying to understand why is it a yes or no" (P36, Oxford biomedical researcher). They expanded on this point by noting,

> Inside the tumour, you have cells. But inside the cells, there's the nucleus, and inside the nucleus, there's DNA. And inside the DNA, there's a sequence and there's a mutation. So, it's very reductionist… (P36, Oxford biomedical researcher).

Private law scholar P39 described a parallel reductionist approach in legal reasoning, where the core challenge is identifying the precise legal question that must be answered. They explained: "I think we're quite good at defining issues, so I, I think we, we often don't know what the answer is, but we're, we're quite good at figuring out what question we should be asking" (P39, Oxford private law scholar). They further illustrated this by comparing legal reasoning to football refereeing:

> So, there's a big debate at the moment as to when you should be penalised for the ball touching your hand in the penalty box. And it, it infuriates me the way this is discussed because people are saying it's unfair…and I think the way I think about that is I just want to know what is the question that the judge, the referee in this case, should be asking themselves. You know, what is, what is the actual test that they should be applying? (P39, Oxford private law scholar)

This approach, much like the reductionism seen in chemistry and medicine, involves distilling complex legal disputes into fundamental principles that come down to a "yes or no" or a logical test.

Chemistry, medicine, and law are goal-oriented disciplines that prioritise definitive answers, applying reductionist thinking for problem-solving. Whether determining the fundamental workings of chemical systems, the root causes or mechanisms of a medical condition, or defining the scope of a legal issue, scholars in these fields seek precise resolutions by breaking down complexity. In contrast, historical thinking builds complexity rather than distilling it. Historians incorporate multiple perspectives and layered connections, aiming for nuanced interpretations rather than definitive answers, making their approach fundamentally distinct from the reductionist methodologies described by some participants in chemistry, medicine, and law.

5.7.3 Addressing lived experience: a bottom-up perspective in law and history

In contrast to the transactional and reductionist approaches, scholars engaged in sociolegal approaches and oral history adopted a bottom-up perspective that prioritises the lived experiences of individuals. This perspective valued qualitative data derived from interviews, fieldwork, and direct engagement with communities.

Glasgow international law scholar P14, who was involved in research on youth and peace processes, described their work as focusing not on the state but on "what individual human beings do and how they interact with political decision-making processes". This emphasis on personal agency was reflected in the work of oral historians, such as Oxford modern historian P9, who employed oral history methods to document the experiences of regional communities:

> Mostly what I do is I'm an oral historian, so...a lot of the time...the bulk of my research takes place out in the field, interviewing people primarily in [country]. (P9, Oxford modern historian)

P27, another historian at Glasgow, highlighted the role of oral and ethnographic methods in integrating marginalised voices into historical narratives:

> …so, oral historians…for us, historical analysis is about looking at that official narrative and then trying to kind of, bring in more diverse voices, bring in a more critical understanding maybe of what's happened (P27, Glasgow modern historian)

Oxford legal scholar P40 further emphasised the value of lived experience in legal research, discussing how they use qualitative methods and digital platforms to build their knowledge about contemporary legal issues:

> In some of my research, I'd be using *this* much more (points to "interviews" and "chats" in drawing), which is the interviews and chats with people. So, the formal interviews that we do…but also sometimes just talking to lawyers to try and understand what some of the issues are. (P40, Oxford private law scholar)

They also highlighted the importance of social media as a research tool by commenting, "The only way of finding out what's happening has been Twitter… it's been absolutely invaluable for me" (P40, Oxford private law scholar). Thus, for some historians and law scholars, knowledge construction is fundamentally shaped by the perspectives of those who experience historical and legal phenomena firsthand.

Despite their disciplinary differences, scholars in chemistry, history, law, and medicine exhibited shared ways of thinking that shaped their methodological approaches. Transactional models structure knowledge as interdependent networks, reductionist thinking breaks down complexity into fundamental components or principles, and bottom-up perspectives prioritise people's lived experiences as essential to advancing disciplinary knowledge. These cross-disciplinary ways of thinking suggest that the cognitive strategies underpinning scholarly inquiry are not solely determined by discipline but rather emerge from broader approaches (sociological, economic, etc.) that transcend individual fields. Recognising these commonalities provides insights into scholarly mental models, suggesting that intellectual disciplinary boundaries are porous.

5.8 Conclusion

This chapter has examined how personal factors—educational background, motivations, specialisation, and collaborations—shape researchers' mental models of knowledge across chemistry, history, law, and medicine. Disciplinary boundaries provide a framework for academic identity and inquiry, yet researchers do not remain confined within them; rather, they negotiate, reinterpret, and sometimes move beyond these structures as their careers and interests evolve.

A central theme is the influence of personal motivations on academic trajectories. Some participants were driven by curiosity and intellectual fascination, whilst others by commitments to social justice or public health. These motivations often aligned with disciplinary orientations: chemists were drawn to problem-solving and the fundamental workings of the natural world; legal scholars toward societal impact; medical researchers navigated clinical and lab-based inquiry, and historians engaged critically with the past to illuminate the present.

Early training further shapes how researchers conceptualise knowledge, whether through the structured, deductive reasoning common in chemistry, law, and medicine, or the interpretative, inductive approaches characteristic of history. Despite these differences, researchers described moments when exposure to new fields or methodologies reshaped their research practices, whether through formal interdisciplinary training or opportunities that emerged organically in the course of their academic careers.

The findings also indicate that interdisciplinary engagement does not necessarily erode disciplinary identity but can reinforce it. Participants described their disciplinary background as an anchor that provided methodological rigour and a stable cognitive framework, even when working across fields. Chemists collaborated with colleagues in physics, biology, and materials science yet generally retained a strong identity in chemistry (with a couple of notable exceptions in physical chemistry). Legal scholars integrated sociolegal or comparative perspectives whilst maintaining a core legal framework. Historians and medical researchers likewise drew on various disciplines to enrich their work. These patterns suggest that interdisciplinary is less about abandoning disciplinary ways of thinking than about extending them.

At the same time, the study identifies common patterns of thinking that cut across disciplinary boundaries. The transactional, reductionist, and bottom-up conceptualisations of knowledge evident in participants' drawings and discussions point to similarities between certain subdisciplines and specialisms, even when they occur in different fields. These shared cognitive approaches highlight how disciplinary thinking can converge in unexpected ways.

Overall, disciplinary identities are dynamic, shaped by institutional expectations, personal experiences, and shifting intellectual commitments. Scholars continually negotiate these identities as their interests, collaborations, and professional contexts evolve. The interaction between disciplinary specialisms and interdisciplinary engagement both reinforces and expands their mental models, allowing scholars to adapt to increasingly interconnected intellectual landscapes.

6 The role of workspaces and social networks

6.1 Introduction

Academic knowledge is not only shaped by formal methods and outputs but also by the everyday practices, environments, and interpersonal exchanges through which scholars engage with their disciplines. This chapter considers how the spatial, material, and social aspects of disciplinary cultures inform and are reflected in scholars' mental models of knowledge.

Findings in this study indicate that these mental models are enacted and embodied in routine practices, often emerging most clearly through informal interactions and the use of space and tools. Whilst formal frameworks such as institutional hierarchies offer structure, it is also in the informal, unstructured settings—over meals and coffee, or at pubs—that mental models are constructed and reshaped.

This chapter draws on qualitative interview and cognitive mapping data to explore how disciplinary mental models are mediated through the spatial and social worlds scholars inhabit. It pays attention to the ways in which access to physical space, networks, and informal exchanges is conditioned by career stage, institutional setting, and disciplinary norms. In doing so, it emphasises that knowledge is not just thought but also lived and spatially embedded.

6.2 The role of physical space in disciplinary thinking

Across interviews and visual data, scholars frequently invoked physical space when describing how they conceive of and conduct their disciplinary work. In cognitive mapping exercises, participants often responded to the prompt "draw your discipline" with depictions of material environments including laboratories, offices, and bookshelves, suggesting that disciplinary thinking is grounded, quite literally, in spatial experience (Figures 6-1 to 6-4).



Figure 6-1 "Working environment in chemistry lab" by Glasgow inorganic chemist P20



Figure 6-2 Depiction of themselves at desk, by Glasgow cancer researcher P24



Figure 6-3 "Scholar" reading at desk by Glasgow medieval historian P26

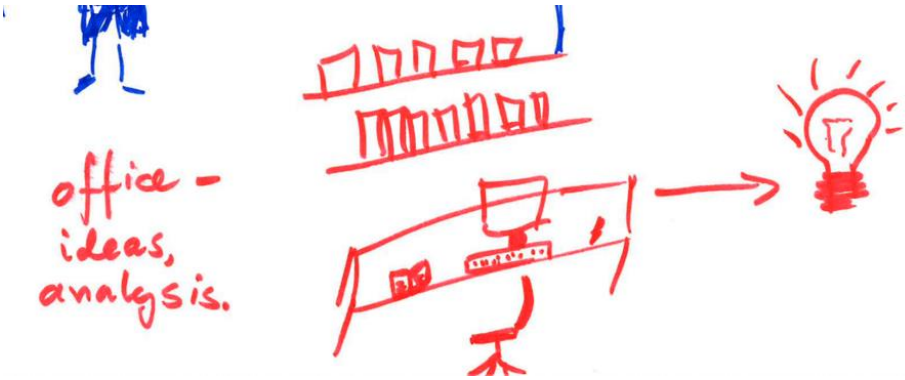


Figure 6-4 "Office – ideas, analysis" by Glasgow biomedical researcher P22

In laboratory-based disciplines, physical layout and proximity emerged as integral to collaborative mental models of knowledge. For instance, inorganic chemist P6 spoke of the benefits of having their office situated close to their lab, allowing for continual informal exchanges with students and postdoctoral researchers:

> I get my coffee several times a day… sharing lunches and coffees and everything, you know? And so, every day you talk several times [about] science… I know what they're doing every day, which is lovely. (P6, Oxford inorganic chemistry professor)

Here, disciplinary thinking unfolds not only during formal meetings or structured supervision but in the rhythm of everyday interactions—coffee breaks, hallway conversations, and shared meals. These habitual exchanges offer a kind of background continuity that shapes and sustains a shared mental model of scientific inquiry as iterative, collective, and responsive. Importantly, P6's seniority and spatial proximity afford them a degree of visibility and influence within their research environment, pointing to the intersection of spatial and social positioning in shaping how knowledge is conceptualised and pursued.

This collective spatiality was echoed by P36, a postdoctoral researcher in biomedicine, who reflected on the open-plan layout of their lab and office:

> …the actual physical lab space is also open plan. So that means we are basically forced to interact with each other… But also, I'm lucky to be in a very friendly space too, so [there's] also like a very heavy social component to it. (P36, Oxford biomedical researcher)

For P36, physical openness did not diminish individual autonomy but rather encouraged a form of intellectual cohesion—where shared tasks, conversations, and visible activity fostered a sense of common purpose. In this context, their mental model of medical knowledge emphasised teamwork and collective practice—values mirrored in the spatial arrangements of their working environment.

In contrast, P19, a forensic toxicologist based at Glasgow, offered a more ambivalent perspective. They described their lab space as both physically cold and socially isolating:

> People in forensic toxicology… are normally working in a lab, trapped in this environment. It's very cold, and sometimes isolated… The deadlines are really strict… there's a judge waiting, there's a family waiting… It's a very stressful environment. (P19, Glasgow medical scholar)

Here, the spatial environment was associated with isolation and pressure—conditions that seemed to shape a conception of forensic science as solitary, rigid, and emotionally taxing. P19's eventual move into health economics was framed as a response to these conditions—a disciplinary shift linked, at least in part, to the embodied experience of space and work culture. This underscores the point that physical space is not neutral; it can actively enable or constrain the kinds of knowledge practices scholars find possible or desirable.

Beyond individual workspaces, the broader geography of institutions also emerged as a factor. At Oxford, for instance, P36 noted difficulties in accessing resources and facilities in different university buildings. Physical distance and bureaucratic compartmentalisation limited the ease of collaboration and contributed to a sense of fragmentation. Conversely, another participant, P1, a physical chemist at Oxford, credited the collegiate system with fostering unplanned interdisciplinary interactions:

> Well, when I started this collaboration, I thought, I couldn't think how that collaboration would have happened when I was at [previous institution]. And I liked being at [previous institution] then… But how would I have ended up talking to someone in a totally different discipline and, therefore, forming a collaboration? It would be hard to imagine how that would be facilitated. And yet here, I was just sat next someone at lunch, we were just chatting. And we, you know, we realised we were doing similar things. (P1, Oxford physical chemist)

Such reflections suggest that institutional spatial structures—how buildings are located, how departments are configured, and how formal and informal spaces are used—play a role in how disciplinary boundaries are perceived and navigated. At Glasgow, by contrast, historians described their faculty as spread across different buildings along a single street. Whilst this supported some internal organisation by time period and geographic area, it could also limit chance encounters beyond one's immediate disciplinary enclave, or require scholars to move around, as noted by P15:

> …we spent quite a lot of time walking up and down University Gardens because, uh, medieval is in, uh, 10 university gardens, Scottish history in nine, and modernism one and two University Gardens. (P15, Glasgow early modern historian)

Taken together, these accounts suggest that physical space is implicated in shaping locally grounded disciplinary mental models. Layouts, proximities, and institutional geographies mediate who scholars see, speak to, and work alongside—and thus influence how knowledge is imagined, structured, and shared. These spatial experiences are in turn shaped by academic position: senior scholars often enjoy greater access and control over space, whilst early-career researchers may work in shared or transitional environments, which condition both their work routines, the colleagues they see, and the kinds of mental models they are able to construct and inhabit.

If spatial design and institutional geography shape broad patterns of access, interaction, and intellectual proximity, the office offers a more intimate scale at which mental models are lived and materialised. Offices are not merely functional spaces but active settings where scholars negotiate the boundaries between professional and personal life, and teaching and research. The material and symbolic configuration of these spaces often reflects scholars' conceptions of what counts as knowledge in their discipline and what it means to produce, possess, and pass on that knowledge. The following section considers the office as a microcosm: a condensed, curated world in which disciplinary mental models are rendered visible and, at times, embodied.

6.3 Everyday life and the office as a microcosm

Personal workspaces—particularly academic offices—emerge in this study as meaningful environments where disciplinary identity, intellectual labour, and daily life intersect. These spaces are both shaped by and generative of scholars' mental models of knowledge. Their arrangement, material contents, and use patterns reflect assumptions about how scholarly work should be done, and what kinds of practices, resources, and tools are seen as central to one's discipline.

For some, the office becomes a highly integrated, multifunctional domain—a site where personal and professional routines converge. P18, a senior academic in bacteriology at Glasgow, offered a striking account of their office space:

> This is the full living experience. So yeah, we have the fridge freezer down here. I have the microwave. In my drawers there, I keep like a full change of clothes... You know, you can go from

> being in shorts and t-shirt to being reasonably smart and being able to handle it, and…if I have to work late, I can, you know, have some food and stay… (P18, Glasgow biomedical researcher)

The office here functions as more than a workplace—it is a kind of "base camp" for all the demands of academic life: internal meetings, research, teaching, late-night work, and professional interactions. The multifunctionality of the space reflects the multifaceted nature of P18's role, as well as a mental model of academic labour as continuous, immersive, and adaptive. Objects such as a mini fridge, microwave, suit, and change of clothes offer a form of self-sufficiency, enabling a fluid transition between different modes of work. The presence of a table for team meetings, a big monitor, and a display of current grant projects further indicate that this office is also a collective and administrative space, underscoring the convergence of the personal, the intellectual, and the managerial.

Apart from P18, most other medical researchers' interviews took place in meeting rooms in their departments or in the hospital so insights into their workspaces are limited, but for many chemists in the study, whiteboards featured prominently as material artefacts that facilitated visual, collaborative work. Chemists in Glasgow and Oxford (e.g., P20, P21, P35) described using whiteboards to work through problems with colleagues or clarify conceptual ideas—an embodied practice of thinking which reinforced a shared mental model of scientific knowledge as iterative, visual, and co-produced.

By contrast, offices in law and history tended to be configured around books and textual resources, with less emphasis on visualisation tools. P39, an Oxford law scholar, explained their discomfort with diagrammatic explanations, noting that the ability to communicate legal complexity in words was central to being a "good tutor". Their office, lined with texts and legal commentaries, echoed this orientation—suggesting a mental model in which verbal clarity and textual authority take precedence over visual reasoning.

Such textual preferences were mirrored among some historians, with participants from both Glasgow and Oxford approaching the drawing activity textually. P5, P9, and P15 completed their cognitive maps primarily in written form, as shown in Figures 6-5, 6-6, and 6-7.

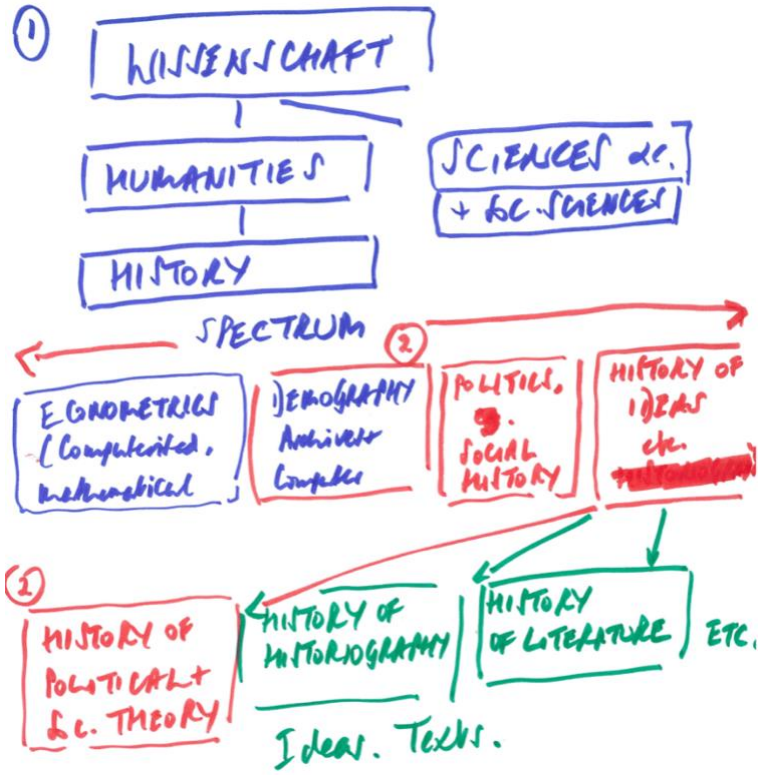


Figure 6-5 Drawing of history by Oxford modern historian P5

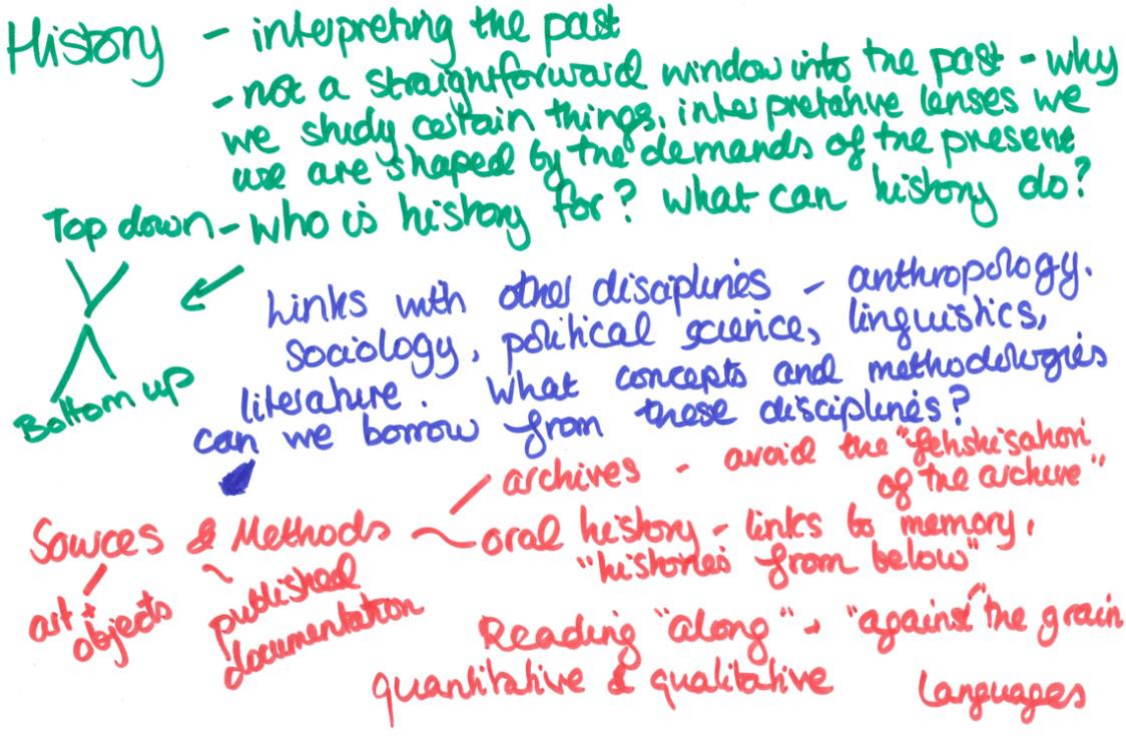


Figure 6-6 Drawing of history by Oxford modern historian P9

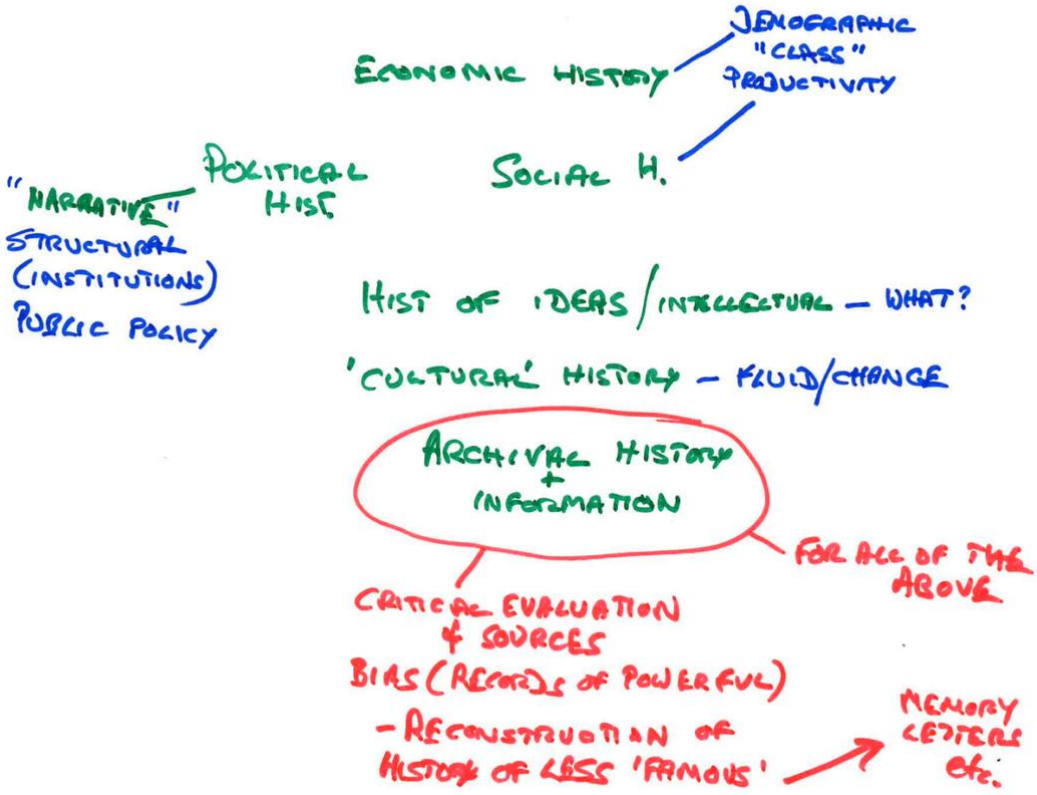


Figure 6-7 Drawing of history by Glasgow early modern historian P15

One Glasgow historian (P30) declined the drawing task altogether, suggesting a discomfort with abstract visualisation as a form of disciplinary expression. These responses suggest that, for some historians, knowledge is conceived as fundamentally textual, and not easily or commonly expressed in visual ways. This orientation was reflected in their office environments, which often featured densely packed bookshelves and documents organised by period, theme, or course.

In Oxford, the college system further reinforced the multifunctional nature of offices, with many doubling as teaching spaces, with ample space and comfortable seating for tutoring sessions. Books were not only research materials but also pedagogical tools, arranged to reflect the structure of courses or "papers". Historians of Britain (e.g., P4, P29) pointed out the importance of handbooks, reference works, and biographical directories in their collections. These resources—organised alphabetically or by institution—shaped and reinforced a mental model of historical knowledge as archival and ordered.

Legal academics similarly used their offices to house subject-specific resources: practitioner texts, casebooks, and law reports, each playing a role in shaping how legal knowledge is accessed, classified, and taught. In both history and law, the office functions as a repository of textual authority and disciplinary tradition, a space where knowledge is stored, retrieved, and transmitted.

Nonetheless, scholars within these disciplines engaged not only with textual modes of thought; several historians (P4, P7, P30) and legal researchers (P12, P16, P40) working in sociolegal or commercial contexts engaged with visual, numerical, and multimedia sources. Their workspaces included photographs, archival facsimiles, or art books, suggesting more pluralistic mental models of knowledge that extended beyond text.

Career stage also played a significant role in shaping how offices were used and experienced. Senior scholars typically had personalised, private spaces tailored to their research and teaching needs. These offices often served as hubs for mentoring, administrative work, and intellectual exchange. Early-career academics, by contrast, were more likely to occupy shared spaces or hot-desking environments, with limited control over layout or resources. This disparity influenced not just workflow but also one's sense of disciplinary belonging and agency.

What surfaces from these observations is a picture of the academic office as more than a neutral backdrop to scholarly activity. Offices are inhabited, curated, and symbolically loaded spaces that participate in the ongoing formation and transmission of disciplinary mental models. Through the arrangement of furniture, the presence (or absence) of particular tools, and the interplay between personal comfort and professional functionality, these microcosms reflect and reinforce broader patterns of academic life—revealing what it means, materially and socially, to be a chemist, a historian, a legal scholar, or a medical researcher.

Whilst the office may serve as a microcosm of scholarly life, it is not always the primary or exclusive site of academic work. For many scholars, particularly those working in historically, socially, or geographically situated disciplines, knowledge is also generated, and mental models shaped, through spaces beyond the office or laboratory. Fieldwork, community engagement, and site-based inquiry emerge as significant settings where disciplinary thinking is extended. These external spaces often involve direct encounters with lived experience, legal ambiguity, material conditions, or oral histories—contexts which demand interpretive flexibility and methodological hybridity. The following section explores how such field-based work informs the evolving mental models of chemists, historians, medical researchers, and legal scholars across a range of contexts.

6.4 Spaces beyond the office or laboratory

For some participants in this study, especially those whose work engages with lived realities or contemporary issues which have not yet been studied, fieldwork offered an essential means by which disciplinary knowledge could be cultivated. The field, in these accounts, is not simply a backdrop for data collection but a generative environment for intellectual reflection, often requiring scholars to navigate ambiguity and cross-disciplinary collaboration.

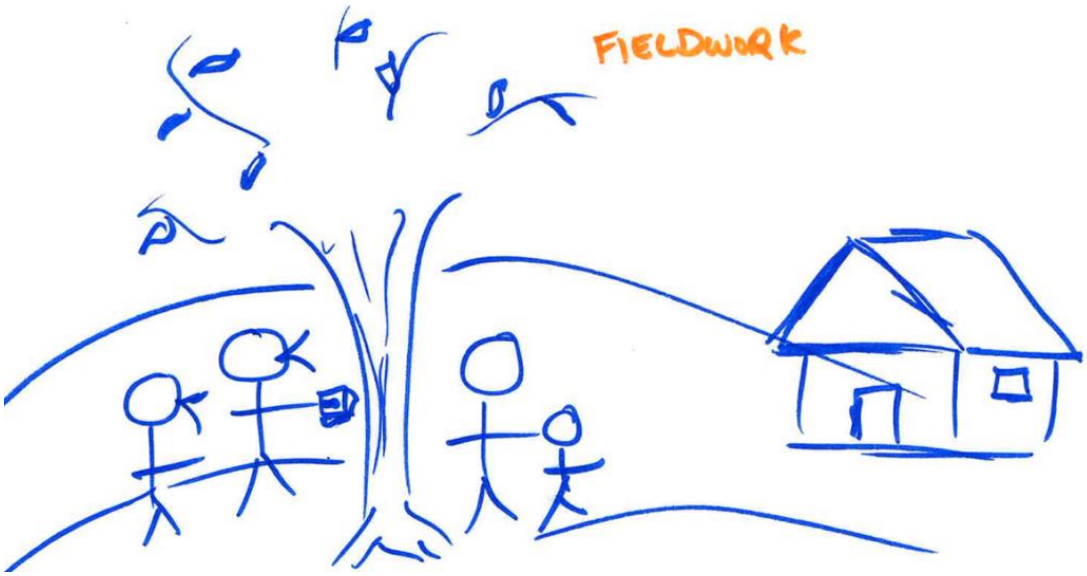


Figure 6-8 Drawing of "fieldwork" by Glasgow modern historian P27

A salient example of this comes from P27, an oral historian at Glasgow. In both their interview and cognitive map (Figure 6-8), P27 emphasised the centrality of fieldwork, drawing "fieldwork" first. Working with survivors, perpetrators, and communities affected by mass atrocities was foundational to their historical practice:

> I've spent a lot of time working with survivors of these atrocities. But also… I've really tried to focus on perpetrators and why they've agreed to participate in them, as well as bystanders… just to get a more nuanced understanding of these conflicts." (P27, Glasgow modern historian)

P27's field encounters not only informed their sources but shaped how they understood the historical process itself. The accounts of those they interviewed often wove together the present with memories of violence reaching back decades or even centuries:

> What would often come out is the links they would draw with earlier periods of atrocities… they didn't often just see these genocides as kind of like a one-off thing… Sometimes… there's stuff going back to 1389 that people tie into what happened to them in 1995. (P27, Glasgow modern historian)

This comment on deep temporal links—how individuals draw connections across centuries—reinforced a mental model of historical knowledge as non-linear, immersive, and often transmitted through memory and narrative rather than documents alone. In many ways, P27's work exemplifies the metaphor of historical scholarship as "shining a torch in a dark room" discussed in Chapter Four: a bottom-up, inductive search for meaning in hidden or undocumented spaces. Fieldwork, in this sense, became both an intellectual and ethical method, filling critical gaps left by other disciplines and surfacing perspectives otherwise marginalised or inaccessible.

Field-based research also featured in global health. P37, a postdoctoral researcher at Oxford, described their work in Africa, where they used a combination of interviews, surveys, and observational methods to understand how health systems function under strain:

> My role…is hopefully just [to] observe and interview people… and hopefully come up with some more practical recommendations on how things could be improved together with them. (P37, Oxford global health researcher)

Their description of research as co-productive and iterative—"together with them"—resonates with an applied, patient-centred model of knowledge previously described in Chapter Four. Moreover, P37's emphasis on methodological pluralism, including distinctions between mixed and multiple methods, suggests a mental model of knowledge that is layered, problem-oriented, and context-responsive:

> There are mixed methods, and there are multiple methods… sometimes… two different colleagues [are] working on one question using different methods. (P37, Oxford global health researcher)

For P37, fieldwork was not a departure from disciplinary norms but a necessary complement to them—helping ground abstract problems like healthcare access or training systems in the practical realities faced by patients and providers alike.

Legal scholars, too, described field-based research practices that extended beyond traditional doctrinal approaches. P12, a French property law scholar at Glasgow, undertook collaborative fieldwork in rural areas to study undocumented systems of collective land ownership:

> When we do fieldwork, we try to adopt sociological methods… we go to the place where the collective property system exists. We interview people… and we try to figure out—to map things and to figure out how it works. (P12, Glasgow private law scholar)

Here, legal reasoning is grounded not in statutes or precedent, but in oral accounts and community practices. P12's team included sociologists, anthropologists, and public lawyers, reflecting a shared recognition that no single legal framework could fully capture the nuances of communal land use. The kinds of questions they ask suggest a hybrid mental model, combining legal reasoning with ethnographic and sociological approaches and collaborative interpretation—a form of thinking that is bottom-up, open-ended, and necessarily interdisciplinary.

A related orientation was evident in Oxford private law specialist P40's approach to sociolegal research at Oxford, which blended case analysis with field observation:

> I've sat in on tribunal hearings… and did some observations… we just sat in and did some observations there. And then obviously the interviews as well. (P40, Oxford private law scholar)

P40 acknowledged how some of these interactions—"chats with lawyers" or informal conversations—did not constitute formal data but nonetheless provided important, novel insights:

> Sometimes just talking to lawyers to try and understand… not in a formal way that I could use… but [it] provides more insights. (P40, Oxford private law scholar)

Like P12, P40's methods suggest a disciplinary mental model that draws on core legal tools—statutes, law reports—but also looks beyond them to surface knowledge that is situated and emergent. In both cases, legal scholarship is not confined to the library or courtroom, but extends into lived space, where the law is experienced, interpreted, and negotiated.

Chemical knowledge is also experienced beyond the local laboratory or office for physical chemist P35, who discussed taking their research group to research facilities in the United States and Japan:

> …we're actually going to Japan in December, so that's our...our kind of next big experiment and, and then…you sort of get seven days or six days of 12-hour shifts or sometimes four days of 24-hour shifts and, and sort of work around the clock to, to get things to work and carry out the measurements. So it's kind of very intense… It's a linear accelerator… It's an enormous

> facility…we rely on, on a huge number of staff that run the facility, so, you know, there's, there's a lot of people who enable us to, to be done [with the experiment]. (P35, Oxford physical chemist)

P35's research relied on access to linear accelerators—facilities available at only a few sites worldwide—requiring short, intense periods of work that brought together not only their own research team but also technicians and other specialist staff. As a result, P35's mental model of physical chemistry was not confined to abstract mathematical equations; it was also deeply situated and based on tangible, collective work.

Together, these accounts show how spaces beyond the office, be they conflict zones, hospitals, tribunals, large experimental facilities, or rural communities—offer scholars a vantage point from which to question and expand their disciplinary assumptions. Fieldwork, in its many forms, appears to encourage mental models that are iterative, socially attuned, and methodologically varied. These models contrast with more deductive, document-centred approaches, yet remain grounded in disciplinary expertise—reconfigured rather than abandoned. In this sense, fieldwork not only brings scholars into contact with new data but often prompts them to rethink what knowledge is, and how it should be gathered.

If fieldwork offers a way of extending disciplinary knowledge into real-world contexts, material objects anchor it in the everyday routines of academic work. They make abstract ideas visible and provide tangible ways to externalise thought. In many cases, these tools do more than assist scholars in their work; they both reflect and shape how they imagine knowledge in their fields. The next section explores how the use, organisation, and meaning of material tools reflect and reinforce disciplinary mental models.

6.5 Material objects and everyday tools

Across the four cases, the material artefacts scholars surrounded themselves with and the ways in which they engaged with them provided insights into how scholars conceptualise and enact their disciplines. Objects were not neutral props but conduits and mediators of knowledge that could help scholars make sense of problems, communicate ideas, and structure intellectual activity. Their use was shaped by disciplinary values, practical needs, and scholars' roles within their institutions.

In chemistry, whiteboards featured prominently. They were present in many of the offices visited, often covered with chemical diagrams or formulae. For P20, a senior inorganic chemist at Glasgow, the whiteboard was integral to both solo and collaborative thinking:

> If you have written [it] down on a piece of paper or on a whiteboard, it's easier to see something that you haven't thought [of] before. (P20, Glasgow inorganic chemist)

This comment reflects a visual and iterative model of knowledge production. Drawing enabled new insights to emerge, connections that might remain hidden in verbal form alone. In another conversation, P20 recounted a moment of collective problem-solving:

> I was having a discussion with someone the other day and we were trying to find other ways how to change a specific molecule, for example. Just writing ideas on the whiteboard and [seeing] what makes sense and what not. (P20, Glasgow inorganic chemist)

The whiteboard became a shared surface for not only visualising but testing ideas in real time. P21, an organic chemist at Glasgow, echoed this sentiment: "We always would need a whiteboard to deliver a tutorial because we would be drawing." Given this familiarity with visual communication, P21 had also formed a fully structured, processual image in their mind of what they wanted to convey before starting their drawing (Figure 6-9). This emphasis on sketching and spatial reasoning, which is built into the curriculum and the teaching method, aligns with a mental model in chemistry that values structural thinking and collaborative problem solving.

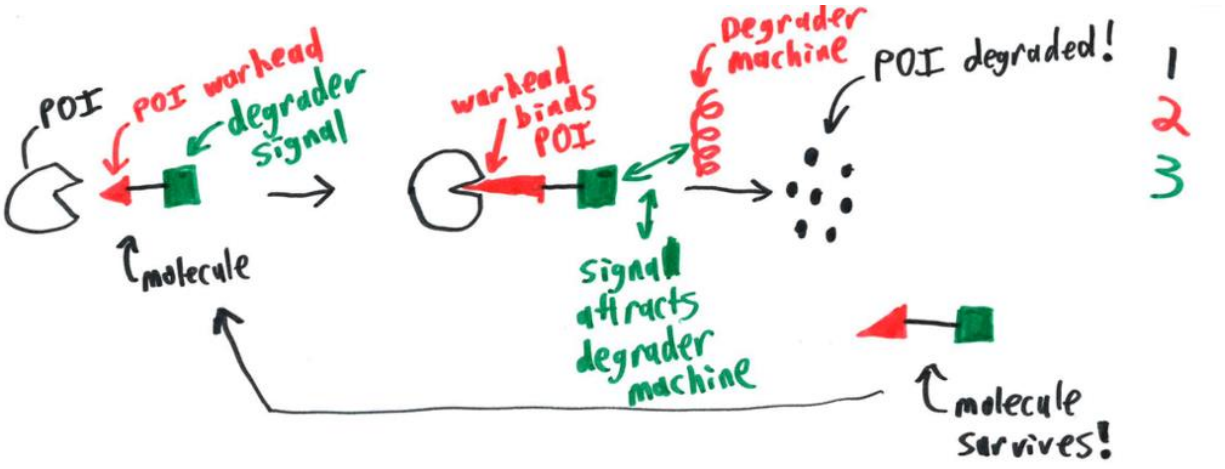


Figure 6-9 Drawing of discipline by Glasgow organic chemist P21

Career stage also shaped access to and use of such tools. Physical chemist P35, a mid-career academic, used their whiteboard to facilitate group discussions, whilst P1, a senior academic, had one covered in mathematical equations. Senior scholars typically had more autonomy to configure their offices around preferred tools and workflows. P18's workspace, complete with domestic conveniences and visual research aids, exemplified this kind of scholarly autonomy. By contrast, early-career academics often

worked in shared offices or labs, where limited space restricted opportunities to personalise their environment or accumulate tools. Meetings with chemistry (P13), history (P33), law (P31) and medical (P24, P34, P36, P37) postdocs were held in local meeting rooms as these researchers did not have their own private spaces. Disciplinary cultures differed also in this regard: medical researchers and chemists commonly worked together in groups, in shared spaces, for years (clinics, laboratories, open plan offices) whilst they carved out their specialisms and formed mental models in collective settings whilst early- to mid-career legal academics and historians were more likely to have private workspaces.

Beyond whiteboards, other tools also revealed disciplinary orientations. P23, an organic chemist, kept molecular model kits on their shelf—not primarily for themselves but for students. During the interview, they retrieved one from a box to demonstrate how carbon atoms are visualised. The tactile handling of model components reflected a pedagogical culture: knowledge, here, is constructed not only visually but materially and spatially, through the manipulation of physical analogues.

In medical contexts, insights were limited, particularly as many of the medical interviewees were postdocs who lacked their own private offices. One senior biomedical participant (P18), however, had a whiteboard listing their active research grants and collaborations. The whiteboard served as a communication device, an efficient way to orient visitors, potential students, and external collaborators to the nature and scope of ongoing work. This use illustrates how material tools can also signal professional identity and institutional productivity, particularly for those at advanced career stages. Their office space, which was deeply personal (equipped with a fridge and change of clothes) was also very public.

Whilst whiteboards were present in some legal offices, their use and meaning varied considerably. P38, a law scholar at Oxford, described using the whiteboard in tutorials:

> Even if it's as simple as just drawing an X and a Y and an arrow between them, [it helps] get something they can hold onto… (P38, Oxford private law associate professor)

Here, the visual sketch helps anchor legal concepts in something graspable, especially for students navigating abstract rules or transactional relationships. However, even this functional use remained relatively confined, often supplementing rather than taking precedent over verbal reasoning.

Others were more ambivalent. P40, an Oxford professor of law, used the whiteboard for textual planning:

> I do love whiteboards… if I've got an article I want to write… I may just stand there and scribble stuff… and then when I feel I've got a breakthrough, go away from the whiteboard and write something down. (P40, Oxford private law professor)

Here, the whiteboard functions less as a visual aid and more as a temporary space for organising and clarifying arguments before formalising them in text. By contrast, P39, another private law associate professor at Oxford, saw diagrams as a sign of failure:

> If I get to a point where I've got to start drawing diagrams, I just really haven't found the words to explain something. (P39, Oxford private law associate professor)

Such reflections suggest that, in legal contexts—particularly within more traditional or doctrinal strands—verbal articulation remains the dominant mode of reasoning. Diagrams or visual representations are viewed as supplementary at best, or even as pedagogical aids, revealing a mental model grounded in language, logic, and precedent rather than spatial reasoning or visual synthesis.

Material tools were equally prominent in historians' offices, but their form and function were distinct. Glasgow-based modern historian P30, for instance, worked in a space lined with books, reprinted archival photographs, annotated documents, and handwritten notes. These tactile materials were central to how they analysed, constructed, and taught history. Rather than serving to model abstract systems (as in chemistry) or outline arguments (as in law), these objects were treated as fragments of the past, sources to be interpreted, situated, and woven into narrative. P4, working with visual culture, described laying out art books side by side to analyse them comparatively. P5, P7, and P9 all organised their book collections partly according to "papers" (Oxford's term for undergraduate courses), suggesting a pedagogical mental model that intertwined historical content with teaching structure. P4 also had a separate area in their office where they kept bibliographies and handbooks published by the Royal Historical Society, which was hidden from immediate view, but was pointed out by the participant. To the Researcher, this seemed like a physical manifestation of the invisible, foundational stock of knowledge that underlies P4's work—the architecture of references that underlies their mental model of history.

The historian's use of space was closely entwined and shared with information sources and often resembled an archive—dense, materially rich, and with an internal logical order. Marking up texts, cross-referencing documents, and physically juxtaposing sources were key techniques, not just for analysing evidence, but for generating insight. Here, knowledge emerges through slow, embodied engagement with sources.

Across all these accounts, material tools not only enabled disciplinary thinking but also made it visible. They shaped the kinds of questions scholars asked, the forms of reasoning they considered legitimate, and the types of knowledge each field could produce. Whether a molecular model, a whiteboard covered in equations, or a box of photographs, these objects reflected and reinforced distinct mental models: in

chemistry, knowledge as spatial, visual, and collaborative; in law, knowledge as linguistic, deductive, and structured; in history, knowledge as contextual, narrative, and evidential. These patterns support the shapes of mental models previously outlined in Chapter Four. Fewer insights emerged for medicine, as most interviews were held in meeting rooms.

In this sense, material objects and everyday tools are more than inert supports for research. They are agents in the construction of disciplinary knowledge, both reflecting and shaping scholars' evolving mental models. Attending to how they are used, displayed, and valued across contexts reveals the deeply embodied, culturally mediated nature of academic thought.

Whilst much of scholarly practice is shaped by structured environments and tangible tools, it is in moments of informal interaction mediated through them that academic life often comes most fully into focus. These seemingly peripheral conversations—over coffee, at pubs, at lunch, in shared offices—are where scholars test new ideas, share doubts, and encounter different perspectives. They are subtle yet generative sites in which disciplinary mental models are iteratively shaped. These interactions are rarely planned, yet they constitute significantly to forms of intellectual reflection and development. In what follows, informal exchanges—conditioned by spatial layout, institutional culture, and career stage—and how they contribute to the everyday negotiation of disciplinary identity and understanding are examined.

6.6 Informal social interaction and disciplinary culture

Across disciplines and institutions, participants described informal interaction as essential to the work of thinking and processing. These social exchanges—over coffee, lunch, in the pub, or during passing conversations—served as spaces for reflection, critique, collaboration, and mutual reassurance. Although often ephemeral, such interactions played a sustained role in shaping disciplinary knowledge and were cited as moments of intellectual clarity or turning points in ongoing projects.

For P38, a private law scholar at Oxford, much of their intellectual life unfolded socially:

> Pub and dinner. That's because you go out and talk law with your friends all the time… You transmit knowledge and you gather knowledge in a very social context by probing each other in a very social way. (P38, Oxford private law scholar)

In their cognitive map (Figure 6-10), these conversations were pictured as part of their disciplinary landscape. Here, legal knowledge is not only formal or textual but social, formed through dialogue, refined through exchange, and evaluated through critical feedback from peers. This dialogic model reflects a broader disciplinary orientation in law, where clarity, argumentation, and rhetorical precision are highly valued. The refinement of legal reasoning, then, does not occur solely in solitude but is forged in conversation, especially for scholars with established networks.



Figure 6-10 Excerpt from Oxford legal scholar P38's drawing of their discipline

Other legal academics highlighted how both formal and informal channels support this social form of disciplinary engagement. P14, a scholar in international law at Glasgow, described how seminars, working groups, and casual conversations all form part of the landscape of scholarly exchange:

> We have a Work in Progress seminar… an international law working group… an internal peer review system… And then, yeah, informal chats, like, over coffee. (P14, Glasgow international law scholar)

These structures suggest that even in law—often portrayed as a solitary discipline—there are lively, collaborative subcultures where ideas are workshopped and shaped collectively.

P11, also in private law, offered a more everyday glimpse of this dynamic:

> I would say that more than ever now, the law school is good and…we read each other's own work… That started to emerge here, which has been really beneficial and in terms of having a critical friend alongside you to ask you some questions… [Recently] one of my colleagues popped into the office, was like, what're you working on today? Talked to him for 20 minutes and then,

> like, what are you doing? They talk for 20 minutes. Cool. And then we ask questions and then he goes, and I go. There's no record of that. (P11, Glasgow private law scholar)

Even unplanned drop-ins served a meaningful purpose, a reminder that scholarly thinking is rarely entirely private, even in fields stereotyped as independent or where work is undertaken as "lone scholars" (P8, Oxford public law scholar).

In the sciences, informal interaction was often described as deeply embedded within collaborative laboratory cultures. P36 mapped their disciplinary world as a branching structure of relationships and ideas—visually captured in their cognitive drawing (Figure 6-11). They explained that "People start converging on certain ideas… not just the ideas, but also the relationships actually shape what we do."

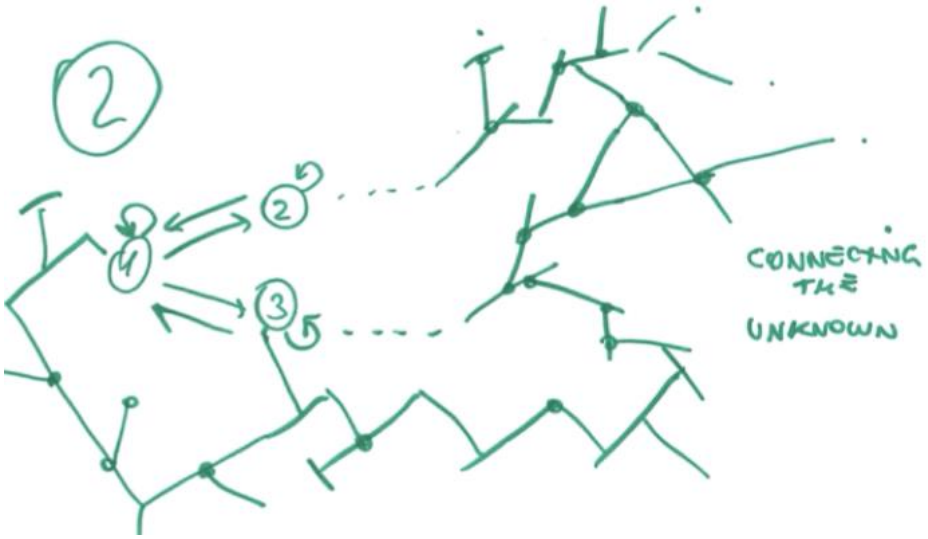


Figure 6-11 P36's drawing of interconnected people and ideas in medicine

This networked model of knowledge development reflects a collective epistemology: ideas evolve not in isolation, but through repeated exchanges within a community of peers.

Senior researchers, such as P6, an inorganic chemistry professor at Oxford, emphasised the value of spatial proximity in facilitating these exchanges, over coffee, lunch, and in passing. For P6, informal conversation—made possible by the closeness of their office and lab—was not incidental but central to their role as a principal investigator (PI). The ease of such encounters, made possible by design and proximity, supported a mental model of science as processual, continuous, and socially distributed, reinforcing their networked mental model.

Similar themes emerged in physical chemist P1's reflections on interdisciplinary collaboration, where P1 credited Oxford's college system for enabling unexpected connections over lunch. The informal spatial ecology of Oxford's college system—dining halls, common rooms, college events—was seen as a crucial enabler of intellectual exchange. In contrast to more compartmentalised institutions, the colleges blurred disciplinary lines and career stages, allowing ideas to circulate between them. The setting, not just the subject, shaped the possibility for dialogue.

P20 and P21, senior chemists at Glasgow, also highlighted how having the lab practically "next door" enabled quick communication and facilitated oversight, even as their roles demanded longer periods of time in the office managing the financial and administrative aspects of their projects: "The vast majority of my time is in the office. I do try to make it a point to go down to the lab, let's say, several times a week" (P21, Glasgow organic chemist).

Furthermore, the fact that chemistry was contained in a single building at Glasgow facilitated informal exchanges, as noted by P25, a physical chemist, who would move around the building quite frequently, between their office, to lecture theatres and labs, or "visiting my various friends and colleagues around the building".

These reflections illustrate how informal interaction is often scaffolded by spatial arrangements such as office and lab location and building layout, which structure who meets whom and how often.

Whilst historians are often associated with solitary work, they too described relying on informal exchanges to take their research into new directions. P4, a professor in modern history at Oxford, described starting a research collaboration "almost by accident":

> …we had a really interesting thing here, which illustrates that to a certain extent, almost by accident, I became involved in, in writing a history of dyslexia…and it happened because…two of my books are about education… [The] then head of college…was rung up one day by colleagues at the University of Bangor who said that these archives were about to be shredded because of GDPR. And she came to me, and I said, they don't need to be destroyed… So, we brought them to college and then got some money from the Wellcome Trust to try and, um, to try and write the history of it. (P4, Oxford modern historian)

Familiar networks within Oxford's colleges enabled informal connections that could evolve into formal research projects, as in P4's example. Being embedded in the local community could thus foster unexpected collaborations, illustrating how research can be shaped by local, informal ties.

P15, a Glasgow-based early modern historian also noted how they refined their ideas in discussion with other colleagues by going to specific settings:

> I'm actually, as it happens, going next week to a conference... I want to go there in person because part of the point is that you have a, a kind of, detailed conversation, often over coffee or whatever, with particular colleagues. So, you try to clarify [concepts] in your own mind. (P15, Glasgow early modern historian)

In seeking out environments that attract specialists, P15 engaged in spontaneous conversations that linked people and research interests, expanding their network and turning informal exchanges into formal research groups:

> …the [research] group that I'm now part of is essentially centred on people that I met at the library…It started over a conversation and coffee in the gardens of Herzog August library, literally because I, you know, somebody would say, are you so-and-so? This is a person who's also interested in the same sort of field. So eventually we ended up setting up a, a research group… (P15, Glasgow early modern historian)

These informal encounters form one part of the wider landscape of informal scholarly communication. Another key site where ideas circulate is the academic conference, discussed in the following section.

6.6.1 Conferences

One setting where communities gather is conferences. Attending conferences was a common way for many of the participants to gather current information, via both formal and informal means. For medieval historian P29, engaging with peers at conferences was an important way of tracking the latest developments in their field:

> I suppose I'm quite reliant on just hearing about things from people at conferences, and maybe I go—maybe I feel that—and this may not be true, but maybe I feel I go to enough conferences and speak to enough people to keep on top of what is new and exciting. (P29, Glasgow medieval historian)

Taking part in conversations at conferences helped P29 stay on top of "new and exciting" ideas and resources they may have missed. There is a sense of pressure to "go to enough conferences" and "speak to enough people" to *feel* relatively up to date, even though there may be a lingering sense that this is not

enough (“this may not be true”). P33 also noted how ideas and publications are exchanged socially at conferences:

> …conferences is always a way, you know, you meet people and hear about things and exchange ideas and people go, do you know this paper, that kind of thing. (P33, Oxford modern historian)

Likewise, P40, a professor in law, discussed conferences as one of the main ways of gathering relevant information in the field and new ideas:

> So you go to conferences and you chat to people […] even if you're not particularly interested in their research, you'll be picking up some ideas about what's kind of going on in the area and you'll pick up...yeah, pick up when there are potentially new books or things that people are talking about. (P40, Oxford private law scholar)

Like an osmotic process in plants, P40 describes how simply being surrounded by other peers at conferences can be conducive to “picking up” useful information. Because of this, it is important to be present at these events, because they could lead to unexpected discoveries, be it ideas or resources.

To chemists P10 and P6, conferences were strategically important. P10, a physical chemist, described conferences as windows into a community’s latest interests:

> And then one very big source of keeping up to date is conferences. So even if I don't go I, I read just the programmes to see who did what because it's...for instance, for, for Gordon Conferences. If you look through the programme, you have a whole community reflecting just who they invite to speak. You see who did something… (P10, Oxford physical chemist)

The Gordon Research Conferences (GRC) (Gordon Research Conferences, no date) constitute a major international network running nearly 400 meetings each year dedicated to cutting-edge, pre-published scientific research. Their non-publication policy is designed to foster candid discussion, and P10’s reference to the GRC underscores how central such specialist gatherings are to scientific life. These meetings operate as trusted sites of exchange where knowledge circulates informally and off the record. By noting that a conference programme’s topics reveal who and what matters at a given moment, P10 highlights how research communities collectively determine relevance and thus how scientific ideas form within a shared social and epistemic environment rather than in isolation.

Oxford physical chemist P35 similarly describes relying on conferences and ongoing conversations to stay current:

> I would say that over, over the last few years, I haven't been reading enough actually. And, and fortunately, I sort of do enough of conferences and discussions to sort of keep abreast of what people are doing. But, you know, you end up reading things because you review papers and so forth, so, you know, there's, there's like a minimum baseline reading and, and via your students. (P35, Oxford physical chemist)

For P35, time pressure is a major factor shaping these practices. Teaching, administration, and supervision limit the capacity of senior scholars to seek out the latest information in their fields. Instead, their position within extensive trusted communities allows them to depend on informal channels to filter and deliver what is most relevant. Such practices show how the social organisation of scientific communities and the everyday movement of information through them actively shapes scientists' sense of what knowledge matters currently, shaping their mental models and the direction of research.

Not all chemists spoke favourably of conferences, however. P2, an early-career organic chemist, avoided specialist conferences and focused on those with broader topics:

> I usually go to, you know, a broader field where I can actually learn about what's going on outside my niche area. Because that will dictate what I do next… There are specialised conferences. It's just, I try to avoid them and yeah, I just don't find it exciting going there at all. (P2, Oxford organic chemist)

P2, a highly motivated new PI, was eager to expand their research beyond their own "niche area" into new directions. They described their research area as "relatively small", with only a handful of groups in the world working on similar topics. Given the size of this specialist community, P2 found that relevant publications eventually found their way to them via friends, colleagues, or students without much active searching. This experience shaped P2's mental model of scholarly knowledge whereby information is expected to circulate reliably through interpersonal networks in a small research community. Feeling they had "already heard everything", P2 perceived themselves as up to date despite being early in their career. Yet their efforts to attend conferences in adjacent or less specialised fields suggest an awareness that knowledge must be actively gathered as they develop their research interests. In contrast, P6, a more senior chemist, has developed a clearer sense of the wider landscape: who their competitors are, which conferences matter for which projects, and how different subfields connect, something that P2 is still learning to navigate.

6.6.2 Virtual communities

In addition to conferences, participants also referred to scholarly communities in the virtual realm. In Ithaka S+R's studies of historians (Ithaka S+R, 2012) and chemists (Ithaka S+R, 2013), there were a few references to the use of social media, as academic social networks had kicked off in 2008 (Jeng, He and Jiang, 2015; Jordan, 2019). Ithaka's later study of public health scholars (Ithaka S+R, 2017b) contained significantly more mentions of social media, possibly indicating a rise in the use of social media in academic communities, although this is also shaped by public health's public-facing nature. A comparable study by Ithaka S+R did not exist for Law. References to social media in these reports were made in relation to dissemination practices (history, chemistry, public health), learning new methods (history), keeping up to date (public health), and self-promotion (public health).

In the present study, participants across the disciplines mentioned social media, and in particular Twitter/X, as a means of keeping up to date with the latest research as well as of information seeking and exchange. Chemists and medical researchers generally regarded the social media platform's potential for informal networking and rapid circulation of information positively and were dismayed by Twitter's acquisition and switch to X in July 2023 due to commercial and political changes reflected on the platform, which occurred in the middle of the data collection phase.

For researchers concerned with immediate updates on a topic, social media was an ideal place to look. Chemist P23, for example, followed specific people in their field to get instant updates on their work:

> (Laughs) Shame on me, but a lot comes from Twitter… I follow the people that work in the area that I like or the area that I'm also working in. And usually, they post something when they have news. So I will get it faster than anybody else, I guess. (P23, Glasgow organic chemist)

P23 laughed, hinting at some embarrassment that social media might not count as a serious scholarly source, even though it constituted a significant channel through which they followed current developments in the field. Likewise, legal scholar P11 followed academics and practitioners in their discipline and received updates on cases through this virtual network more quickly on Twitter/X or WhatsApp than anywhere else:

> One of the key things I do is... I must follow about 4,000 people. I would say probably about 500 of them are lawyers or legal academics. Maybe about...150 of them are subject specialists in my area. And we—like, a recent case. I'll probably see the case before I would get an alert via...the main database, Westlaw… Again, social media, then, I would be talking about the research group I'm in here. The really good thing is there's a group of us in a WhatsApp group who are all interested in the same thing and a message will pop in. (P11, Glasgow private law scholar)

P16, another legal scholar, found that researchers in their field often published short texts related to theory, case briefings, and regulatory updates, among other things, on social media, aiding discovery of new information. It was useful to use social media for updates in their field particularly when "I can see the information first from my smartphone instead of from articles".

Following relevant academics on social media (primarily on Twitter/X but also LinkedIn, ResearchGate, and blogs) was common across the disciplines but featured most prominently in medicine and law. Medical researchers P18, P22, and P37 discussed how they followed people working on similar topics to receive updates on their latest work. P3 said they did not use Twitter/X but discussed how their research group's PI would relay relevant information discovered on the platform to them.

P37 (Oxford global health researcher) reported that following relevant people was useful not only when looking for papers but also for disseminating their own research, since their paper would reach appropriate audiences through their virtual network of specialists.

P18 (Glasgow biomedical researcher) found that the informal exchanges enabled by the platform really helped foster a sense of community and openness in the sciences ("Twitter felt like it was…almost perfect for that information exchange") and expressed their disappointment towards the ongoing changes in ownership and management that were causing many academics to leave: "when it got bought out, a lot of people left because they, they didn't agree with the politics or the way it was being run".

Even as the social media landscape changed, medical researchers continued to engage in these online spaces. Patterns differed across specialisms and individuals, but many used social media both as consumers of information and as active contributors to virtual scientific communities.

In law, blogs featured as a prominent medium for keeping up to date and disseminating knowledge. Oxford European law scholar (P31) discussed using a combination of blogs, "academic Twitter", and LinkedIn to stay current:

> But now, the academic blogs are very popular and there are some very reputable for you. So that's that. Also Twitter, I use Twitter basically only to follow those who write something. You know, some current stuff on EU law. So, my Twitter is very much academic Twitter. LinkedIn, people post again from blogs. So yeah, these, all these blogs and then social media, really. (P31, Oxford European law scholar)

Other legal scholars (P14, P38, P40) also reported reading and/or writing blogs, which in the field of law are not personal websites but closer to "short online articles" (P14) consisting of expert content hosted on

institutional websites that are “fairly well read” (P38) and can be “very reputable” (P31). This points to the ecology of grey literature that is accessible to those in the know since there is no centralised catalogue or database to find these. The European law scholar cited above knew where to look or whom to follow on social media to access relevant EU law blogs; another legal scholar specialised in international law (P14) read blogs posted on the United Nations websites. A scholar in property law (P40) discussed writing numerous blog posts over the years aimed at a wide audience including academics, professionals, and the general public, to make unfolding legal issues more accessible.

Historians did not discuss social media as much as scholars in other disciplines, but in the previous section historian P9 discussed how listservs were used to exchange information amongst a community of scholars who subscribed to specific forums based on geographical area and language (H-France).

In general, participants’ responses suggest there are active and responsive communities online that serve not simply to connect people socially and professionally but to facilitate exchanges of specialist information quickly and efficiently. Rather than relying on active searching or contacting information professionals, scholars connect themselves virtually to relevant people or channels to receive updates on potentially relevant information and disseminate information back out to them. In some cases this looks fragmentary (blogs scattered across institutional websites), and based somewhat on chance (that someone has the answer to your query and will respond on a listserv, or that those you follow will post relevant things), but all of these different sources—trusted people, accounts on academic Twitter, subscribers to listservs, networks of local and international conferences—are like nodes in a network, with different levels of density across the network for different disciplines. These networks form the backbone of researchers’ mental models of academic knowledge.

As the preceding section has shown, informal interaction plays a substantial role in shaping how scholars think, communicate, and situate themselves within their disciplines. Yet these interactions are experienced differently across academic fields. These differences are not merely circumstantial; they reflect deeper patterns in how disciplines organise time, space, and knowledge. The kinds of conversations that take place in a laboratory differ from those in a college dining room or during conference breaks.

As such, informal social interaction is not simply background ambience to disciplinary work. It constitutes a significant means through which academic knowledge is generated, circulated, and legitimised. Whether shared over coffee or passed through virtual channels, these interpersonal

engagements animate the lived, dynamic cultures in which disciplinary mental models are continually made and remade. Section 6.7 further examines how social and spatial practices diverge across disciplinary cultures, and how these divergences contribute to the development of distinct mental models of knowledge.

6.7 Disciplinary differences in social and spatial practice

Whilst informal interaction is a common thread across academic life, the ways it is experienced and the forms it takes are closely bound to disciplinary norms. Each field fosters particular expectations about collaboration, communication, and workspace organisation. These expectations are not incidental but deeply embedded in how scholars imagine their work, their roles, and the nature of disciplinary knowledge itself. The spatial and social patterns observed across this study reveal not only pragmatic distinctions but also disciplinary assumptions: about where knowledge happens, how it should be shared, and with whom.

In the sciences, collaboration is often, though not always, built into the very architecture of the discipline. Laboratories, clinics, and open-plan offices are designed as spaces of shared expertise that facilitate interaction, troubleshooting, and continuous exchange. As postdocs P13 (Glasgow chemistry) and P36 (Oxford medicine), associate professor P10 (Oxford chemistry), and professor P28 (Glasgow medicine) noted, work in these settings is often collaborative and “heavily social”. This level of integration—between people, space, and process—supports a mental model in which scientific knowledge is generated through collective effort and spatial co-presence. The open-plan design is not merely a logistical arrangement; it is perceived as a prompt for intellectual connection. Chemists’ and medical scholars’ mental models of scientific work thus emerges through this social and spatial embeddedness, where collaboration is not optional but constitutive of how science is understood and enacted.

By contrast, legal scholarship is often structured around dialogic forms of exchange, but in smaller, more deliberative groupings. P38 captured this dynamic when describing how they “talked law with their friends” at dinners and pubs.

Rather than happening in a shared laboratory, knowledge in law is developed through one-to-one discussions, small seminars, and social occasions that double as intellectual spaces. These dialogues are often focused on clarity of reasoning, precision of language, and critical engagement—values deeply

embedded in legal training and scholarship. The mental model here is one of knowledge as discursive, interpretative, and tested through rhetorical exchange.

Whilst spatial proximity is less critical in law than in the sciences, social proximity—access to peers, mentors, and critical interlocutors—remains central. P14, a Glasgow-based international law scholar, described a culture of regular feedback through seminars, working groups, and informal chats. P11, also in law, emphasised how casual office visits could become entry points for meaningful academic dialogue. Yet even in this relatively sociable culture, many legal academics also valued the solitude needed to write and reflect, suggesting a rhythm that fluctuates between dialogue and retreat.

Historians offered a different perspective again—one grounded in solitary research but punctuated by moments of curated dialogue and encounters. Much historical work takes place in archives, libraries, or home offices, often involving long periods of reading, note-taking, and analysis. However, informal networks, both local and international, physical and virtual, still matter, as discussed by P4, who embarked on unexpected projects through academic connections, P15, who refined their ideas in conversation with colleagues at conferences and libraries, and P9, who utilised mailing lists to tap into the knowledge of other specialists in their field.

These disciplinary cultures also shape scholars' relationship to space. In chemistry and medicine, junior researchers often work in close physical proximity to senior colleagues, offering high visibility but also a sense of hierarchy. This can create strong communities but may also generate pressure, as with P19 who felt that the forensic toxicology lab was uncongenial, depending on lab dynamics. In law and history, individual offices or shared workspaces are more common, offering greater autonomy but sometimes limiting opportunities for spontaneous exchange.

Career stage further mediates these spatial and social experiences. Senior scholars like P6 or P1 have the autonomy to choose or shape their space and networks, often acting as central nodes in their disciplinary communities. In contrast, early-career researchers such as P24, P33, P36, and P37 rely more heavily on local peer networks and the affordances of shared spaces. Their mental models are still emerging, formed through observation, emulation, and iterative negotiation of disciplinary norms in group settings.

These varied spatial and social configurations reflect deeper disciplinary frameworks about what it means to "do" academic work. In the sciences, work is embodied and collective, inseparable from the tools and people in the lab. In law, it is enacted discursively, through debate and critique. In history, it is often contemplative, emerging slowly through solitary engagement with sources. Each model carries implications for how scholars think, collaborate, and orient themselves within their field.

Recognising these disciplinary differences allows for a more nuanced understanding of how social interaction, space, and material culture shape the lived experience of academic work. Mental models are not just individual schemas; they are shaped by the affordances and constraints of disciplinary worlds, which vary significantly in their rhythms, practices, and infrastructures.

6.8 Conclusion

This chapter has explored how scholars' mental models of knowledge may be shaped, expressed, and refined through the material, spatial, and social dimensions of academic life. Rather than treating knowledge production as a purely cognitive or intellectual process, the findings suggest that everyday academic environments—offices, laboratories, field sites, whiteboards, bookshelves, common rooms—play an important role in how scholars come to know, think, and communicate within their disciplines across Glasgow and Oxford.

What emerges is not a single, unified model of academic space, but a series of overlapping and sometimes contrasting practices that appear to reflect deeper disciplinary assumptions and expectations. For some, particularly in the sciences, co-location and access to shared tools (whiteboards, models, lab benches) afford a model of knowledge that is collaborative, iterative, and physically situated. In other fields, such as law, informal dialogue—often outside formal workspaces—appears to play a central role in shaping thought, with a focus on verbal clarity and debate. In history, the solitary and often text-based nature of research is balanced by informal scholarly networks that help researchers calibrate their identity within specialised subfields. Across these contexts, disciplinary traditions seem to shape how space is used, what counts as legitimate intellectual labour, and how individuals position themselves in relation to broader epistemic communities.

Importantly, these practices appear not only to vary across disciplines but also across career stages. Senior academics frequently had the ability to personalise their spaces, extending their intellectual and social presence through offices that doubled as sites of teaching, mentoring, and even more personal activities. Early-career researchers, by contrast, often navigated more transient or shared environments, where access to peers and tools influenced how they understood their place in the field. These differences in spatial autonomy and social integration may have subtle but significant effects on how mental models are formed and sustained over time.

Whilst it is not possible to draw fixed conclusions about causality, the material observed here does suggest that academic knowledge is not produced in isolation from its contexts. Instead, it seems to take shape through a complex interplay of material infrastructures, social relationships, and spatial arrangements, all of which are imbued with disciplinary expectations and norms. These environments do not merely support scholarly work; they may also participate in shaping how scholars conceptualise the nature and purpose of that work.

Ultimately, attending to the informal, the material, and the everyday offers a way of understanding academic life that moves beyond output and performance. It invites reflection on the tacit, situated, and often affective processes through which scholarly knowledge is not only produced, but also imagined, questioned, and shared. Mental models are not static or internal constructs—they are lived, shaped in and through the environments that scholars inhabit. Recognising this may help us understand more fully what it means to know, and to become, within contemporary academic life.

7 Discussion and Conclusion

This study was guided by two central questions: What do researchers' mental models look like across academic disciplines? And how do these mental models of the organisation of knowledge vary across disciplines? To address these questions, the study explored how scholars from the Universities of Glasgow and Oxford across four disciplines—chemistry, history, law, and medicine—conceptualise and organise disciplinary knowledge. Taking a qualitative, interpretivist approach informed by library user experience (UX), information practice, and critical literary studies, this study explored a largely uncharted area: disciplinary mental models. Following Polkinghorne and Given's (2021) holistic paradigm, it treated information practice and mental models as dynamic, socially and materially embedded constructs shaped through interaction with institutional structures, disciplinary cultures, personal career trajectories, and everyday environments.

The preceding empirical chapters were organised thematically from the most to least influential factors shaping participants' mental models. Chapter Four examined extrinsic, structural factors; Chapter Five addressed individual and career trajectories; and Chapter Six considered the social, spatial, and material dimensions of scholarly work. This inductive, bottom-up design allowed themes to emerge from participants' accounts of their working practices, intellectual frameworks, and disciplinary norms.

The findings reveal distinct, context-dependent patterns of thought that illuminate disciplinary variation in how scholars seek, organise, and make sense of information. Mental models, forged within particular disciplinary settings, influence how researchers conceptualise information and engage with the systems through which it is managed and accessed. In this way, this study extends the discussions of information behaviour and practice and mental models introduced in Chapter Two by highlighting how they are embedded within and sustained by particular academic cultures.

This perspective also contributes to longstanding critiques of systems design that position users as needing to conform to the logic of information systems rather than designing systems that accommodate and leverage users' perspectives and situated practices (Borgman, 1986b, 1996; Brennan, Kelly and Arguello, 2014; Mckay et al., 2020). The empirical data from this study illustrate moments of both synchrony and friction between researchers' cognitive strategies and the functionalities of the systems they use, depending on how well systems reflect disciplinary modes of inquiry. This echoes Norman's (1983, 2013) observation that usability issues can arise from discrepancies between the designer's model, the system representation, and the user's mental model.

To conceptualise these encounters, the study drew on Pratt's (1991) contact zone metaphor, framing scholar–system interaction as a site of ongoing negotiation where both systems and users bring particular, situated assumptions. Systems are not neutral; they reflect institutional, technical, and design choices, whilst users approach them through disciplinary lenses that may not align with a system's organising principles. This interpretation resonates with debates in the digital humanities, human–computer interaction, and Science and Technology Studies that regard digital tools as "rhetorical devices" carrying "communicative power" (Ramsay and Rockwell, 2012, p. 78) and with Mak's (2014, p. 1516) observation that digitisation practices are embedded "in a particular social, cultural, economic, and political climate". More recent scholarship exposes how algorithms encode bias (Noble, 2018) and how "universalist" design practices reproduce structural inequalities and erase marginalised groups (Costanza-Chock, 2020). These arguments reinforce the view that search and discovery environments are not impartial but contested contact zones, where differences among users—particularly disciplinary ones, in this study—and the logic of designed systems intersect.

Alongside the digital and cognitive dimensions, the study underscores the enduring importance of material and social contexts in scholarly work. Participants consistently described the intellectual and social value of physical materials, environments, and encounters, from labs and libraries to whiteboards and informal conversations. Attending to these settings highlights how mental models are not engaging with digital systems in isolation but also through embodied and social interaction. These findings extend the work of Olsson and Lloyd (2017) and Cox (2018), who emphasise that even within increasingly digitalised academic environments, scholarly information practices remain deeply embodied, spatial, and materially situated.

Building on these insights, this chapter synthesises the study's main findings and situate them within the broader literature on scholarly information practices and search and discovery in LIS. It first discusses the conceptual "shapes" of disciplinary mental models identified across the four case studies, before turning to the key findings from Chapters Four, Five, and Six. It then examines cross-disciplinary patterns of thinking and identity negotiation that emerged. Subsequently, it examines how scholarly mental models and discovery systems intersect across disciplines—at times in alignment, at times in tension—and argues for system design that is more responsive to disciplinary ways of thinking. The chapter concludes with reflections on the study's limitations and suggestions for future research.

7.1 Shapes of mental models across disciplines

A key contribution of this study is the identification of the mental models through which scholars conceptualise disciplinary knowledge. Building on foundational works by Gentner and Stevens (1983) and Craik (1943) that describe mental models as internal representations of phenomena in the external world, particularly of tools, the empirical findings in the present study extend mental models into the academic, epistemic realm and view them more as embedded and shaped by the external world rather than just reflecting it. As explained in Chapter Four, the four disciplinary mental models are characterised by distinct "shapes" or organising rationales, to some extent confirming "signature pedagogies" across disciplines (Shulman, 2005) and domain-specific knowledge (Hjørland and Albrechtsen, 1995). These are not fixed or universally applicable typologies but situated representations grounded in participants' experiences and perceptions, which emerged from their own descriptions of how they think, conduct research, and make sense of their fields. They offer a way of articulating the differing cognitive frameworks through which scholars approach knowledge and how these modes of thought are embedded within wider disciplinary practices.

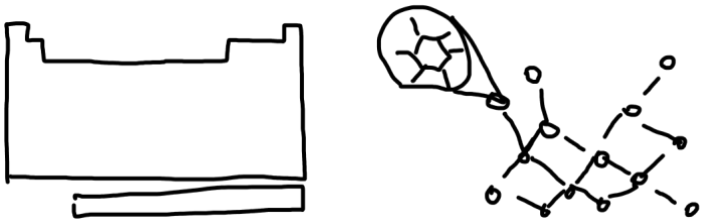


Figure 7-1 Shape of mental model in chemistry drawn by Researcher

Despite internal diversity within each field, participants described recurring cognitive and organisational patterns. As discussed in Section 4.2, chemists often engaged in visual-spatial reasoning, abstracting networked mental models based on molecular structures and the periodic table. These align with prior accounts of science as both abstract and materially grounded (Shapin, 2010; Latour and Woolgar, 2013; Daston, Galison and Galison, 2021). This foundation supports increasingly complex levels of organisation, from molecular diagrams to the broader interconnections between subfields such as organic chemistry, biochemistry, and materials science. The mental model here is often networked and porous, reflecting both the physical organisation of matter and the collaborative, interdisciplinary nature of chemical research previously highlighted in the RIN (Meyer *et al.*, 2011) and Ithaka (Ithaka S+R, 2013) studies. The significance of the molecular perspective, the ability to think on different scales of magnitude, and to think representationally (e.g., through equations and graphs) voiced by participants in the study is reflected in studies of chemical pedagogy (Johnstone, 1993; Gravelle and Fisher, 2012).



Figure 7-2 Shape of mental model in history drawn by Researcher

The mental model of historical inquiry was likened to shining a torch in a dark room, where fragments of evidence are brought to light and woven into a narrative. Historians work inductively, gathering and critically interpreting historical sources, which resonates with Collingwood's (1993) idea of historical inquiry as critical reconstruction. Knowledge, in this view, is characterised by "saturation in empiricism" and by "serendipity", or the chance discoveries and unexpected connections that emerge in the research process (P7, Oxford historian). The perspectives on disciplinary knowledge expressed by participants in this study echo findings from disciplinary pedagogy, particularly the works of Hounsell and Anderson (2008) and Westhoff (2012) who highlight core historical skills such as close reading, interpretation, contextualisation, and drawing connections between pieces of historical evidence. This inductive approach emphasises immersion in disparate fragments of illuminated evidence and the interpretation of that evidence from a particular standpoint. The role of serendipitous discovery in historians' research practices has likewise been noted in LIS research (Martin and Quan-Haase, 2016).



Figure 7-3 Shape of mental model in medicine drawn by Researcher

In medicine, iterative, patient-centred thinking came to light, shaped by the applied and diagnostic focus of the discipline, which echoes ongoing discussions in the medical field on the need to consider patients holistically to deliver comprehensive care (McWhinney, 1997; Cassell, 2004; Charon, 2008). Clinical and biomedical researchers described research trajectories that begin with the identification of a health

problem that eventually circles back to the patient through applied interventions. Compared to chemistry, the key unit of study in this case is the cell, as described in the RIN study of regenerative medicine (Research Information Network and British Library, 2009). The RIN and Ithaka studies do not cover clinical medicine; however, the Ithaka study (Ithaka S+R, 2017b) of public health scholars describes a focus on disease prevention at the community level, with a view to implementing strategic behavioural, policy, and health management interventions to care for individuals and communities. This cyclical mental model captures the iterative nature of medical knowledge production and learning, particularly for clinicians, whose training has feedback built into it (Penman *et al.*, 2021).

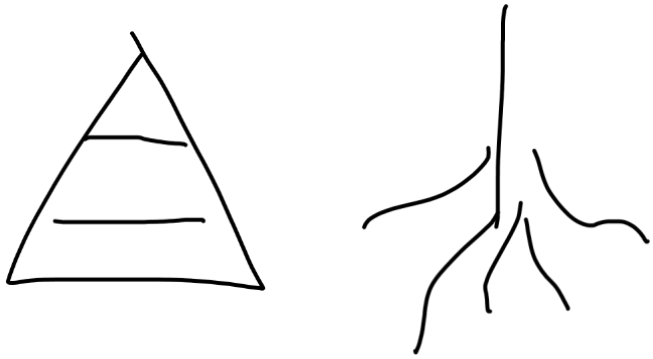


Figure 7-4 Shape of mental model in law drawn by Researcher

The legal mental model has a pyramidal or inverted tree structure, reflecting the hierarchical and tightly organised nature of legal knowledge. Law participants in this study discussed hierarchical taxonomies and deductive frameworks, reflecting what legal scholars have previously described as the schematic, rule-based nature of legal reasoning (Twining, 1997; Alexander and Sherwin, 2021). Central to this model is the framework of case law and legislation, in which legal arguments are built on precedents and organised into normative principles. This structure enables scholars and practitioners to situate new cases within an existing taxonomy, promoting coherence and interpretive stability.

The shapes of these mental models echo Donald's longitudinal study of curricula across subjects discussed in Chapter Two. By analysing key concepts in higher education curricula, Donald (2002) identified distinctive disciplinary patterns. The sciences generally had more hierarchical and interconnected conceptual structures in Donald's study, which resonates with the structured and networked mental model in chemistry found in this study. Donald also found that in the social sciences, concepts were organised around logical, hierarchical relationships, which is reflected in the hierarchically arranged mental models expressed by legal participants in this study. In contrast, curricula for subjects in

the humanities showed looser, fragmented conceptual relationships in Donald's study, containing echoes of the exploratory, inductive mental model identified in history in the present research.

In addition to the shapes, the table below summarises key findings across the four cases.

	Chemistry	History	Law	Medicine
Shape of knowledge	Networked, molecular	Torch-lit dark room	Hierarchical, inverted tree	Cyclical, patient-centred
Basic unit	Element / molecule	Fragments of evidence / primary source	Precedent / Statute	Cell / Patient
Mode of reasoning	Visual-spatial, connective	Inductive, interpretive, often textual	Deductive, doctrinal	Iterative, evidence-based
Knowledge is…	Built by modelling and connecting	(Re)constructed from partial traces	Classified and applied	Cycle from bench to trial, and to patient for clinical research
Key systems	Structure- or property-based databases (e.g. ChemSpider)	Fragmented: specialist bibliographies, archives, libraries	Westlaw, LexisNexis	PubMed, MeSH, systematic review
System-model alignment	High: systems mirror chemical knowledge	Low: Keyword search clashes with contextual search	High: databases mirror legal taxonomy	Moderate to high: standardised methods/terminology, comprehensiveness anxiety persists
Characteristic friction	Minimal; infrastructure largely invisible	Persistent visibility; internalised self-doubt	Confidence within known systems; disorientation outside it	Fear of missing something
Sociomaterial setting	Laboratory, whiteboard, shared problem-solving	Archive, library, book-lined office	Office, ordered bookshelves, pub and dinner	Laboratory, clinic, team meetings
Community mode	Structured teams, networks of expertise	Individual scholarship, informal social exchanges	Individual scholarship, informal social exchanges	Structured teams, networks of expertise

Table 7-1 Summary of findings

This study highlights that disciplinary and metadisciplinary categories continue to hold meaning and are institutionally viable still today, reflected in the ways in which the RIN (Research Information Network and British Library, 2009; Bulger *et al.*, 2011; Meyer *et al.*, 2011) and Ithaka S+R studies (Ithaka S+R, 2012, 2013, 2014, 2017b, 2017a, 2017c, 2018, 2019a, 2019b, 2020) as well as other scholarship looking at disciplines and academic domains (Given and Willson, 2018; Gordon *et al.*, 2018; Aakre *et al.*, 2019; Korkeamäki and Kumpulainen, 2019; Maryl *et al.*, 2020; Strand, 2020; Bronstein and Solomon, 2021) have framed their work. By foregrounding the diversity of epistemic frameworks across disciplines as well as their porosity, this study supports the broader move within information science towards models that account for the cultural and material conditions of knowledge seeking, production, use, and sharing. Rather than reducing engagement with information to discrete acts of seeking, it is conceptualised as part of a broader ecosystem of scholarly practice that is dynamic and socially, technologically, materially, and institutionally negotiated.

The three subsections that follow (7.1.1 to 7.1.3) are organised according to the degree to which extrinsic factors shape scholarly mental models, from the most significant to the least. Each theme emerged directly from the data of this study, with the final subsection (7.1.3) inductively arising during fieldwork through the observation of participants' workspaces.

7.1.1 Extrinsic factors

Three extrinsic factors shaping mental models emerged from the data: disciplinary norms and practices, university structures, and libraries and archives.

Disciplinary norms and practices

Chemistry and medicine were marked by strong visual and practical components. Visual-spatial reasoning and mathematical expression figured most prominently in chemistry, reflecting the skills deemed critical in the subject according to the UK Quality Assurance Agency for Higher Education (QAA)'s (2022) Subject Benchmark for chemistry. Almost all chemistry participants had little issue expressing their disciplines in the cognitive mapping activity, in some cases using more than one sheet of paper, and in others having a fully formed image prior to starting the drawing, as in the cases of two organic chemists (Oxford chemist P2 and Glasgow chemist P21), even though the question was not provided in advance. Likewise, detailed or elaborate visualisations with multiple interrelated components were also common in the medicine case study, highlighting the visual-spatial thinking also present in the mental models of

medical researchers discussed in the RIN (2009) study which discussed how regenerative medicine uses imaging, and in the QAA (2023a) subject benchmark for biomedicine. This poses a stark contrast to the drawings made by some of the historians, composed almost entirely of words.

In addition to visual-spatial reasoning, both chemistry and non-clinical medicine were centred around lab-based work, which highlighted the collaborative and social dimensions of their disciplinary mental models. Day-to-day tasks varied depending on participants' roles, where postdoctoral and early career researchers would spend time in the laboratory whilst senior researchers managed their work, switching between the office and the laboratory. Echoing findings from the Ithaka (2013) report on chemists, collaboration between team members, chemists, with other scientists, and with lab technicians was common, shaping the flow of their daily practice. Given the fast-paced and collective nature of their work, medical participants in particular discussed sharing the latest research with their team members both online and in person, reflecting previous literature on shared or team mental models and how mental models are shaped by collective settings and tasks (Banks and Millward, 2000; Davison and Blackman, 2005b; Mohammed, Ferzandi and Hamilton, 2010). Participating in conferences regularly to both know what is happening in the field, but also to know what similar research groups are working on (Oxford chemists P2 and P6). This reinforces the networked, interconnected, collaborative conception of chemistry as a discipline as described by participants, where neither conceptual nor practical work happens in isolation, demonstrated clearly by Oxford physical chemist P35, whose research depended on combining mathematical equations they could work out on their own, and experiments conducted in teams using complex, large-scale equipment.

Medicine was anchored in patients and human health, but approaches were highly varied due to the clinical versus non-clinical nature of researchers' work. Biomedical researchers worked in lab-based teams, whereas clinical researchers worked directly with patients in hospitals and clinics, requiring a different kind of collaboration and care. Despite these differences in practice, medical researchers commonly portrayed causal or processual modes of thinking in their drawings compared with the networked conceptualisations in chemistry.

In contrast, history and law were more individualistic—although collaboration did also occur, but in smaller numbers and less frequently—grounded in archival research and doctrinal analysis, and often privileging the text and the book, showing a continuation in practice since the Ithaka study of historians was conducted (Ithaka S+R, 2012). The scholarship was more of an individual journey in critical analysis of evidence in both cases, and this is reflected in the QAA's Subject Benchmarks for History and Law, which lists "working independently" (The Quality Assurance Agency for Higher Education, 2022) and

"intellectual independence" (The Quality Assurance Agency for Higher Education, 2023b) as the first in a list of essential skills.

In law, however, participants described a particular legal "black letter" method, established and taught as doctrinal analysis (Hutchinson and Duncan, 2012; Smits, 2015; Alexander and Sherwin, 2021). Participants in History, on the other hand, generally were less likely to define a "method" per se, describing instead an implicit, "mystical" approach to analysing sources via immersion in and serendipitous encounters with source material (Glasgow historians P26, P30 and Oxford historian 7). One historian (Oxford P9) gave a more concrete example of their method, based on teaching students to read "along and against the grain", an approach discussed when working with archival, colonial sources (Stoler, 2009).

In addition, each academic discipline was supported by professional and specialist organisations such as the Royal Historical Society (UK) and the Royal Society of Chemistry (UK), which monitored subject curricula and produced specialist resources for information in the field. The Royal Society of Chemistry, for example, developed ChemSpider, which, along with other chemical databases, enables searching for chemical structures and properties, incorporating chemical categories into the system's features. Scholars in medicine were taught to conduct systematic searches using specific medical databases and advanced search methods, including MEDLINE and PubMed, maintained by the National Institutes of Health (NIH) in the US; commonly used medical index terms called Medical Subject Headings (MeSH) are also maintained by the NIH, thereby shaping the language and classification in which knowledge is conceptualised in the discipline. Legal scholars also utilised major subject databases, such as LexisNexis and Westlaw UK, reinforcing the subject-based categories and approaches to searching. History, based on the participants interviewed, was the least systematic in its methodological training and most diffuse when it came to authoritative databases, as there were no comprehensive, systematically indexed history-specific information sources, unlike those in the other disciplines. The exception to this was for British sources, where, as British historians P4 (Oxford) and P27 (Glasgow) noted, had authoritative bibliographies and indexes curated by the Royal Historical Society. By providing databases that take into account the categories and visual interfaces that would best suit users in a discipline, they not only reflect and support, but also reinforce these disciplinary ways of organising knowledge. This supports previous studies that demonstrate how utilising specific databases can influence mental models (Zhang, 2013; Han *et al.*, 2020).

University structures

University structures were found to shape how participants experienced and organised knowledge within their disciplines though, as discussed in Section 7.1.3, less at the level of the underlying shape of their mental models than at the level of scope, expectations, and practice. Differences in institutional and physical organisation affected not only how research was conducted but also how scholars perceived their disciplinary boundaries. As previous work on disciplinarity and disciplinary pedagogy have argued, institutional teaching practices and expectations of higher education learning foster specific intellectual habits and entrench disciplinary values (Kreber, 2008; Gurung, Chick and Haynie, 2009; Trowler, Saunders and Bamber, 2013; Chick, Haynie and Gurung, 2023).

In Glasgow's history department, the physical organisation of the department reflected and supported cohesion and specialisation. Subfields were divided by period and geography, categories also reflected in the specialist databases used by historians such as the Bibliography of British and Irish History and *People of Medieval Scotland* discussed by participants in Chapter Four. In Medicine, Glasgow's official designation of clinical fields under the medical faculty raised questions about non-clinical fields and complicated who could be considered a medical researcher, as medical researcher P22's comment highlighted: "I'm not based in the medical faculty… I don't work with patients… Am I a medical researcher?" In both Chemistry and Law, centralised facilities supported shared practices and collaboration. Chemists P20, P21, P23, and P25 described working across teaching spaces, research labs and offices in proximity, whilst legal scholars P11 and P14 discussed how the layout of their working environments facilitated frequent encounters with colleagues.

In contrast, at Oxford, disciplinary organisation was more dispersed physically. Medicine was the most prominent example, where research and clinical work are spread across multiple sites and hospitals in central Oxford and beyond, contributing to a sense of its expansiveness, especially given that Medicine is also an entire division, unlike in Glasgow where medical research is housed in several schools. The size and dispersion also deepened a sense of specialisation and compartmentalisation, which was felt keenly by one postdoctoral researcher (P36) who found their lack of access to a college and bureaucratic challenges accessing experimental equipment restrictive. By contrast, almost all historians and legal scholars typically worked in more individualised environments—except younger scholars and the few who preferred to work from home or at public cafes—often defined by private offices sometimes lined with custom shelves and layouts and lined with personal book collections arranged in institutionally specific ways (legal scholars P8, P31; historians P4, P5, P7), where the interviews took place, highlighting the significant intellectual activity within the colleges. Oxford scholars P4 and P7, for example, explained that some of their books were arranged by "paper" or course. Oxford legal scholar P38 also described arranging their books in gradients, where subjects run together. This sort of spatial

arrangement is a physical manifestation of their conceptual organisation of knowledge, which echoes information practice literature that emphasises how the material dimension is integrated in the information experience (Orlikowski, 2007; Veinot and Pierce, 2019; Levesque, 2020)

In general, differences such as centralisation versus dispersion, clinical versus research emphases, and single site versus multi-site locations shaped how scholars envisioned the reach and boundaries of their disciplines, their sense of belonging, and their expectations of how knowledge should be organised and accessed.

Libraries and archives

Previous studies have asked how scholars perceive and use physical and digital libraries, with a heavy emphasis on the latter in recent LIS and DH literature (Stelmaszewska and Blandford, 2004; Blandford, Rimmer and Warwick, 2006; Makri *et al.*, 2007b; Crymble, 2016; Feliciati, 2018; Leigh, 2021). The question of how libraries and archives shape users' perceptions, however, is less frequently asked, if at all. The present study found that libraries and archives can shape scholars' mental models, serving as scaffolds for knowledge organisation in which disciplinary mental models are learned and reinforced—particularly for historians.

Senior scholars in chemistry and medicine whose formative years in the field involved physical visits to the library framed librarians as search experts and libraries as skill-building spaces, noting that librarians—particularly subject librarians—were experts in effective search strategies (Oxford chemist P1 and Oxford medical researcher P3) and libraries provided "a tactile connection to the research" (Glasgow medical researcher P18). Whilst most scientists in the study no longer made use of the physical library, preferring online access and in some cases not realising that these are also part of library service provision, historians were the heaviest users of libraries and archives, and these environments appeared to have shaped their views of knowledge organisation.

As noted in Chapter Four, historians emphasised how the physical organisation of library collections mirrors the field: "nothing replaces… having a look at the bookshelf and that really gives you a sense of the field as well and how it's changed" (Oxford historian P9). Deep familiarity with a library's spatial arrangement became a mental map for research, where the intellectual organisation of materials merged with physical navigation; as Glasgow historian P15 recalled from memory, "social history is in floor six… history of ideas is mostly on floor nine and ten… it shows up in… my itinerary around the library".

Similarly, archives were sites of practical and intellectual engagement. Practical work began with grasping how a collection is organised, as "you need to understand how and why they've classified it in a certain way" (Oxford historian P9). As archival practices can vary across repositories and across countries, making sense of a collection and finding relevant items could be "hit or miss" (Oxford historian P7), as labels could be misleading or historically contingent. Glasgow historian P27, for example, found that a British Library file was named after a king, whilst its contents were much more expansive than the individual, but it was necessary to "flip through the pages" to know the content. Archivists were seen as mediators, and in smaller or private repositories, historians were highly dependent on their expertise, needing to become familiar with the archivists' and the institution's organisation (Oxford historian, P33). In this sense, historians needed to absorb the unique intellectual and physical arrangements of archives, shaping their mental models of knowledge organisation.

When it came to digital libraries and archives, some historians and legal scholars discussed challenges they faced using them, as the simplified interface did not meet their expectations. As discussed in Chapter One, Google led the way in transforming the library sector by enabling and streamlining online discovery through federated search and discovery layers (Prescott and Erway, 2011; Caplan, 2012; Wells, 2021). These transformations were quickly adopted by libraries, leading some users to view library discovery layers as indistinguishable from commercial search engines (Makri *et al.*, 2007b), and others' perceptions to change over time, when comparing the quality and quantity of results in Google Scholar and library search tools (Howland *et al.*, 2009; Oh and Colón-Aguirre, 2019). In this study, discovery interfaces drew criticism for flattening hierarchies into a single search box: "they hide the structured organisation of collections… You lose the depth and rigour" (Glasgow historian P30). That opacity fed anxiety about missing key sources, as expressed by Glasgow historian P29: "if I don't find a result, I'm not always confident that's because it's not there… so I do tend to give up". Even among senior legal scholars, the missed expectations led to self-doubt and lack of confidence in one's own search skills, where they commented: "maybe I'm just not very good at this" (Oxford legal scholar P8) and "I get lost very easily… I probably am not efficient at searching" (Oxford legal scholar P40). P8 and P40 would turn to librarians for help if searches did not produce the results they were expecting. This frustration with online search tools, coupled with the adoption of structured knowledge organisation systems in libraries and archives discussed above, suggests a potential mismatch between participants' mental models and the organisation of search systems.

Altogether, participants' accounts show how library and archival organisation—from classification, spatial layout, and staff expertise—shape the mental scaffolds that scholars rely on. The level of influence

of libraries and archives on mental models, however, varied by discipline and by the degree to which scholars used these resources, with the greatest impact on historians' practices and ways of thinking.

7.1.2 Personal and social factors

Chapter Five explored how participants' individual motivations and academic journeys also influenced their mental models, which builds on the findings of Zhang and Chignell (2001), who found that professional and educational backgrounds helped explain individual differences in mental models. Participants in this study described shifting perspectives over time, shaped by career changes, collaborations, and exposure to new fields, which supports the existing literature on disciplinary identity as fluid and negotiated (Brew, 2008; Jawitz, 2009; Sugimoto and Weingart, 2015), as well as foundational studies of mental models in psychology that support the notion that mental models evolve through social experience over time (Piaget, 1962; Vygotsky, 1978; Shayer, 2003).

In chemistry, motivations for entering a discipline included curiosity about the natural world (Oxford chemists P6, P10). An appetite for learning and satisfying one's curiosity drove others (Glasgow chemists P13 and P35). Like chemists, some legal scholars cited intellectual challenge as a motivator (Oxford legal scholar P31). A significant number of others discussed justice, fairness, and social responsibility as their motivations for pursuing law (Glasgow legal scholars P11, P12, P14, P16, P17; Oxford legal scholars P38, P40). One participant was initially drawn by the practical employment prospects (Oxford legal scholar P38).

Historians highlighted an enduring fascination with understanding cultural and social phenomena and interpreting the past (historians P4, P7, P15, P27, P33). Oxford historian P4 described how they enjoyed 'trying to think about how you might approach history in a different way"; Oxford historian P33 discussed the stimulation of "investigating phenomena…that lack a historical perspective". Oxford historian P7 credited teachers for shaping habits of thought where there were no "dictated notes" but rather "It was very much about argument…based on the evidence". These early orientations reinforced interpretive and evidence-based mental models central to historical thought.

For medical researchers, intellectual curiosity was intertwined with social and ethical motivations (medical scholars P22, P24, P28, P34, P37). Glasgow medical researcher P24, for example, described how they found biological research and the pursuit of understanding disease "beautiful". Others linked research to impact: "I like things where I could directly see an impact of my work" (Oxford medical

researcher P37). Whilst motivated by similar reasons, one public health specialist chose a non-clinical route because of the stress of patient care (Oxford medical researcher P34). These reflections situate medicine's mental models within a continuum of scientific analysis and human care.

These individual aspirations merged with formative academic experiences. Family and early educational influences were discussed as catalysts, as Oxford chemist P6 recalled the inspiration sown by their parents. Glasgow legal scholar P14 described their passion for human rights and justice as a young person. Historians P15 (Glasgow) and P33 (Oxford) reflected on how a multilingual and international upbringing shaped their comparative orientation. Others developed hybrid intellectual frameworks through early interdisciplinary exposure at the university. Oxford chemists P10 and P35, for example, had been trained in physics and later moved across departmental boundaries. This experience shaped their hybrid cognitive styles and sense of disciplinary flexibility, positioning them ideally to work in physical chemistry.

These differing motives and influences shaped participants' early mental models of their disciplines, ranging from idealistic and impact-oriented to logical and pragmatic. The narratives suggest that both biography and training inform disciplinary identity formation. Beyond these aspects, there were also in-person and virtual social networks that were found to shape scholars' mental models, which is supported prior studies of mental models developed in collective settings (Banks and Millward, 2000; Mohammed, Ferzandi and Hamilton, 2010; Uitdewilligen *et al.*, 2021).

Conferences, for example, functioned as key information worlds (Jaeger and Burnett, 2010; Burnett and Jaeger, 2011), where disciplinary norms and values—particularly in relation to scholarly communication—were both enacted and reproduced. Across disciplines, participants described these events as important sites for staying up to date on what and who mattered in their fields—whether through formal presentations or informal exchanges. Chemist P6 viewed conferences strategically for mapping competitors, whilst other chemists, historians, and law academics discussed conferences as a means of knowing what is new and relevant in their fields and inviting discussion on their own work. Conferences were described as sites where disciplinary identities were collectively maintained through social interaction and knowledge acquisition.

Alongside formal social gatherings, scholars increasingly relied on informal and virtual networks that served as information grounds (Fisher and Naumer, 2006), or social settings in which information is exchanged spontaneously. Across disciplines, "word of mouth" (P3, P18, P36, P38) was discussed as a significant mechanism for identifying, validating, and sharing key information. These dense, overlapping

interpersonal networks, including lab groups, college ties, specialist communities, and project collaborators, enabled efficient knowledge circulation shaped by trust.

Social media extended these information grounds into virtual spaces. Platforms such as Twitter/X, LinkedIn, WhatsApp, and academic blogs became dynamic sites where scholars discovered new work, monitored emerging debates, and disseminated their own research. Chemists and medical researchers valued these virtual networks for their collegiality and immediacy, whilst legal scholars used them to track developments in legal cases and access dispersed grey literature through blogs. These digital social communities acted as fluid, real-time extensions to more formal, physical disciplinary networks, forming an evolving information world that informs scholars' mental models.

7.1.3 Everyday physical environments

During data collection, it became apparent that physical and social environments constituted a significant aspect of scholars' mental models, prompting the addition of an observational element in the methods and the in-depth exploration of this theme in Chapter Six. Work environments revealed how mental models are not only cognitive but also spatially and materially grounded, an emphasis shared by LIS studies emphasising place/space (Savolainen, 2006; Buschman and Leckie, 2007; Pomerantz and Marchionini, 2007; Pilerot, 2012; Gibson and Kaplan, 2017; Olsson and Lloyd, 2017). Section 7.1.1 explored how the spatial organisation of universities, libraries, and archives shaped mental models and Section 7.1.2 touched on formal and virtual social spaces. Beyond this, daily physical environments, such as laboratories and offices, and the tools and materials therein, revealed that these spaces reflect and reinforce disciplinary culture and values, shaping how scholars conceptualise knowledge in their fields.

Physical settings featured prominently in the drawings of several scholars when asked to depict their discipline, indicating how much *where* their work took place was integral to their research and how they conceptualised it. Glasgow biomedical researchers P22 and P24, Glasgow chemist P20 and P25, Glasgow historians P27 and P29, and Oxford legal scholars P38 and P40 included illustrations of laboratories, office desks, field sites, and even the pub.

For laboratory-based researchers in chemistry and medicine, proximity and layout fostered and enabled collective task distribution and problem-solving. Oxford chemist P6 described the rhythm of daily interaction as integral to scientific life; similarly, Oxford medical researcher P36 highlighted how open-plan labs and offices compel people to interact. Habitual engagement fostered a mental model of

chemistry and medicine as a "shared" endeavour—science as socially enacted through material proximity. At the same time, hierarchies were also inherent in the layout of scientific spaces, as younger researchers shared offices and laboratory space, whilst senior academics typically had private offices near the experimental facilities, both to be part of the research group and to monitor and manage their teams.

Laboratory environments could also feel isolating. Glasgow toxicologist P19 described their former forensics laboratory as "very cold, and sometimes isolated… It's a very stressful environment." The physical and emotional atmosphere here mirrored a conception of scientific work as pressured and procedural rather than collegial, prompting this participant's eventual shift toward a different field, health economics. Spatial design thus not only enabled but also constrained and shifted scholars' sense of belonging and intellectual identity.

Office environments revealed disciplinary contrasts. One senior medical scholar's office was designed as a multifunctional "microcosm" of academic life, reflecting personal, administrative, and intellectual dimensions at once; P18 described theirs as "the full living experience… fridge freezer, microwave, full change of clothes," as well as a meeting desk and large monitor, reflecting a model of academic life as multifaceted and immersive. Chemists' offices, equipped with whiteboards and, in one case, physical models of molecules, facilitated visual-spatial thinking and expression. As P20, an inorganic chemist, explained, "If you have written [it] down on a whiteboard, it's easier to see something that you haven't thought [of] before." These setups reflected disciplinary cultures of tactile, visual, and embodied practice.

By contrast, historians' and law scholars' offices tended to mirror their text-based orientations. Visual expression even signalled conceptual failure rather than insight for one participant (Oxford legal scholar P39), in contrast to chemists' ways of thinking. Extensive bookshelves organised by topic, course, and book type (art, bibliography, etc.), structured space and thought alike. Historians' book-lined offices served both practical and symbolic functions, aligning with Lee and Ocepek's (2022) notion of material spaces as co-constitutive of creative practice. One historian (Oxford P5) had built up their personal collection over the years, with the overflow in their home, and had custom-built double bookshelves along their walls to hold all their books. Legal scholars relied on structured legal texts, in P4's case, organised neatly according to themed series, which supported systematic argumentation. Offices in these cases served as repositories of knowledge and reflections of a scholar's career, with their own internal order, reinforcing a mental model of knowledge as text-based and self-contained.

Outside formal spaces, informal encounters were equally significant. Across institutions, pubs, dining halls, and common spaces in department buildings emerged as crucial "third places" (Oldenburg, 2023), or informal sites where communities are sustained. Oxford chemist P1 recalled that one of their cross-

disciplinary collaborations began “just sat next to someone at lunch… we realised we were doing similar things.” For Oxford law scholar P38, disciplinary dialogue unfolded in more convivial settings: “Pub and dinner—that’s because you go out and talk law with your friends all the time. You transmit knowledge and you gather knowledge in a very social context.” Such exchanges reveal how disciplinary thinking is often advanced through embodied, social practices in a range of physical settings rather than purely formal ones. Historians, whilst often solitary in their daily work, also relied on such spaces for intellectual stimulation. Serendipitous encounters led to lasting collaborations, as Glasgow historian P15 recalled: “It started over a conversation and coffee in the gardens of Herzog August library”. These accounts underscore how seemingly peripheral environments act as catalysts for scholarly connection and knowledge exchange.

Altogether, these accounts suggest that the physical and material aspects of academic life—from bookshelves to office layouts—are constitutive of how scholars think. They mediate both collaboration and solitude. The laboratory fosters shared problem-solving; the office manifests disciplinary order; the pub or dinner venue enables reflection and debate. These spaces collectively show that mental models are not abstract schemas but lived ecologies, continually shaped by the physical and social architectures through which academic work unfolds.

Factors that did not shape participants’ mental models, that shaped them less, or that fell outside the study’s scope also deserve mention. Career stage and seniority shaped the scope of scholars’ views of the field, their spatial autonomy, their networks, and their expectations, whilst the underlying mental models remained similar to those of others in the same discipline. This was particularly salient in the sciences: postdoctoral medical researchers P24, P36, and P37 depicted or described a narrower view of the field, drawing lab benches or noting the absence of private space, compared with more senior researchers who occupied their own offices and carried wider responsibilities, networks, and perspectives on the field. Career stage was not, however, a category built into the study’s design, and as any researcher beyond the PhD stage could participate, postdoctoral researchers were unevenly distributed across the four cases, with Medicine having the most (five of the ten participants). Gender was likewise not within the study’s scope. Institutional differences, discussed in Section 4.4, shaped how scholars understood their disciplines within their particular institutional contexts, including their expectations and assumptions about how knowledge is organised; the underlying shapes of their mental models, however, remained consistent across the two universities, foregrounding discipline as the differentiating factor.

Several of the findings were unexpected and are worth drawing out because each complicates an assumption in the existing literature. The first was the self-doubt of senior scholars: experienced

researchers, including established legal academics and historians, described themselves as "not very good" at searching, internalising as personal inadequacy what this analysis identifies as system misfit. The mental models literature would predict the opposite: expertise and repeated use should produce better adapted models (Zhang, 2013; Han et al., 2020). That seniority did not confer confidence suggests the deficit lies in the system's model of knowledge rather than the user's, reversing the direction of the deficit framing that has dominated LIS mental models research (see Cole et al., 2007; Borgman, 1986b).

The second was the emergence of spatiality and materiality as constitutive rather than contextual. Participants did not merely work in laboratories, offices, and archives; they thought with them—a finding that emerged through the drawings and accounts, prompted changes to the interview design, and ultimately required a chapter of its own. Whilst sociomaterial perspectives are well established in the information practice literature (Huizing and Cavanagh, 2011; Lloyd, 2010; Olsson and Lloyd, 2017; Olsson et al., 2018; Orlikowski, 2007), mental models research has treated cognition as placeless; these findings suggest it cannot be.

The third was the fluid and nested identity of scholars who move between or work within multiple overlapping disciplines (Brew, 2008; Sugimoto and Weingart, 2015). The mental models tradition assumes a stable knower, and institutional disciplinary organisation appears rigid, but participants were not stable in that sense, with the same scholar identifying as a historian, a medieval historian, or a "charter person" depending on context, whilst others, including senior scholars, questioned whether they belonged to their discipline at all. Rather than undermining the disciplinary findings, this fluidity helps explain how the models attached to such situational identification may be correspondingly plural and context-dependent, supporting this thesis's re-conception of mental models as adaptive rather than fixed.

Finally, variation in ways of thinking did not always fall along disciplinary lines. Transactional, reductionist, and bottom-up styles of thinking recurred across formally unrelated specialisms—commercial law with economic history, physical chemistry with private law, oral history with sociolegal studies—suggesting that the specialism, not the discipline, is sometimes the operative unit of scholarly mental models. This extends observations of sub-disciplinary variation in RIN (RIN and British Library, 2009; Meyer et al., 2011; Bulger et al., 2011) and Ithaka S+R (2012-2020) studies and complicates the disciplinary landscape beyond the "two cultures" binary (Snow, 1959) and the tribal metaphor (Becher and Trowler, 2001).

Thus far, sections 7.1.1 to 7.1.3 offered a layered account of the factors shaping scholars' mental models. In participants' accounts, mental models emerged as adaptive, embodied, and socially situated constructs, shaped by intellectual traditions, institutional structures, individual trajectories, social norms, and material

environments. Altogether, these findings support the claim made at the outset that this is less a cognitive study in an HCI sense than a cultural one. The shapes of knowledge, the motives and trajectories that lead scholars into their fields, and the offices, laboratories, archives, and pubs in which they work and exchange knowledge, are not solely influences acting on an individual's mind but different facets of disciplinary culture, a culture learned through training, shared within communities, and enacted in everyday practice. This thesis offers a bottom-up account of scholarly culture in UK higher education, built from researchers' own drawings and descriptions rather than from curricula, institutional categories, or data from systems. It complements existing scholarship on epistemic cultures (Knorr-Cetina, 1999), academic tribes (Becher and Trowler, 2001; Trowler, Saunders and Bamber, 2013), and the sociology of knowledge (Kuhn, 1962; Whitley, 2000; Barnes, 2013). Whereas these describe disciplinary cultures at the level of the collective, this study shows how such cultures are carried and reproduced by individual scholars, and how they meet the information systems those scholars use.

7.2 Cross-disciplinary insights

Whilst there were clear disciplinary distinctions in participants' mental models, shared themes and patterns also emerged across the four cases. Academic identity appeared fluid rather than fixed, as scholars navigated multiple social contexts within academia. Certain specialist research areas required methods and approaches that diverged from disciplinary conventions, at times resonating more closely with modes of thinking found in other disciplines or subdisciplines. This section examines these two themes: disciplinary identification and shared cognitive patterns across specialisms.

7.2.1 Negotiating disciplinary identity

Disciplinary identity emerged as layered, shifting, and continually negotiated in relation to audience, methodology, and institutional context. Participants positioned themselves as insiders, outsiders, or somewhere in between, reflecting what Brew (2008) describes as the fluid and relational nature of academic identity.

These complexities were particularly visible during the cognitive mapping exercise, where participants were invited to draw their discipline. Several expressed discomfort with the task, questioning the premise of a fixed disciplinary form. A Glasgow historian declined to draw altogether, whilst another focused on

their methodological practice—oral history and archival research—rather than the conceptual aspects of their discipline, explaining that they did not feel they belonged to any single discipline. Such responses suggest that for some scholars, disciplinary knowledge and identity cannot be easily visualised precisely because they are not static, singular, or contained.

As discussed in Chapter Five, participants often redefined their sense of belonging as they moved across academic environments and research problems. Some operated at the intersection of disciplines, such as organic chemists P2 and P21, who bridged chemistry and biology, whilst others experienced their disciplinary self-understanding as nested and situational. As Glasgow historian P29 described, identity could shift from "historian" to "medieval historian" to "charter person", depending on audience and context.

This fluidity was evident across all four disciplines. Historians often framed themselves as "unusual" or "in between" because their work straddled multiple intellectual traditions; medical researchers such as P22 navigated tensions around legitimacy within tightly bounded biomedical communities; and legal scholars such as P40 constructed hybrid scholarly identities that drew on both doctrinal and sociolegal approaches. In the sciences, physical chemists P6, P10, and P35 navigated porous boundaries with physics, revealing distinctions in how fields define valid inquiry, as participants drew on principles and methodologies from both fields. These feelings of disciplinary uncertainty were embedded in self-narratives of education and career trajectory, echoing Cuevas-Garcia's (2021) argument that "disciplines are also in part established, maintained, and reproduced through the narratives that individuals tell about themselves…as individuals construct their identities, they also construct the identity of their disciplines."

These findings suggest that fluid identities arise not only from mismatches between institutional categories, research foci, and personal identification but also from scholars' capacity to actively shape disciplinary narratives. In this view, individuals are not only inhabiting or negotiating between disciplines but are also participating in their ongoing construction.

Overall, the findings support arguments that disciplines remain meaningful categories, yet disciplinarity is inherently fluid and contingent (Brew, 2002, 2008; Sugimoto and Weingart, 2015). For some participants with single disciplinary backgrounds, affiliation remained strong and stable; for others, it was shifting, uncertain, and context dependent. Educational background, career mobility, institutional roles, and evolving research interests all contributed to how scholars located themselves within or between disciplines. As academic work becomes increasingly collaborative and interdisciplinary (Trowler, Saunders and Bamber, 2013), these findings underscore the need for more flexible models of

disciplinarity—models capable of capturing the complex, situated, and evolving nature of scholarly identity.

Becher and Trowler's (2001) notion of disciplines as "academic tribes", each with its own culture and norms continues to hold explanatory power (Simula and Scott, 2021; Tellmann, 2022). Yet subsequent work by Trowler et al. (2013) acknowledges that disciplinary boundaries are porous and increasingly challenged in a landscape of interdisciplinary and problem-based research. Whilst institutional classifications and pedagogical frameworks may impose formal categories, the realities of scholarly practice are far more fluid and negotiated.

Whitchurch's (2008, 2012) concept of the "third space" in higher education, where academic and professional roles intersect, further illustrates how scholars working across disciplinary domains often occupy liminal spaces which can enable innovation but also produce feelings of marginality or uncertainty, sentiments echoed by participants in this study.

Whilst disciplinary identity was shown to be fluid and context-dependent, another key theme to emerge was the presence of shared cognitive approaches across specialisms. Despite distinct institutional and disciplinary affiliations, some researchers described similar ways of framing problems, interpreting data, and structuring knowledge. These cross-cutting cognitive strategies appear to transcend formal disciplinary boundaries, a theme explored in the following section.

7.2.2 Shared cognitive orientations

Although the findings highlight disciplinary distinctions, notable parallels also emerged in the reasoning patterns described by researchers working across different specialisms. Three broad modes of thinking were particularly evident:

- Transactional thinking: visualising networks or systems (equity/commercial law, economic history, and health economics).
- Reductionist thinking: breaking complex problems into smaller components and identifying underlying principles (physical chemistry, biomedicine, and property law).
- Experiential thinking: grounding inquiry in lived experience (oral history and sociolegal research).

A recurring pattern was transactional or systems-based reasoning, characteristic of researchers in commercial law, economic history, and health economics. These scholars tended to conceptualise knowledge as a network of agents, flows, or relationships. For instance, P38, an equity law scholar, drew a diagram of relationships to illustrate a legal theory, whilst P16 (commercial law), P33 (economic history), and P19 (health economics) each produced schematic representations of financial or policy relationships. Such models reflected a way of thinking concerned with interconnection, process, and the movement of value or influence within systems, resonating with Gentner's (1983) structure-mapping theory, which posits that reasoning involves mapping and interpreting underlying relational structures of elements.

A second "reductionist" (P35, P36) mode of reasoning centred on simplifying complex phenomena through systematic deconstruction. This approach was especially evident in physical chemistry, biomedicine, and property law. Physical chemists P10 and P35 described reducing problems to their mathematical or theoretical essence. Biomedical researchers P24 and P36 applied a similar approach at the cellular or molecular level. P39, a property law scholar, offered a parallel analogy, likening legal reasoning to refereeing in sport: distilling the relevant rule based on precedents to apply to a given situation. Across these examples, researchers addressed complexity by stripping things down to their essential components or principles, applying tightly defined methods to reach precise conclusions.

By contrast, researchers in oral history and sociolegal studies described an approach grounded in lived experience. Oral historians P9 and P27 emphasised the value of collecting personal narratives to challenge dominant historical accounts. Similarly, legal scholars P12, P14, and P40, who researched contemporary social issues, gathered insights through interviews, conversations, and social media, often collaborating with scholars or practitioners in related fields. In each case, inquiry was grounded in the lived experiences of individuals and communities, emphasising interpretive richness over abstraction or reduction.

These findings challenge enduring binaries between the sciences and humanities (Snow, 2008) and question the territorial metaphors of "academic tribes" (Becher and Trowler, 2001; Trowler, Saunders and Bamber, 2013). They suggest instead that whilst disciplinary training provides a general orientation, researchers' cognitive strategies may respond more directly to the demands of their specific specialism or research problem. This supports foundational theorists in information behaviour who view reasoning and information seeking as contextual, evolving, and situated within particular tasks or domains of work (Dervin, 1983a; Bates, 1989; Hjørland and Albrechtsen, 1995), as well as scholarship identifying shared methods and information practices across the humanities and social sciences (Ellis, 1989b; Unsworth,

2000). The RIN studies (Research Information Network and British Library, 2009; Bulger *et al.*, 2011; Meyer *et al.*, 2011) also highlighted how sub-disciplinary cultures differ, and Jamali and Nicholas (2008) noted in their study of physicists and astronomers that there can be sub-disciplinary characteristics that are significant and should not be overlooked. The findings from this study thus offer a multi-dimensional view of scholarly practice and mental models: grounded in discipline, shaped by context, and negotiated through everyday practice.

Having established this picture of disciplinary mental models, the following section examines how these ways of thinking interact with the information systems scholars use to locate and make sense of information. Disciplinary reasoning does not develop in isolation but is shaped through encounters with both digital and physical infrastructures of discovery. The following section explores these interactions, exploring how researchers navigate, adapt to, and negotiate with the tools that mediate access to scholarly information. Rather than measuring the accuracy or alignment of mental models to information systems as previous studies of search and retrieval have done (Zhang and Chignell, 2001; Cole *et al.*, 2007; Zhang, 2013; Han *et al.*, 2020), this study adopts a situated perspective, attending to how scholars interpret and respond to system affordances in practice.

7.3 Navigating the gaps: embedding information systems in users' life worlds

Wilson's (1981) "universe of knowledge" model, though subsequently refined in later iterations, remains valuable for depicting a holistic view of the user's information world, where users, systems, and resources form overlapping and interdependent constellations. This model depicts information systems as integral to, rather than separate from, the user's life world. Systems and users coexist within the same environment, shaping and being shaped by the social, institutional, and intellectual contexts in which scholarship occurs. This perspective reinforces the need to examine how disciplinary ways of knowing influence engagement with systems, and how systems, in turn, shape those ways of knowing.

Building on this view, the discussion draws on Pratt's (1991) notion of contact zones to conceptualise the intersections between disciplinary mental models and system architecture. Rather than assuming simple alignment or misalignment, these intersections represent dynamic spaces of negotiation. This perspective resonates with Borgman's (1986b, 2010) critique of system-centric expectations of users. Systems are not neutral or equitable but embedded with cultural, technical, and institutional assumptions (Noble, 2018;

Costanza-Chock, 2020; Hyning, Jones and Wagner, 2024). Scholars are neither passive recipients nor fully accommodated by technology; instead, both users and systems co-construct the search experience.

In highly codified domains such as chemistry and law, disciplinary taxonomies and conceptual categories from the disciplinary discourse are often mirrored in system architecture, facilitating relatively smoother pathways for discovery. Medical researchers also benefit from controlled vocabularies such as MeSH and formal training in systematic searching. By contrast, historians and sociolegal scholars work within a fragmented information landscape, comprising bespoke databases, partial digitisation, and uneven metadata. Because library interfaces and general search tools rarely provide the contextual transparency these scholars value, they often rely on workarounds such as serendipitous browsing, personal collections, and peer recommendations to locate relevant sources.

The interaction between disciplinary mental models and system design is therefore complex and evolving. As P38 (Oxford, Law) observed of Westlaw, “My mind’s in it now. And so, I know how it works.” This comment captures the process of adaptation and internalisation through which repeated use engrains system features into scholars’ conceptual frameworks—a process also noted in studies of how users’ mental models evolve through experience (Zhang, 2013; Han *et al.*, 2020). Yet such integration is contingent, depending on design features, search architecture, disciplinary conventions, and individual familiarity.

Previous studies offer useful parallels. The final RIN study (Meyer *et al.*, 2011) found that, compared with physical scientists, humanists often developed sophisticated strategies for navigating information despite using comparatively simple technologies. Similarly, in this study, historians engaged strategically with digital tools—sometimes even building their own—to access to rare or obscure materials, echoing earlier findings on the persistence of humanities scholars in overcoming technical limitations to get to the sources they need (Warwick, Terras, Huntington, *et al.*, 2008; Bulger *et al.*, 2011; Whitelaw, 2015). Chemists benefited from highly tailored systems yet still relied on personal networks and subfield-specific strategies. Law and medicine, though supported by centralised repositories, also required improvisation in specialised areas. Across all disciplines, researchers described drawing on colleagues, prior knowledge, and persistence when information systems failed to meet their expectations and deliver what they were looking for.

A central theme to emerge was the ongoing negotiation between informal, community-based information flows and the formal infrastructures of information retrieval. In everyday academic life, knowledge circulates through situated networks, involving conversations, emails, listservs, and social media, which are governed by tacit hierarchies of trust, shared understanding, and disciplinary judgment. Within these

spaces, relevance and credibility are determined relationally through collective expertise. In contrast, formal systems such as databases and repositories rely on classificatory schemes that can feel opaque to users, as relevance is inferred algorithmically and context is often stripped away. As Marchionini (2006) argues, systems designed around short, transactional queries cannot adequately support exploratory or iterative forms of inquiry that characterise much scholarly research. Some scholars become adept at navigating these systems, particularly where systems are well integrated into disciplinary life—for instance, databases created by subject experts or accompanied by disciplinary training—yet others experience persistent disorientation. As P3 (Oxford, Medicine) reflected, "There's an ever-present danger of missing something."

These dynamics were most evident in history and sociolegal studies, where limited training and fragmented resources prompted researchers to depend on informal discovery practices, not only to find materials but also to interpret and contextualise them. Such practices do not operate outside formal systems but alongside and in response to them, filling the gaps where systems fall short. They are guided by researchers' mental models of where knowledge resides and what constitutes meaningful information. In contrast, disciplines such as chemistry and law demonstrated stronger continuity between mental models and system design, supported by stable terminologies and well-established, centralised repositories.

These differences reveal not a binary but a spectrum of relationships between disciplinary practice and system design. In some disciplines, systems act as extensions of scholarly reasoning; in others, researchers must draw more heavily on community-based modes of knowing. Information systems should thus be understood as part of the broader universe of knowledge in which human and technical agents continually interact and negotiate the conditions of knowing. Furthermore, the interface between researchers and information systems is less a point of access than a dynamic site of negotiation. Systems are shaped by technical standards, design decisions, and commercial pressures, yet they also intersect with the lived realities of scholarly work. For researchers, these encounters are filtered through disciplinary mental models—frameworks for framing problems, seeking evidence, and ascribing value. Where systems resonate with these frameworks, they reinforce disciplinary habits and expectations; where they do not, they prompt adaptation and workarounds.

It is worth returning, finally, to the framing with which this thesis began. The Google-style search paradigm was introduced in Chapter One as the context that motivated the study. The findings now allow for a more precise statement of what is at stake in it. A single search box is not merely an interface choice; it embeds an implicit model of knowledge that is flat, keyword-based, ranked by algorithm, and

uniform across domains. The scholars in this study, however, carry different models: networked, hierarchical, cyclical, patient-centred, fragmentary, and torch-lit. The frictions documented in the preceding chapters are therefore best understood not merely as usability problems but also as collisions between different representations of knowledge, between the model embedded in the system and the model carried by the scholar. Critical scholarship on search has established that such embedded models are not neutral (Introna and Nissenbaum, 2000; Noble, 2018). Star's account of classification and infrastructure explains how they become invisible to those they fit and obstructive to those they do not (Star, 1999; Bowker and Star, 1999). What this study adds is the other half of the encounter: a grounded account of the disciplinary models with which the system's model collides, and of the costs of this friction—including workarounds, internalised self-doubt, and reliance on informal networks—borne by scholars whose ways of knowing the search paradigm does not accommodate.

This framing also clarifies the significance of the study's timing. Data collection concluded in 2023, at the threshold of a further development: generative AI tools. These now increasingly mediate scholarly discovery, synthesising answers rather than returning ranked lists of sources. Such systems are likely to intensify the dynamic this thesis describes; they embed a model of knowledge that is even less visible to the user, and even further removed from the structured, contextual, and relational models that scholars carry. Thus, the findings presented here offer more than a portrait of a transient search paradigm: they provide a baseline from before generative AI's integration into scholarly discovery as well as an analytical vocabulary for asking of any discovery technology the question this thesis has asked of the search box: whose model of knowledge does this system embed, and at whose cost?

7.4 Towards more disciplinarily responsive library systems

The preceding discussion showed that disciplinary mental models interact in complex ways with the information systems they use. These systems, though designed to organise and deliver knowledge efficiently, are not always experienced as supportive or transparent. Scholars often navigate them through adaptation, workarounds, and community-based exchange, revealing the need for infrastructures that more accurately reflect the diversity of academic practice. This section considers how these findings might inform the future design of library systems, services, and institutional support.

Library and information systems have traditionally been built around a standardised model of knowledge organisation (McDonald and Trujillo, 2024), expecting individuals to adapt to existing systems. Yet, as this study and others suggest, the relationship between systems and users is negotiated rather than one-

directional. Designers should recognise the disciplinary contexts in which search takes place and embed flexibility, transparency, and opportunities for feedback wherever possible (Makri *et al.*, 2007b; Huber, 2021; Hyning, Jones and Wagner, 2024). Participatory and user-experience approaches in library design emphasise the value of systems that are co-created with users and responsive to local, contextual needs. In this sense, library interfaces can be understood not simply as technical gateways, but as evolving social artefacts shaped through dialogue between users, designers, and disciplinary cultures.

Information practices are not uniform but embedded in the research methods and communication norms of each field (Case, Given and Willson, 2023). In this study, chemists and legal scholars described using structured systems aligned with the formal organisation of their research objects—chemical compounds, case law, and statutes—whilst historians emphasised interpretive, serendipitous, and contextual strategies. Crymble's (2016) study of historians' digital practices similarly shows that historians expect search tools to mirror the exploratory and interpretive dimensions of their work, underscoring the importance of discipline-sensitive design. Medical researchers, by contrast, worked across both formal systems such as PubMed and informal networks of expertise, reflecting the standardised and team-centred nature of their field.

The implications of this study for system design are that information systems should not be treated as neutral or isolated platforms, but as situated interfaces, or contact zones, where mental models, disciplinary conventions, and technical constraints meet. Friction often arises when system structures fail to meet users' conceptual frameworks. The findings resonate with Star's work on infrastructure and classification. Star (1999) observed that infrastructure is relational—what functions as invisible and taken-for-granted for one community may be an obstacle to another—and that it is learned as part of membership in a community, becoming visible primarily in moments of failure. This describes precisely the disciplinary asymmetries documented in this study: for chemists and legal scholars, whose specialist databases were built to mirror disciplinary taxonomies, information infrastructure recedes into the background of practice; for historians, whose modes of thought the dominant search paradigm does not accommodate, the infrastructure is persistently, frustratingly visible. Bowker and Star (1999) further showed that classification systems embed the values and assumptions of their makers and exert "torque", or a forced twisting, on the lives of those whose experiences misalign with existing categories. The self-doubt expressed by senior scholars in this study—the internalisation of system misfit as personal inadequacy—can be read as torque in exactly this sense. Read alongside the contact zone, Star's work clarifies what is at stake in disciplinarily responsive design: not merely improved usability, but the redistribution of infrastructural visibility and friction across scholarly communities.

Rather than attempting to eliminate such friction through complete standardisation, designers might instead accommodate multiple search styles, including exploratory, iterative, and socially mediated practices (Marchionini, 2006; White and Roth, 2009). Drawing on Unsworth's (2000) argument that tools should reflect the scholarly practices they are intended to support, designers might consider features such as relevance rankings that are more transparent or tailored to a specific community—in the way Jatowt et al. have done in their development of unique ranking criteria (2024)—as well as filtering and metadata that reflect disciplinary specificity, in the way chemical databases do best. A decade ago, Whitelaw (2015) advocated for "generous interfaces" and similarly advocates for systems that promote transparency and contextual richness, enabling users to engage more openly with collections rather than being constrained by minimal search boxes or hidden algorithms. These design principles can foster greater user trust and engagement, particularly in disciplines such as history where hierarchy and context are especially important.

Beyond design, institutional support plays a critical role in bridging the gap between formal and informal knowledge practices. Across all disciplines, participants emphasised the importance of peer recommendations and community discussion—through listservs, conversations, conferences, messaging groups, and shared resources—in identifying relevant literature. This aligns with prior studies showing that informal, socially embedded knowledge exchange remains central to scholarly communication (Fry and Talja, 2004, 2007; Fry *et al.*, 2016). Libraries can help legitimise and support these practices by acknowledging that access to information is not purely a technical or cognitive problem but also a social and affective experience shaped by confidence, belonging, and community participation.

In practical terms, libraries can act as mediators between systems and users, supporting variable and context-sensitive guidance. Existing library services and expertise, comprised of subject librarians, discipline-specific workshops, and tailored resource guides, can help align system functionality with scholarly expectations by liaising more closely with their local disciplinary communities and their needs, particularly in subjects or specialisms where there are few generalist, centralised databases and scholars rely on grey literature and/or scattered repositories for information. Workshops might not only demonstrate how to use a database but also explain *why* it is structured in certain ways and what implications this has for discovery in a particular domain—a form of critical information literacy that deepens researchers' understanding of how systems shape what can be known. This echoes Dempsey's (2020) call for libraries to adopt an "outside-in" perspective: to view discovery from the standpoint of complex, networked research environments whilst maintaining a focus on the specific needs of their local scholarly communities.

Finally, libraries—both digital and physical—can function as connective infrastructures, where formal systems intersect with the informal, social, and networked dimensions of academic life. Initiatives such as virtual reference services (Arnold and Kaske, 2005; Côté, Kochkina and Mawhinney, 2016; Estes, Twomey and Johnson, 2024; Yang, 2024; Nogueira, 2025) already reflect this potential, but do not yet provide services tailored to disciplinary needs and expectations. Adding more nuance to these and other services, such as workshops and resource guides, in ways that explicitly recognise the disciplinary diversity of research practices could make libraries more equitable and responsive. Enhancing access to academic information therefore requires more than improving system efficiency: it calls for a deeper understanding of scholars' epistemic beliefs, expectations, and disciplinary assumptions. Designing library systems as situated, negotiated interfaces—rather than standardised delivery mechanisms—offers a way to support plural knowledge pathways and the multiplicity of contemporary scholarship.

7.5 Limitations

This study has provided substantial, in-depth insights into the disciplinary mental models that shape academic information practices across four disciplines at two UK universities, yielding rich and context-specific qualitative data. It demonstrates how disciplinary ways of thinking influence how scholars conceptualise, seek, and use information—an aspect often overlooked in existing LIS research. In highlighting these disciplinary variations, the study contributes to ongoing debates about how library and information systems can more effectively respond to the cognitive, cultural, and methodological diversity of scholarly work (Unsworth, 2000; Crymble, 2016; Seale, Hicks and Nicholson, 2022; Dempsey, 2020).

The study was conducted between spring and autumn 2023, a period marked by significant technological changes, including the rise of generative AI tools such as ChatGPT and Claude, and changes to major social media ecosystems such as the change in ownership of Twitter/X (Quelle *et al.*, 2025). These developments have been reshaping how academics perceive and engage with digital tools, informal networks, and knowledge infrastructures. The present findings therefore capture a particular moment in time—just before these shifts gained wider momentum—and offer a baseline for future studies examining how such technologies may reconfigure mental models and scholarly practice.

Mental models, by their very nature, are challenging to study. They are internal, cognitive representations that cannot be directly observed and are inherently dynamic (Norman, 1983; Johnson-Laird, 1983). The analysis presented here captures a snapshot within an evolving academic landscape. These models shift over the course of careers, projects, and technological transitions; what is presented is not a definitive or

fixed account, but a grounded exploration of how disciplinary perceptions and information practice intersect at a particular historical juncture.

There is, in addition, the difficulty of representing knowledge at all, something this study encountered at two levels. Participants encountered it when asked to draw their disciplines, as some produced images fluidly, others hesitantly, others only in words, and one declined to draw altogether. Whilst these different responses also reflect differences in people's comfort with drawing, these struggles were treated as data, as they also pointed to something the findings repeatedly confirmed: disciplinary knowledge is lived relationally, whether through training, conversation, spaces, or practices, and any static representation of it is a reduction. The same difficulty exists in relation to this thesis's own central finding. Norman's (1983) distinction between the target system, the designer's conceptual model, the user's mental model, and the scientist's conceptualisation of that mental model anticipated this problem. Each layer is a representation of a representation. The four shapes add a further layer, as the researcher's representations of participants' representations, produced through the interpretive processes described in Chapter Three. This is a finding in its own right, and one that speaks to longstanding debates about what can and cannot be captured formally (Bowker and Star, 1999); knowledge organisation systems and cognitive maps are situated attempts to capture statically something that is processual. The approach this thesis has attempted, following its holistic framework (Polkinghorne and Given, 2021), is not to give up representation but to hold it lightly: to produce models whilst declaring their situatedness, and to keep the relational life of knowledge in view throughout.

Whilst the study drew on cognitive mapping, interview, and observational data to infer participants' mental models, such qualitative approaches necessarily involve interpretation. Future work could extend these insights by exploring how mental models evolve longitudinally or across different institutional and geographical settings. Systematically examining perspectives across career stages, from doctoral researchers to senior scholars, could help to illuminate how disciplinary understanding develops and transforms over time.

Another boundary concerns disciplinary scope. The selection of chemistry, history, law, and medicine enabled comparison across distinct academic cultures, but findings should not be generalised to all scholarly domains. Subfield variation, particularly in medicine, revealed notable differences between specialisms, especially between clinical and non-clinical researchers, suggesting that disciplinary identity and information practice are more internally diverse than categorical labels imply. Expanding the scope to include the social sciences, engineering, or the creative arts would further enrich understanding of how disciplinary mental models manifest across the academic spectrum.

The study also foregrounds a gap between library users' mental models and system design. Whilst previous work in library and information science has emphasised the importance of designing tools that reflect scholarly practices, there remains limited empirical evidence on how disciplinary mental models and disciplinary differences are, in practice, translated into system or interface design. Approaches in library UX and participatory design, applied critically and with care (Lanclos and Asher, 2016; Costanza-Chock, 2020; Seale, Hicks and Nicholson, 2022), offer valuable frameworks for bridging this gap by engaging users more directly in the co-construction of systems and services. However, this study did not engage directly with user interface (UI) or user experience (UX) designers, nor did it examine the design rationales behind academic platforms. Understanding whether and how designers incorporate disciplinary mental models into system architecture would help contextualise user–system interactions more fully and could facilitate closer collaboration between researchers, libraries, and developers.

7.6 Future research directions

Whilst this study contributes to understanding disciplinary mental models and their relationship with information systems, much remains to be explored. The field is dynamic and increasingly shaped by technological, institutional, and cultural change. The following areas represent directions for further research.

1. Mental models in other disciplines

The study focused on four disciplines (chemistry, history, law, and medicine), but future work could extend this approach to other domains such as engineering and the creative arts. Broadening disciplinary scope would help develop a more comprehensive understanding of how knowledge is conceptualised and organised across academia.

2. Emerging technologies and artificial intelligence (AI)

The rise of generative AI and AI-assisted research tools presents both opportunities and disruptions to scholarly information practices. Future research could investigate how these technologies influence scholars' conceptual frameworks: do they support, reshape, or even displace existing mental models of knowledge? Recent studies have begun to explore AI in the library and information domain (Estes, Twomey and Johnson, 2024; Yang, 2024; Gorichanaz, 2025; Nogueira, 2025), even in relation to mental models (Degachi *et al.*, 2025). However, disciplinary differences remain unexplored. Examining how AI-assisted tools interact with disciplinary ways of thinking will be important for understanding future directions of scholarly work.

3. Longitudinal perspectives

Mental models are not fixed but are shaped by various individual, social, and institutional factors, as this study explores. Longitudinal studies could trace how researchers' mental models and information practices develop across career stages, from doctoral training to senior academic roles. Such work would extend earlier studies that have gestured towards developmental trajectories in mental models, such as Mlilo and Thatcher's (2014), but remain rare.

4. Cross-cultural, interdisciplinary, and international comparisons

Academic disciplines are not experienced uniformly across institutional, regional, or national contexts. Comparative research could examine how cultural norms, educational systems, and research policies shape disciplinary mental models and information practice in different regions.

5. Collaboration with system designers

Future studies could also include the perspectives of those who design and maintain academic information systems. How do designers conceptualise their users, what assumptions underpin interface design choices, and to what extent are users' mental models considered? Building partnerships between researchers, designers, and librarians could help bridge the gap between user studies and system development, producing tools that better reflect scholarly reasoning and disciplinary diversity.

6. Collaboration with subject librarians

Subject librarians occupy a unique position between researchers and information systems. As specialists in disciplinary resources and practices, they hold valuable insights into how scholars conceptualise and seek information. Engaging subject librarians in research on mental models could deepen understanding of disciplinary knowledge structures and support the development of more contextually informed library services.

7. The role of funding, policy, and evaluation frameworks

Several participants in this study noted that funding, institutional policies, and research evaluation frameworks shape what kinds of questions can be asked and how they are pursued. Future research could explore how these structural conditions influence disciplinary norms, researchers' mental models, and the design of research infrastructures, building on the foundational analyses of Gibbons (1994), Henkel (2000), and Whitley (2000). National and regional differences may emerge in disciplinary mental models, given the specificity of systems with which academics work.

8. Mental models of spatial information environments

Finally, little is known about disciplinary differences in how scholars conceptualise the physical and spatial aspects of their information environments. Historians who recalled the layout of library floors or

researchers whose work was shaped by laboratory or office configurations revealed that spatial familiarity also informs mental models of knowledge. Future studies could examine how the design of scholarly spaces—physical and digital—supports or hinders disciplinary practice.

Continued research in these areas will not only enrich theoretical understanding but also help design more responsive systems, policies, and environments that support the diversity of scholarship.

7.7 Conclusion

Summary of the study

This study examined how scholars from four disciplines at two UK universities conceptualise and structure knowledge within their fields, drawing on a qualitative, interpretivist approach. It makes an original and significant contribution by demonstrating how disciplinary mental models are shaped by structural, individual, relational, material, and spatial dimensions. In doing so, the study advances a more holistic understanding of how scholars engage with information, both cognitively and contextually.

Mental models of knowledge were found not to be static, internal representations but socially constructed, materially mediated, and continually shaped over time. They model the expectations, beliefs, and assumptions about scholarly information that inform researchers' information practices across disciplines. This interpretation aligns with the works of Chatman (2000), McKenzie (2003), Fisher and Naumer (2006) and Talja and Hansen (2006), who view information practices as socially and discursively embedded.

Across all four disciplines, information practices emerged as collaborative, relational, and shaped by disciplinary and institutional culture. Historians engaged in resource sharing and creation; legal academics refined ideas through dialogue with colleagues; chemists and medical researchers worked in teams to identify new research directions. Such diversity challenges the universalist and individualistic models of information seeking that have historically dominated the field. Early theorists such as Johnson-Laird (1983), Norman (1983), and Gentner and Stevens (1983) conceptualised mental models primarily as internal constructs supporting individual reasoning. Whilst their frameworks remain influential, they underplay the cultural, social, and material dimensions that later research in information practice and mental models has brought to the fore.

The present study suggests that mental models are not only cognitive or functional schemas but also socially cultivated frameworks. How scholars locate, interpret, and evaluate information depends on shared disciplinary practices and discourse, as well as institutional training and structure. Building on existing studies of users' mental models (Brandt, 2001; Brandt and Uden, 2003; Westbrook, 2006a; Zhang, 2012; Given and Willson, 2014; Furlough and Gillan, 2018; Uitdewilligen *et al.*, 2021), this study shows that the effectiveness of information systems in academic contexts depends both on usability and technical performance as well as their resonance with users' disciplinary mental models and epistemic contexts.

Accordingly, this research reinforces critiques of system- and interface-centred understandings of users. It moves beyond depicting researchers as rational agents optimising queries, to instead foreground the social and cultural structures that shape what is sought and what is considered meaningful. This perspective aligns with Dervin's (1976, 1983b, 1983a) sensemaking theory, which frames information seeking as a communicative process for bridging knowledge gaps, and with Hjørland and Albrechtsen's (1995) domain analysis, which emphasises context and discourse in information practice.

Importantly, the study focuses not on scholars' mental models of systems or online tools, as is common in human–computer interaction and information science research, but on the disciplinary mental models that underpin how they approach, seek, and use information. It argues that disciplinary ways of thinking fundamentally shape researchers' engagement with information environments, extending beyond the interface level of interaction.

Conceptual findings

A key contribution of this thesis is the identification of disciplinary mental models expressed visually and conceptually through "shapes" representing how participants understood the structure of knowledge in their fields: the cyclical, patient-centred model in medicine; the torch-lit room in history; the networked schema and periodic table in chemistry; and the hierarchical, inverted tree in law. Whilst their underlying shapes remained broadly consistent across the two universities and across career stages, the ways in which these mental models were held, including scope, emphases, and expectations, are contingent on institutional environment, career stage and trajectory, individual motivations, and specialisation, illustrating how disciplinary thinking is embedded in social, material, and temporal contexts.

As noted above, these mental models are not fixed or universal. They are contingent on institutional environment, career stage, individual motivations, academic trajectory, and specialisation, illustrating how disciplinary cognition is embedded in social, material, and temporal contexts. Collectively, they show that mental models in academia are living and lived constructs that are contextually grounded, disciplinary in nature, and reflective of how knowledge is organised and valued across research communities.

Contributions to the field

This study makes four interrelated and original contributions to research on information practices and mental models. First, it advances understanding of how users' assumptions and expectations of information vary across disciplines. By introducing a holistic, empirically grounded approach, it extends earlier work on mental models and epistemic cultures to show that disciplinary patterns of thinking influence what scholars seek, how they search, and how they interpret information.

Second, it reframes user-system interaction as a negotiated process. Rather than assuming alignment or misalignment between systems and users, the study foregrounds the embeddedness of systems in users' information worlds. It reveals the interpretive negotiations that occur when scholars encounter the organising principles of digital and institutional systems, moving beyond functional or cognitive models of search.

Third, it offers implications for user-centred design in academic libraries and information systems. By recognising the layered roles of personal, interpersonal, spatial, material, and institutional environments in shaping scholarly thought, it calls for infrastructures that are responsive, inclusive, and context aware. Though two decades have passed since the emergence of the Google-like paradigm, search design has changed little. The findings here support a shift toward systems that treat disciplinary variation as a source of insight rather than an obstacle to standardisation, and that enable the multiplicity of scholarly practices to thrive.

Fourth, it offers a cultural account of scholarly knowledge. By investigating how scholars themselves describe and draw their fields, it shows that disciplinary mental models are learned, shared, and enacted within communities, and that disciplinary culture is reproduced not only through teaching and institutional structures but also through the everyday material and social features of academic life. In

offering this account, it connects research on epistemic cultures and disciplinary pedagogy to the study of information practice.

Final reflection

The study shows that mental models are best understood as adaptive and grounded frameworks shaped by disciplinary culture, institutional life, personal motives, social exchange, and material practice. The disciplinary mental models identified here offer a new lens through which to view the epistemic diversity of academic work.

Conducted just before the widespread adoption of generative artificial intelligence, the study captures a moment of transition in scholarly information practice. Whilst AI-integrated systems promise new forms of exploration, they also risk reinforcing universalised, individualistic, and opaque modes of search that obscure the cultural, social, and collective dimensions of information practice. These technologies remain only partially informed by user-centred thinking and rarely account for the contextual diversity—the social, temporal, material, embodied groundedness—that characterises scholarly inquiry. As discussed in the preceding section on future research directions, further work is needed to understand how AI tools are reshaping scholars' mental models of information and discovery.

Ultimately, this study calls for information systems and scholarly infrastructures that recognise and reflect the diversity of academic practice. Rather than privileging standardisation and efficiency, design should embrace diversity, enable exploration, and support the social, cultural, and evolving dimensions of knowledge. This is not a final conclusion but an invitation to rethink how we design for, and with, scholarly life in all its varied forms.

Appendix I: Institutional organisation at the Universities of Glasgow and Oxford

Colleges, schools, and subjects at the University of Glasgow
https://www.gla.ac.uk/colleges/
https://www.gla.ac.uk/schools/

College of Arts & Humanities
- School of Critical Studies
  - Creative Writing
  - English Language & Linguistics
  - English Literature
  - Scottish Literature
  - Theology & Religious Studies
- School of Culture & Creative Arts
  - Film & Television Studies
  - History of Art
  - Music
  - Theatre Studies
  - Media & Cultural Policy
- School of Humanities
  - Archaeology
  - Celtic & Gaelic
  - Classics
  - History
  - Information Studies
  - Philosophy
- School of Modern Languages & Cultures
  - Comparative Literature
  - Modern Languages & Cultures
  - Translation Studies

College of Medical, Veterinary & Life Sciences
- School of Biodiversity, One Health & Veterinary Medicine
  - Veterinary Medicine
  - Biodiversity
  - One Health
- School of Cancer Sciences
  - Cancer Sciences
- School of Cardiovascular & Metabolic Health
  - Cardiovascular & Metabolic Health
  - Pharmacology
- School of Health & Wellbeing
  - Health & Wellbeing
- School of Infection & Immunity
  - Infection & Immunity
  - Parasitology

- School of Medicine, Dentistry & Nursing
    - Dentistry
    - Medicine
    - Nursing & Health Care
- School of Molecular Biosciences
    - Molecular Biosciences
    - Sports Science
- School of Psychology & Neuroscience
    - Psychology & Neuroscience

College of Science & Engineering

- School of Chemistry
    - Chemistry
- School of Computing Science
    - Computing Science
    - Data Science & Artificial Intelligence
- School of Engineering
    - Engineering
    - Aerospace Engineering
    - Biomedical Engineering
    - Civil Engineering
    - Electronics & Electrical Engineering
    - Healthcare Technologies
    - Mechanical Engineering
- School of Geographical & Earth Sciences
    - Geographical & Earth Sciences
- School of Mathematics & Statistics
    - Mathematics
    - Statistics
- School of Physics & Astronomy
    - Physics & Astronomy
    - Quantum & Nanotechnology

College of Social Sciences

- Adam Smith Business School
    - Business
    - Accounting & Finance
    - Economics
    - Management
- School of Education
    - Education
- School of Law
    - Law
- School of Social & Environmental Sustainability
    - Environment & Sustainability
    - Tourism
- School of Social & Political Sciences
    - Central & East European Studies
    - Economic & Social History
    - Politics & International Relations
    - Sociology

- Urban Studies

Divisions and departments at the University of Oxford
https://www.ox.ac.uk/about/divisions-and-departments

Humanities Division

- American Institute, Rothermere
- Art, Ruskin School of
- Asian and Middle Eastern Studies, Faculty of
- Classics, Faculty of
- English Language and Literature, Faculty of
- History, Faculty of
- History of Art department
- Linguistics, Philology & Phonetics, Faculty of
- Medieval and Modern Languages, Faculty of
- Music, Faculty of
- Philosophy, Faculty of
- Theology and Religion, Faculty of
- TORCH | The Oxford Research Centre in the Humanities
- Voltaire Foundation

Mathematical, Physical & Life Sciences Division

- Begbroke Science Park
- Biology, Department of (formerly Zoology and Plant Sciences)
- Chemistry, Department of
- Computer Science, Department of
- Doctoral Training Centre
- Earth Sciences, Department of
- Engineering Science, Department of
- Materials, Department of
- Mathematical Institute
- Physics, Department of
- Statistics, Department of

Medical Sciences Division

- Biochemistry, Department of
- Clinical Medicine, Nuffield Department of
- Clinical Neurosciences, Nuffield Department of
- Experimental Psychology, Department of
- Medicine, Radcliffe Department of
- Oncology, Department of
- Orthopaedics, Rheumatology and Musculoskeletal Sciences, Nuffield Department of
- Paediatrics, Department of
- Pathology, Sir William Dunn School of
- Pharmacology, Department of
- Physiology, Anatomy & Genetics, Department of
- Population Health, Nuffield Department of

- Primary Care Health Sciences, Department of
- Psychiatry, Department of
- Surgical Sciences, Nuffield Department of
- Women's & Reproductive Health, Nuffield Department of

Social Sciences Division

- Anthropology and Museum Ethnography, School of
- Archaeology, School of
- Business School, Saïd
- Economics, Department of
- Education, Department of
- Geography and the Environment, School of
- Global and Area Studies, Oxford School of
- Government, Blavatnik School of
- International Development, Department of
- Internet Institute, Oxford
- Law, Faculty of
- Oxford Martin School
- Politics and International Relations, Department of
- Social Policy and Intervention, Department of
- Sociology, Department of

Appendix II: Participants' demographic information

Participants' disciplinary and institutional affiliations and roles, listed and numbered in the order they were interviewed.

Participant #	Discipline	University	Specialism	Position/Role
Participant 1	Chemistry	Oxford	Physical Chemistry	Professor
Participant 2	Chemistry	Oxford	Organic Chemistry	Associate Professor
Participant 3	Medicine	Oxford	Neurology	Consultant/PI
Participant 4	History	Oxford	Modern, British	Professor
Participant 5	History	Oxford	Modern, Intellectual	Professor
Participant 6	Chemistry	Oxford	Inorganic Chemistry	Professor
Participant 7	History	Oxford	Early modern, British	Researcher (retired professor)
Participant 8	Law	Oxford	Public Law	Professor
Participant 9	History	Oxford	Modern, global	Associate professor
Participant 10	Chemistry	Oxford	Physical Chemistry	Associate professor
Participant 11	Law	Glasgow	Private Law	Senior lecturer
Participant 12	Law	Glasgow	Property Law	Lecturer
Participant 13	Chemistry	Glasgow	Organic Chemistry	Postdoctoral researcher
Participant 14	Law	Glasgow	International Law	Lecturer
Participant 15	History	Glasgow	Early modern, European	Researcher (retired professor)
Participant 16	Law	Glasgow	Commercial Law	Lecturer
Participant 17	Law	Glasgow	Public Law	Lecturer
Participant 18	Medicine	Glasgow	Infection and Immunity	Professor
Participant 19	Medicine	Glasgow	Medicine, Dentistry, and Nursing	Lecturer (LTS track)
Participant 20	Chemistry	Glasgow	Inorganic Chemistry	Senior lecturer
Participant 21	Chemistry	Glasgow	Organic Chemistry	Senior lecturer
Participant 22	Medicine	Glasgow	Infection and Immunity	Professor
Participant 23	Chemistry	Glasgow	Organic Chemistry	Lecturer
Participant 24	Medicine	Glasgow	Cancer Sciences	Postdoctoral researcher
Participant 25	Chemistry	Glasgow	Physical Chemistry	Senior lecturer (LTS track)
Participant 26	History	Glasgow	Medieval, European	Senior lecturer
Participant 27	History	Glasgow	Modern, global	Senior lecturer
Participant 28	Medicine	Glasgow	Cardiovascular & Metabolic Health	Professor
Participant 29	History	Glasgow	Medieval, British	Lecturer
Participant 30	History	Glasgow	Modern, global	Senior lecturer
Participant 31	Law	Oxford	EU Law	Postdoctoral researcher
Participant 32	Medicine	Oxford	Population Health	Researcher

Participant 33	History	Oxford	Modern, European	Postdoctoral researcher
Participant 34	Medicine	Oxford	Primary Care Health Sciences	Postdoctoral researcher
Participant 35	Chemistry	Oxford	Physical Chemistry	Associate professor
Participant 36	Medicine	Oxford	Department of Physiology, Anatomy and Genetics	Postdoctoral researcher
Participant 37	Medicine	Oxford	Global Health	Postdoctoral researcher
Participant 38	Law	Oxford	Equity law	Associate professor
Participant 39	Law	Oxford	Property law	Associate professor
Participant 40	Law	Oxford	Private law	Professor

Appendix III: Data Generation Protocol

1. INTRODUCTION (10 minutes)
Note: Audio recording via Researcher's phone; manual recording of details on paper by Researcher

The Researcher will briefly go over the nature and purpose of the project. After participants have reviewed the Participant Information Sheet and agreed to participate in the study, they will be asked a few preliminary questions relating to their work and discipline:

- What is your disciplinary background—where/what did you study?
- Where do you typically work? Do you work in a lab, office, or another setting?
- Do you work with other people? If so, what kind of role do you have in your research team?
- Is there a collaborative aspect to your work? Does that involve collaborators in History or other disciplines as well?

2. DRAWING ACTIVITY (20 minutes)
Note: Visual and documentary recording on paper by Participant; audio recording via Researcher's phone

Prompt: Please draw your subject discipline. (You can use illustrations, text, lines, and shapes, or anything else you'd like.) This is not a test of your drawing skills or your knowledge.

Follow-up questions:
- Could you please explain what you drew?
- How are these elements/concepts in your drawing related to each other?
- Would you have added anything else if you had more time? Could you tell me more?
- Is this a drawing of your discipline as a whole?
  - If yes: Where does your research fit within this disciplinary landscape?
  - If no: Where does your drawing fit within the broader landscape of your discipline?
- How is your discipline related to other academic fields of study?

3. SEMI-STRUCTURED INTERVIEW (30 minutes)
Note: Audio recording of interview via Researcher's phone

Personal/affective:
- Why did you choose your discipline? / What drew you to your discipline? With hindsight would you have studied a different subject?
- What are the most enjoyable aspects of your research?
- What are the most challenging aspects of your research?

Setting/environment and practices:
- You said you worked in a lab/office/other setting. Could you tell me a bit more about your work environment?
- Could you tell me about the books/resources/other resources in your office? How are they organised?
- (if working with others and not addressed by previous question) You said you worked in a team. Could you tell me a bit more about that?

Ways of thinking/general knowledge/validation

- What kinds of methods/What methodology do you use in your research?
- How typical are the ways of doing research that you just described for your discipline?
- How do you teach students the necessary skills to conduct research in [discipline]?
- Could you tell me a bit about how you come up with new research projects? How do you develop the project further? How do you find information related to the topic?
- How are you able to determine if your research findings are significant?
- Is there a basic unit of analysis in your discipline? (e.g., the cell for biology; the molecule for chemistry)
- Do you find that there are differences between the way scholars in your field think and those in other fields? Is there a particular way that [chemists/historians/etc.] think?

Information resources (sharing, discovery, seeking, organisation)

- What kinds of [primary/secondary] literature do you typically work with? And how do you identify and look for them?
- What are the main challenges to identifying and looking for sources?
- How do you teach your students to find relevant information?
- It seems from what you have told me (or from your drawing) that knowledge in [Chem/Law/Hist/Med] is organised in a [hierarchical/networked/nested] way. Is that reflected in how information resources are organised?
- How do you keep up to date with the latest research in your discipline?
- How do researchers in your field share knowledge with each other? What are the main channels of communication and discussion in your field/discipline/department?

Closing question

- What kind of skills or knowledge make for an excellent researcher in your discipline?

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