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A review of digital curation professional competencies: theory and current practices

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Abstract

Purpose – The purpose of this paper is to examine the concept of professional competency in current digital curation literature through the lens of competency theories in management science and organizational studies. This paper also aims to provide recommendations to articulate and expand professional competencies in future digital curation research and professional education.

Design/methodology/approach – The outcomes presented in this paper are based on a multi-disciplinary literature review and a qualitative content analysis. The literature review explores theoretical foundations of professional competency in management science and organizational studies and how the concept of professional competency is used in digital curation literature. The content analysis scrutinizes 16 digital curation publications that have discussed professional competency, with an in-depth examination of seven empirical studies in these publications.

Findings – The findings include: the concept of professional competency is inconsistently used in digital curation literature, the digital curation literature exhibits disparate coverage of different types of professional competencies, and the digital curation empirical studies often narrowly operationalize the concept of professional competency but the empirical studies using multiple or in-depth qualitative methods yield more comprehensive findings reflecting a broader scope of the concept.

Originality/value – Although past research focused on the competencies required for digital curation, there is no research scrutinizing the conceptual construct of professional competency in the digital curation literature. This paper will be of value to digital curation researchers and educators to better determine the competencies needed for digital curators as an emerging profession.

Keywords Content analysis, Competency theories, Digital curation, Digital curation education, Professional competencies

Paper type General review

Introduction

Digital curation is an emerging professional and research area in archival science, information science and records management studies. The National Research Council of the USA, in its intensive study of digital curation, found that:

> Demands for readily accessible, accurate, useful, and usable digital information from researchers, information-intensive industries, and consumers have exposed limitations, vulnerabilities, and missed opportunities for science, business, and government, as a result of the immaturity and ad hoc nature of digital curation. There is also a push for greater openness and transparency across many sectors of society. Taken together, these factors are creating an urgent need for policies, services, technologies, and expertise in digital curation (The National Research Council, 2015, p. 15).

Digital curation is a relatively new concept that attempts to bridge boundaries among archivists, librarians, records managers and other information professionals. Its tasks and

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goals are remarkably such as those of archivists and records managers, who, in a digital world, must begin planning for and managing data early in the records life cycle to ensure that long-term preservation occurs in spite of evolving formats and rapid technological obsolescence. Thus, more and more archivists and records managers are engaging in digital curation activities, even if they are not aware of it. With its focus on ensuring access, it also relates closely to the activities of librarians and archivists.

According to Beagrie (2008), the term first arose in 2001 during the "Digital Curation: Digital Archives, Libraries and E-Science Seminar" sponsored by the Digital Preservation Coalition and the British National Space Centre to establish dialog among archivists, library and information management specialists and data managers in e-Science (the term e-Science is used in Britain roughly analogously to the way "Cyberinfrastructure" is used in the USA). The term "digital curation" was designed to avoid confusion with a few other terms, such as "digital preservation," "digital archiving" and "digital records management," which were inconsistently used in different professional circles.

The definition of digital curation has been improved and articulated since then. Giaretta and Rankin (2005) distinguished digital curation from other related terms as "looking after and somehow 'adding value' to digital data", which led to the Joint Information System Committee's (JISC) definition of the term as "maintaining and adding value to a trusted body of digital information for current and future use, specifically the active management and appraisal of data over the entire life cycle" [the Joint Information System Committee (JISC), 2006]. Yakel (2007, p. 338) pointed out that the term digital curation reflected the life cycle activities related to research or e-Science data, and it can be used as the "umbrella term for digital preservation, data curation, digital assets and electronic records management". Finally, Digital Curation Centre (DCC) (2010a) summarizes that "Digital curation involves maintaining, preserving and adding value to digital research data throughout its lifecycle", and it asserts that the digital curation comprises a range of activities that promote the maintenance, accessibility, and preservation of digital data.

Thus, within this article, "digital curation" refers to the range of activities required to manage, maintain, preserve and ensure access to digital information. As we focus on digital curation activities spanning across the digital information's entire life cycle rather than focusing on the specific use of the term "digital curation", the literature discussed within this article also encompasses related areas where digital curation activities are fundamental to these areas, such as data curation, digital preservation, electronic records management, e-Science and digital librarianship.

As digital curation becomes a rising research and professional field, Yakel *et al.* (2011) predict a growing need for a new generation of information professionals who can perform digital curation activities in the digital environment. These professionals are often known as digital curators. To meet such requirements, educators and researchers have examined the competencies that are essential for this emerging type of information professional. Meanwhile, academic and professional institutions have initiated educational and training programs to prepare future digital curators. Many current programs take a relatively pragmatic approach that emphasizes digital curation skills that are currently needed, but fewer programs adopt a competency-based approach that aims to build a range of competencies that are needed for digital curation work. Competency-based approaches have been increasingly accepted in professional education and training around the world (Le Deist and Winterton, 2005); it is time to comprehensively examine digital curation from the perspective of professional competency.

Competency-based approaches provide a wider conceptual framework that captures more essential activities and better represents the totality of digital curation work, thereby

offering training that is both more comprehensive and more in line with the full range of digital curation work. This is supported by Lado and Wilson (1994), who showed that a comprehensive focus on all organizational and extra organizational skills and competencies produce an organization that has more strategic strength and is able to position itself better in its environment.

Within this article, we review the theoretical foundations for professional competency in management science and organizational studies and analyze how the concept of professional competency is used in digital curation literature. We then present a content analysis of 16 publications that discuss professional competency within the broad scope of digital curation. Based on the literature review and the content analysis, we argue that it is crucial to expand the concept of professional competency under a more comprehensive conceptual framework in future digital curation research and professional education and training.

Theoretical foundations for professional competency

Professional competency, also frequently referred to as professional competence, occupational competency or occupational competence, is a commonly yet inconsistently used term in management science, organizational studies, professional education and vocational training. It broadly refers to the individual knowledge, skills and abilities that are required to perform the activities within a specific organization or profession (Boyatzis, 1982; Woodruffe, 1993). In the business world, employers and human resource managers look for candidates with generic and transferable skills for most job roles or specific positions (Stasz, 1997)[1].

In management science and organizational studies, a large body of literature has discussed competency and numerous researchers have developed conceptual frameworks to operationalize the concept. Mansfield (1993) believed professional competencies were rooted in the reality of work, so he proposed a functional approach that defines professional competency by the standards of a specific profession, evaluated by the outcomes of the activities performed in that profession. He suggested four types of competencies that are required for one to be considered fully competent in any particular work role:

(1) technical skills;

(2) contingency management skills;

(3) task management skills; and

(4) role environment skills.

Technical skills are those concrete skills required to perform a specific job; if one exhibits technical skills, one is able to use the appropriate tools for the job and follow an appropriate set of logical steps to complete it successfully. Contingency management skills are those skills that enable one to assess risk and uncertainty, variations in practice over time and to succeed at the work via decision-making, problem-solving and process management. Task management involves integrating different role components to achieve a specific task. Role environment skills are broad sets of skills that are required to work in the particular environment in which the employee is immersed, and they can include "soft skills" such as excellent verbal communication, ability to manage upward, understanding of the norms and ethics in one's work environment.

Mansfield's depiction of functional analysis originated from early attempts in England to develop occupational standards. He did not use the term "function", as it was used in an earlier organizational theory, whereby an organization was assumed to be broken up into

"functional" units that were purported to represent the bureaucratic structure of that organization (e.g. accounting and human resources). For Mansfield, a function is the set of activities that are performed to achieve particular work outcomes within an occupation or organization, where outcomes can be either a material product or a process that contributes to the completion of a higher-level process. Functional analysis involves identifying the key purpose(s) of an organization (or occupation), assessing the main functions that enable the purpose(s) to be met and then engaging in disaggregation to come up with more detailed functions. It involves disaggregating the functions until the level of detail needed for the analysis is achieved. This level of detail varies from purpose to purpose and from environment to environment.

Elkin (1990) categorized professional competencies into micro-level, job-task-related competencies and macro-level, management-related competencies. By micro-level, job-task-related competencies, Elkin referred to the abilities that allow one to perform specific tasks to achieve a work goal. By macro-level, management-related competencies, he meant those competencies that will allow one to move beyond pure task performance, making more strategic decisions and managing others. He noted that new entrants into an occupation or "lower-level" workers tend to be selected for hire (or evaluated) based on their task-related or micro-competencies, whereas managers tend to be assessed less for the specific tasks they can perform and more for the social and behavioral competencies they exhibit, such as ability to identify job risks and ability to adapt work to new environments. Similarly, Brown (1993) found human resource practice narrowly focused on the competencies that can be easily measured by work performance and outcomes, so he introduced the term "meta-competency" to describe higher-level professional competencies that can neither be demonstrated directly nor be easily measured, such as managerial abilities and communication skills.

Cheetham and Chivers (1996, 1998) investigated how professionals "acquire and maintain their professionalism". They reviewed the literature on functional competency, behavioral competency and meta-competency and developed a holistic model to encompass and integrate these various concepts. They based their research on a combination of these competence-based approaches and the "reflective practitioner" approach put forth by Shön (1987). Shön deemed that professional competency goes well beyond the types of intellectual-, knowledge- and skill-based competency that many educators have promulgated. He saw competency as a form of artistry, recognizing the tacit dimension in all expert professional practice. Some professionals are simply outstanding and others recognize this expertise. However, even if the expert himself or herself were asked to explain the difference between their own expertise and others' less than expert performance, they would generally find it difficult because of the large amount of tacit knowledge that resides within expert behavior. The "reflective practitioner" is one who, during the process of engaging in work, is able to seamlessly continue to work on his or her processes even when surprises arise. At times, a novel element is introduced into one's work and an expert is able to immediately recognize this element as a "surprise event" and generally sees the surprise as some sort of problem[2]. He or she, however, is able to intelligently reflect on the nature of the surprise and while continuing to work, try out techniques that can enable him or her to integrate the surprise into the overall workflow and still achieve the goal that he or she is working on. The ability to narrow the field of possible responses to surprise, based on both knowledge and "knowing-in-action," separates the expert from the novice. In some ways, then, the expert is much such as a jazz musician, who "has a feel" for where the music should go next.

Cheetham and Chivers accepted this assessment of expertise and tried to build it into their own competency model. They separated competency into four components:

(1) knowledge/cognitive competency;

(2) functional competency;

(3) personal or behavioral competency; and

(4) values/ethical competency.

Each of these is broken into components that include characteristics such as theoretical knowledge, tacit knowledge (i.e. "knowing-in action"), procedural knowledge and conceptual knowledge.

Building upon Cheetham and Chivers' work, Le Deist and Winterton (2005) proposed a typology to articulate the concept of professional competency (Table I). In this topology, they outlined two dimensions: one dimension indicates whether certain competency is conceptual or operational and the other dimension measures whether the competency is occupational or personal. They analyzed four types of competencies commonly discussed in prior competency research and fit them into the two-by-two topology matrix. The four types of competencies are: cognitive competency (defined as knowledge and the ability to apply knowledge for a specific profession); functional competency (defined as skills required to perform job responsibilities); social competency (defined as the ability to cooperate and interact with other people, overlapped with personal or behavioral competency in earlier competency literature); and meta-competency (defined as higher level abilities that cannot be generically measured that are nonetheless required for a specific profession, overlapped with managerial competency in earlier competency literature).

Literature in management science and organizational studies accepts that multi-dimensional and holistic conceptual models (Cheetham and Chivers, 1996, 1998; Le Deist and Winterton, 2005) define professional competency more comprehensively than the earlier conceptual models that focused on a single aspect such as job tasks or personal behaviors. Multi-dimensional models often provide more complete and coherent frameworks to guide professional education and training than the single-dimension models.

A review of digital curation professional education and training

Digital curation educators and researchers understand the importance of training the workforce, and they have made great efforts to tailor digital curation education to meet the needs of the human resources market. The endeavors to approach digital curation professional competency can be categorized as digital curation initiatives, which include working groups and funded research projects aimed at setting the fundamentals for digital curators as new professionals and digital curation education and training, which includes educational programs at academic institutions and training programs provided by professional organizations. Note that many digital curation projects span both categories. In the following section, this article reviews key projects from the perspective of both categories and discusses how these projects conceptualize professional competency.

Table I.
A typology for competency by Le Deist and Winterton (2005)

Dimensions	Occupational	Personal
Conceptual	Cognitive competency	Meta-competency
Operational	Functional competency	Social competency

Digital curation initiatives

In the UK, the Digital Curation Centre (DCC) (2016) initiated a series of early research projects that tried to identity core skills for data management. DCC later collaborated with the JISC and the Research Information Network on the Research Data Management Skills Support Initiative (DaMSSI) project and on its second phase DaMSSI-Assessment, Benchmarking and Classification (ABC). The two projects aimed at promoting good data management practices among practitioners and identified the curriculum structure and learning outcomes for data manager training [Digital Curation Centre (DCC), 2010b, 2012]. The focus of these projects was limited to research data management.

In the US, library and information science schools put forward initiatives to facilitate discussion on the educational issues of training future "digital curators" – the professionals specialized in digital curation. For example, the DigCCurr project at the University of North Carolina at Chapel Hill (UNC) made significant contributions to digital curation curriculum development by holding a series of conferences and symposia on curation-relevant issues (DigCCurr, 2008). DigCCur's subsequent projects Closing the Digital Curation Gap and Digital Curation Exchange also provide further resources to reach the consensus for digital curation skills [Closing the Digital Curation Gap (CDCG), 2010; Digital Curation Exchange (DCE), 2016]. The Graduate School of Library and Information Science at the University of Illinois at Urbana-Champaign (UIUC) addressed current topics in digital curation education, such as digital humanities and data curation, by hosting its Data Curation Education Program summer institutes [Graduate School of Library and Information Science at UIUC (GSLIS), 2009].

Globally, the International Data Curation Education Action working group held two conferences in 2008 to discuss the issues in data curation education (Davidson and Hank, 2009). Funded by the European Commission, the DigCurV project explored a new curriculum framework for vocational training in digital curation among different organizational settings, including libraries, archives and museums (DigCurV, 2013).

These digital curation initiatives laid foundations for articulating the skills and abilities needed for digital curation, upon which later education and training programs were built.

Digital curation education and training

The Institute of Museum and Library Services of the US funded three projects aiming to develop programs and curricula within the scope of digital curation, including the DigCCur project at UNC, the new data curation concentration at UIUC and the DigIn project at the University of Arizona (UA). These three projects focused on digital curation curriculum development and offered formal degree programs in digital curation (Fulton *et al.*, 2011).

A number of other academic institutions, including the University of Michigan at Ann Abor, the University of California at Los Angeles and the University of Toronto, have also made efforts to enhance their graduate degree programs in digital curation or data curation (Ray, 2009). In fact, in recent years, an increasing number of library and information science schools have started offering digital curation degree programs, concentrations, certificates, or at least, courses (Harris-Pierce and Quan Liu, 2012).

Many academic institutions and professional organizations have also provided non-degree digital curation training programs, primarily targeting information professionals who need to upgrade skills to perform digital curation activities. For example, the Society of American Archivists (SAA) (2013) offers a Digital Archives Specialists (DAS) curriculum and certificate program, University of London Computer Centre runs the Digital Preservation Training Programme (DPTP) (2016) and the US Library of Congress holds a

Digital Preservation Outreach and Education (DPOE) training workshops for working professionals (DPOE, 2016).

These degree or non-degree education and training programs offered by academic institutions and professional organizations play a vital role in shaping the concept of digital curation professional competency.

The concept of professional competency in digital curation

After reviewing literature on key digital curation projects described above, we found that these digital curation initiatives and education and training programs inconsistently use the term "competency", often interchangeably with "skills" and "abilities" without further explaining the context of these terms. For example, Botticelli *et al.* (2011) described what they believe to represent a core curation knowledge base and key challenges in developing curation competencies. They suggested that one could think of a list of professional competencies as a "mission statement" for a digital curation program, though they did not specifically define or describe how they conceptualized the term "competency". Likewise, Moles (2014) used the phrase "knowledge, skills and competencies" within his discussion of the DigCurV project, although he did not define or differentiate these terms. Still, the DigCurV project offers a unique way to expand a digital curation education program by taking a comprehensive approach to training. The project offered a set of characteristics that a digital curation program must exhibit to support broader curation goals. In addition, it separated three levels of competency – practitioner, manager and administrator – and recommended competencies needed by workers in each level.

Specifically, we found that current digital curation professional training programs (i.e. DPOE, DPTP, DAS) heavily emphasize the generic skills needed for digital curation without further involving the term "competency". It is understandable as these programs primarily aim at skilling up working professionals for the increasing demand for digital curation work.

However, it is our view that as the concept of competency is vague and subject to political, geographical and disciplinary regimes, authors should be careful when using them to clarify their intellectual tradition of use.

A content analysis of professional competency for digital curation

Our literature review shows that the concept of professional competency is not clearly and consistently defined in digital curation initiatives or in education and training programs. Now we will analyze how professional competency is actually conceptualized and operationalized in digital curation research using a content analysis.

Methods

We selected 16 scholarly and professional publications that have explicitly discussed professional competency in digital curation for the content analysis.

We applied four inclusion rules when selecting publications for analysis. First, as this article emphasizes digital curation activities rather than the specific term "digital curation," we examined literature on professional competency for digital curation as well as related areas where digital curation activities are fundamental, including data curation, digital preservation, e-Science and digital librarianship. Second, the publications explicitly discussed at least one aspect of professional competency for digital curation based on the competency literature reviewed earlier. For example, an article could study directly what knowledge and skills are needed for digital curation positions, or it could discuss how to improve education programs to train students with proper skills for digital curation

positions. Third, we covered several types of publications, including research articles and reports from the digital curation projects described above, theoretical or conceptual papers, case studies and empirical studies. Fourth, if an author or a group of authors published multiple works from the same project within our scope, we included either the most recent or the most comprehensive work of the author(s).

We adopted Le Deist and Winterton's multi-dimensional and holistic model of professional competency to create our coding scheme. We identified four types of competencies: cognitive competency, functional competency, social competency and meta-competency. The original definitions in management science and organizational studies are given in the literature review above, and we articulated them in the scope of digital curation for more accuracy, as shown in Table II.

Figure 1 shows the coding scheme that we used to analyze how different types of professional competencies are covered in the selected digital curation publications. Two authors coded these publications independently and then finalized the codes collaboratively to improve inter-coder reliability.

Then, we closely examined seven empirical studies among 16 selected publications. Empirical research is the approach that "uses data gathered from naturally occurring situations and experiments, rather than via laboratory or simulation studies, where

Types	Definitions in the scope of digital curation
Cognitive competency	Knowledge of digital curation and the ability to learn new knowledge, such as an understanding of digital curation theories and concepts, as well as mastery of tacit knowledge gained by experience
Functional competency	Generic skills and abilities required to perform digital curation activities, such as familiarity with metadata standards and digital curation systems
Social competency	Personal characteristics and social skills needed to perform digital curation activities dealt with people and organizations (e.g. data creators, data users, collaborating data repositories)
Meta-competency	High-level abilities required for digital curation that often cannot be generically measured, such the ability to learn, reflect and cope with uncertainty

Table II.
Four types of professional competency in the scope of digital curation

A. Cognitive competency
- A1 Knowledge
- A2 Application of knowledge

B. Functional competency
- B1 Job functions/responsibilities
- B2 Skills to perform job functions
- B3 Experience

C. Social competency
- C1 Behavior
  - C1.1 Communication
  - C1.2 Collaboration
- C2 Attitude and professionalism

D. Meta-competency
- D1 Learning ability
- D2 Reflection ability
- D3 Managerial ability
- D4 Values, ethics, and laws

Figure 1.
Coding scheme

researchers have more control over the events being studied" (Flynn *et al.*, 1990, p. 251). Compared to conceptual research, which is generally used by researchers to develop new concepts or to reinterpret existing ones, empirical research is data-based and often yields conclusions that are capable of being verified by observation or experiment (Kothari, 2004, p. 4). In the emerging field of digital curation, empirical studies reflect the current digital curation practices in the real world. Specifically, empirical studies require researchers to operationalize the concept being examined to ensure the validity of the data used. From such studies we can discern how the concept of professional competency is decomposed in digital curation professional practices. Thus, we investigated the operationalization of professional competency in seven empirical studies. In addition, we further examined the research methods used in these empirical studies to determine whether specific research instruments affect the comprehensiveness of professional competency in their findings.

Findings

Professional competency coverage. Table III shows our coding results of professional competency coverage in each of the selected publications, identified by authors and publication year. The publication type column provides the general classification for each publication, including project reports, position papers, case studies and empirical studies. Note that publication types are non-exclusive so that one publication can be classified into more than one type.

Overall, the selected publications have covered all four types of competencies but unevenly. Cognitive competency and functional competency are covered by 14 publications and 16 publications, respectively, and their sub-codes are also relatively evenly covered. In comparison, social competency and meta-competency are less covered by eight and 13 publications, respectively, and their sub-codes exhibit disparity among publications. For example, the social competency sub-code "behavior", including communication and collaboration, has been covered in eight publications, yet the other sub-code "attitude and professionalism" has not been explicitly discussed in any of the selected publications. Also, eight out of 13 publications that cover meta-competency only touch upon one sub-code of meta-competency.

The results show that selected publications provided relatively thorough coverage of cognitive competency and functional competency in their discussion and analysis of professional competency for digital curation, indicating digital curation literature places an emphasis on the occupational dimension of competency (cognitive competency and functional competency) as it is defined by Le Deist and Winterson's topology in Table I. However, there is room for expansion and clarification on social competency and meta-competency in digital curation research and education.

Taking the individual publication as unit of analysis, we discover that the publication type demonstrates a connection with the comprehensiveness of professional competency covered in each publication. First of all, empirical studies tend to generate more comprehensive discussion on professional competency, as six out of all seven empirical publications have covered all four types of competencies. Second, case studies also provide relatively comprehensive coverage. Among five case studies, one publication (Guy, 2013) covers four types of competencies, three publications (Fulton *et al.*, 2011; Kelly *et al.*, 2013; Kim, 2015) cover three types and the other one (Yakel *et al.*, 2011) covers two types. Third, position papers and project reports yield limited yet inconsistent coverage. For example, Molloy *et al.* (2013) present a report from DigCurV project that fully tackles most aspects of professional competency for digital curation, while a few project reports and position papers

Author(s) and year	Publication type	Professional competency coverage based on the coding scheme in Figure 1			
		A. Cognitive competency	B. Functional competency	C. Social competency	D. Meta-competency
Fulton *et al.* (2011)	Case study	A1, A2	B2, B3		D1, D3, D4
Guy (2013)	Case study, project report	A1, A2	B2, B3	C1.1, C1.2	D2
Kelly *et al.* (2013)	Case study	A1, A2	B2, B3		D4
Kim (2015)	Case study	A1, A2	B2, B3		D2
Kim *et al.* (2011)	Empirical study	A1, A2	B2	C1.1	D3
Kim *et al.* (2013)	Empirical study	A1, A2	B2, B3	C1.1, C1.2	D1, D2, D3
Lee and Tibbo (2011)	Empirical study	A1	B1, B2	C1.1, C1.2	D2, D3, D4
Madrid (2013)	Empirical study	A1	B1, B2	C1.2	D3, D4
Molloy *et al.* (2013)	Project report	A1, A2	B2, B3	C1.1	D3
Palmer *et al.* (2014)	Empirical study	A1	B1	C1.1, C1.2	D3
Pryor and Donnelly (2009)	Position paper		B1, B2		D3
Ray (2009)	Position paper	A1	B2, B3		D4
Stanton *et al.* (2011)	Empirical study	A1	B2	C1.1, C1.2	D1, D3
Swan and Brown (2008)	Empirical study, project report		B2		
Weber *et al.* (2012)	Position paper	A1	B1, B2		
Yakel *et al.* (2011)	Case study	A1	B1, B2, B3		

Table III.
Professional competency coverage in selected publications

(Pryor and Donnelly, 2009; Swan and Brown, 2008; Weber *et al.*, 2012) only touch upon one or two types of competencies.

Operationalization and research methods of empirical studies. In total, seven out of the 16 selected publications are empirical studies that investigate the digital curation professional by collecting and analyzing primary data. Table IV demonstrates the operationalization and research methods used in these empirical studies.

As shown in Table IV, seven empirical studies in digital curation either operationalize the concept of professional competency as knowledge, skills and abilities (Kim *et al.*, 2011, 2013; Lee and Tibbo, 2011; Stanton *et al.*, 2011) or as job functions and responsibilities (Madrid, 2013; Palmer *et al.*, 2014, Swan and Brown, 2008). This also demonstrates the emphasis on the occupational dimension (cognitive competency and functional competency) in current digital curation empirical studies. Social competency and meta-competency are covered in the findings of these empirical studies but not in the concept operationalization process. One possible reason is that the occupational dimension of professional competency is easier to observe and measure. By operationalizing the professional competency based on occupational dimensions researchers have more justification for their data collection and analysis methods.

Research methods of these empirical studies vary – researchers have used both quantitative and qualitative methods in these empirical studies, including quantitative content analysis (Kim *et al.*, 2013), quantitative or qualitative surveys (Swan and Brown, 2008; Lee and Tibbo, 2011; Palmer *et al.*, 2014) and in-depth qualitative methods such as interviews and focus groups (Lee and Tibbo, 2011; Stanton *et al.*, 2011; Madrid, 2013).

Note that most of these empirical studies generate more comprehensive findings of different types of professional competency in comparison with case studies, position papers and project reports. This shows the importance of empirical studies to advance the research for an emerging field. However, empirical studies only draw from the status quo of digital curation activities, as opposed to expert predictions of the future of the field. "Digital curator" is still a new yet developing profession, thus researchers and educators should look beyond the status quo and try to discern future prospects.

Key empirical studies. A few of the selected empirical studies for our analysis are worth discussing in regard to their operationalization and methods, which offer insights into approaches that can provide a comprehensive competency development model.

Table IV.
Operationalization and research methods in empirical studies

Author(s) and year	Operationalization	Research methods
Kim *et al.* (2011)	Knowledge, skills and abilities needed for e-Science professionals	Interviews, focus groups
Kim *et al.* (2013)	Knowledge, skills and abilities required to perform a broad range of digital curation functions	Content analysis
Lee and Tibbo (2011)	A matrix of digital curation knowledge and skills	Interviews, workshops, surveys
Madrid (2013)	Specific characteristics of the task or job that a digital curator can do	Delphi study
Palmer *et al.* (2014)	Job functions and responsibilities of data curators	Surveys
Stanton *et al.* (2011)	Knowledge, skills and abilities needed for e-Science professionals	Interviews, focus groups
Swan and Brown (2008)	Job responsibilities of current data scientists and data curators	Surveys

Swan and Brown (2008) tried to describe the skills, roles and career structure for data scientists and data curators by screening current data science practitioners' status. They analyzed current data science practitioners' skill sets and roles in organizations and suggested certain revisions to their training. Kim *et al.* (2013) directly tackled the concept of competency in their study examining the contents of digital curation job advertisements. Based on an analysis of 173 job advertisements, seven kinds of competencies are needed for digital curators. Palmer *et al.* (2014) surveyed the graduates from a data curation program to identify the actual professional needs from data workforce; they found a majority (90 per cent) of the graduates were able to apply their data skills in their current work and the most useful data skills that respondents reported were metadata, preservation planning, modeling, data management and programming. These empirical studies solidly tackle the concept of professional competency from the occupational dimension.

In comparison, empirical studies using multiple and in-depth qualitative methods yield more comprehensive findings on professional competency. For example, Lee and Tibbo (2011) used a grounded theory research design to develop the DigCCurr matrix of digital curation knowledge and skills. They used multiple methods (interviews, workshops and survey) to obtain opinions and feedback from diverse stakeholders (domain experts, researcher, educators and students), and their DigCCurr matrix elaborated digital curation knowledge and skills in six dimensions, providing a comprehensive description of digital curator as a new professional role. Madrid (2013) used the Delphi method, a research technique used to develop a consensus of opinion when topics lack previous knowledge, to identify digital curators' professional competency. Based on the consensus from a three-round questionnaire survey with a panel of domain experts in digital curation, the author created 20 statements describing what a well-trained digital curator should be able to do, thereby including all four types of competency defined by Le Deist and Winterton.

Discussion

Our literature review and content analysis show that digital curation researchers and educators understand the importance of identifying professional competencies required for digital curation work and have made great efforts to build up adequate digital curation education curriculums to meet the demand of the workforce. However, few digital curation publications approach the concept of professional competency in the holistic manner that has been achieved within organizational studies and management science. Therefore, we argue that digital curation professional competency can be expanded in the following aspects.

Comprehensiveness of the concept

Our findings show that the concept of professional competency is not comprehensively scoped in digital curation literature in comparison with the disciplines where the concept has been fully developed. Specifically, the empirical studies analyzed above operationalize professional competency narrowly as cognitive competency and functional competency. Though their findings touched upon other types of competency, the digital curation literature often starts with a narrower and often functional sense of the concept, perhaps because archival literature itself focuses upon functional analysis for other purposes. In management science and organizational science, scholars have discussed the benefits of the holistic or multi-dimensional approach to operationalize the concept (Cheetham and Chivers, 1996, 1998; Le Deist and Winterton, 2005), such as providing all-inclusive guidelines to assess professional competency. Holistic or multi-dimensional conceptual frameworks of professional competency are rarely used in the digital curation literature so

far. Future research can explore holistic or multi-dimensional conceptual models to operationalize professional competency for digital curation. In particular, the DigCCurr matrix of knowledge and skills can be used as a diving board into more comprehensive conceptions of competency. For example, the digital curation literature discussed here has noted that this emerging field will play an important role not only in archives and repositories but also for social and scientific research, governmental agencies seeking to meet open data requirements and for-profit business organizations that desire to take advantage of big data to examine trends over a long period of time. One way to expand comprehensiveness would be to examine whether or not differences in digital curation professional competency exist with respect to business sector along the multi-dimensional typology discussed by Le Diest and Winterton. Because legal and environmental requirements vary across sectors and key ethical orientation may also vary across sector, competencies may also vary.

Research instruments

The second aspect to expand is the research methods used in digital curation empirical studies to examine professional competency. Three major research methods are used in the selected literature: content analysis of digital curation job advertisements, surveys of digital curation practitioners and in-depth qualitative methods such as interviews and focus groups to gather data from domain experts. All three methods have strengths and limitations. Content analysis of job advertisements is an established method to analyze required qualifications and skills for library and information science professionals (Smith and Lynch, 1999; Lynch and Smith, 2001; Choi and Rasmussen, 2009). Job advertisement content analysis can authentically reflect what qualifications and skills are needed in the industry; however, the market demand is just one side of the story and cannot fully define a profession. Surveys and in-depth qualitative methods are commonly used in social science research and they are an effective way to obtain data about how professionals perceive specific problems but self-reporting can have issues. Our analysis shows that empirical studies using multiple methods and in-depth qualitative methods tend to yield more comprehensive findings, but bias may exist in qualitative methods with a small number of homogeneous participants. We recommend researchers should consider using multiple methods or mixed methods in their future investigation to achieve higher validity.

Future prospects

Current research and educational endeavors largely draw from the status quo of digital curation activities, which mainly reflects the demand for digital curation professionals today. "Digital curation" as an emerging profession is still evolving rapidly, thus the competencies needed right now may not be enough in the near future. Researchers and educators should not only limit their vision to the status quo but also examine the future prospects of the profession in regard to professional competency. Therefore, the third aspect for digital curation education and training to expand is to incorporate future prospects into professional competency. The findings show that the personal dimension of competency, including social competency and meta-competency, was less covered in digital curation literature, which should be the area for digital curation education and training to enhance with future prospects.

We are aware that teaching digital curation is one of the key challenges for digital curation education and training for several reasons. First, selecting materials to cover in a course represents a huge challenge because digital curation is both wide and deep

as a topic. Second, there is a strong need for having hands-on and technical practice, which poses another challenge to organize courses. Third, certain aspects of competency cannot be generically measured and are thus difficult to teach, such as managerial, reflective and learning skills. Therefore, we proposed that future digital curation education and training should specifically incorporate two relatively teachable competencies:

(1) communication and collaboration skills of social competency; and

(2) values, ethics and laws of meta-competency.

The two competencies also reflect the uniqueness and future prospect of digital curators as a profession. Communication and collaboration skills should be a key strength of digital curators. As digital curation activities require high levels of collaboration and coordination, digital curators often play a role as liaison for organizations and stakeholders. Values, ethics and laws, which are barely covered in current digital curation literature, are types of competency that distinguish digital curators from other professions.

Conclusion

This article presents findings from a multi-disciplinary literature review and a content analysis, showing that the concept of professional competency is not comprehensively used in digital curation in comparison with the disciplines where the concept is fully developed. The findings confirm the importance of articulating a broader notion of professional competency for digital curation because it helps to guide the advancement of digital curators as a new profession and to improve digital curation education and training. We also provide evidence that there is a need to expand professional competency in future digital curation research and digital curation professional education.

Notes

1. By saying they are generic skills, we mean to suggest (as Stasz and others have) that we distinguish between competencies as underlying characteristics of an individual (or team) and the actual tasks they perform. Tasks are not competencies. The characteristics that allow an individual to perform the tasks *are* the competencies (Elkin).
2. Seely-Brown *et al.* (1989, p. 35) later discuss situated learning in much the same fashion as Shön does, pointing out that the expert is able to take ill-defined problems and work out the solution by acting in context, thereby using "cognition in context".

References

Beagrie, N. (2008), "Digital curation for science, digital libraries, and individuals", *International Journal of Digital Curation*, Vol. 1 No. 1, pp. 3-16.

Botticelli, P., Fulton, B., Pearce-Moses, R., Szuter, C. and Watters, P. (2011), "Educating digital curators: challenges and opportunities", *International Journal of Digital Curation*, Vol. 6 No. 2, pp. 146-164.

Boyatzis, R. (1982), *The Competent Manager*, Wiley, New York, NY.

Brown, R.B. (1993), "Meta-competence: a recipe for reframing the competence debate", *Personnel Review*, Vol. 22 No. 6, pp. 25-36.

Cheetham, G. and Chivers, G. (1996), "Towards a holistic model of professional competence", *Journal of European Industrial Training*, Vol. 20 No. 5, pp. 20-30.

Cheetham, G. and Chivers, G. (1998), "The reflective (and competent) practitioner: a model of professional competence which seeks to harmonise the reflective practitioner and competence-based approaches", *Journal of European Industrial Training*, Vol. 22 No. 7, pp. 267-276.

Choi, Y. and Rasmussen, E. (2009), "What qualifications and skills are important for digital librarian positions in academic libraries? A job advertisement analysis", *The Journal of Academic Librarianship*, Vol. 35 No. 5, pp. 457-467.

Closing the Digital Curation Gap (CDCG) (2010), "The project", available at: http://digitalcurationexchange.org/cdcg/ (accessed 18 August 2016).

Davidson, J. and Hank, C. (2009), "International data curation education action (IDEA) working group: a report from the second workshop of IDEA", *D-Lib Magazine*, Vol. 15 Nos 3/4.

DigCCurr (2008), "About our projects", available at: www.ils.unc.edu/digccurr/ (accessed 18 August 2016).

DigCurV (2013), "Digital curator vocational education Europe", available at: www.digcur-education.org/ (accessed 18 August 2016).

Digital Curation Centre (DCC) (2010a), "What is digital curation?", available at: www.dcc.ac.uk/digital-curation/what-digital-curation (accessed 10 February 2017).

Digital Curation Centre (DCC) (2010b), "DaMSSI", available at: www.dcc.ac.uk/training/damssi (accessed 18 August 2016).

Digital Curation Centre (DCC) (2012), "DaMSSI – assessment, benchmarking and classification", available at: www.dcc.ac.uk/training/damssi-abc (accessed 18 August 2016).

Digital Curation Centre (DCC) (2016), "Projects", available at: www.dcc.ac.uk/projects (accessed 18 August 2016).

Digital Curation Exchange (DCE) (2016), "About the DCE", available at: http://digitalcurationexchange.org/about (accessed 18 August 2016).

Digital Preservation Training Programme (DPTP) (2016), "About us", available at: http://dptp.org/about-us/ (accessed 18 August 2016).

Elkin, G. (1990), "Competency-based human resource development – making sense of the ideas", *Industrial and Commercial Training*, Vol. 22 No. 4.

Flynn, B.B., Sakakibara, S., Schroeder, R.G., Bates, K.A. and Flynn, E.J. (1990), "Empirical research methods in operations management", *Journal of Operations Management*, Vol. 9 No. 2, pp. 250-284.

Fulton, B., Botticelli, P. and Bradley, J. (2011), "DigIn: a hands-on approach to a digital curation curriculum for professional development", *Journal of Education for Library and Information Science*, Vol. 52 No. 2, pp. 95-109.

Giaretta, D. and Rankin, S. (2005), "DCC approach to digital curation", available at: www.dcc.ac.uk/sites/default/files/documents/DCCApproachtoDigitalCuration-20040827.pdf (accessed 10 February 2017).

Graduate School of Library and Information Science at UIUC (GSLIS) (2009), "GSLIS to hold summer institute for humanities data curation", available at: https://ischool.illinois.edu/articles/2009/01/gslis-hold-summer-institute-humanities-data-curation (accessed 18 August 2016).

Guy, M. (2013), "RDM training for librarians", available at: www.dcc.ac.uk/sites/default/files/documents/publications/case-studies/Training-for-librarians-case-study.pdf (accessed 18 August 2016).

Harris-Pierce, R.L. and Quan Liu, Y. (2012), "Is data curation education at library and information science schools in North America adequate?", *New Library World*, Vol. 113 Nos 11/12, pp. 598-613.

Kelly, K., Marlino, M., Mayernik, M.S., Allard, S., Tenopir, C., Palmer, C.L. and Varvel, V.E. Jr, (2013), "Model development for scientific data curation education", *International Journal of Digital Curation*, Vol. 8 No. 1, pp. 255-264.

Kim, J. (2015), "Competency-based curriculum: an effective approach to digital curation education", *Journal of Education for Library and Information Science Online*, Vol. 56 No. 4, pp. 283-297.

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

Kim, Y., Addom, B.K. and Stanton, J.M. (2011), "Education for eScience professionals: integrating data curation and cyberinfrastructure", *International Journal of Digital Curation*, Vol. 6 No. 1, pp. 125-138.

Kothari, C.R. (2004), *Research Methodology: Methods and Techniques*, New Age International. New Delhi.

Lado, A.A. and Wilson, M.C. (1994), "Human resource systems and sustained competitive advantage: a competency-based perspective", *The Academy of Management Review*, Vol. 19 No. 4, pp. 699-727.

Le Deist, F.D. and Winterton, J. (2005), "What is competence?", *Human Resource Development International*, Vol. 8 No. 1, pp. 27-46.

Lee, C.A. and Tibbo, H. (2011), "Where's the archivist in digital curation? Exploring the possibilities through a matrix of knowledge and skills", *Archivaria*, Vol. 72, pp. 123-168.

Lynch, B.P. and Smith, K.R. (2001), "The changing nature of work in academic libraries", *College & Research Libraries*, Vol. 62 No. 5, pp. 407-420.

Madrid, M.M. (2013), "A study of digital curator competences: a survey of experts", *The International Information & Library Review*, Vol. 45 Nos 3/4, pp. 149-156.

Mansfield, B. (1993), "Competence-based qualifications: a response", *Journal of European Industrial Training*, Vol. 17 No. 3, pp. 19-22.

Moles, N. (2014), "DigCurV curriculum framework: applications in the development of digital curation vocational training programmes", *Proceedings of iConference 2014 in Berlin, Germany*, *iSchools*, pp. 972-975.

Molloy, L. Konstantelos, L. Gow, A. Wilson, D. Ross, S. and Moles, N. (2013), "Initial curriculum for digital curators", available at: www.digcur-education.org/eng/Resources/D4.1-Initial-curriculum-for-digital-curators (accessed 18 August 2016).

Palmer, C.L., Thompson, C.A., Baker, K.S. and Senseney, M. (2014), "Meeting data workforce needs: indicators based on recent data curation placements", *Proceedings of iConference 2014 in Berlin, Germany*, *iSchools*, pp. 522-537.

Pryor, G. and Donnelly, M. (2009), "Skilling up to do data: whose role, whose responsibility, whose career?", *International Journal of Digital Curation*, Vol. 4 No. 2, pp. 158-170.

Ray, J. (2009), "Sharks, digital curation, and the education of information professionals", *Museum Management and Curatorship*, Vol. 24 No. 4, pp. 357-368.

Seely-Brown, J., Collins, A. and Duguid, P. (1989), "Situated cognition and the culture of learning", *Educational Researcher*, Vol. 18 No. 1, pp. 32-42.

Shön, D.A. (1987), *Educating the Reflective Practitioner*, Jossey-Bass, San Francisco, CA.

Smith, K.R. and Lynch, B.P. (1999), "The changing nature of work in academic libraries", paper presented at Racing Toward Tomorrow, ACRL Ninth National Conference, in Detroit, Michigan, April 8-11, available at: www.ala.org/acrl/sites/ala.org.acrl/files/content/conferences/pdf/lynch99.pdf (accessed 18 August 2016).

Stanton, J.M., Kim, Y., Oakleaf, M., Lankes, R.D., Gandel, P., Cogburn, D. and Liddy, E.D. (2011), "Education for eScience professionals: job analysis, curriculum guidance, and program considerations", *Journal of Education for Library and Information Science*, Vol. 52 No. 2, pp. 79-94.

Stasz, C. (1997), "Do employers need the skills they want? Evidence from technical work", *Journal of Education and Work*, Vol. 10 No. 3, pp. 205-223.

Swan, A. and Brown, S. (2008), "The skills, role and career structure of data scientists and curators: an assessment of current practice and future needs", available at: http://eprints.soton.ac.uk/266675/ (accessed 18 August 2016).

The Joint Information System Committee (JISC) (2006), "Digital preservation briefing paper", available at: www.webarchive.org.uk/wayback/archive/20140614202005/http://www.jisc.ac.uk/publications/briefingpapers/2006/pub_digipreservationbp.aspx (accessed 10 February 2017).

The National Research Council (2015), *Preparing the Workforce for Digital Curation*, The National Academies Press, Washington, DC, available at: www.nap.edu/catalog/18590/preparing-the-workforce-for-digital-curation

The Society of American Archivists (SAA) (2013), "Digital archives specialist (DAS) curriculum and certificate program", available at: www2.archivists.org/prof-education/das (accessed 18 August 2016).

Weber, N.M., Palmer, C.L. and Chao, T.C. (2012), "Current trends and future directions in data curation research and education", *Journal of Web Librarianship*, Vol. 6 No. 4, pp. 305-320.

Woodruffe, C. (1993), "What is meant by a competency?", *Leadership & Organization Development Journal*, Vol. 14 No. 1, pp. 29-36.

Yakel, E. (2007), "Digital curation", *OCLC Systems & Services: International Digital Library Perspectives*, Vol. 23 No. 4, pp. 335-340.

Yakel, E., Conway, P., Hedstrom, M. and Wallace, D. (2011), "Digital curation for digital natives", *Journal of Education for Library and Information Science*, Vol. 52 No. 1, pp. 23-31.

Further reading

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 18 August 2016).

Lee, C.A., Tibbo, H.R. and Schaefer, J.C. (2007), "Defining what digital curators do and what they need to know: the DigCCurr project", *Proceedings of the 7th ACM/IEEE-CS joint conference on Digital libraries in Vancouver, Canada, 2007, ACM, New York, NY*, pp. 49-50.

Mansfield, B. and Mitchell, L. (1996), *Toward a Competent Workforce*, Gower, Hampshire.

Moles, N. and and Ross, S. (2013), "Report on the context of the DigCurV curriculum framework", available at: www.digcur-education.org/eng/Resources/D6.2-Report-on-the-context-of-the-DigCurV-curriculum-framework (accessed 18 August 2016).

Yakel, E., Conway, P. and Krause, M.G. (2009), "Thinking like a digital curator: creating internships in the cognitive apprenticeship model", *Proceedings of DigCCurr 2009, University of North Carolina, Chapel Hill, NC*, pp. 7-11.

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