Creating and Using Personas for Web2.0 Information Search: Deriving Innovative Services from Psychological and Social Analyses of Questionnaire Surveys, In-depth Interviews, and Tracking Observations

Authors: Gu Liping

Date: 2016-06-09T00:00:00+00:00

Abstract

Based on C. C. Kuhlthau' s information search model, this study incorporates sharing, co-creation, and collaborative construction from the Web 2.0 concept, as well as embedding, driving, and interaction from the Personas concept, to create and utilize Personas 2.0 for developing differentiated user behavior models. Through questionnaire surveys, interview surveys, and tracking observations, personas with psychological and social characteristics are established to explore how to improve information service systems. This thus potentially extends the research and application domains of the Kuhlthau model.

Full Text

Creating and Using Personas for Information Search in Web 2.0—From Psychological and Social Analysis Through Questionnaire, Deep Interview, and Tracking Observation to Innovation Service

Abstract

Building upon C. C. Kuhlthau' s information search model, this study incorporates Web 2.0 concepts of sharing, co-creation, and collaborative building, together with Personas concepts of embedding, driving, and interaction, to create and utilize Personas 2.0 for developing differentiated user behavior models. Through questionnaire surveys, interviews, and tracking observations, we establish personas with psychological and social characteristics to explore how

to enhance information service systems. This approach may thus extend the research and application domains of the Kuhlthau model.

Keywords: Information behavior; Information service; Information system; Web user; Information retrieval

1. Research Background and Motivation

The Internet plays an increasingly important role in enabling students and educators to obtain useful information. The library field has historically emphasized research on user information behavior, producing systematic findings that have played a key role in guiding and evaluating literature information services.

However, the current user information environment and information behavior have undergone fundamental changes: (1) the high usage rate of search engines has made libraries a secondary information source [1]; (2) most researchers and doctoral students prefer self-learning information retrieval over library user training [2]; (3) the next generation of college students prefers visual learning over text-based learning modes [3]; (4) learning-oriented users increasingly rely on the Internet for information seeking, dissemination, and utilization [4]; (5) most students study during library off-hours [5]; (6) people expect quick results without considering library concepts and processes [6]; and (7) the "Google phenomenon" affects not only young people but also the elderly and children, representing a comprehensive transformation of the information society [7].

The library field attaches great importance to these phenomena. Although numerous studies have been conducted, current research suffers from several limitations: (1) systematic, progressive empirical investigations combining qualitative and quantitative approaches to examine the structural mechanisms of user behavior remain scarce; (2) information behavior patterns of users in network environments have not yet been summarized from systematically collected phenomena; (3) in-depth scientific explanations of user behavior and its patterns are lacking; and (4) due to these limitations, it has been difficult to propose recommendations for innovating and developing library services based on users' network information behavior, resulting in a lack of suggestions for extending behavior models to innovative library services.

Information behavior represents an enduring research theme in library service and development. As an important foundation for library services, library information systems, and library innovation, the pursuit is to comprehensively, clearly, and systematically depict the relationship between people and information, enabling libraries to fully play their role in serving readers and disseminating knowledge. Therefore, building upon previous research and earlier findings [8-10], this study conducts a "systematic, structured, differentiated" empirical investigation of information search behavior in the Web 2.0 environment. Systematization aims to broadly and comprehensively investigate and describe network user information behavior before progressing to structuration. Structuration aims to deeply and meticulously model and theorize network and

psychological aspects. Based on this process of "simplifying complexity (information behavior) into models," we propose several library innovation service recommendations that "use simple models to manage complex information services."

2. Research Status

2.1 Information Seeking Research

We downloaded 5,603 records from the LISA database using the keyword "information seeking" (last updated: January 5, 2009). Using a JAVA program to convert LISA's txt format, we then generated charts in Excel based on statistical results.

[Figure 1: see original paper] Information Seeking Research (1970–2008)

The development stages of information seeking research [11] can be roughly divided into: (1) bibliographic query and computer retrieval stage (1970–1984); (2) actor theory and human-computer interaction stage (1985–1989); (3) behavioral process and linear model stage (1990–1995); (4) dynamic interaction and non-linear model stage (1996–2002); and (5) information seeking behavior in network environments stage (2003–2008).

After converting author names for data cleaning and conducting a second screening, we used the free software Ucinet for data analysis. The graphical output is shown in Figure 2 [Figure 2: see original paper].

[Figure 2: see original paper] Cooperation Relationships Among Information Seeking Researchers

Based on two principles—author publication volume (number of articles indexed in LISA) and occupation of key nodes in the network—we selected representative authors and research teams from the past decade. After reviewing original works, we systematically organized them: (1) Amanda Spink focuses on information seeking systems as the research core, collaborating across different disciplines; (2) Reijo Savolainen uses daily life theory from sociology as the foundation for information behavior research; (3) David Nicholas, with scholars as research subjects, averages one paper per year entering the LISA database; (4) Gary Marchionini specializes in information search research in electronic environments and currently leads a large research team of master's, doctoral, and postdoctoral students; (5) Wilson T. D.' s Model of Information Behavior receives numerous citations, including in mainland Chinese research papers; and (6) Kuhlthau C. C.' s Information Search Process model receives extensive citations abroad but fewer in mainland China, with relatively more citations in Taiwan.

2.2 Information Search Models

Regarding empirical research on information behavior, information seeking behavior in network environments requires both theoretical foundations in psychol-

ogy, education, and library science, as well as rich research accumulation. C. C. Kuhlthau, who spent six years developing her model (see Table 1), republished the seminal work *Seeking Meaning* in 2003 [12], which includes many follow-up studies from after 1994.

Table 1. Research Process for Establishing the Information Search Model (C. C. Kuhlthau)

Study	Year	Participants	Key Findings
First	1987	6 college students	Established model durability
Second	1990	4 college students (originally 6)	Established model durability
Third	1990	-	-
Fourth	1991	147 college students	Understood confusion and uncertainty when students begin writing research reports
Fifth	1993	358 college students	Revealed similarities among library users with lower performance

The information search model (see Table 2) has been consistently cited over the past twenty-five years and has rarely required modification due to technological or social changes. This is because the empirical research tradition in library science information behavior emphasizes the replicability and verifiability of theories and models, as well as the model' s inherent extensibility (sustainable development).

However, when other researchers and C. C. Kuhlthau conduct information behavior studies, most implicitly assume users as having a single, mass character. If we re-examine users who are considered single, unchanging, passive, and mass-oriented, and recognize that they actually possess different, changeable, both active and passive, personalized or independent characteristics, we may: (1) break through the limitations of information search models and extend research and application scope; and (2) better explain information behavior in Web 2.0.

2.3 Creating and Using Personas

Changes in network environments and development of new technologies bring users various conveniences and comforts, while also creating necessity for understanding user behavior. Personas represent a method for classifying users and describing their behavior—a classification derived from user behavior, describing user characteristics and behaviors, and explaining reasons while suggesting design strategies. In other words, personas can be defined as "accurately describing users and what they want to accomplish" [13].

Persona research in the library field exhibits a phenomenon similar to "simultaneous discovery." In September 2008, *D-Lib Magazine* published Jack M. Maness et al.' s "Using Personas to Understand the Needs and Goals of Institutional Repository Users" [14], while in the same month, domestic literature published "Digital Library Interactive Interface Design Based on Web 2.0 Personas" [15]. The former established user models to guide system construction based on qualitative research, while the latter established user models to guide information services and identified expandable research directions for personas based on quantitative research. In December of the same year, T. D. Wilson, whose articles on information seeking are heavily cited by domestic information systems research, wrote a book review for *The User Is Always Right* [16], noting that "personas" have academic research significance for understanding user behavior and practical significance for assisting system design [18]. In June of the following year after this "simultaneous discovery," the IFLA IT Section Newsletter published "Creating and Using Personas for Digital Library Service in the Web 2.0 Era" [19], exploring how to conduct combined qualitative and quantitative persona research in the digital library domain.

In summary, through systematic empirical research, we can create and use personas to clearly describe the regularity of user behavior. This not only distinguishes the actual behaviors and needs of different user types but also provides concrete suggestions for service innovation and development.

3. Research Questions

Based on the main viewpoints and assumptions of behaviorism and cognitive psychology, this study establishes the following hypotheses: (1) user information behavior in network environments is significantly different from that in traditional environments; (2) different types of users exhibit different patterns of information behavior in network environments; and (3) these different behavior patterns have corresponding psychological and behavioral mechanisms.

According to the theoretical framework and research hypotheses, the research questions include three main issues: (1) under common information behavior patterns, what psychological and social factors influence behavior; (2) whether different individuals can be depicted as several typical users based on information search behavior according to different psychological and social factors; and (3) what their possible expectations are for information service systems (not limited to libraries). These are further subdivided into several detailed research questions, allocated and asked according to the actual data collection methods.

4. Research Design

To address the research questions, we adopted a progressive combination of quantitative and qualitative methods: questionnaire survey, in-depth interview, and tracking observation. We selected research tools according to the needs of the research process and used SPSS Version 12 statistical software.

The questionnaire survey sample came from questionnaire returns of a previous study [20]. Under the name of the National Science Library of the Chinese Academy of Sciences, we distributed and collected questionnaires from the same group of research samples from October 10, 2008, to November 1, 2008. We mailed 300 copies and recovered 155 valid questionnaires.

Data collection for in-depth interviews was conducted through face-to-face notes. Based on questionnaire returns from the previous study, we identified suitable interview subject groups. For students willing to be interviewed, we contacted them via email and office phone to obtain complete communication information (mobile phone, telephone, email, office address), then formally scheduled interview times and locations under the name of the National Science Library of the Chinese Academy of Sciences. Face-to-face interviews were conducted from November 15, 2008, to November 25, 2008. A total of 36 people were interviewed, with each interview lasting one hour.

Data collection for tracking observations was conducted through face-to-face visits and email. Based on questionnaire and interview results, we identified representative users and conducted tracking observations from January 5, 2009, to June 5, 2009. We tracked participants four times over six months: first through a face-to-face visit, then two email contacts, and finally another face-to-face visit. A total of 16 people were selected for tracking observation, with 8 actually completing the process.

5. Research Results and Findings

5.1 Questionnaire Survey Results

Through chi-square analysis, Pearson correlation coefficient tests, and contingency table observation, no significant variable correlations were found. Only the Pearson coefficients between "library website providing downloadable book articles" and "library website providing experimental data for book articles," and between "library website providing experimental data for book articles" and "library website providing direct problem-solving methods," were 0.539 and 0.554 respectively—greater than 0.5 but still below the 0.1 significance threshold. The survey results are shown in Table 3 .

The survey revealed that users have strong purpose when entering library websites and expect information services beyond bibliographic or general borrowing functions. They anticipate services similar to intelligence analysis, researcher identification and contact, and methods and strategies to assist in solving research problems.

5.2 Influence of Psychological Factors on Information Search

Based on interviews with the same sample as the questionnaire survey, we found that some people experience anxiety when searching and reading large amounts of information, while others experience pleasure. This contrast between anxiety

and happiness was particularly pronounced among respondents nearing graduation, where a clear polarization was evident. For other respondents with one or one-and-a-half years remaining before graduation, anxiety and pleasure occurred mixed together, without other reactions or opinions regarding information seeking. Generally, according to the degree from anxiety to pleasure, information seeking can be divided into four types: "collecting small amounts of information with little criticism," "collecting small amounts of information with much criticism," "collecting large amounts of information with little criticism," and "collecting large amounts of information with much criticism."

(1) Tracking-type information seeking. Tracking-type information seeking is most evident in continuous investigation of specific databases. This type is common in high-tech fields. For example, graduate students developing imitations of fixed-model chips indicated they retrieve information from company website databases or collect possible information about the technology through other means, then evaluate whether the information can assist the team in developing the imitation (Interview No. 01).

The same situation occurs in research on the latest circuit structure design. One respondent explained that although knowledge is acquired through various information sources such as Nature/Science databases, the latest developments in ScienceNet, the latest developments in electronic machinery and technical reports, recently published articles domestically and internationally, and IEEE database publications, the graduate student still focuses on a few specialized database materials to complete the research. For example, querying information through publications indexed by the U.S. Engineering Index mainly serves to help the graduate student judge information, guide actual experiments, and compare experimental results (Interview No. 18).

Another graduate student conducting conductive polymer experiments explained how they compare experimental results against Chinese and English books, ACS, RSC, previous work, or classic literature (Interview No. 19).

Additionally, in the field of biochemistry, finding new protein crystal arrangement methods is accomplished through information seeking in genetic databases. Although literature reviews may also consult NCBI, PubMed, Google Scholar, and Science to propose working methods, actual comparison of experimental results still relies primarily on data from genetic databases (Interview No. 35).

A graduate student researching protein 3D structure prediction mentioned that one of their daily tasks is tracking a core journal and sharing information with team members who track different core journals. This information is used to understand the latest developments and find alternative algorithms in solutions or work that others have not done (Interview No. 34).

A graduate student researching protein gene imitation retrieves information from academic society websites and genetic databases according to work progress, referencing research methods, current status, and achievements. They

evaluate the research value and methods of information and compare it with experimental results (Interview No. 08).

Such users either propose improvement plans after tracking, propose alternative solutions, or conduct imitation after tracking. For instance, one graduate student' s work is researching electromagnetic material media. After querying relevant databases through ISI, they conduct literature reviews and repeat the work described in articles (Interview No. 16). Another graduate student specializing in a particular species in the CDNA immunology database searches for information through Google Scholar, Pubmed, ISI, VIP, and NCBI, then compares others' work to identify laboratory errors or new directions (Interview No. 14).

(2) Integration-type information seeking. Integration-type information seeking is more evident than other types in information behavior participating in portal community websites or forums. This type of information behavior may be common in environmental engineering. For example, a student researching solar cell polymer materials indicated they search literature through electronic bulletin boards, databases, and Beilstein, generally to judge whether information can guide actual experiments and compare it with their own experimental results (Interview No. 20).

A student researching water-solid intrusion mechanisms said she searches information through Google Scholar, Pubmed, VIP, and NCBI, then consults individual experts for the same purpose of judging whether information can guide actual work (Interview No. 15).

Additionally, researchers in archaeology or botany also need integration-type information services. For example, a graduate student researching dinosaur egg fossils indicated that after searching literature through core journals and international conference reports and recording sample types from publications, they write letters to verify content and compare their own discoveries with experimental results. The domestic and international experts and peers they know communicate in Yahoo forums (Interview No. 28).

Another graduate student researching high-performance leaf items in separation chromatography, during the research proposal stage, first uses electronic bulletin boards (Xiaomuchong) to inquire about relevant information before searching for scientific literature in search engines (Interview No. 21).

A student researching the latest protein recombination methods searches for information through NCBI, PubMed, Google, and foreign company protein data to summarize new approaches and judge whether they can guide experiments. The research results are used to explain theoretical research on biological physiological change processes based on experimental results (Interview No. 32).

A graduate student researching radar technology prediction and parameter calculation generally searches for information through ISI or foreign conference proceedings. They use filtered information to propose specific working methods

and compare them with experimental results (Interview No. 17).

For a graduate student in biology working on a national species catalog database, although information sources may be extensive, including books, journals, and database website information (pictures), the primary source is academic society websites because the work requires expert assistance in reviewing and identifying the authenticity of pictures (Interview No. 36).

A graduate student engaged in traditional Chinese medicine extraction first establishes a database for an automated traditional Chinese medicine system. In this initial task, they search for literature through libraries, teachers, classmates, and conferences at traditional Chinese medicine universities. They obtain assistance from other teachers in judging information usefulness through their advisor' s interpersonal relationships in professional societies (Interview No. 25).

For a graduate student researching waste soil treatment methods, it is necessary to extensively reference domestic and international conference papers, carefully study (reading carefully and learning as if following guidelines) project reports from teachers or within the institute, and consult specialized public welfare groups. The information sources are not necessarily academic society websites; sometimes they involve different blog circles within Sohu (a major news portal) to obtain research inspiration and resources (Interview No. 05).

(3) Refinement-type information seeking. Refinement-type information seeking is relatively evident in strong demand for and recognition of professional societies. This type of information behavior may be common in basic science and other soft science fields. For example, a graduate student researching various possible petroleum syntheses indicated they usually search for materials at the American Chemical Society, compare different products before experiments, and compare research results from literature after experiments (Interview No. 03).

In the same chemical field but different specialty, a graduate student researching chemical material modification (Interview No. 04) also exhibits this pattern.

(4) Exploration-type information seeking. Exploration-type information seeking is most evident not only in large-scale searches of search engines or electronic journals but also in the work of using and evaluating large amounts of literature when almost every paper is read. This occurs in virtually any field. In fact, graduate students of other types also search for information through search engines and electronic journals, but the characteristic of this exploration-type information seeking is: processing literature information and non-scientific literature exchange information on the Internet almost word by word and article by article.

For example, a graduate student developing new yeast strains for beer varieties indicated she searches for information through search engines, libraries, NCBI, Blackwell, and Science. The purpose is to excavate various possibilities through permutation and combination, conducting experiments on each possibility and

comparing expected effects with experimental results to find new varieties (Interview No. 11).

A graduate student researching ecological environment data simulation mentioned that they search for literature through search engines, science and technology news, and electronic journal databases, summarizing literature conclusions to judge whether they match experimental simulations (Interview No. 23).

A graduate student researching nano-polymer composite materials said they search for English literature through ISI and search engines after first consulting Chinese literature. They evaluate the feasibility of references and compare them with experimental results. Nevertheless, they still worry about missing information (Interview No. 27).

A graduate student researching the basis of ruminant therapy revealed that they can hardly miss any literature from Google Scholar, PubMed (new developments), Elsevier (major conclusions), or virology journals (updated relevant literature), because this is crucial for evaluating whether information can be used to solve problems (Interview No. 06).

In the psychology field, a graduate student researching cognitive neuroscience in child development searches for literature through CNKI, Google Scholar, and ScienceDirect. They use information to propose specific working methods and compare them with experimental results. When researching completely unknown fields, they can only achieve several small preliminary results through accumulation of previous relevant knowledge and gradual calculation of experimental data (Interview No. 31). Similarly, a researcher in zoology studying the possibility of cognitive impairment in the elderly also searches for information through PubMed and library databases, summarizing literature content to judge whether it explains actual cases (Interview No. 12).

A respondent researching polymer physical material characterization indicated that during the research proposal stage, they search for information through ISI, ACS, and Google Scholar to summarize new approaches and judge whether they can guide experiments. However, during the experimental period and article writing stage after experiments, they will also regularly collect relevant information on a large scale (Interview No. 30). Additionally, a respondent researching compounds expressed the same situation. Since the research work involves describing compound properties through performance testing, they often use keywords to conduct large-scale searches in search engines and libraries. The collected materials must both summarize research hotspots and be compared with experimental results (Interview No. 02).

A student researching solar cell electrolytes indicated that large-scale literature collection and evaluation is almost impossible for one person to complete alone; it is mostly group collaboration. They search for literature through ISI and professional journals, classify abstracts, and propose explanatory theories and conclusions. The evaluation concerns whether they can be combined with laboratory conditions for experiments (Interview No. 26). Another researcher using a

similar approach, from the field of transgenic medicine and agriculture, searches for information through foreign core journals, search engines, and classic literature. They read and classify literature to make judgments about conducting research (Interview No. 09).

A graduate student researching fungal classification in aquatic ecology indicated that information sources are absolutely not single search engines or journals but diverse—the more diverse the information sources, the better—because only this can grasp potentially missing key information. They search for literature through library websites, project proposals, databases, and core journals. They use information to design experiments, compare species, and compare experimental results. This work is continuously repeated (Interview No. 33).

Not everyone always queries information from specific databases, nor can anyone obtain all the information needed for research work solely from portal website communities or forums. In fact, the vast majority of respondents pay attention to various information sources to avoid missing important information and losing the integrity of information materials. The difference lies in that the four types of users have different key information sources, different work natures, different information behavior habits, and different psychological states. Therefore, this study summarizes them into four types: tracking-type, integration-type, refinement-type, and exploration-type information seeking.

5.3 Influence of Social Factors on Information Search

According to interview results, several important influences on organizational behavior and individual decision-making come from: advisors, classmates, organizations (institutes), and institutions outside the organization. Similarly divided into different types, they are categorized as: unorganized, weakly organized, strongly organized, and anti-organized types, described as follows:

(1) Unorganized type: Advisor-centered. Unorganized type does not mean completely unconstrained by organizational norms. On the contrary, unorganized users may unconsciously follow established organizational culture in many aspects because the advisor is part of the organization. The difference is that for unorganized users, they are more influenced by the advisor' s personal style and working methods. For example, an advisor might arrange students from different majors to take remedial courses at other universities or participate in training seminars for other classes. The advisor arranges basic course learning and finds people to provide guidance (Interview No. 30). Although this approach is not subject to organizational intervention, it actually uses the advisor' s personal influence or vision to provide additional training for the graduate student outside the organization, even though the purpose is to better serve the organization in the future.

Among other respondents, advisor-centered situations were mentioned. For example, although one graduate student is a member of an institute, some research work relates to domestic environmental news and environmental groups with-

out special influence from within the institute (Interview No. 05). In this case, the advisor and classmates interpret and judge literature together, formulate plans, and execute research. They only attend institute activities on important occasions, essentially working independently of the institute alongside the advisor.

Other students live in the advisor's research team rather than completely relying on the institute's curriculum planning, even though the research team nominally belongs to the institute. This mostly involves the advisor assigning specific work, with graduate students conducting research based on previous laboratory work (Interview No. 15). This pattern is also common when advisors provide research directions and graduate students regularly report to advisors (Interview No. 22, 23, 24, 35).

The more common situation is that the Graduate School of the Chinese Academy of Sciences has unified management methods, while each institute has its own traditions and strict academic requirements. However, actual implementation is mostly decided by advisors according to actual work needs and individual graduate student characteristics. For example, situations where advisors judge research feasibility, graduate students interpret literature with other classmates, hold weekly group meetings, and each person reports learning progress to the advisor (Interview No. 10, 31).

(2) Weakly organized type: Peer-centered. Weakly organized users are those more influenced by peers, either cooperating or competing with them. The scientific community achieves cumulative academic progress precisely because they have formed clear consensus internally on what types of problems, techniques, and solutions are reasonable, and because they exclude any researchers who do not conform to the current framework. Weakly organized types are not unaffected by organizations or advisors, but their individual decision-making mainly comes from observing, learning, imitating, and copying others' practices.

For some graduate students, peer influence comes from the inheritance of basic operations and norms within the laboratory from senior graduate students. In this case, graduate students mainly conduct their own research work on the basis of existing work (Interview No. 02). Their learning objects are completely the same research directions and methods as others.

Some graduate students conduct research that cannot be completed individually within the same team, so they divide the work in information and document acquisition, and their respective sporadic experiments and testing work are also interrelated (Interview No. 26). They complete research together with others in a collaborative work environment.

Conversely, some graduate students compete with classmates without communication (Interview No. 33). The pattern where advisors assign specific work and classmates compete with each other is subject to dual constraints: on one hand, influenced by goals given by teachers; on the other hand, they must compete with other classmates for better performance opportunities. Thus, they remain

peer-centered weakly organized users because they must consider the actions of competitors within the group.

Another more harmonious competition-cooperation pattern involves advisors judging research feasibility, classmates exchanging experimental methods, techniques, and analysis means, and each submitting a short paper weekly (Interview No. 06). In this way, they both share information with others and ensure they have their own research results in each time period.

The two major characteristics of weakly organized users are: first, inheritance of basic operations and background knowledge in the laboratory from classmates (Interview No. 04, 32); and second, advisors proposing improvement requirements and research directions, with classmates interpreting and judging literature together (Interview No. 16, 21, 34).

(3) Strongly organized type: Organization-centered. Strongly organized users are graduate students under strong organizational norms, either as a group or as a collection of individuals. The characteristic of strongly organized users is that work requirements and norms are established by the institute, or they are constrained by institutionalized organizations in addition to advisor and classmate influences.

Although some users have discussions related to classmates, they are also influenced by the institute and need to regularly report work progress to the institute (Interview No. 13, 18). In more cases, this is to reduce the possibility of direct competition. Because in narrow professional fields, where advisors provide research directions and classmates interpret literature together, multiple people might research the same problem. Having graduate students report directly to the institute can reduce unnecessary conflicts and competition.

Some classmates discuss with others but divide work individually, reporting monthly to work groups within the institute (Interview No. 01, 19, 27). This is also a preventive measure to avoid conflicts caused by direct competition. However, its significance goes beyond this. Because they divide work individually, the possibility of repetitive research is 本来就不容易发生. In other words, more importantly, this is a knowledge-sharing system where the organization regulates each person' s sharing with others. Under this system, strongly organized users are more inclined to become members of the organization rather than merely observed and protected objects.

Explaining this strong organizational binding force may come from the institute' s funding for building experimental environments (Interview No. 07). However, there are different situations. For example, advisors grasp overall research directions, classmates inherit basic laboratory operations, graduate students conduct research based on previous work, and experimental material costs are supported by funds outside the institute (Interview No. 08). The former is more influenced by economic power, while the latter may be more influenced by organizational culture traditions.

(4) Anti-organized type: Externally-supported. Externally-supported users attempt to explore new rules and various new possibilities. They may not fully agree with old ways of thinking or may perceive the resource limitations of their institutes. However, anti-organized users do not mean blindly opposing their organization' s behaviors. On the contrary, the reason they can obtain external support is precisely because their organization agrees with and is willing to support them. Because such unconventional practices often bring new resources and atmosphere to the organization, and only through cooperation between organizations can anti-organized users obtain external support.

The parts influenced by other units have many different types. It may be that project funding and requirements come from other institutions, such as cooperation with traditional Chinese medicine universities (Interview No. 25). It may also be that experimental data come from hospitals, for example, actual case data from Beiyi Third Hospital (Interview No. 12). Or it may involve collaborative data collection with other teams, such as field sample collection teamwork with Zhejiang University (Interview No. 28). There are also cases of entrusted training directly related to original work units, such as occasionally undertaking military projects (Interview No. 29, 17), research cooperation with Guangxi University (Interview No. 09), research cooperation with Northwest Military Medical University (Interview No. 14), and research related to projects with Beijing University of Science and Technology and Beijing Jiaotong University (Interview No. 20). Or it may be fulfillment of long-term entrustment contracts between the institute and other units, such as research cooperation with well-known domestic beer companies (Interview No. 11) and research entrusted by CNOOC Company (Interview No. 03).

The influence of organizations on individual decision-making can be divided into several aspects: organizational division of labor and subgroups within institutes, leaders, academic leaders, advisors, experienced researchers, relationships between graduate students, and other factors. Understanding organizational behavior and individual decision-making helps explain the possible behavior patterns and psychological mechanisms of different types of network users.

5.4 Tracking Observation Survey Results

According to four types of psychological factors and four types of social factors, there could be 16 typical user types. However, through tracking observation of 8 graduate students' learning situations, we can preliminarily summarize four typical users.

6. Discussion

For tracking-type users, technical science addresses practical problems, so its cognitive content differs from the universal forms of basic science disciplines. Whenever basic science serves as the foundation for technical science, extensive formal exchange through tracking-type research is required. On one hand, this

makes the knowledge and content of basic science applicable; on the other hand, it thoroughly reinterprets according to the social background requirements of practical application. In most cases, scientific activity involves forcing natural phenomena into conceptual frameworks provided by professional education [21]. This process is the normal science stage, which does not seek fundamental innovation but strives to expand its empirical range without changing its basic orientation.

[Figure 6: see original paper] Fourth Typical User—Persona D

For integration-type users, judging people is more reasonable than judging knowledge viewpoints. This tendency may relate to the existence of so-called elites in science, who exert significant influence on the overall direction of scientific research. When researchers have common scientific/technical backgrounds and can choose to focus on problems they believe can be solved within their common framework, academic consensus is quickly and firmly established. As Ravetz [22] points out, scientists only choose problems they believe can be solved. Such graduate students usually select peers' research findings from literature that they consider reliable for various reasons. In other words, these graduate students believe that if problems come from a certain paradigm they are well-trained to use, they are likely to choose similar problems.

For refinement-type users, graduate students engaged in basic scientific research aim to contribute something new to the scientific knowledge system. This goal can be explained according to Merton [23] as: a product of compliance with the norm of originality. For example, graduate students' research projects are carefully selected by advisors to ensure students have opportunities to make original contributions to knowledge. They believe research topics needing attention are phenomena not anticipated within existing theoretical frameworks. Their actual research goals reflect this situation; they pursue higher experimental precision, resolve experimental or theoretical anomalies, or refine existing theoretical assumptions.

For exploration-type users, they use previous experience and special expertise to expand and change patterns. Patterns constantly change during their research process. Gilbert' s formulation of scientific concept formation [24] emerges from relatively unstable and variable academic consensus. He points out that among research members, there exist some constantly changing, different yet interconnected family patterns, rather than a unified shared pattern. Therefore, although patterns used by members of a research community have a family resemblance to another person' s pattern, they are never completely identical. They prove their discoveries by citing conclusions that are generally recognized in their field and simultaneously consistent with their own patterns. Some discoveries will be continuously cited because they fit patterns used by most members and thus become the basis for evidence sought in that field' s research.

Advisor-centered unorganized users mostly follow certain research methods and thinking patterns because this situation comes from complete submission to

the advisor' s apprenticeship inheritance system. Based on the advisor' s past success in leading other seniors, fixed research paradigms are formed. There may be a day of failure, but generally, it is a quite safe and stable learning mechanism for graduate students. Similarly, such graduate students' needs for network academic information behavior are not immediate or obvious.

Peers often play the role of irrational emotional motivation. Because research is a hard game requiring months or even years of work that seems to make no progress, sometimes graduate students feel very confused, then suddenly have a breakthrough. At this time, it is best to have encouragement from those around them. Peer-centered weakly organized users understand this very well.

Strongly organized users need not worry that research may yield no results or disproportionately small results because their organization adopts an explicit policy to avoid duplicate research. This policy itself is a form of cooperation that greatly reduces the possibility of direct competition. However, this does not mean they have no competitive pressure; this pressure may be double: on one hand from internal organizational competition and cooperation pressure, on the other hand from external academic competition pressure.

Because anti-organized users believe they will immediately recognize important problems when they encounter them, they hope to wait for the right time and are unwilling to quickly decide to spend too much time focusing on relatively unimportant problems. Their ability to endure delayed rewards, combined with self-confidence that major problems will appear in due time and that their discernment will enable them to recognize and deal with them when they appear, is reinforced in their creative external support organizational environment. Therefore, anti-organized users are most sensitive to changes in the external environment.

Based on the four typical users, according to their different feelings, thoughts, and actions under the information seeking model, combined with their mental maps during learning periods and their direct complaints and wishes regarding libraries or other information service systems, we map the functions of a new generation digital library information service system as shown in Table 3.

Table 3. Functional Design of Personas in Information Service System Construction

Function	Description	User Need
Automated interface transformation	Interface changes with user actions	Sometimes want to query, sometimes want to organize, sometimes want to write; each workflow is different

Function	Description	User Need
Automated information customization changes	Customized information term frequency calculation	Based on recent query terms and topics, refine RSS
Interactive entertainment education	Short videos, games, music, animations, comics	Rapid and reliable practice and learning of information resources; but sometimes just want to see the interesting side of libraries
Information delivery to designated locations	Pre-set computer actions and designate storage locations anytime	Don’ t need to sit in front of computer to start information seeking and downloading; can pre-complete actions through computer
Information source tracking	Automatic source checking for charts and article content	After pasting charts and articles online, need to cite references, but didn’ t note them initially
Information filtering and combination	Exclude irrelevant information from different databases and networks	Tracking technology development requires excluding large amounts of unnecessary information; collecting large amounts of information also requires filtering
Meta-analysis intelligence system	Secondary analysis of intelligence system analysis reports	Too many research data reports, don’ t know where to start; hope for analysis of “analysis reports”
Interface content automatic reorganization	Adjust webpage layout according to user needs, not fixed	Sometimes read news, sometimes write blogs, sometimes query databases; don’ t want to repeatedly click into different systems

Function	Description	User Need
Workflow automatic reorganization	Workflow tool software adjusts sequence anytime	Sometimes want to query, sometimes want to organize, sometimes want to write; each workflow is different
Researcher automatic matching	Provide contact information, automatically assist in contacting personnel and institutions	Need to know who, which institutions, and which projects are conducting the same research and how to contact and cooperate
Research plan trend comparison	Analyze large research reports	List similar reports and analyze report credibility
Information automatic summary permission	Automatically extract and classify information from different sources with one command	Computer automatically executes: download, organize, analyze, purchase, borrow, and other permission applications
Information quality certification	Quickly know which information is reliable and which is relatively important authoritative literature	Need to quickly know which information messages are reliable and which are relatively important authoritative documents
Knowledge innovation evaluation	Automatically evaluate innovation based on statements, word usage, subject fields, and function word error correction	After extensive reading, can no longer distinguish which are one' s own and which are others' creations; hope that after writing a paragraph, computer can analyze whose viewpoint it is similar to
Information designated confidentiality time lock	Encrypt and temporarily store ideas, viewpoints, and materials in library, decrypt when publicly published	Avoid "priority" competition, can focus on technology development; even if preemptively published, doesn' t affect proof of independent research rather than plagiarism

Function	Description	User Need
Relevant information error correction	Intelligent information service support directly from work progress without secondary queries	No need to repeatedly enter secondary queries; directly obtain intelligent information service support from work progress

7. Conclusion

Compared with what previous research has not revealed, the new progress completed by this study includes: (1) completing the work of creating personas from questionnaire surveys, in-depth interviews, and tracking observations; (2) creating and using personas from psychological and social perspectives; and (3) extending the application scope and functions of information search models from the perspective of "differentiated" users and services.

Research limitations include: (1) social science research methods can only obtain temporary conclusions, and the rules and logic expressed in this paper still require verification; (2) because the sample selected students from the Graduate School of the Chinese Academy of Sciences, when using this paper to explain other schools, units, or groups, other relevant research should be consulted. For cases where causal relationships are not yet clear, future research should adopt experimental research methods. Additionally, between what log analysis cannot measure and the limitations of social science survey methods, there may exist user behaviors that have not been observed. This should be one of the directions for breakthroughs in persona research to reach higher levels in the next stage.

Although this study explores and classifies user behavior from psychological and social perspectives, whether user services correlate with user behavior, how to measure and improve this correlation, and how to predict or change user behavior based on existing persona models toward more efficient and naturally accepted information behavior patterns remain blank areas. If research in this area can be conducted and scientific results obtained, it will be possible to influence users' library usage behavior by changing their cognition of libraries, or influence users' cognition of libraries by changing their behavior, thereby better integrating user behavior models with library service models.

Acknowledgments: Thanks to Professors Zhang Xiaolin, Meng Liansheng, Chu Jingli, Sun Tan, Liang Zhanping, Lu Xiaobin, Jing Xianghu, and Prof. Antony Ferguson for their criticism and encouragement.

References

2. Research Information Network (RIN). [2008-07]. http://www.rin.ac.uk/researchers-discovery-services

3. Oblinger, D. G. & Oblinger, J. L., *Educating the Net Generation*, 2006. [2008-01]. http://www.educause.edu/ir/library/pdf/pub7101.pdf

4. OCLC. *Sharing, Privacy and Trust in Our Networked World*, 2008. http://www.oclc.org/reports/

5. Foster, N. F. & Gibbons S. ed. *Studying Students: The Undergraduate Research Project at the University of Rochester*. American Library Association (ALA), 2008. [2008-07]. http://docushare.lib.rochester.edu/docushare/dsweb/Get/Document-27275/Foster-Gibbons_cmpd.pdf

6. JISC & SCONUL library management systems study. (2008-08). [2008-22]. http://www.jisc.ac.uk/media/documents/programmes/resourcediscovery/lms_section_2_summary

7. Google Generation. (2007-30). [2008-08]. http://www.jisc.ac.uk/whatwedo/programmes/resourcediscove

8. Gu Liping. Web 2.0 User Behavior Survey Research—Taking Chinese Academy of Sciences Students' Use of Social Software as an Example. *Library and Information Service*, 2007(9)

9, 11. Gu Liping. Academic Information Retrieval Behavior in Web 2.0 Environment. *Library and Information Knowledge*, 2008(6)

10, 20. Gu Liping. Interaction Design Based on Web 2.0 User Information Retrieval Behavior: Meta-design

12. Kuhlthau, C. C. *Seeking Meaning (2nd ed.): A Process Approach to Library and Information Services*. Norwood, NJ: Ablex Publishing, 2003.

13. Alan Cooper; translated by Ding Quangang. *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity* (2nd Edition). Beijing: Publishing House of Electronics Industry, 2007.

14. Jack M. Maness, Tomasz Miaskiewicz, Tamara Sumner. Using Personas to Understand the Needs and Goals of Institutional Repository Users. *D-Lib Magazine*, 2008(9/10):14. [2008-13]. http://www.dlib.org/dlib/september08/maness/09maness.html

15. Gu Liping. Digital Library Interactive Interface Design Based on Web 2.0 Personas. *Library and Information Service*, 2008(9)

16. Mulder S., Yaar Z. *The User Is Always Right: A Practical Guide to Creating and Using Personas for the Web*. Berkeley, CA: New Riders Press, 2006.

17. Mulder S. & Yaar Z; translated by Fan Xiaoyan. *The User Is Always Right: A Practical Guide to Creating and Using Personas for the Web*. Beijing: China Machine Press, 2007.

18. Wilson, T. D. *The User Is Always Right: A Practical Guide to Creating and Using Personas for the Web* (Book Review). *Information Research: An International Electronic Journal*, 2008.

19. Li-Ping Ku. Creating and Using Personas for Digital Library Service in Web 2.0 Era. *IFLA IT Section Newsletter*, 2009. [2009-07]. http://www.ifla.org/files/information-technology/IFLANewsletterJuly2009.pdf

20. Kuhn, T. S. *The Structure of Scientific Revolutions*. Chicago: The University of Chicago Press, 1962.

21. Ravetz, J. R. *Scientific Knowledge and Its Social Problems*. Oxford: Clarendon Press, 1971:132

22. Merton, R. K. Priorities in Scientific Discovery. In B. Barber and W. Hirsch (eds.), *The Sociology of Science*. New York: The Free Press, 1962.

23. Gilbert G. N. The Transformation of Research Findings into Scientific Knowledge. *Social Studies of Science*, 1976, 6(3/4):302.

(Received: 2009)

Note: Figure translations are in progress. See original paper for figures.