Digital Curation

Higgins, Sarah

Published in:
Journal of Documentation

DOI:
10.1108/JD-02-2018-0024

Publication date:
2018

Citation for published version (APA):
Higgins, S. (2018). Digital Curation: The development of a discipline within information science. *Journal of Documentation*, *74*(6), 1318-1338. https://doi.org/10.1108/JD-02-2018-0024

Emerald Journal of Documentation

Digital Curation: The development of a discipline within information science

Journal:	*Journal of Documentation*
Manuscript ID	JD-02-2018-0024.R1
Manuscript Type:	Article
Keywords:	Digital curation, Development, Education, History, Models, Professional associations

Digital Curation: The development of a discipline within information science

Introduction

With the embedding of personal computers and hand-held devices into modern society digital information has become ubiquitous, reaching into every aspect of our personal and professional lives and creating new ways of learning, working and undertaking research. Digital information is increasing exponentially (Domo, 2017) and this digital information needs to be effectively managed if it is to be used and reused by society. Digital curation has emerged over the last 20 years as a new discipline from within the information sciences umbrella that addresses the technical, administrative and financial ecology required to maintain access to digital material through organisational and technical changes over the long-term (Abbott, 2008; Digital Curation Centre, 2005a; Higgins, 2011; Kim, Warga, & Moen, 2013, p.67; Pennock, 2007; Tibbo, 2012 pp. 2-3; Tibbo & Lee, 2010, p.126). The discipline's origins lie in two parallel early information science research foci. The first from the archives and records discipline concentrated on the *preservation of electronic materials* - maintaining the bit-stream of those records and archives we would now call *born-digital* (Day, 1997; Hirtle, 2010, p.125; Marc Fresko Consultancy, 1996). The second from a library science focus on what was then called *digital preservation* - producing digital surrogates of analogue material through digitisation to increase their lifespan (Hirtle, 2010, pp. 124-125). As information becomes increasingly digital, digital curation would now seem to be a discipline that reaches into all sub-disciplines of information science while maintaining obvious synergies with the discipline of computer science. This paper will investigate how digital curation has developed into a mature discipline in its own right and identify where this new discipline sits within the overarching aegis of information science. As debate continues regarding the discipline's focus and status, and appropriate education and training for digital curators (Bettivia, 2017; Higgins, 2017; Kilbride, 2017; Schisler, 2017), understanding its disciplinary developmental status, and its place within the information sciences domain, can inform practitioners and educators of the boundaries and reach of their discipline so that effort and resource can be expended appropriately.

The nature of a discipline

In his critique of capitalist society Foucault identified that disciplinary methods are adopted 'in response to particular needs' (Foucault, 1975, p138) as societies and economies change and develop. He identified that a *disciplinary society* adopts techniques for assuring order and embedding power structures by enclosing and organising analytical spaces. Although critical of the use of discipline to maintain power positions and feed the state, his work illuminates how these organised analytical spaces become academic disciplines through rigorous pedagogical organisation, the development of hierarchies of specialisation, and stages of increasing difficulty through which individuals need to progress to master a subject (Foucault, 1975). Detailed characterisation, classification and specialisation develop firm foundations to embed disciplines as distinct knowledge bases, with contextualised research theories and methods, and acknowledged scholars (Foucault, 1975; Dirks, 1996; Schommer-Aikins, Duell and Barker, 2003; Cohen and Lloyd, 2014).

> 'The disciplines characterize, classify, specialize; they distribute along a scale, around a norm, hierarchize individuals in relation to one another and, if necessary, disqualify and invalidate.'
>
> (Foucault, 1975, p.223)

Krishnan (2009, p.9) identifies six stages that progress in a linear fashion to the mature definition of a discipline: a particular object of research, a body of accumulated specialist knowledge, theories and concepts to effectively organise this specialist knowledge, specific language, specific research methods and institutional recognition through university or college level education. Bawden and Robinson (2012, p.10) note the foundation of representative professional bodies as the first sign of public recognition adding a seventh stage to the progression (Figure 1).

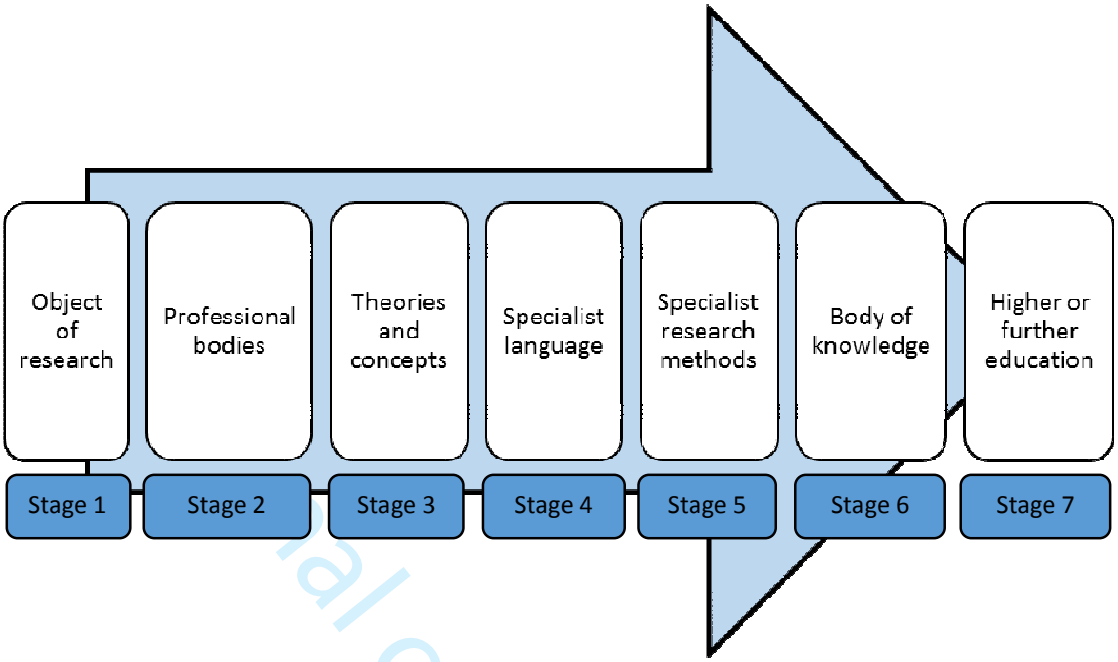

Figure 1: The developmental stages of a discipline (after Bawden & Robinson, 2012; Krishnan, 2009)

The common understanding of specialist knowledge surrounding an academic discipline is inherited, entrenched and reproduced through learning and teaching (Krishnan, 2009, p.9; Cohen and Lloyd, 2014). The boundaries are drawn-up and protected through the coherence of their theories and the development of tacit or encoded rules regarding acceptable truth (Foucault, 1975); giving its proponents a safe cultural identity through shared discourse and epistemology. This safe cultural identity is further protected through rigid organisational and educational structures that cannot be endorsed outside the group, so that disciplines can become isolated silos (Krishnan, 2009; Gill, 2013).

However disciplines need to fulfil societal needs which are not static; so they continue to develop through research in *continuous evolutions* while individuals find their own *genesis* within the discipline (Foucault, 1975, pp.160-161). These societal *evolutions* and personal *geneses*, through practical application of theory, can lead to the identification of anomalies in the hitherto accepted underlying theories and methods so that, to solve these, the whole discipline changes its theoretical and methodological framework in a paradigm shift (Kuhn, 1962; Foucault, 1977).

> 'Practice is a set of relays from one theoretical point to another, and theory is a relay from one practice to another. No theory can develop

> without eventually encountering a wall, and practice is necessary for piercing this wall'.
>
> (Foucault, 1977, p.206)

Less radical are incremental changes in disciplines as new research brings forward new solutions so that variations occur. If variations become pronounced then new disciplines may develop through *speciation* 'the division of a single discipline into two or more *genetically* similar but distinct ones' (Cohen & Lloyd, 2014, p.194). Meanwhile parallel disciplinary developments may combine through interdisciplinary activities to create a new hybrid discipline with distinct features from both. Practically orientated disciplines may in fact be multi-hybrid or multi-disciplinary, drawing on a number of different disciplines that shed light on their primary object of research (Hirst, 1974; Bawden and Robinson, 2012). A meta-discipline may develop if the object of research cuts across and draws on a number of disciplines (Bates, 2015; *STEM in schools*, 2017). Harmon (1969) quantified this dynamic nature of academic disciplines identifying a lifecycle in which: 41% of their lifespan is emergence, 33% is unified growth and 26% differentiation into specialisations.

Biglan's taxonomy (1973a, 1973b) classifies academic disciplines according to multi-dimensional characteristics identified by 'bipolar adjectives' (Biglan, 1973b, p.196). These characteristics identify the level to which a discipline has:

> '(a) concern with a single paradigm (hard vs. soft), (b) concern with application (pure vs. applied), and (c) concern with life systems (life-system vs. non-life system)'
>
> (Biglan, 1973a, p.204)

Becher & Trowler (2001, p.36) further characterise Biglan's first two dimensions into: hard-pure, soft-pure, hard-applied and soft-applied; associating these directly with categories of academic disciplines and the nature of their pursuit of knowledge (

Figure 2).

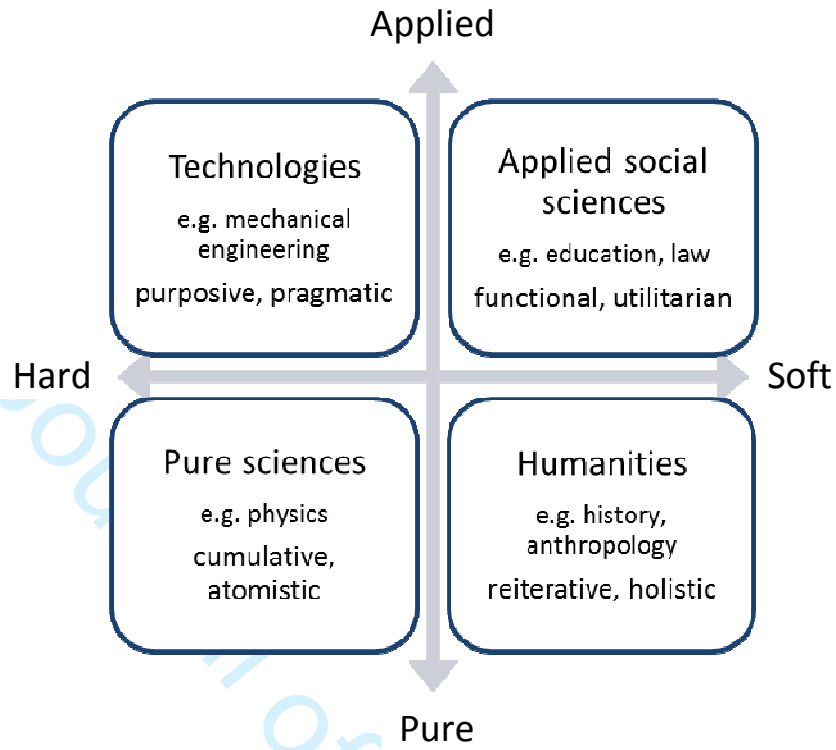

Figure 2: Characterisation of academic disciplines (after Becher & Trowler, 2001, p.36)

For applied disciplines, strong links to a recognised career path can emphasis their distinctive nature through a feedback mechanism between the institutional development of a curriculum and the professionalisation of the discipline.

In these cases the disciplinary knowledge focuses on relevant skills for employment and fulfilment of the underlying social agenda and lies in the professional domain outside of institutional education; while the coalescence of this knowledge into coherent theory, the methods and research to advance the knowledge and the curriculum developed to teach it, are internal to the academic domain of the educational institution. This feedback loop ensures that the discipline stays aligned to both the needs of the job market it feeds but also retains intellectual rigour (Figure 3) (Eastwood, 1994; Krishnan, 2009; Cohen and Lloyd, 2014). Åström (2008) identifies an important variation to this loop for modern academic practice, where academics and professionals collaborate in research to build the knowledge base, often funded by the professional partners.

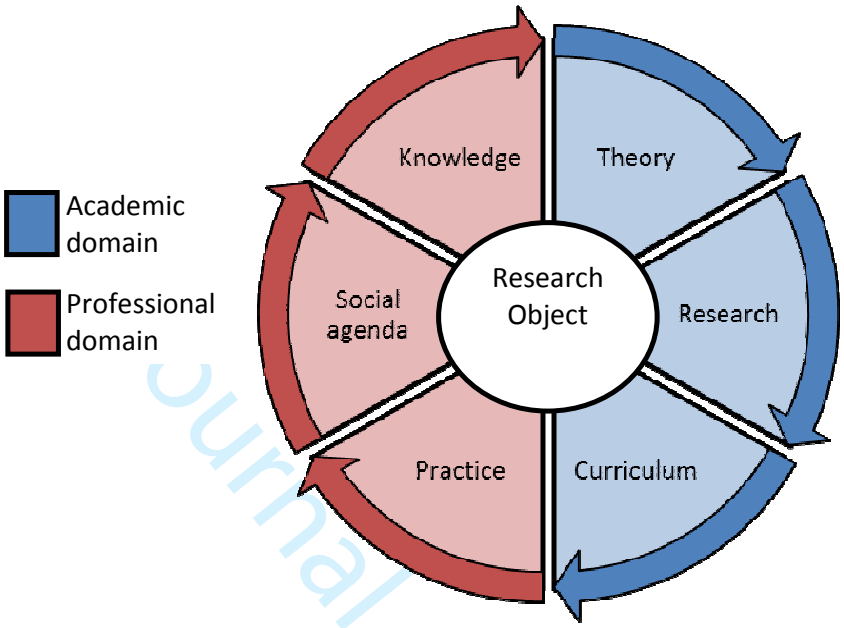

Figure 3: The academic to professional feedback loop of a professionally orientated discipline (after Cohen & Lloyd, 2014; Eastwood, 1994; Krishnan, 2009)

Information science as a discipline

Capurro and Hjørland (2003, p.364) identify information science as a discipline which is academically inter-disciplinary and multi-disciplinary. It conforms to the academic to professional feedback loop of a professional applied discipline described above, being a fusion of its two dimensions: the professional practice from which its knowledge base derives (the objective or disciplinary dimension) and the academic study of information as a research object (the subjective or academic dimension) (Harmon, 1971; Robinson and Karamuftuoglu, 2010; Bawden and Robinson, 2012; Smiraglia, 2014). Generally agreed to have its origins in the traditions of *bibliography*, the *documentation movement* and *library science,* the original focus was on the three main institutions created to store physical material – libraries, archives and the related museums (LAMs) and the discipline revolved around the traditional problems of storage and retrieval (Bawden and Robinson, 2012; Bates, 2015); with sub-disciplines emerging from different sectors and subject areas as specialised responses to the storage problem when the quantity of materials being stored became too great for the retrieval methods used (Harmon, 1971). This means that the boundaries of information science can be seen to be fluid, drawing upon disciplines across

the arts and humanities, social and behavioural sciences and natural sciences (Bates, 2015). The spectrum of information science disciplines was mapped by Bates (2015) according to their synergy with these academic areas and their level of focus on the cultural record or the sciences to enable the organisation of the 3rd edition of the *Encyclopedia of Library and Information Sciences* (Bates and Maack (Eds), 2010). Eleven core disciplines and their main academic foci were identified giving rise to over fifty sub-disciplines (Figure 4).

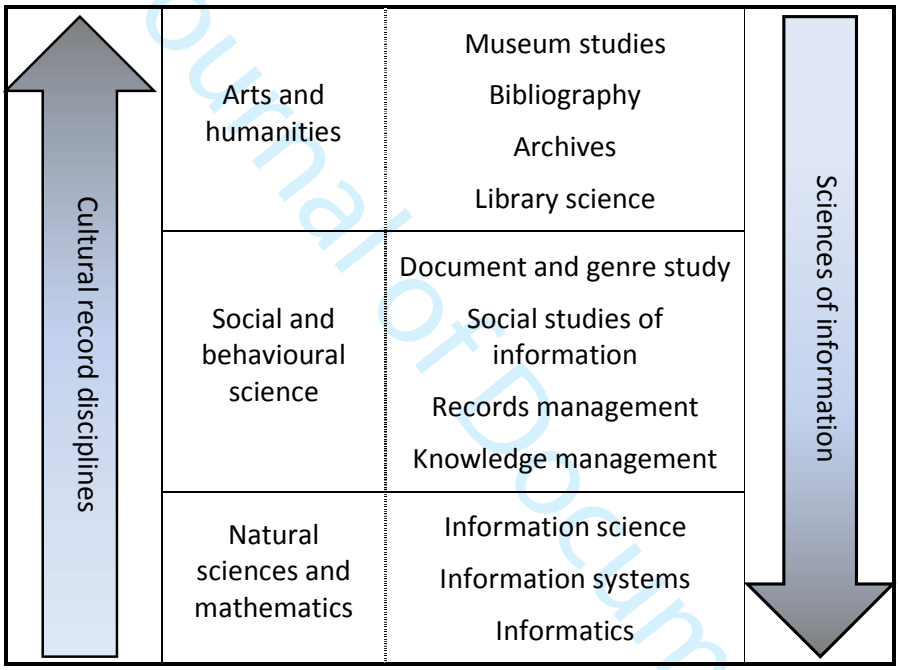

Figure 4: Core information disciplines and their main foci (after Bates, 2015)

It can be seen then that the information disciplines can be described as a meta-discipline, one that sits above and draws upon all other disciplines while researching specific problems in the information domain (Harmon, 1971; Zins, 2007; Bawden and Robinson, 2012; Bates, 2015). It:

> 'deals with knowledge in all the conventional fields on the academic spectrum, but does so from a particular orientation or position that is needed to accomplish the work and the theorising of its area'.
>
> (Bates, 2015)

As such the research object of the information disciplines can be identified as human recorded information and the complex issues surrounding it, across the different contexts of its creation and use and the subject matter it encompasses (Goonatilake, 1991; Robinson

and Karamuftuoglu, 2010; Bawden and Robinson, 2012). However, defining their disciplinary boundaries has proved to be an academic discourse in itself with a number of different models developed to explain these. These models use different terminology in their analyses, but all identify information science as being an orchestration of different emphases of three separate dimensions – the academic study of information, the professional management of information and technical implementation of tools to manage information.

Slamecka (1968) quoted by Harmon (1971, p.238) identified a systems based paradigm for information science: the *theory of information* considers the representation, measure and structure of information; the *theory of abstract information processes* considers activities of the information lifecycle; while the *theory of information systems* embraces and builds upon the other two former theories. These could be considered the academic, professional and technical dimensions of information science respectively (Figure 5).

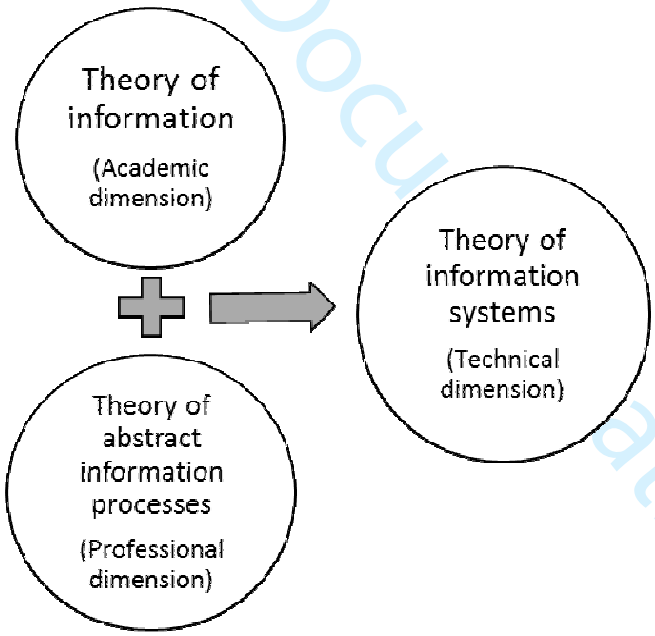

Figure 5: Slamecka's typology of information theories (1968)

Capurro & Hjørland (2003, p.389) illustrate these different foci in the academic/professional feedback loop (Figure 3) with academic information scientists (the academic dimension) taking a top-down approach to the discipline; with the whole of the information domain as its primary research object and specific sub-disciplines the secondary research object.

Conversely the domain experts (the professional dimension) take a bottom-up approach; with a narrow sub-discipline as their primary research object and the wider information domain its secondary focus. However, like Slamecka (1968), Capurro and Hjørland highlight the technical dimension, in the form of systems for information retrieval and storage, as the main focus of information science (pp. 380-384).

Zins (2007) collected multiple definitions of the information science discipline, which when analysed took either an academic or professional dimension as their research scope. He identified four phenomena of information as the research object – data (symbols that can be decoded), information (information management), knowledge (ideas and their communication) and message (selection and interpretation of information). Those identifying with the academic dimension had a generic research focus, while those identifying with the professional dimension had a narrow research focus on methods for mediating information. The technical dimension of information science, identified by both Slamecka (1968) and Capurro and Hjørland (2003), is also present in Zin's analysis. However this is no longer the main paradigm of the discipline; rather it is encompassed by two aspects of mediating information within the professional dimension; one focuses on systems and methods (technology), the other on computer based technologies (hi-tech) (Figure 6).

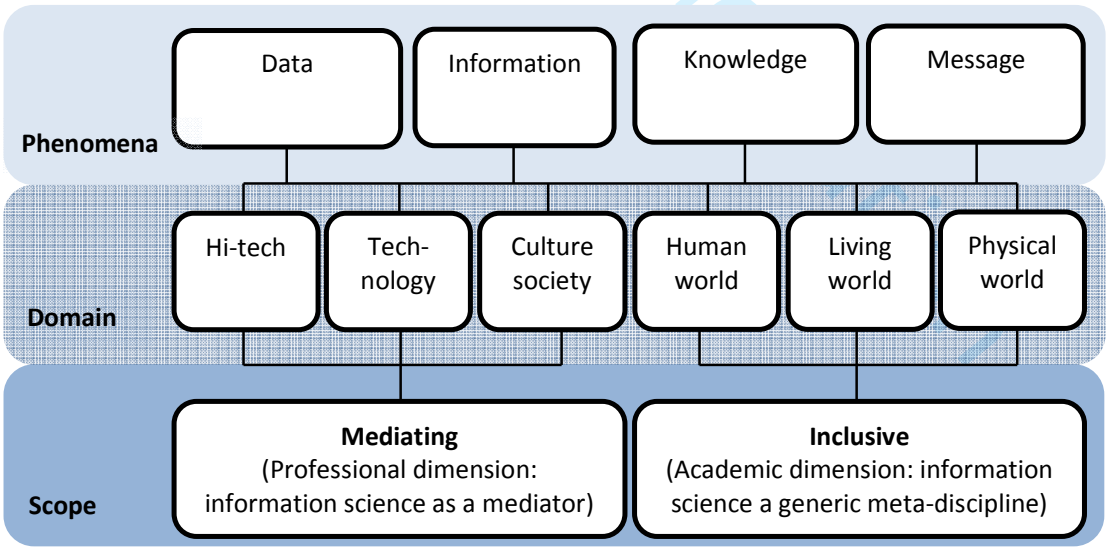

Figure 6: A conceptual framework for the information science domain (adapted from Zins, 2007)

Robinson & Karamuftuoglu (2010) identify six professional activities as the *information lifecycle* and the basis of the discipline (professional dimension). When combined with the information lifecycle identified by Borko (1968) (quoted by Capurro & Hjørland (2003, p.387)) ten professional activities can be identified. Academic activity and by extension sub-disciplines build on top of these by combining components of the information lifecycle with the research approaches identified through domain analysis by Hjørland (2002) and the general context of the research (academic dimensions) (Figure 7). For Robinson and Karamuftuoglu the technical dimension has no separate identity, never mind being the focus of the discipline, rather technical implementations are subsumed into the professional activities identified and the research questions which arise from these.

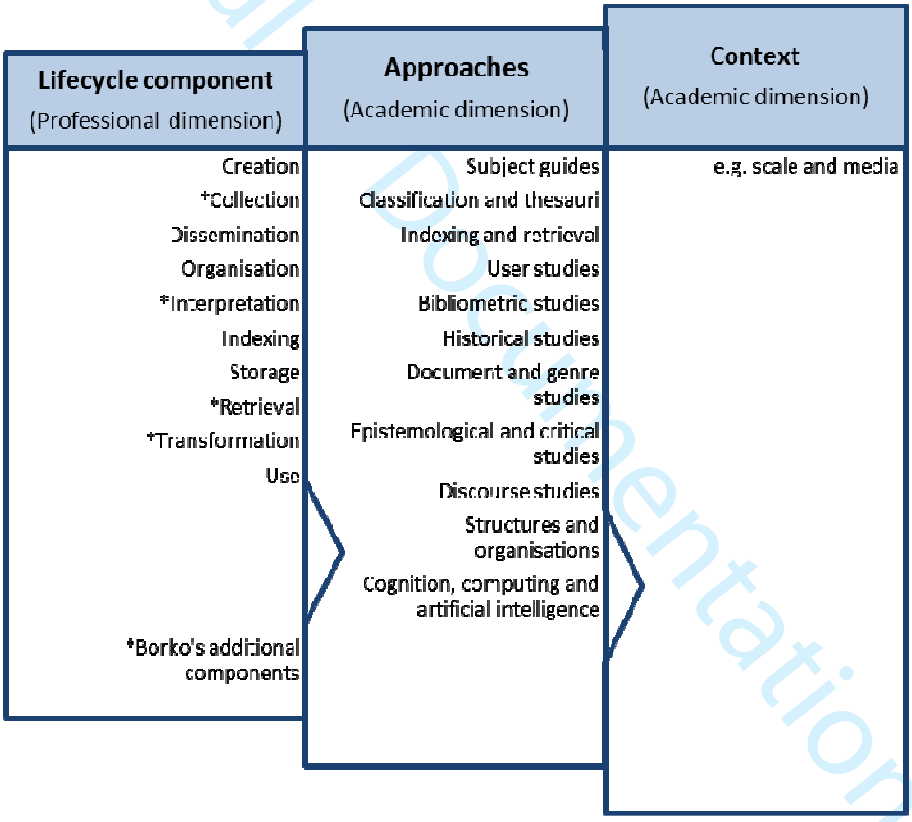

Figure 7: Robinson and Karamuftuoglu's model for information science (2010) with lifecycle components from Borko (1968)

Bates (2015) does not separate the academic and professional dimensions of the discipline. Rather she identifies seven generic facets (only one of which specifically embraces the technology dimension). Two or more of these facets can be combined to explain the academic dimension of different sub-disciplines of information science (Figure 8).

Figure 8: The generic facets of information science sub-disciplines (after Bates, 2015)

Digital information – the new paradigm

As highlighted by the models above, the shift from the systems driven paradigm of information science, inherited from its origins in *bibliography* and *documentation*, began in the late 1960s with the early introduction of computer technology to the automation of these tasks; and their subsequent side-lining into sub-disciplines such as library automation and (electronic) information retrieval (Mccallum, 2003; Hjørland, 2014; Bates, 2015). Meanwhile the focus of research moved to the wider 'sociological and epistemological' paradigm of the cognitive approach (Capurro & Hjørland, 2003, p. 389), greatly increasing the scope of information science as a discipline (Harmon, 1971; Ellis, 1992; Capurro and Hjørland, 2003; Hjørland, 2014).

Harmon (1971) predicted a 'complete supra-system of knowledge which would unify the arts, sciences and professions' (p.240). With the advents of the personal computer, the Internet and handheld devices this prediction has become a reality, and with it a third paradigm in information science. The information ecology has changed so that not only information's metadata but also the actual information being managed is manifested in digital formats (Hjørland, 2014). Of the 54 sub-disciplines of information science identified

by Bates (2015) a third pertain exclusively to some specialist aspect of the management or utilisation of digital materials e.g. digital humanities, digital asset management, digital libraries, data mining, and a number of domain specific branches of informatics. This has led to new ways of conceptualising information as a research object and changed the information professional from a gatekeeper to an enabler (Floridi, 2010).

Curation in information science

Curation has not been a term generally used in information science, outside of the museum studies discipline, and is not specifically identified as a professional activity by the commentators discussed, although it could be argued that Borko (1968) and Robinson and Karamuftuoglu's (2010) lifecycle components together constitute information curation. Certainly a similar set of duties for the *curation* of library resources have been identified (Parsons, 2010; Daigle, 2012; Johnston, 2014; Valenza, Boyer and Curtis, 2014; LibSource, 2017). However these authors also argue that *curation* goes beyond the mechanical activities of collecting materials and making them accessible, to the conscious design and development of a collection to support learning in a defined community while engendering trust and authority. This trust arises from human judgement regarding value (Johnston, 2014) guided by policies (Daigle, 2012). LibSource, a US information consultancy, identifies this judgement of value as a professional role:

> 'Curation is the act of individuals chartered with the responsibility to find, contextualize, and organize information, providing a reliable context and architecture for the content they discover and organize.'
>
> (LibSource, 2017)

It is this combination of professionalism, policy and trust that has made *digital curation* the favoured term for the combination of academic, professional and technical activities that address the challenges and resource implication of managing information manifested digitally (Kenney *et al.*, 2007), while preserving those core characteristics which can be easily manipulated or compromised in digital materials - authenticity, reliability, integrity and usability (International Organization for Standardization, 2001, p.7).

Digital curation as a discipline

Digital curation is a discipline that is concerned with a primary research object – data (here defined as information that is manifested digitally) and a single paradigm – ensuring data's continued access and use over the long-term. As an applied discipline it could be characterised according to Becher and Trowler's model (2001) (Figure 2) as hard-applied being purposive, pragmatic and concerned primarily with technology and its application. As such it has synergies with the computer science discipline, although this traditionally focuses more narrowly on the digital technology used to create, access and use information, than the information itself.

Over the last 20 years digital curation has moved through the identified developmental stages of a discipline (Figure 1) so that it is now mature enough for specialist higher education courses to be offered at a growing number of universities across the World, while being routinely included in the curricula for different sub-disciplines of information science. This means that a common understanding of the discipline is now being reinforced and replicated, while a meaningful feedback mechanism between the academic and professional domains of the discipline (Figure 3) is starting to develop and an emerging career path is being defined.

Like information science as a whole digital curation initially had a technical focus, considering foremost the preservation of data. By its very nature the technical dimension is still its primary focus, but a more holistic view of the discipline is now taken so that it is seen as a 'more complex and dynamic undertakings than preservation alone' (Tibbo, 2012, p.2) involving 'the wider remit of maintaining persistence and access' to all types of data (Higgins, 2011, p.80) and requiring 'a wide array of individuals with various skills, knowledge and perspectives' (Tibbo, 2012, p.3).

> 'Digital curation, broadly interpreted, is about maintaining and adding value to a trusted body of digital information for both current and future use: in other words, it is the active management and appraisal of digital information over its entire life cycle.'
>
> (Pennock, 2007)

An exhaustive history of digital curation cannot be given here, rather indicative highlights of its early achievements in Europe and the US, from the late 1990s to around 2011, are mapped below to the seven identified stages of disciplinary development (Figure 1), to signpost its progress in becoming a discipline.

Stage 1- Object of research identified

The research objective of ensuring continued access and use of digital information through its curation was identified in the mid-1990s (Hedstrom, 1998; Ross, 2000) with action in the UK spearheaded by the Joint Information Systems Committee (JISC) [i].

Stage 2: Development of professional bodies

JISC's funded activities led to the establishment of two UK professional bodies to co-ordinated support, raise awareness, provide resources and lead research in the area: the Digital Preservation Coalition (DPC) in 2001 [ii] and Digital Curation Centre (DCC) in 2004 [iii] (Digital Curation Centre, 2004; Higgins, 2011). Parallel activities in the US saw the foundation of the National Digital Information Infrastructure and Preservation Program (NDIIPP) by the Library of Congress in 2000 which aimed to 'build a network of committed partners working through preservation architecture with defined roles and responsibilities' (Library of Congress, no date). These bodies were charged with developing a specialist professional community for practitioners caring for digital materials through co-ordinated support; while raising awareness, providing resources and leading research in the area (Digital Curation Centre, 2004).

Stage 3: Development of theories and concepts

The theories and concepts to support the research foci of these new professional bodies were still to develop. At its first International Digital Curation Conference (IDCC) in 2005 the DCC's focus group entitled '*What is digital curation?*' concluded that a clear definition of activities encompassing the professional domain of digital curation were required for it to operate effectively (Kerr, Reddington and Wilkinson, 2005).

Meanwhile the need for a robust conceptual definition of digital curation was highlighted by working groups in both the US and the UK. The US *Task Force on Archiving of Digital Information* noted that there was a 'urgent' need for 'a far-sighted set of cultivation actions' for the digital environment (Garrett & Waters, 1996, p. 40) observing that:

> 'the digital world is still too new for us to describe fully the life cycle of the information objects that do now, or will in the future reside there'.
>
> (Garrett & Waters, 1996, p.11)

The three JISC funded *Warwick* workshops, which were the primary arena for setting the digital curation research agenda in the UK (Higgins, 2011), made recommendations in 1995, 1999 and 2005 concerning the need to define theoretical matrices for digital curation to support academic research, professional practice and technological development. These should draw on the archive management discipline in particular and delineate lifecycle activities and workflow while articulating guidelines for best-practice (Marc Fresko Consultancy, 1996; Cedars Project, 1999; Digital Curation Centre, 2005b). Inroads to defining a sequential set of lifecycle activities were made by Beagrie and Greenstein's *Digital Resource Lifecycle* (1998), later extended by Feeney (1999, pp. 26-27), in specific response to the 1995 Warwick Workshop.

Around the same time drafts of the influential *Reference Model for an Open Archival Information System* (OAIS) became available. This describes a technical workflow for digital preservation and 'establishes a common framework of terms and concepts' (Consultative Committee for Space Data Systems, 2002, p.iii). *The Cedars Project* [iv] undertook the testbed implementation of this recommended by the 1999 Warwick Workshop, concluding that OAIS 'presents a useful approach for the establishment of digital archives – particularly in a distributed environment' (Cedars Project, 2001). It has subsequently been widely recommended, adopted and critiqued as a theoretical construct for the discipline (Lavoie, 2000, 2014; Beedham *et al.*, 2005; Allinson, 2006; Ball, 2006; Egger, 2006; Knight and Hedges, 2007; Vardigan and Whiteman, 2007; Schumann and Recker, 2013; Ruest, 2014).

The DCC's own theoretical construct was a lifecycle model which provided an organisational matrix for developing their research, planning, advisory and training activities. *The DCC Curation Lifecycle Model* (Higgins, 2008) built on previous work in this arena (Higgins, 2007) and provided an alternative to OAIS with a high-level, succinct and less technically orientated graphical definition of lifecycle activities and their workflow; along with a framework for developing best-practice in professional, academic and technical domains. This conceptual model quickly established international reach through its central role in driving digital curation activities both within and beyond the DCC (Tibbo, 2012, p.6).

Stage 4: Specialist language

Both the *OAIS Reference Model* and the *DCC Curation Lifecycle Model* have served to provide a specialist language for the digital curation discipline, with the former being particularly influential. From the outset it was noted that OAIS introduced a valuable standardised vocabulary to describe packages of information and their custodial curation (Cedars Project, 2001; Beedham *et al.*, 2005, p.7; Allinson, 2006, p13; Ball, 2006, p.15); while the DCC's *lifecycle actions* provide verbs that are widely used operationally to describe discrete activities that need to be undertaken and the order in which to do them (e.g. Portsmouth University Postgraduate Online Research Training, 2013; Lee, 2016; Eckard, Pillen and Shallcross, 2017).

Stage 5: Specialist research methods

The theoretical construct of OAIS provided a baseline framework for digital curation so that benchmarking research activities against it enabled further conceptual developments. These defined both the professional and technical dimensions of the discipline and included the definition of a *trusted digital repository* and how to audit one (RLG/OCLC Working Group on Digital Archive Attributes, 2002; nestor Working Group Trusted Repositories - Certification, 2006; Online Computer Library Center and Research Library Group, 2007); risk assessment for digital collections (McHugh *et al.*, 2007); and metadata specification (PREMIS Working Group, 2005).

Stage 6: A body of knowledge

A body of professional and technical knowledge in digital curation developed through funded research projects. The European Union's 6th and 7th framework programmes invested €90million funding 18 projects between 2001 and 2011 [v] (Strodl, Petrov and Rauber, 2011). The earliest projects focused on preserving simple digital objects along with awareness raising, community building, training and 'definition, design and discussion of basic concepts, systems and methods' (Strodl, Petrov and Rauber, 2011, p.17); the second tranche built on these developing solutions for preserving more complex digital material and advancing technical architectures through the development of testbeds, tools and registries. In the UK JISC funded 12 different programmes in the area of digital curation (JISC, 2014a) and the related areas of repositories and research data management for higher education institutes. One programme alone, *Digital Preservation and Records Management* (JISC, 2014b), funded 48 research projects between 2003-2011 focusing across institutional support, exemplar testbeds and tools development. In the US the Library of Congress spent US$100 million building a national infrastructure through NDIIPP with over 150 partners and 40 projects across the US working towards the major goals of developing a stewardship network, a national digital collection, a technical infrastructure and supporting public policy (NDIIPP, 2011). A further US$2 million came from the National Science Foundation to fund joint projects (National Science Foundation, 2004). All this investment ensured that digital curation:

> 'evolved into a large community of experts, developed a solid understanding of the problems to master, and developed solutions that help to address the challenges faced by current stakeholders'
>
> (Strodl, Petrov and Rauber, 2011, p.5).

Stage 7: Higher or further education

Awareness raising workshops and research briefings in digital curation formed an aspect of the majority of the funded projects highlighted above; and more structured Continuing Professional Development (CPD) courses in digital curation were offered by some of these

as well as the professional support bodies [vi]. Only one third of iSchools offered modules focussed on digital curation in early 2010 (Costello, 2010), although the first dedicated postgraduate programmes emerged around 2009. Amongst the first to offer dedicated postgraduate these were University of North Carolina at Chapel Hill and Luleå University of Technology (Higgins, 2011). Informed by the curriculum development projects such as the DigCCurr Project at the Chapel Hill (2006-2013) [vii] and the European Commission funded DigCurV Project (2010-2013) [viii], dedicated master's courses have since been introduced by a number of other universities [ix], while DigCurV's final conference in 2013 saw presentations concerning an array of educational developments (Cirinnà, Fernie and Lunghi, 2013).

Differentiation in digital curation

As identified by Harmon (1969) strong periods of emergence and growth in a discipline eventually lead to differentiation and digital curation has been no exception. Differentiation revolves around different digital manifestations of information so that specialist research agendas and dedicated methods have emerged, and continue to develop, around these; examples include web-archiving, personal digital archiving, research data management and email preservation. These sub-disciplines are rooted in the same theoretical constructs as their parent discipline but have built strong communities of support in furtherance of their particular aims while paralleling and collaborating with the wider discipline. To take web-archiving as an example; bodies started to support web-archiving specifically in the early 2000s e.g. the International Internet Preservation Consortium (IIPC) [x], the Internet Memory Foundation (IMF) [xi] and the UK Web Archiving Consortium (UKWAC) (now the UK Web Archive) [xii]; while multiple specific tools and standards for web-archiving have been developed (Digital Preservation Coalition, 2016).

Positioning digital curation in information science

Taking the early focus of digital curation as a research problem in the technical dimension, it could be perceived that digital curation has a systems based paradigm as described by Slamecka (1968) (Figure 5); while mapping its data-centric concerns to Zins' model (Zins,

2007), could identify the discipline to be a sub-discipline of information science restricted to mediating data and information in a hi-tech domain (Figure 9).

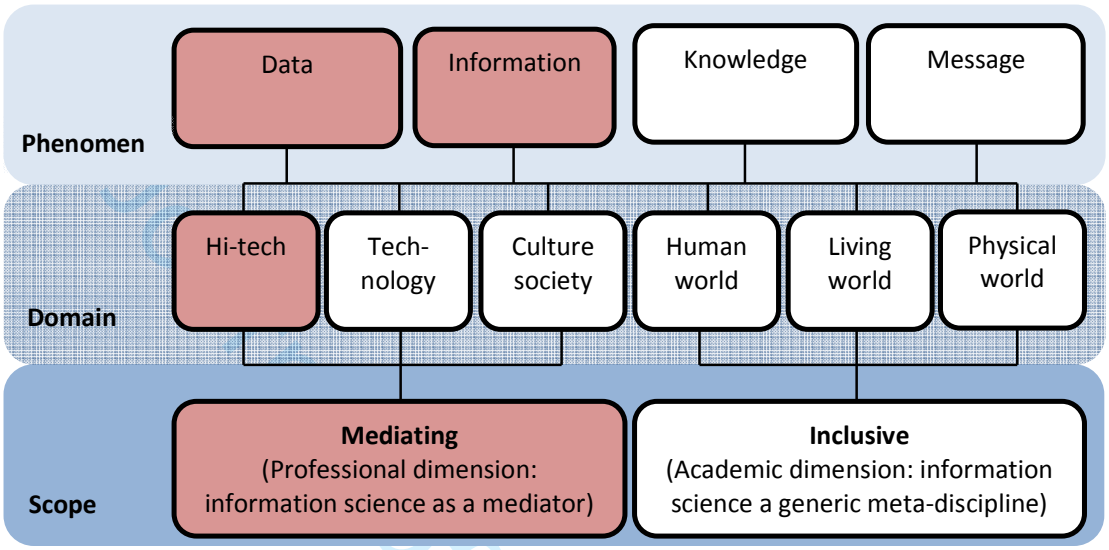

Figure 9: Zins' model applied to digital information (after Zins, 2007)

Similarly, mapping Bates' 2015 facets to those that could be explicitly cross-walked to data as a primarily technical research focus restricts the reach of digital curation to the management of information through information technology (Figure 10).

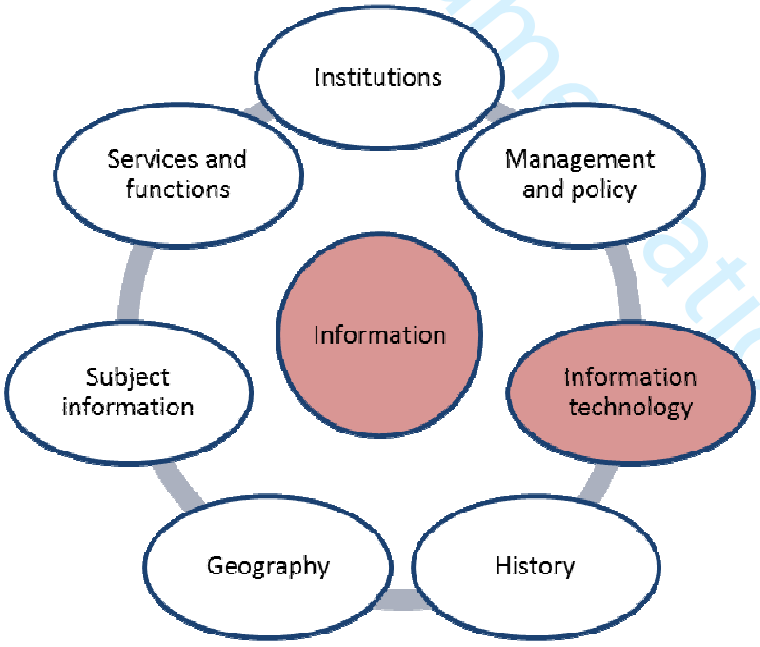

Figure 10: Bates' model mapped to digital information (after Bates, 2015)

However, as we saw above, digital curation has 'evolved into a dedicated and highly specialized discipline in its own right' (Strodl, Petrov and Rauber, 2011, p.4). With data as its primary research object, it has developed in response to societal need so that its research focuses on the inter-play between the professional, academic and technical dimensions to ensure that information *created digitally* remains accessible and usable, through the use of digital technology, over the long-term.

The format neutrality of information described in the models of Zins (2007), Bates (2015) and Robinson and Karamuftuoglu (2010) means that digital curation can be seen to embrace the facets and activities of the professional dimension of information science discipline that they identify.

The *OAIS Reference Model* and the *DCC Curation Lifecycle Model* provide a blueprint for the professional dimension of digital curation. These models assume the custodial care of digital resources within a policy governed management environment, encapsulating Zins' *mediating* scope and Bates' *institutions* facet for information science as a whole. *OAIS* defines this environment in its *functional model* (Consultative Committee for Space Data Systems, 2012, p.4-1 to 4-19) in terms of a set of controlled utilitarian services to ensure *producers'* resources are made available to *consumers*; mapping directly to Zins' definition of *mediating* activities for information science as those that 'facilitate the connection between the D[ata]-I[nformation]-K[nowledge]-M[essage] originators and users' (Zins, 2007, p.340), and Bates' identification of the facets *services and functions* and *management and policy*. OAIS's mandatory responsibility to define a *designated community* of consumers is akin to Zins' *cultural domain*; while the creation of the information packages described by its *Information Model* (Consultative Committee for Space Data Systems, 2012, p.4-20 to 4-49), with their requirement information architecture planning, maps to his *technology domain*. The more operational professional activities for information science described by Robinson and Karamuftuoglu (2010) (Figure 7) can be mapped to both the *DCC Curation Lifecycle Model* and *OAIS's* activities for digital curation (Insert Table 1).

Insert Table 1

The academic dimension of information science for Zins (2007) and Bates (2015) focuses on generic research applied to information as the research object, rather than on operational requirements for information's custody. Their assumed format neutrality for information enables the academic dimension of these models to be applied to digital curation research without explicit mapping to specific models for the discipline. Robinson and Karamuftuoglu (2010) also describe generic *approaches* to the academic study of information, however their *approaches* specifically related to controlling and dissemination information such as subject guides, classification, thesauri and indexing are embraced by both OAIS's *Information Model* and the DCC's *description and representation action*; while retrieval can be mapped to the *access* function of both OAIS and DCC.

The normalisation of creating and distributing information in the digital realm then, means that digital curation embraces all the facets of an information science discipline identified by Zins (2007) and Bates (2015) or the activities for information science identified by Robinson and Karamuftuoglu (2010). Digital curation is not included in Bates' typology (2015), which could be further classified into disciplines concerned with:

- Information's support for societal function;
- The subject matter of the information;
- Information systems design; and
- Storage location of the information.

Digital curation's unique concern with the digital manifestation of information means it cannot be included primarily in any of these classifications but instead straddles across them. It has reach into all the information science disciplines and sub-disciplines Bates identifies, whether they are explicitly concerned with digital information (such as digital libraries, digital asset management and informatics); or whether their concern is format neutral (such as specialist libraries and records management).

As such digital curation has no clearly identifiable disciplinary boundaries. Instead it could be characterised as a sub-meta-discipline – one that is within the information science meta-discipline but transcends and influences all of its disciplines and sub-disciplines (

Figure 11).

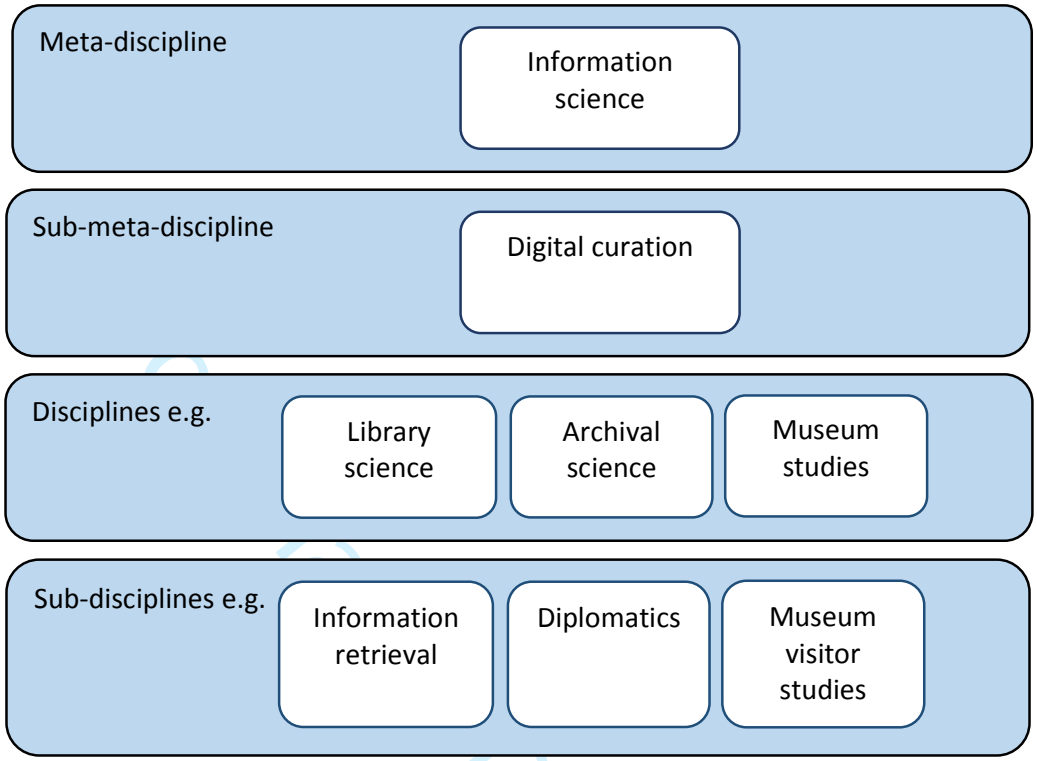

Figure 11: Digital curation as a sub-meta-discipline of information science

Conclusion

Digital curation has progressed through the developmental stages of a discipline. It has matured from its early emphasis on the technical dimension of digital information as a research object to embrace the academic and professional dimensions of the discipline. As such it is a hard-applied discipline where an academic to professional feedback loop is now engendered through formal higher education in the discipline.

The identification that digital curation overarches the traditional disciplines of information science, and sub-disciplines that have emerged from these, informs the future position of its practitioners in both the academic and professional domains and its future development as a defined profession. Its position as a meta-discipline implies that, as the volume and scope of digital information continues to increase, digital curation education will progressively become the dominant archetype and digital curation skills foremost in demand. Rather than education in digital curation being predominantly offered within the curricula for LAM professionals, these traditional disciplines could become specialisations, within a digitally

orientated information science curricula; while digital ready information professionals are likely to increasingly become the norm.

Bibliography

Abbott, D. (2008), "What is digital curation?", available at: http://www.dcc.ac.uk/resources/briefing-papers/introduction-curation/what-digital-curation (accessed 9 February 2018).

Allinson, J. (2006), "OAIS as a reference model for repositories an evaluation", available at: http://www.ukoln.ac.uk/repositories/publications/oais-evaluation-200607/Drs-OAIS-evaluation-0.5.pdf (accessed 9 February 2018).

Åström, F. (2008), "Formalizing a discipline", *Journal of Documentation*, Vol. 64 No. 5, pp. 721–737.

Ball, A. (2006), "Briefing paper: the OAIS Reference Model", available at: http://www.ukoln.ac.uk/projects/grand-challenge/papers/oaisBriefing.pdf (accessed 9 February 2018).

Bates, M. (2015), "The information professions: knowledge, memory, heritage", *Information Research*, Vol. 7 No. 1, available at: http://www.informationr.net/ir/20-1/paper655.html#.WRx98jfTVLM (accessed 9 February 2018).

Bates, M. and Maack, M. N. (2010), *Encyclopedia of Library and Information Sciences*. 3rd edn., CRC Press, New York

Bawden, D. and Robinson, L. (2012), "What is information science? Disciplines and professions", *Introduction to Information Science*, Facet Publishing, London, UK.

Beagrie, N. and Greenstein, D. (1998), "A strategic policy framework for creating and preserving digital collections", available at: http://opus.bath.ac.uk/35448/1/framework.pdf (accessed 9 February 2018).

Becher, T. and Trowler, P. R. (2001), *Academic Tribes and Territories*. 2nd edn. SRHE and Open University Press, Philadelphia, USA.

Beedham, H., Missen, J., Palmer, M. and Ruusalepp, R. (2005), "Assessment of UKDA and TNA compliance with OAIS and METS standards", available at: http://data-archive.ac.uk/media/1692/OAISMETS_report.pdf (accessed 9 February 2018).

Bettivia, R. (2017), "Educating digital stewards", *Digital Preservation Coalition Blog*, available at: http://www.dpconline.org/blog/idpd/educating-digital-stewards-blog (accessed 8 February 2018).

Biglan, A. (1973a), "Relationship between subject matter characteristics and the structure

and output of university departments", *Journal of Applied Psychology*, Vol. 57 No. 3, pp. 204–213.

Biglan, A. (1973b), "The characteristics of subject matter in different academic areas", *Journal of Applied Psychology*, Vol. 57 No. 3, pp. 195–203.

Borko, H. (1968), "Information science: What is it?", *American Documentation*, Vol. 19 No. 1, pp.3-5.

Capurro, R. and Hjørland, B. (2003), "The concept of information", *Annual Review of Information Science and Technology*, Vol 37. No. 1, pp. 343–411.

Cedars Project (1999), "Warwick2 Workshop on Digital Preservation: Final recommendations from small groups to plenary", available at: http://web.archive.org/web/19991109092233/www.leeds.ac.uk/cedars/OTHER/warwickrec.htm (accessed 8 February 2018).

Cedars Project (2001), "The Cedars project report: April 1998-March 2001", available at: https://web.archive.org/web/20030802161351/http://www.leeds.ac.uk:80/cedars/admin/CedarsProjectReportToMar01.pdf (accessed 8 February 2018).

Cirinnà, C., Fernie, K. and Lunghi, M. (Eds.) (2013), *Proceedings of the Framing the Digital Curation Curriculum Conference Florence, Italy, 6-7 May, 2013*, available at: http://ceur-ws.org/Vol-1016/ (accessed 8 April 2018).

Cohen, E. B. and Lloyd, S. J. (2014), "Disciplinary evolution and the rise of the transdiscipline", *Informing Science: the International Journal of an Emerging Transdiscipline*, Vol. 17, pp. 189–215, available at: http://www.inform.nu/Articles/Vol17/ISJv17p189-215Cohen0702.pdf (accessed 8 February 2018).

Consultative Committee for Space Data Systems (2002), "Reference Model for an Open Archival Information System (OAIS)", available at: https://public.ccsds.org/pubs/650x0m2.pdf (accessed 8 February 2018).

Consultative Committee for Space Data Systems (2012), "*Reference model for an open archival information system (OAIS)*", available at: http://public.ccsds.org/publications/archive/650x0m2.pdf (accessed 8 April 2018).

Costello, K. L. (2010), "Digital Preservation Education in iSchools", paper presented at iConference 2010, February 3-6 2010, Urbana, IL., available at: https://ils.unc.edu/digccurr/Costello_Final_iSchool_Poster_Web.pdf (accessed 8 April 2018).

Daigle, B. (2012), "Stewardship and curation in the digital world", *Collection Development in the Digital Age*, Facet Publishing, London, pp. 93–107.

Day, M. (1997), "Preservation of electronic information: a bibliography", available at: http://homes.ukoln.ac.uk/~lismd/preservation.html (accessed 8 February 2018).

Digital Curation Centre (2004), "About the Digital Curation Centre", available at: https://web.archive.org/web/20040419150719/http://www.dcc.ac.uk:80/about.html (accessed 8 February 2018).

Digital Curation Centre (2005a), "Digital curation and preservation: Defining the research agenda for the next decade", available at: http://www.dcc.ac.uk/sites/default/files/documents/data-forum/documents/events/Warwick_Introduction.pdf (accessed 8 February 2018).

Digital Curation Centre (2005b), "Report of the Warwick workshop - 7&8 November 2005: Digital Curation and preservation: Defining the research agenda for the next decade", available at: http://www.dcc.ac.uk/sites/default/files/documents/Warwick_Workshop_report.pdf (accessed 8 February 2018).

Digital Preservation Coalition (2016), "Web-archiving", in *Digital Preservation Handbook*. 2nd edn. Digital Preservation Coalition, available at: http://www.dpconline.org/handbook/content-specific-preservation/web-archiving (accessed 8 February 2018).

Dirks, A. L. (1996), "Organization of knowledge: The emergence of academic specialty in America", paper presented at HIED 630 History of American Higher Education, Graduate College of Education, Univ. of Mass. Boston, available at: https://web.archive.org/web/20080319031909/http://webhost.bridgew.edu/adirks/ald/papers/orgknow.htm (accessed 8 February 2018).

Domo (2017), "Data never sleeps 5.0", available at: https://web-assets.domo.com/blog/wp-content/uploads/2017/07/17_domo_data-never-sleeps-5-01.png (accessed 8 February 2018).

Eastwood, T. (1994), "Archival theory: What is it and why is it important?", *Archivaria*, Vol. 37, pp. 122–130.

Eckard, M., Pillen, D. and Shallcross, M. (2017), "Bridging technologies to efficiently arrange and describe digital archives: the Bentley Historical Library's Archives Space-Archivematica-DSpace Workflow Integration Project", *Code{4}lib Journal*, No. 35., available at: http://journal.code4lib.org/articles/12105 (accessed 8 April 2018).

Egger, A. (2006), "Shortcomings of the Reference Model for an Open Archival Information System (OAIS)", available at: http://www.ieee-tcdl.org/Bulletin/v2n2/egger/egger.html (accessed 8 February 2018).

Ellis, D. (1992), "The physical and cognitive paradigms in information retrieval research", *Journal of Dcoumentation*, Vol. 48 No. 1, pp. 45–64.

Feeney, M. (1999), "The digital culture: Maximising the nation's investment - A synthesis of JISC/NPO studies in the preservation of electronic materials", available at: http://www.ukoln.ac.uk/services/elib/papers/other/jisc-npo-dig/intro.html (accessed 8 February 2018).

Floridi, L. (2010), *Information - A Short Introduction*, Oxford University Press, Oxford.

Foucault, M. (1975), *Discipline and Punish: The Birth of the Prison*. Vintage Books: Random House, New York.

Foucault, M. (1977), *Language, Counter-memory, Practice*. Ithaca, Cornell University Press, New York.

Garrett, J. and Waters, D. (1996), "Preserving digital information: Report of the task force on archiving of digital information", available at: https://www.clir.org/wp-content/uploads/sites/6/pub63watersgarrett.pdf (accessed 9 February 2018)

Gill, T. G. (2013), "Culture, complexity, and informing: How shared beliefs can enhance our search for fitness", *Informing Science: The International Journal of an Emerging Transdiscipline*, Vol. 16, pp. 71–98.

Goonatilake, S. (1991), *The Evolution of Information: Lineages in Gene, Culture and Artefact*, Pinter, London.

Harmon, G. (1969) *Human memory as a factor in the formation of disciplinary systems*. Case Western Reserve University, Cleveland, Ohio.

Harmon, G. (1971), "On the evolution of information science", *Journal of the American Society for Information Science*, Vol. 22 No. 4, pp. 235–241.

Hedstrom, M. (1998), "Digital Preservation: A Time Bomb for Digital Libraries", *Computers and the Humanities*, Vol. 31, pp. 189–202.

Higgins, S. (2007), "Draft DCC curation lifecycle model", *International Journal of Digital Curation*, Vol. 2 No. 2, pp. 82–87.

Higgins, S. (2008), "The DCC curation lifecycle model", *The International Journal of Digital Curation*, Vol. 3 No. 1, pp. 134–140.

Higgins, S. (2011), "Digital Curation: The emergence of a new discipline", *The International Journal of Digital Curation*, Vol. 6 No. 2, pp. 78–88.

Higgins, S. (2017), "Time to become our own profession?", *Digital Preservation Coalition Blog*, available at: http://www.dpconline.org/blog/time-to-become-our-own-profession (accessed 8 February 2018).

Hirst, P. (1974), *Knowledge and the Curriculum*. Routledge and Kegan Paul, London.

Hirtle, P. B. (2010), "The history and current state of digital preservation in the United States.", in *Metadata and Digital Collections: A Festschrift in Honor of Thomas P. Turner*. Cornell University, Ithaca, New York, available at: https://cip.cornell.edu/DPubS/Repository/1.0/Disseminate?handle=cul.pub/1238609304&view=body&content-type=pdf_1 (accessed 8 February 2018).

Hjørland, B. (2002), "Domain analysis in information science: Eleven approaches - traditional

as well as innovative", *Journal of Documentation*, Vol. 58 No. 4, pp. 422–462.

Hjørland, B. (2014), "Information science and its core concepts: Levels of disagreement", in Ibekwe-SanJuan, F. and Dousa, T. M. (eds), *Theories of Information, Communication and Knowledge a Multidisciplinary Approach*. SpringerLink.

International Organization for Standardization (2001), *ISO 15489-1:2001, Information and Documentation - Records Management - Part 1: General*.

JISC (2014a), "Digital preservation and curation programmes", available at: http://webarchive.nationalarchives.gov.uk/20140702175539/http://www.jisc.ac.uk/whatwedo/topics/digitalpreservation.aspx?page=1&filter=Programmes (accessed 8 February 2018).

JISC (2014b), "Digital preservation and records management programme", available at: http://webarchive.nationalarchives.gov.uk/20140702162925/http://www.jisc.ac.uk/whatwedo/programmes/preservation.aspx (accessed 8 February 2018).

Johnston, L. (2014), "What could curation possible mean?", *The signal: digital preservation*, available at: https://blogs.loc.gov/thesignal/2014/03/what-could-curation-possibly-mean/ (accessed 8 February 2018).

Kenney, A. R., McGovern, N. Y., Entlich, R., Kehoe, W. R. and Buckley, E. (2007), "Where to begin?, Digital preservation management: Implementing short-term strategies for long-term problems", available at: http://www.dpworkshop.org/dpm-eng/conclusion.html (accessed 8 February 2018).

Kerr, P., Reddington, F. and Wilkinson, M. (2005), "Digital curation, Where do we go from here?", *Ariadne*, Vol. 45, available at: http://www.ariadne.ac.uk/issue45/dcc-1st-rpt (accessed 8 February 2018).

Kilbride, W. (2017), "Born in a storm", *Digital Preservation Coalition Blog*, available at: http://www.dpconline.org/knowledge-base/preservation-lifecycle/ethics (accessed 8 February 2018).

Kim, J., Warga, E. and Moen, W. (2013), "Competencies required for digital curation: An analysis of job advertisements", *International Journal of Digital Curation*, Vol. 8 No. 1, pp. 66–83.

Knight, G. and Hedges, M. (2007), "Modelling OAIS compliance for disaggregated preservation services", *The International Journal of Digital Curation*, Vol. 2 No. 1, pp. 62–72.

Krishnan, A. (2009), "What are academic disciplines?", *ESRC National Centre for Research Methods NCRM Working Paper Series*, Vol. 3 No. 9, available at: http://www.forschungsnetzwerk.at/downloadpub/what_are_academic_disciplines2009.pdf (accessed 8 February 2018).

Kuhn, T. S. (1962), *The structure of scientific revolutions*. 1st edn. University of Chicago Press, Chicago, USA.

Lavoie, B. F. (2000), "Meeting the challenges of digital preservation: The OAIS reference model", *OCLC Research*, available at: http://www.oclc.org/research/publications/library/2000/lavoie-oais.html (accessed 8 February 2018).

Lavoie, B. F. (2014), "The Open Archival Information System (OAIS) Reference Model: Introductory guide", *Digital Preservation Coalition Technology Watch Report*, No. 14-02.

Lee, J. (2016), "The data lifecycle: Curating partners to curate data", available at: https://www.slideshare.net/BaltimoreNISO/lee-the-data-lifecycle-curating-partners-to-curate-data (accessed 8 April 2018).

Library of Congress (no date), "National Digital Information Infrastructure and Preservation Program", available at: https://www.loc.gov/loc/lcib/0601/ndiipp2.html (accessed 8 February 2018)

LibSource (2017), "Top 5 librarian skills: #1 information curation", *LibSource Blog*, available at: https://libsource.com/top-five-skills-required-for-librarians-today-tomorrow/ (accessed 8 February 2018).

Marc Fresko Consultancy (1996), "Long term preservation of electronic materials", available at: http://www.webarchive.org.uk/wayback/archive/20130718161937/http://www.ukoln.ac.uk/services/elib/papers/other/preservation/ (accessed 8 February 2018).

Mccallum, S. (2003), "40 years of technology in libraries: A brief history of the IFLA Section on Information Technology, 1963/64 -2003", available at: https://www.ifla.org/files/assets/information-technology/publications/40-years-of-its.pdf (accessed 8 February 2018).

McHugh, A., Ruusalepp, R., Ross, S. and Hofman, H. (2007), "DRAMBORA: Digital repository audit method based on risk assessment", available at: http://www.repositoryaudit.eu/download/ (accessed 8 February 2018).

National Science Foundation (2004), "Digital preservation program launches research grants initiative" *News Release,* 04-085, available at: https://www.nsf.gov/news/news_summ.jsp?cntn_id=100399 (accessed 8 February 2018).

NDIIPP (2011), "Preserving our digital heritage: The National Digital Information Infrastructure and Preservation Program 2010 report", available at: http://www.digitalpreservation.gov/documents/NDIIPP2010Report_Post.pdf (accessed 8 February 2018).

nestor Working Group Trusted Repositories - Certification (2006), "Catalogue of criteria for trusted digital repositories: Version 1", available at: http://files.dnb.de/nestor/materialien/nestor_mat_08-eng.pdf (accessed 8 February 2018).

Online Computer Library Center and Research Library Group (2007), "Trustworthy repositories audit & certification: Criteria and checklist, Version 1.0", available at:

https://www.crl.edu/sites/default/files/d6/attachments/pages/trac_0.pdf (accessed 8 February 2018).

Parsons, A. (2010), "Academic liaison librarianship: Curatorial pedagogy or pedagogical curation?", *Ariadne*, Vol. 65, available at: http://www.ariadne.ac.uk/issue65/parsons (accessed 8 February 2018).

Pennock, M. (2007), "Digital curation: A life-cycle approach to managing and preserving usable digital information", *Library and Archives Journal*, Vol. 1 No. 1, pp. 1–3.

Portsmouth University Postgraduate Online Research Training (2013), "*The history data management lifecycle (HDML) model"*, available at: http://port.sas.ac.uk/mod/book/tool/print/index.php?id=1220 (accessed 8 April 2018).

PREMIS Working Group (2005), "Data dictionary for preservation metadata. Final report of the PREMIS Working Group" available at: https://www.oclc.org/content/dam/research/activities/pmwg/premis-final.pdf (accessed 9 February 2018).

RLG/OCLC Working Group on Digital Archive Attributes (2002), "Trusted digital repositories: Attributes and responsibilities", available at: http://www.oclc.org/content/dam/research/activities/trustedrep/repositories.pdf (accessed 8 February 2018).

Robinson, L. and Karamuftuoglu, M. (2010), "The nature of information science: changing models", *Information Research*, Vol 14. No. 4, available at: http://www.informationr.net/ir/15-4/colis717.html (accessed 8 February 2018).

Ross, S. (2000), *Changing Trains at Wigan: Digital Preservation and the Future of Scholarship*. National Preservation Office, London, UK.

Ruest, N. (2014), "Critical processes and OAIS mandatory responsibilities", available at: https://digital.library.yorku.ca/documentation/critical-processes-and-oais-mandatory-responsibilities (accessed 8 February 2018).

Schisler, M. (2017), "Inform and form - the role of education in digital preservation", *Digital Preservation Coalition Blog*, available at: http://www.dpconline.org/blog/idpd/inform-and-form-the-role-of-education-in-digital-preservation (accessed 8 February 2018).

Schommer-Aikins, M., Duell, O. K. and Barker, S. (2003), "Epistemological beliefs across domains using Biglan's classification of academic disciplines", *Research in Higher Education*, Vol. 44 No. 3, pp. 347–366.

Schumann, N. and Recker, A. (2013), "De-mystifying OAIS compliance: benefits and challenges of mapping the OAIS reference model to the GESIS Data Archive", *IASSIST Quarterly*, Vol. 36 No. 2, pp. 6–11.

Slamecka, V. (1968), "Graduate programs in information science at the Georgia Institute of Technology", *Special Libraries*, Vol. 59 No. 4, pp. 246–250.

Smiraglia, R. P. (2014), *Cultural Synergies in Information Institutions*. Springer.

Strodl, S., Petrov, P. and Rauber, A. (2011), "Research on digital preservation within projects co-funded by the European Union in the ICT programme", available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.227.9406&rep=rep1&type=pdf (accessed 8 February 2018).

Successful Students: STEM (2017), "STEM in schools", available at: http://www.successfulstudents-stem.org.au/stem-in-schools (accessed 8 February 2018).

Tibbo, H. (2012), "Placing the horse before the cart: Conceptual and technical dimensions of digital curation", available at: http://www.cceh.uni-koeln.de/files/Tibbo_final.pdf.

Tibbo, H. and Lee, C. A. (2010), "Convergence through Capabilities: Digital Curation Education for Libraries, Archives and Museums", in *Archiving 2010*. IS&T, pp. 53–57.

Valenza, J. K., Boyer, B. L. and Curtis, D. (2014), "Introduction", in *Social Media Curation*. ALA TechSource, Atlanta, GA.

Vardigan, M. and Whiteman, C. (2007), "ICPSR meets OAIS: Applying the OAIS reference model to the social science archive context", *Archival Science*, Vol. 7 No. 1, pp. 73–87.

Zins, C. (2007), "Conceptions of information science", *Journal of the American Society for Information Science and Technology*, Vol. 58 No. 3, pp. 335–350.

i Joint Information Systems Committee (JISC): https://www.jisc.ac.uk/

ii Digital Preservation Coalition (DPC): http://www.dpconline.org/

iii Digital Curation Centre (DCC): http://www.dcc.ac.uk/

iv Cedars Project: https://web.archive.org/web/20070607091736/http://www.leeds.ac.uk/cedars/

v The 18 projects were: APARSEN, ARCOMEM, BlogForever, CASPAR, DELOS, DigitalPreservationEurope, ENSURE, ERPANET, KEEP, LiWA, PARSE.Insight, PrestoPRIME, PLANETS, PROTAGE, SHAMAN, TIMBUS, Wf4EverSCAPE

vi Examples of structured CPD training courses include: Digital Curation 101 (DCC), Digital Preservation Training Programme (originally JISC funded), Digital Preservation Roadshows (DPC) and DELOS Summer School

vii DigCCurr Project: https://ils.unc.edu/digccurr/

viii DigCurV Project: http://www.digcurv.gla.ac.uk/

ix These include: Aberystwyth University, John Hopkins University, King's College London, Robert Gordon University, San Jose State University, University of Maine, University College Dublin

x International Internet Preservation Consortium (IIPC): http://netpreserve.org/about-us/

xi Internet Memory Foundation: http://internetmemory.org/en/

xii UK Web Archive: https://www.webarchive.org.uk/ukwa/

DCC Curation Lifecycle Model 'Actions'	**OAIS Functional Model**	**Lifecycle component** Robinson and Karamuftuoglu (2010) and Borko (1968)
Conceptualise		
Create or Receive	Submission Information Package	Creation
Appraise and select		Collection
Ingest	Archival Information Package	Organisation
Preservation action	Preservation planning, Data management	
Store	Archival storage	Storage
Access, use and reuse	Access, Dissemination Information Package	Retrieval, Use, Dissemination
Transform	Dissemination Information Package	Transformation
Curate and preserve	Preservation planning, Data management	
Community watch and participation	Preservation planning	
Preservation planning	Preservation planning	
Description and representation Information	Descriptive information	Indexing Interpretation
Reappraise		
Migrate		

Table 1: Activities in digital curation conceptual models mapped to information science lifecycle components