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Computer knowledge in the field of personal archiving: an exploratory study based on grounded theory

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Abstract

Introduction. Personal archiving has transformed from traditional general knowledge to literacy-oriented ability, which requires professional knowledge and skills in the digital age. The purpose of this paper is to propose a theoretical framework to illustrate the computer knowledge applied by computer practitioners and their mechanisms for applying computer knowledge in their personal archiving.

Method. In-depth interviews were conducted with twenty-one computer practitioners in China.

Analysis. The grounded-theory methodology was adopted for data analysis, and an integrated model of computer-knowledge composition and application mechanisms in the personal-archiving field was constructed.

Results. Computer knowledge is reflected in the cognitive, archiving, sorting, storage and retrieval processes of personal archiving. It focuses mainly on archiving skills, document naming and sorting, archive security and storage, and archive retrieval. Computer practitioners have developed a knowledge-application mechanism that focuses on demand- and knowledge-driven actions in their personal-archiving behaviour. Moreover, the computer-knowledge composition in the personal-archiving field is very close to the knowledge requirements of computer literacy.

Conclusions. Computer literacy should become an indispensable part of personal-archiving knowledge composition. Moreover, increasing the efficiency of personal archiving is a feasible method to enhance its motivation.

Introduction

Personal archives are a set of documents in any format that are created, acquired, or received by an individual and provide evidence of an individual's activities (Dictionary Working Group of the Society of American Archivists, 2024). They not only include letters, memoirs, diaries, photo albums, articles, legal documents, certificates, and other printed or written records, but also include electronic documents, emails, blogs, digital photos, videos, audio tapes, websites, and other digital records. The storage, management, and access of these digital records relies on the specific information and communication devices that are used. Personal archives have indispensable historical, cultural, and evidential value for an individual, a family, and society. Their importance results from their ability to provide unique views of events; represent individuals and their richly individualistic activities; offer evidence of the underlying processes behind achievements and historical events; document the creative process; and bring the world of the past alive in evocative ways (John *et al.*, 2010).

Since the 1980s, with the application of electronic products, such as personal computers, digital cameras, and smartphones, and the popularity of the Internet, it has become extremely convenient for individuals to generate and store digital archives (Zhao *et al.*, 2019). Individuals can easily generate and accumulate information resources in quantities, formats and types of complexity comparable to past collections in libraries or archives (Lee, 2011). However, they face challenges of digital stewardship, distributed assets, value and accumulation, and retrieval from long-term storage (Marshall, 2008).

Personal archiving, which is the behaviour of creating, acquiring, receiving, organising, preserving, retrieving, and utilising personal archives that are related to individuals and have preservation values, is no longer a problem that can be effectively solved by simple storage; it also requires categorisation, storage, migration and backup to ensure that it can be stored securely and completely and used over time. It is clear that personal archiving has shifted from traditional common sense to literacy-based competencies that require specialised knowledge and skills. Scientists, teachers and the general public should acquire the necessary personal-archiving knowledge and skills to meet the challenges of the '*digital dark ages*' (Kuny, 1998).

It is the duty of the library and archival community to provide the general public with professional guidelines for personal archiving and enhance their personal-archiving literacy (Cushing, 2016; Becker and Nogues, 2012). Reasonable and effective personal-archiving guidelines, or literacy-enhancement programs, must be based on a scientific and rigorous personal-archiving knowledge system. However, academic work on the theoretical framework, or body of knowledge, on personal archiving is currently immature. Huang *et al.* (2021a) used in-depth interviews and grounded theory to construct the knowledge composition of archivists' personal archiving and found that it had a kernel of archiving, categorisation, organisation, preservation and authentication.

However, related studies have also found that archivists' personal-archiving practices face dilemmas, such as the archival ocean and digitisation anxiety, in the digital age, and that the essence of this lies in the lack of a professional-grade deep understanding of modern information and communication technology and the appropriate use of their derivatives (Huang *et al.*, 2021b; Huang and Zhong, 2021). Moreover, research on personal archiving in the computer-science field focuses on the effective organisation and retrieval of massive personal archives (Trullemans and Signer, 2014; Zhao *et al.*, 2014), information security of archives (Chen and Zhu, 2017) and the improvement of archiving efficiency (Liu *et al.* 2022). All these are real problems that must urgently be solved to address the above dilemmas.

The organisation, retrieval, security and backup of archive information are topics of common concern and cross-fertilisation between archival science and computer science (Liu, *et al.*, 2022); therefore, relevant computer-science knowledge and skills should be an integral part of personal archiving. However, research has not yet answered the question of what knowledge and skills in the vast body of computer science are necessary and effective for personal archiving.

We believe that experts with a background in computer science and working in information and communication-related fields have a better understanding of the principles and technologies of computer systems, networks, programs, file systems, databases, and storage and information security. Moreover, they are good at applying their professional knowledge to solve the practical problems of personal archiving. In addition, the computer-science knowledge and skills they use in personal archiving are those that should be available. Therefore, one of the best ways to acquire a body of computer-science knowledge in the personal-archiving field is by generalising from the personal-archiving practices of computer-science practitioners.

Therefore, this study focused on the knowledge and skills needed to manage, maintain, and access personal digital archives in the field of computer science. We conducted in-depth interviews with twenty-one people who have a professional background in computer science, are engaged in information and communication-related work and have relatively rich experience in personal archiving. We adopted the grounded theory to explore the composition of computer-science knowledge and its method of applying personal archiving. We also attempted to generalise the knowledge and skills required for managing, maintaining, and accessing personal digital archives, considering the personal archiving practices of computer-science practitioners. We aim to contribute to the construction of a personal-archiving knowledge system, provide theoretical support for the release of personal-archiving guides to the general public by relevant organisations, and implement personal-archiving literacy education.

Literature review

Since the beginning of the twenty-first century, personal archiving has attracted the attention of researchers in the fields of library and information science and computer science. Library and information science is devoted to researching the value orientation and behaviour of personal archiving (Guo, 2018), considering email (Whittaker *et al.*, 2006), smartphones (Hand, 2016), blogs and social media (Zhou *et al.*, 2018) as important auxiliary tools for personal archiving. It explores how archival institutions, libraries, and archivists can intervene in and take responsibility for storing personal digital archives on their shelves (Burrows, 2006), and try to provide professional guidance on personal archiving for the general public (Cushing, 2016; Becker and Nogues, 2012).

Researchers in the computer-science field focus on how to use modern information technology to solve the problems of tools, labelling, retrieval and security in personal archiving, and mainly focus on three aspects.

Firstly, they develop personal-archiving tools. In the face of large and widely distributed personal digital records, the primary challenge is how to effectively manage them. Although the operating systems of ordinary computers and mobile devices can basically manage personal digital archives stored on the devices, it is difficult to implement systematic management, organisation, backup and retrieval. Therefore, researchers in the field of computer science are more concerned with developing personal-archiving tools, such as Gray Area (Bergman *et al.*, 2019), Stuff I've Seen (Boardman and Sasse, 2004) and the WebBox (Van Kleek *et al.*, 2012). Some of these have received good market responses and assist in storing, organising, retrieving and accessing personal digital archives.

Secondly, they design and optimise the labelling and retrieval algorithms for personal archives. Personal archives have personalised characteristics, with various forms of public management and storage of personal digital archives; however, they all face the problems of effective management, convenient retrieval and access, *etc*. Therefore, labelling and retrieval have attracted considerable attention.

Researchers are committed to considering the impact of document importance on the storage and retrieval of personal archives (Bergman *et al.* 2009; Li, 2011). They use semantic technology to assist in the labelling of personal archives (Weippl *et al.*, 2007; Zhou and Zhong, 2010); try to address the barriers to organising and managing personal information posed by diverse data sources (Jones *et al.*, 2008; Berlin *et al.*, 2017); reduce the trouble caused by different system architectures on the maintenance and access of personal data (Van Kleek *et al.*, 2012; Liu and Zhu, 2013); and explore more optimal personal-archive retrieval methods (Zhao *et al.*, 2014) and storage solutions (Wang *et al.*, 2008). They hope to manage and share cross-platform personal files (Trullemans and Signer, 2014), collaborate and query personal cloud files (Bergman *et al.*, 2019), and assist in the interaction between users and computers in mobile environments (Chen *et al.*, 2010) to enhance the user's personal archiving experience.

Thirdly, they address the backup and security of personal archives. The digitisation of file and storage forms is one of the biggest differences between traditional and digital files, and the security and backup of files in the context of new technologies and equipment are causes for concern. Related research is committed to solving many technical problems of storage, arrangement and backup of personal digital archives.

Research has found that the proliferation of personal digital archives places new demands on data synchronisation and backup (Song *et al.*, 2011), leading to the emergence of cloud-storage solutions (Ai *et al.*, 2011). In addition, to solve the potential problems of data loss and information leakage, blockchain technology has been used to control access rights (Zheng *et al.*, 2018; Zichichi *et al.*, 2020), which ensure that the data are real, accurate and difficult to tamper with. Embedding encryption algorithms further protects the security level of personal privacy (Li, 2021; Xian, 2022), which ensures the efficiency and security of the users in managing and utilising their personal archives.

Overall, personal archiving in the digital age has become an academic issue that should be discussed specifically. Moreover, researchers in the fields of computer science and library and information science have explored the issues of achieving safe storage, effective management and convenient use of personal digital archives from the perspective of information technology. However, this is based on the public's perceptions, needs and behaviour in the management, storage and retrieval of personal digital archives, as well as the selection, evaluation and use of archiving tools, among other issues.

Archiving tools are only the foundation. More relevant knowledge and skills are required to support the public’s better understanding, storage and use of personal digital archives and the various archiving tools available on the market. From this perspective, we should discover and understand what and how computer-science knowledge and skills are used by professional computer practitioners in personal digital archiving, and understand and systematise the computer-science knowledge required for personal archiving.

Together with the findings of our existing research on the composition of the archival body of knowledge, we can more accurately and appropriately construct a knowledge framework that can provide effective guidance for improving the public's personal-archiving literacy.

Approach and Methodology

Grounded theory

As mentioned above, few research results are available on what computer-science knowledge and skills are useful for personal archiving and how people use them; it is difficult to use large-scale quantitative research methods to investigate this. To construct a theory system, it is more desirable to use qualitative research methods, such as in-depth interviews and participant observation, and to explore the experiences of experts who apply computer-science knowledge and skills to personal archiving.

The procedures of grounded theory involve taking data apart, conceptualising it, developing concepts in terms of their properties and dimensions, and then integrating the concepts relating to a core category (Corbin and Strauss, 2015. *pp*.98). It emphasises collecting and analysing data during the research process (Corbin and Strauss, 2015. *pp*.29) through open coding, axial coding and integration to identify concepts, integrate categories and develop the theories. This methodology is applicable to the goal of this study, which is to develop a knowledge system of personal archiving by mining the personal archiving experience of experienced computer practitioners, that is, to identify concepts, classify categories, and form a theoretical/knowledge system. Therefore, this study adopted an in-depth interview method to collect data and used the grounded theory approach to analyse the data and construct a body of knowledge.

The grounded theory coding and analysis of the textual material operates at three levels in this study. The process of open coding involves breaking data apart and delineating concepts to stand for interpreted meaning of raw data (Corbin and Strauss, 2015. *pp*.240); it is exploratory and leads to concept identification and sorting into categories (Corbin and Strauss, 2015. *pp*.104). The task of axial coding is to discover the underlying logical relationships between principal categories and subcategories and to verify those using raw data (Corbin and Strauss, 1990). Integration is linking categories relating to a core category and refining and trimming the theory (Corbin and Strauss, 2015. *pp*.290).

In grounded theory, saturation refers to data sufficiency and the collection of data within the scope of manipulation until no new information emerges (Morse, 1995). It is usually explained in terms of '*when no new concepts are emerging*' (Corbin and Strauss, 2015. *pp*.146). This generally means that no new concepts, categories, or relationships are discovered.

Sampling

Computer-science practitioners represent a broad field, and there is some variation in how the profession is defined across countries. This study mainly relied on China's Catalogue of Undergraduate Majors in General Colleges and Universities (China Ministry of Education, 2020) to qualify it as necessary.

In this study, theoretical sampling was used to select individuals with at least one degree in computer science and related majors as specific interview subjects. When selecting majors, according to the aforementioned catalogue, the scope of computer science in this study was limited to electronic and information (0807), automation (0808), computer science (0809), information and computational science (070102) in mathematics (0701), and management science and engineering (1201).

Diverse educational schools, majors, occupations, genders and age groups were selected as far as possible, and convenience sampling was used to select respondents for grounded-theory coding after interviewing the twenty-one respondents. The basic information is shown in Table 1, with the interview period ranging from February 2022 to May 2023. The completed interviews were found to be saturated by the saturation test (see **Data analysis**, ***Saturation test*** for details).

Number	Sex	Age	Major (B.S., M.S. or Ph.D.)	Occupation (content of work)
001	Male	51	Library science/software engineering	Collegiate teacher
002	Female	34	Computer science and technology/computer syste m architecture	Information technology librarian of university archives
003	Male	42	Computer science and technology/educational tec hnology/information and communication engineer ing	Information technology librarian of university archives
004	Male	25	Information management and information system/ computer science and technology	Graduate
005	Male	26	Electronic information science and technology	Mobile Communications, Ltd. w orker
006	Male	26	Computer science and technology/computer scien ce and technology	Graduate
007	Female	25	Computer science and technology/electronic infor mation	Graduate
008	Male	33	Software engineering	Internet practitioner
009	Female	40	Electronic information science and technology/co mmunication and information system	University administrator
010	Female	41	Computer science and technology/computer scien ce and technology	Information technology librarian of university library
011	Male	34	Computer science and technology/software engine ering	Police officer
012	Male	41	Management science	Professional staff of the universit y information centre
013	Male	38	Computer science and technology/software engine ering	Chief expert of power grid infor mation centre
014	Female	41	Computer science and technology/computer scien ce and technology/communication and informatio n system	Information technology librarian of university library
015	Male	45	Computer networks/archives	Information technology librarian of university library
016	Male	44	Computer science and technology/software engine ering	Information technology librarian of public library
017	Male	29	Electronic information engineering	Enterprise software developer
018	Male	26	Computer science (overseas)	Enterprise software developer
019	Male	26	Software engineering/computer science	Graduate
020	Male	26	Spatial information and digital technology	Front-end development engineer
021	Male	36	Electronic information engineering/signal and info rmation processing	Chief technology officer
Note: The respondents received computer science and related professional degrees from Yunnan University, Hefei University of Technology, Southwest University of Science and Technology, Chongqing University of Posts and Telecommunications, Sichuan University, Xiamen University, Zhejiang University, Central South University, South-Central University for Nationalities, Wuhan University, Xi'an University of Architecture and Technology, North China				

Electric Power University, Kunming University of Science and Technology, Guilin University of Electronic Technology, Dalian University of Technology, Beijing Institute of Technology, Tianjin University and Kalamazoo College.

Table 1. Summary of basic information of interviewed computer-science practitioners

One-on-one in-depth interviews were conducted, with the consent of the interviewees, and were audio-recorded. The interviews focused on the following nine areas:

(1) How do you usually manage your personal documents or archives?

(2) Do you, and how do you, use specialised fixtures and equipment to store and protect paper or physical archives?

(3) Do you, and how do you, manage your digital documents or archives using digital or online media?

(4) How do you ensure consistency of file or archive content across multiple storage devices?

(5) For what purpose do you keep your personal documents or archives?

(6) Can you accurately locate the personal documents or archives you have retained?

(7) How do you identify and retrieve retained personal documents or archives?

(8) How has your expertise or work helped you to manage your personal documents or archives?

(9) What difficulties and obstacles have you encountered in managing your personal documents or archives?

Data analysis

This study employed grounded theory, an exploratory research methodology, to code the interview textual material at three levels using the Nvivo 11 Plus qualitative-analysis software. It also refined and revised the composition of computer-science knowledge in the personal-archiving area until theoretical saturation was reached, through an analytical mindset of continuous comparison of the interview textual content.

Open coding

In this study, we labelled the audio-recorded text of the interviews, copy by copy and sentence by sentence. After continuous merging and integration, we deleted the initial concepts of only one material source, and finally obtained thirty-two initial concepts, corresponding to 182 material sources.

Because the number of initial concepts was relatively large, they were reclassified, organised and categorised to finally obtain eleven categories. Table 2 lists the resulting thirty initial concepts and their corresponding eleven categories, with one original statement listed as an example for each initial concept.

Category	Initial concept (source of material or unit)	Original statement (example)
Technical cognition	Computer-related knowledge base affects archiving awareness (12)	002: I think the biggest thing that has helped me is computer awareness and storage awareness. I have a better sense of cat egorisation.
	Good at researching and experimenting with computers and Internet tools (5)	001: I think about whether this software or tool will be helpfu l for me to manage my files. When I see it, I think about how to understand it and use it.
	Understanding the convenience and risks of cloud services (7)	016: I'm a major in this subject, and netbooks are of the publi c server type. From my professional point of view, I don't rea lly trust netbooks as a product.
Archival purpose	Memory retention (11)	005: For example, the photos may be all about memories. I h ave to leave a little mark and a thought.
	Recording life (5)	021: The personal documents are a record of our personal life .
	Improvement of work efficiency (4)	018: I feel that it has improved the efficiency of some aspects of my daily life, work and study.
	Will use again in the future (17)	009: Certificates, for example, may be needed in many place s throughout your life.
Archival habits	Classification and citation of paper archives (6)	014: I would write on the outside of the packet of papers, bec ause it wasn't particularly much. When I opened it, I knew w ho this packet was about. It was equivalent to having a label.
	Centralised storage of paper archives (14)	010: Because there aren't that many, there's not one drawer f or each thing. It's a little bit more concentrated; maybe sever al things in one drawer.
	Preservation of digital archives using web-based tools (17)	019: We take notes when we read papers, and I keep these no tes on an online note-taking platform.
Archival skills	Applying computer technology to archiving (7)	003: I can deploy a set of facial recognition tools on my own computer. It's still easier for me to deploy my own locally.
	Comparing performance to choose the best archiving tool (6)	014: First was Baidu cloud, and now there is Ali cloud. The Ali cloud stability is not as good as the Baidu cloud. For som e Baidu cloud features, I need to buy a membership. Tencent also has a cloud, but the function is not very good and the sp eed is too slow. Baidu is good to use.
	Design clear naming rules for archives (7)	017: I name it with words that I usually decide on myself.
Archival classification	Saving by subject or content (19)	015: One large folder for one year, with several smaller folde rs underneath, divided into categories such as projects, meeti ngs, extension services and events.
	Hierarchical preservation by level of importance (5)	017: The personal ones are divided into sensitive, public and general, and will be graded as well.
Document naming	Named by time + place or content (11)	003: The outermost folder I would name after the date at the t ime or add a simple location.
	Named after the original title (4)	009: For general naming, like a file, I use its filename.
	Named by purpose of use (2)	006: It's usually named after what it's used for.
	Named by version numbers (4)	017: I'll change the previous version number; for example, V 10 is the tenth version, which means I've changed it ten times .

Archival sorting	Set serial number ordering for archives (3)	001: I like to put 01, 02, 03 in front of the file, so the most im portant one is in front.
Archival security	Data privacy and security through encryption (5)	008: I'll scan and make an electronic copy, encrypted.
	Rarely use cloud storage and do not store private archives (17)	002: No, because I still think there may be security risks on t he internet, and I won't upload documents or personal inform ation. All I have on my netbook now are my study materials.
Archival storage	Digital preservation of commonly used and important paper archives (13)	011: When I use important certificates, I make an electronic c opy to archive them.
	Important paper archives are kept in a safe (3)	016: The safe isn't very big. It's not for storing possessions, b ut for storing these important materials.
	Important digitised archives are kept on CD-ROM for preservation (4)	003: I used to do occasional disc-burning backups for a while .
	Paper preservation of important digital archives (2)	011: For particularly important documents, I would print out a paper copy for safekeeping.
Archival preservation	Build a private cloud (e.g., network attached storage) to store and backup archives (6)	012: I considered using something called NAS [network attac hed storage] before.
	Regular backups, updates to maintain data consistency (18)	014: After a while, I'll sync the data and back it up.
	Digital archives set up multiple backups (19)	002: I have a copy on my own office computer, and I keep a f ile on my personal computer, as well as my hard drive.
Archival retrieval	Level-by-level search according to the classification program (6)	005: The numeric category is usually categorised and stored a ccording to a hierarchical structure, which gives me a very cl ear logic to find things.
	Retrieve archives using the find function of the operating system (9)	010: I'll use the search function that comes with my compute r and do a search using the keywords.
	Use tools (e.g., Everything) to retrieve archives (7)	017: I can actually find things pretty quickly if I use a tool lik e Everything.

Table 2. Open coding and its categorisation of computer-science knowledge composition and use mechanism

Axial coding

In this study, the different categories were grouped according to their interrelationships and logical order in the personal-archival behavioural sessions, and a total of five main categories were identified: cognition, archiving, organising, storage and retrieval. Each main category and its corresponding open-coded category are listed in Table 3. Compared with the knowledge composition of archivists (Huang *et al.*, 2021a), the main authentication category is missing; however, two main categories of cognition and retrieval have been added, and the storage connotation is richer.

Main category	Corresponding category	Relationship connotation
Cognition	Technical cognition	Knowledge of computers and information technology contributes to a better understanding of the performance, benefits and risks of hardware, software and network equipment for personal archiving.
	Archival purpose	Archiving pre-conceived behavioural goals and outcomes for individuals.
Archiving	Archival habits	Behavioural habits formed in the practice of personal archiving.
	Archival skills	Expertise and competence in archiving behaviour.
Organising	Document classification	Classification methods and programs implemented for personal documents.
	Document naming	Relatively stable naming scheme for personal documents.
	Document sorting	Arrangement and sorting methods for storing personal documents.
Storage	Archival security	Strategies adopted to ensure the security of personal records.
	Archival preservation	Ways and means adopted to preserve personal records.
	Archival protection	Strategies adopted to ensure authenticity, security, integrity and usability.
Retrieval	Archival search	Search strategies, tools and methods used to access personal records.

Table 3. Main categories formed by the axial coding of computer-science knowledge composition and its use mechanisms

Integration

In this study, a typical relational structure of the core categories was constructed arising out of the core topic of computer-science knowledge archived by individuals, as presented in Tables 3–4. It is important to note that the division between knowledge and action is not rigorous or either/or; rather, it is determined based on their primary functions, such as the archiving habit being both a form of knowledge and action.

Typical relationship structure			Relationship-structure connotations
Cognition **Cognition** (knowledge)	→	**Archiving** (action) **Organising** (action) **Storing** (action) **Retrieving** (action)	*Archival purpose* and *technical knowledge* are the intrinsic motivation and knowledge base of computer-science practitioners to perform personal archiving, which determines their specific actions of archiving, organising, storing and retrieving.
Archiving Archival habits (knowledge) Archival skills (knowledge)	→	**Organisation** Document classification (action) Document naming (action) Document sorting (action)	*Archival habits* and *archival skills* are the basis for the computer-science practitioner's actions in organising personal archives (document classification, document naming, document sorting). It is *knowledge* that determines specific *action* strategies.
Retrieval (requirement)	→	**Archiving** (action) **Organising** (action) **Storing** (action)	*Retrieval* is essentially the specific needs of computer-science practitioners to use personal records and their actions to guide them to continually improve the ways and means of archiving, organising and storing their personal records to increase the efficiency of retrieval.

Table 4. Typical relational structure of selective coding of computer-science knowledge composition and its utilisation mechanism

We identified the core category of computer-science practitioners as the computer-science knowledge component of personal archiving and found that computer-science knowledge has an impact on personal archiving in the areas of awareness, archiving, organisation, storage and retrieval of personal archives.

We found that the use of computer-science knowledge consists of two aspects: knowledge and action. Knowledge includes technical knowledge, archiving habits and skills, *etc*. This type of professional knowledge is the source of motivation for computer-science practitioners to understand the value of personal archiving and develop it into specific actions for personal archiving. The second aspect involves using knowledge in an action, which includes archival classification, document naming, document sorting, archival security, archival preservation, archival storage and archival management.

Retrieval is essentially the specific needs of computer-science practitioners to make use of their personal archives and their actions, which leads them to improve the ways and means of archiving, organising and storing their personal archives to increase the efficiency of retrieval. Thus, we have constructed an integrated model of computer-science knowledge composition and use of personal archives, as shown in Figure 1.

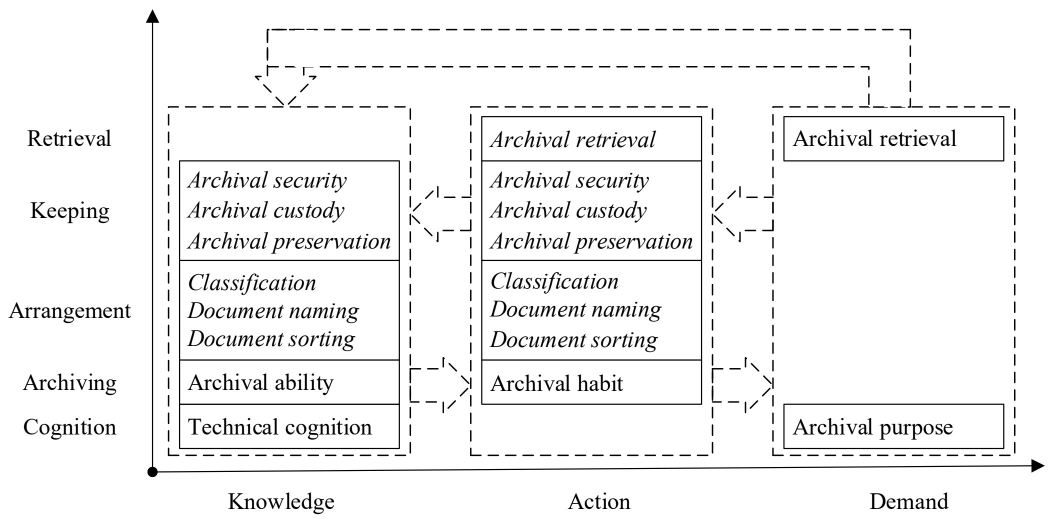

Figure 1. Integration model of computer-science knowledge composition and use of mechanisms for personal archiving

Saturation test

In this study, after completing the open coding of the twenty-one interviews, a theoretical saturation test was conducted, based on the thirty-two initial concepts formed by the coding (Tables 3–5). Only one new initial concept appeared in the coding of the interview records from Nos. 007 to 012, and no new initial concepts appeared in the coding of the nine interview records from Nos. 013 to 021, which led to the decision that saturation had been reached.

Interview transcript number	001	002	003	004	005	006	007	008	009	010	011
Focusing on conceptual numbers	18	16	16	11	12	16	12	16	13	12	12
Number of additions	-	5	2	2	1	3	0	0	0	0	0
Interview transcript number	012	013	014	015	016	017	018	019	020	021	-
Focusing on conceptual numbers	17	13	12	13	7	16	11	7	10	14	-
Number of additions	1	0	0	0	0	0	0	0	0	0	-

Table 5. Focused concepts and number of additions per copy formed by focused coding of computer-science practitioner interview transcripts

Results and discussion

Composition of personal-archiving computer knowledge

The coding in Table 3 shows that the computer-science knowledge involved in personal archiving is a body of knowledge that consists of a combination of cognition, archiving, organisation, storage and retrieval. This is in line with the core knowledge points directed by researchers in the field of computer science working on the collection, organisation, storage, retrieval and tool development for the general public (Al-Omar and Cox, 2016; Zhan, 2018; Yeo and Li, 2014; Sinn *et al.*, 2019; Warraich *et al.*, 2018), as well as the acquisition, classification, storage and retrieval of personal archives from a technological perspective (Barreau, 1995; Boardman and Sasse, 2004), which are subdivided as follows.

Cognition: efficiency and technical rationality

Cognition can be further subdivided into two subsets of knowledge: archival purposes and technical cognition.

The purposes of archiving consist of four aspects: to preserve memories, to record life, to increase productivity and to be used again in the future. This finding is similar to the qualitative findings of the researcher's interviews with archivists (Huang *et al.*, 2021a), but has some differences. There are fewer subsets of preserving evidence and preserving heritage and passing on culture for next generation, but there are two more initial sets of documenting life and improving work efficiency, reflecting the rationality of computer-science practitioners' efficiency in personal archiving.

Technology awareness consists of three dimensions: computer-related knowledge base affects archival awareness, being good at researching and experimenting with computers and internet tools and understanding the convenience and risks of cloud services. These perceptions highlight the strong professionalism of computer-science practitioners, which is centred on their ability to understand the principles and performance of commercially available personal computers, USB, CD-ROMs, and hard disks, as well as the principles and performance of computers, network hardware and software equipment and tools, such as the Internet, network devices, cloud storage and cloud services, and to identify and make use of available tools to implement their personal-archiving activities and ensure their security, integrity and usability.

Archiving: common sense and professionalism go hand in hand

In terms of coding, archival habits and skills together constitute the archiving dimension of knowledge.

For archival habits, three initial concepts were identified: classifying and labelling paper archives, centralised storage of paper archives, and use of web-based tools for digital archives. Paper archives were classified and labelled mainly for ease of reference and access. Because of their small number, respondents generally indicated that their paper archives were stored in fixed drawers, bookcases, *etc.*, which is a notable common-sense feature.

Compared to paper archives, digital archives are large in number, rich in formats, and wide in range; they are mostly archived through tools, such as applications (020: Dingding), computer software (009: EndNote), and online platforms (007: GitHub). Using specialised tools in the field of computer science (e.g., GitHub) and a wide range of software tools is becoming the norm.

In terms of archival skills, three initial concepts were identified: applying computer technology to archiving, comparing performance to choose the best archiving tool and designing clear naming conventions for documents. These skills indicate that computer practitioners apply software-development project skills and work practices to personal archiving. Moreover, they are more adept at solving archiving problems through technology compared to non-computer professionals, such as '*called an interface and wrote an encrypted applet*' (006) to encrypt important documents, and '*deployed a set of face-recognition tools on my own computer*' (003) to identify and retrieve a large number of photo archives, *etc*. This greatly improved the security of archives and the convenience of retrieval. In addition, using computer expertise, skills and tools has become the most distinctive feature of archivists' personal-archiving behaviour.

Organisation: understanding computer rules

The organisation category consists of two subsets of knowledge: archival classification and naming.

Archival classification includes the initial concepts of preservation by subject or content and preservation by level of importance. Most of the interviewees classified files by subject or content, especially work-related personal digital files, which were classified into many categories, such as '*projects*, *meetings*, *promotional services and activities*' by Interviewee 015. In addition, as archivists are familiar with the confidentiality level of archives, computer practitioners are aware of the confidentiality level of projects. Their work has influenced the formation of a classification system that preserves files according to their level of importance.

Archival naming includes four initial concepts of naming by (1) time and place or content, (2) original title, (3) purpose of use and (4) version number. Specifically, photos and videos are mainly named according to the time and place, or content; announcements and notices are mainly named according to the title of the document; and certificates and documents are mainly named according to their purpose of use. Documents that need to be modified several times include a date or version number to prevent them from being overwritten or lost.

Overall, computer-science practitioners are better able than archivists to understand computer storage, retrieval and organisational rules in terms of naming archival documents, and to flexibly apply knowledge, such as version numbers of computer software, to personal archiving.

Storage: safety first

Storage can be divided into three knowledge subsets: archival security, preservation, and protection.

Archival security consists of two initial concepts: ensuring data privacy and security through encryption, and rarely using cloud storage and not storing private documents there. Professional backgrounds make computer practitioners more concerned about information security. Knowing that cloud services have security risks of information leakage, the respondents said that they store materials that can be made public and are not confidential (013), and they choose to store private and highly important documents locally. They also encrypt the data on the local device before uploading it to the cloud platform (019) to further ensure the privacy of the data.

Archive preservation consists of four initial concepts: digitally preserve commonly used and important paper documents, safely keep important paper documents, burn important digital documents onto CD-ROMs and preserve paper copies of important digital documents. Computer practitioners mainly use multi-carrier storage for archival preservation. Digitising paper files can improve their ease of use and materialising digital files can aid in long-term preservation.

Archive protection consists of three initial concepts: setting up a private cloud (*e.g.*, NAS) to store and back up documents, making regular backups and updates to maintain data consistency and setting up multiple backups of digitised documents. As mentioned earlier, the public cloud has the potential for information leakage, and '*building a private cloud [using my] own expertise*' (005) helps enhance data security and privacy protection. In addition, regular and multiple backups ensure the integrity and availability of the archives.

Retrieval: tools first

Archival retrieval is a relatively self-contained knowledge component that can be subdivided into three initial concepts: searching hierarchically according to a classification scheme, retrieving a document using the search function of an operating system, and retrieving a document using a tool (*e.g.*, Everything). Their professional background and nature of work make computer practitioners familiar with data structures and good at applying them to organising and retrieving files.

The prerequisite for a file retrieval is that the files have been well organised in the preliminary separation and organisation activities. For example, classifying and storing the files according to a hierarchical structure (005), which makes the retrieval logic clear, and paying attention when naming documents (008) enables the system search function to meet daily needs.

In terms of retrieval, computer practitioners paid more attention to studying and trying various tools and applying them to personal-record management, such as Everything (002), Anything (013), and AnyTXT (003).

Applying archival knowledge to personal archiving

The interviews revealed that computer-science practitioners have a more comprehensive understanding of the purpose of archiving. They classify and categorise paper archives and use safes for important paper documents. They also digitise frequently used and important paper documents and keep important digital documents in paper form. This is the general public's way of keeping personal records, and was the norm for personal archiving before the spread of digitisation and Internet access.

However, in contrast to the interviews with archivists (Huang *et al.*, 2021a), computer-science practitioners were not concerned with what to keep (the selection criteria), or the value of the archives they kept, or even the retention of and access to personal paper archives. This is another example of personal archiving as a common-sense endeavour or task. However, the specialised nature of computer-science knowledge is still well represented and used in practical personal archiving.

Demand-driven

When computer-science practitioners use their computer-science expertise for personal archiving, they do not simply apply the tools of their expertise, but adapt and optimise them as needed to locate and retrieve personal files. For example, the emphasis on storing personal documents in common formats and designing clear naming rules for documents was developed after encountering difficulties in retrieving personally stored documents using good retrieval tools (*e.g.*, Everything). Alternatively, it was only after the need for retrieval arose that the naming convention for personal documents was developed and optimised for retrieval.

It is very likely that computer-science practitioners' research on personal archiving also stems from their practical archiving needs. Whether it is developing tools, designing and optimising algorithms for annotation and retrieval of personal archives, or designing and optimising annotation and retrieval algorithms (Zhao *et al.*, 2014), the researcher's intention is not to serve others, but to facilitate their own needs. Some of our interviewees indicated that they considered designing their own software to facilitate more efficient storage and retrieval of personal archives (013).

Knowledge determines action

Computer-science practitioners have a more profound understanding of computers and networks. Their relevant professional knowledge ranges from archival habits and skills, to document naming and sorting, file security, preservation and protection, and even file retrieval and other personal archives, throughout the entire process. This knowledge can be applied to the naming of documents, flexible use of programming specifications (such as the Alibaba programming specifications), using a software version number for different versions of documents, depending on the computer operating system's file or folder sorting rules, and developing personal document sorting.

Computer-science expertise is also put to good use in the preservation of files, such as setting up a private cloud and using GitHub, syntax, and other tools in the computer industry to manage and synchronise personal files. In other words, computer-science expertise essentially determines the strategies, tools, and methods used by its practitioners to retain, organise and preserve personal archives.

Implications

This study found that the computer-science knowledge and skills involved in personal archiving mainly focus on the working principles and performance of computer- and network-related software and hardware devices; the storage, organisation, and retrieval rules of operating systems and databases; and various software tools that can meet personal archiving needs. These components represent the core knowledge and skills associated with computer literacy. At the same time, it was found that owing to the higher level of computer literacy among computer-science practitioners, they have a stronger need for personal archiving and higher personal archiving efficiency. The findings of this study can provide constructive suggestions for improving the body of knowledge in the personal-archiving field and promoting public personal archiving.

Computer literacy is an indispensable knowledge component of personal archiving

Interviews with computer-science practitioners revealed that they were well able to organise and maintain their personal digital archives using their computer-science knowledge and skills. This is an important dilemma faced by archivists in the digital age (lack of tools, archival ocean, digitisation anxiety, *etc.*). The deep understanding and knowledge of computers, networks and digitisation devices by computer-science practitioners is a cure for digitisation anxiety. The good use of search tools is an essential tool for dealing with the archival ocean.

For the public, acquiring the necessary computer and network knowledge and skills is essentially about improving one's computer literacy, which is generally defined as '*an individual's ability to use [information and communication technology] appropriately to access, manage, and evaluate information, develop new understanding, and communicate with others*' (Fraillon *et al.*, 2019). Education and guidance on personal archiving should not be limited to the development of guidelines for family archiving (Yang, 2018) and guidelines for personal archiving (Library of Congress, 2021). It should also include the knowledge, skills and understanding of risks associated with equipment, tools and methods for organising, storing and retrieving personal archives, which are closely related to personal digital archiving.

Improving efficiency is a viable way to increase personal motivation for archiving

In contrast to the archivist interviews, computer-science practitioners rarely mentioned a lack of motivation, archival ocean, or digitisation anxiety associated with personal archiving. This is partly because of the obvious efficiency rationale of their archiving purpose. They recognise that personal archiving can improve productivity. In addition, they have more pragmatic and efficient tools to store and retrieve personal files. They rarely feel distressed or anxious about the large number of files because they are accustomed to working with a large amount of data; therefore, to them, personal digital files are simply a small dataset.

More importantly, computer-science practitioners are adept at using (and sometimes developing) tools that improve the storage and retrieval of personal records without much difficulty. Therefore, to increase the motivation, ability, and efficiency of the public to archive their personal records, it is important to develop and disseminate convenient and efficient tools for managing personal records, in addition to strengthening computer literacy education.

Stimulating demand is an endogenous dynamic for enhancing personal archiving actions

Research has found that awareness of the value and utility of personal archives plays a leading role in the knowledge application mechanism of archivists (Huang *et al*., 2021a), while the storage and retrieval demands of personal archives play a crucial role in the knowledge application mechanism of computer-science practitioners. Archivists and computer-science practitioners have different knowledge systems and practical experiences, and their different knowledge application mechanisms can provide guidance for us to better understand personal archiving knowledge training.

The need for personal archiving is superficial, and its core lies in the understanding of the value and role of personal archives, that is, the awareness of retaining, organising, and using archives. Therefore, to enhance the endogenous motivation of personal archives, it is necessary to make individuals understand what personal archives are, their value and role, and their benefits to individuals, families, and society.

Conclusions

Personal archiving, specifically personal digital archiving, has attracted the attention of researchers in library and information science as well as computer science. However, for the public's personal archiving, the type of computer-science knowledge that can be applied, and whether it has become the exclusive right of computer-science practitioners owing to technical barriers, have not been answered by existing research, and this study made beneficial attempts.

This study showed that computer-science knowledge is embodied in the cognition, archiving, organisation, storage and retrieval of personal archives. Computer science and technology cognition are the core, mainly focusing on archiving skills, document naming and sorting, archival security and storage, and archival retrieval in the midst of knowledge and action. Computer-science practitioners exhibit common-sense regarding paper archives, but their professionalism in managing, maintaining, and accessing personal digital archives was highlighted, which is mainly reflected by the following three aspects.

First, these practitioners have a good understanding of the working principles and performance of software and hardware devices related to computers and networks. Therefore, they are better able to understand the characteristics, advantages, and potential risks of commercial systems including common personal computers, USB drives, CDs, hard drives, and cloud storage. They particularly value the privacy and security of personal digital archives and can use relevant equipment to manage personal digital archives in a reasonable manner.

Second, they have knowledge, skills, and practical experience related to software development and are better able to understand the storage, organisation, and retrieval rules of operating systems and databases. They can flexibly apply knowledge such as the file management rules of operating systems and naming conventions of computer software to personal digital archives to meet daily management and retrieval needs.

Third, they are adept at using various tools to meet their personal archiving needs. These respondents were adept at using commercial software tools to manage personal digital archives, including using facial recognition tools to manage photo archives, constructing a private cloud (such as NAS) to store and backup personal digital documents, and using tools such as Everything to retrieve personal digital documents.

Our findings indicate that computer science techniques are not involved in the design and optimisation of algorithms and system development. The computer-science knowledge composition in the field of personal archiving is similar to the knowledge requirements for computer literacy. Specifically, it is the understanding and application of computer and network fundamentals, such as the composition of computer and network systems, values, data, hardware, programming, *etc.*, that have a substantial impact on the personal-archiving practices of computer-science practitioners.

In short, the application of computer-science knowledge in the personal-archiving domain is almost exclusively focused on computer literacy, meaning that non-computer-science practitioners can acquire these knowledge and skills. It also suggests that the value of constructing a personal-archiving knowledge system is that the public or archivists implementing it do not necessarily need to receive a specialised computer-science education, but should have basic computer literacy. In other words, basic knowledge in the fields of computers and networks, information organisation, and retrieval must be incorporated into a personal-archiving knowledge system, so that the public can make full and rational use of a variety of platforms and tools, based on an understanding of the principles of computers and networks, to improve the efficiency of personal archiving.

This study also found that in their personal-archival behaviour, computer-science practitioners have formed demand-driven and knowledge-determined action mechanisms. These mechanisms differ from and are complementary to the knowledge-application mechanisms of archivists, which primarily concern the awareness of personal archives (Huang *et al.*, 2021a).

The demand comes from external needs, while consciousness comes from internal drives. The different knowledge application mechanisms of the computer-science practitioners and archivists reveal that archival knowledge and computer-science knowledge have their own strengths. To further enhance the motivation of personal archiving, it is necessary to further integrate knowledge and tools from different fields.

One limitation of this study is the composition of the sample of computer-science practitioners interviewed. Although a theoretical sample was conducted, it was only possible to sample from those with whom we could make connections and those who were willing to participate. Therefore, the sample may have been biased because it was not a random selection of all computer-science practitioners.

Finally, personal archiving is a common phenomenon in people's lives. While we explored the issue of knowledge composition and use mechanisms in the field of archiving in our previous study, this study focused on the knowledge composition and use mechanisms in the field of computer science. Whether other disciplines and fields have more distinctive knowledge systems and use mechanisms remains to be further explored.

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