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# The Digital Reference Research Agenda

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**Abstract**

This article presents a research agenda for the study of digital reference. The agenda stems from a research symposium held at Harvard in August 2002. The agenda defines digital reference as "the use of human intermediation to answer questions in a digital environment." The agenda also proposes the central research question in digital reference - "How can human expertise be effectively and efficiently incorporated into information systems to answer user questions?" The definition and question are used to outline a research agenda  centered on how the exploration of digital reference relates to other fields of inquiry.

**Background**

Digital reference is a distinct and growing practice in libraries today. Academic, public and special libraries are rushing to offer human intermediation services over the Internet. Conference sessions on the topic are filled, workshops are well attended, and major library organizations (RUSA, ACRL, OCLC)  are developing digital reference training. However, unlike the interest shown in studying digital libraries, there has been relatively little research interest in digital reference. Aside from the work of a small group of researchers (Lankes 2001, Janes , McClure 2001 and White ) digital reference has remained primarily in the province of the practitioner.

Practitioner orientation to digital reference  can be demonstrated when one looks at the Virtual Reference Desk (VRD) Conference (http://www.vrd.org/conf-train.shtml). Attendance for  the VRD conference, the largest and only international conference

dedicated to digital reference, has steadily increased every year since its inception in 1999. The 2001 VRD conference organizers received nearly 80 session proposals, only 3 of which were submitted by Library and Information Science (LIS) faculty members/researchers.

The separation between research and practice has very real consequences. Universities, public libraries, governmental agencies and foundations invest large amounts of money in digital reference services. These monies are invested in services, software and planning without benefit of clear empirical research designating best practices, and without benefit of clear understanding of these services' benefits and shortcomings.

The lack of interaction between the digital reference and digital library communities presents a further problem. While digital reference can be conceived of as a sub-field of digital libraries, few cases exist where research or development in both of these areas have been coordinated. Both of these communities however are now beginning to understand the importance of the other.

In order to encourage participation by the research community ( universities, libraries and beyond) in digital reference, Syracuse University's Information Institute of Syracuse organized a symposium on digital reference research at Harvard University. The symposium was sponsored by the National Library of Canada, ALA's Association of College & Research Libraries, OCLC, the Harvard Graduate School of Education and the Library of Congress.

The stated objective of the symposium was to create a research agenda in digital reference that bridged the areas of digital reference, library practice and digital libraries. A research agenda was the outcome of a two-day symposium which was attended by 20 high-level researchers in library science, digital libraries, and computer science To seed symposium discussion, five white papers were commissioned. The initial list of topics was identified at the 2001 Virtual Reference Desk Conference, namely:

- Question Negotiation in an Electronic Environment (authored by Joseph Janes of the University of Washington)

- Education for Digital Reference Services (authored by Linda Smith of the University of Illinois, Urbana-Champaign)

- Standards, Systems and Software for Digital Reference (authored by Michael McClennen of the Internet Public Library)

- Policies and Standards for Digital Reference in Consortia (authored by Jo Bell Whitlatch of the University of California San Jose)

- Fit of Digital Reference into the Digital Library Arena (authored by Jeffery Pomerantz of Syracuse University)

- Digital Reference in Primary and Secondary Education (authored by R. David Lankes of Syracuse University)

The author presents the results of the Harvard symposium in this article. The initial research agenda was derived from the papers, the symposium discussion and from

ongoing reflection by and from the field. While this agenda comes from a snapshot in time (a snapshot of a time when practice had far outpaced scholarship), the hope is that it is a starting point for a concerted research effort to examine the growing digital reference phenomenon. The proposed research agenda identifies more gaps in our understanding of digital reference than areas of agreement, but it points the way to a cohesive understanding of the field.

**Introduction**

For the purposes of this article a research agenda is defined as a reference document that seeks to indicate:

- The scope and scale of a phenomenon
- What is known about the given phenomenon under investigation
- What gaps are recognized in the understanding of the phenomenon
- A common belief regarding priorities in filling these gaps

It is at once an objective description of a field of inquiry, and a political document that seeks to focus the attention of the research and practitioner community.

The author presents a cohesive framework for exploration in this article. Ways to operationalize this framework into a series of relationships to other domains of knowledge, theory & practice, and to a series of specific research questions will be discussed.

**A Working Definition of Digital Reference**

Many terms are used to describe the study and practice of digital reference (e.g., virtual reference, real-time reference, chat reference, real-time chat reference, live reference) All share a central concept: the use of software and the Internet to facilitate human intermediation at a distance. This centrality can be seen in the definitions of digital reference  found within the whitepapers presented at the digital reference research symposium:

> "Digital Reference Services are Internet based services that employ human experts or intermediaries to provide information to users." Whitlatch (2003)

> "digital reference is a service that provides users with answers to questions in a computer-mediated environment." Pomerantz(2003)

> "Digital reference services seek to enhance the ability of users to locate needed information through the work of reference librarians providing both direct and indirect services.  While one aspect of digital reference services involves assisting users in accessing digital library resources, digital reference services encompass any reference services provided over the Internet and can involve use of print as well as digital resources." Smith (2003)

> "Digital reference refers to a network of expertise, intermediation and resources put at the disposal of a person seeking answers in an online environment." Lankes (2003)

While these definitions vary, they have common themes. The first theme is the concept of intermediation. The second is the concept of question answering. The third is the concept that question answering and intermediation occurs in a digital environment. What is not self-evident in these quotes, and yet apparent in both the practice of digital reference and the conduct of research studies and methods in digital reference, is the necessity of human intermediation. Digital reference does not refer to so-called "self-help" searching, or to the field of automated question answering as seen in the TREC Question Answering track (http://trec.nist.gov/). While these areas are certainly related (as will be discussed later), they do not encompass the unique nature of digital reference - human intermediated question answering in a digital environment. This then, will be the working definition of digital reference used throughout this agenda: the use of human intermediation to answer questions in a digital environment. It should be noted, that this definition does not rule out partial automation of the question-answering process, discussed by McClenon and Pomerantz, rather it places automation in service of human answering.

**The Central Question in Digital Reference**

A definition is necessary, but insufficient to create a research agenda. A definition is sufficient to identify a field or practice, but lacks analytical ability necessary to define the shape and direction of the field. Any domain of inquiry is predicated on a central question. The question provides boundaries for the unique nature of a discipline and situates the domain in the realm of other streams of exploration. In the specific case of

digital reference, the central question must center on why digital reference is different from traditional library-based reference research and digital library research. It must also, of course, define how digital reference is related to these domains (as well as to information retrieval, and computer mediated communication).

A Thought Experiment for Digital Reference

At the Harvard research symposium that spawned this article, William Arms raised the issue of a central question in the form of a provocative "thought experiment" replicated here.

Suppose a prestigious academic institution has just hired a new president. To welcome the president, each department within the university selects its outstanding, world-class researchers to extol the accomplishments of the departments. In the fields of chemistry or physics the university selects Nobel Prize winners who have unlocked fundamental operations in nature. The economics department selects a scholar who has advanced the understanding of complex markets. The education school selects a researcher who has advanced the understanding of language acquisition. The point is that each department can not only determine a "star" who has made a fundamental contribution to knowledge in the specific field the department specializes in, but that the contribution can also be recognized as meaningful and important by the other departments.

Now, hypothetically speaking, the "Department of Digital Reference" selects a scholar who has made not only a fundamental contribution to the advancement of digital reference, but the contribution is recognized across the whole of the university as meaningful and important.

What was that contribution? What question did that "digital reference scholar" answer that was fundamental enough to define a field, and powerful enough to be recognized as significant beyond the field of digital reference? This is the challenge that must lie at the center of digital reference, or digital reference remains simply a practice, or an application of existing knowledge.

**Digital Reference: The Central Question**

The central question for digital reference is "How can human expertise be incorporated effectively and efficiently into information systems to answer information seekers' questions?" This central question has several components and assumptions which the author examines below.

Question Components

Question components are defined as the key areas of understanding needed to explore digital reference, and from which deeper understanding can be drawn and studies conducted to further the understanding of the central question. They are the atomic units

of inquiry that may be shared by many disciplines, but in combination are unique to the study of digital reference. For example, the "Question" and "Answer" components certainly have great relevance to the field of information retrieval, and "efficiency" and "effectiveness" are core to the study of economics. It is their combination and specific application that create a unique question. Their application to other domains positions the field of digital reference within the larger context of scientific inquiry. The author identifies five question components for digital reference:

*Component 1: Human Expertise*

What is the nature of human expertise in a system? It is proposed, for further exploration, that expertise exists in a continuum from subject knowledge to process knowledge. Subject knowledge is the understanding of a core collection of facts and their inter-relations, such as in the field of chemistry where the facts range from natural laws to molecular structures. Process knowledge is defined as the ability to manipulate a system to achieve a desired result where core understanding of the system's content is not required. In digital reference practice, these two extremes are often portrayed as scientists with ready and extensive knowledge of a domain and librarians with information seeking skills to inform that domain. It is assumed that the placement of a given individual or even the placement of a knowledge domain may shift on the continuum of subject knowledge to process knowledge based on the context of application. In the field of library and information science, as an example, the process knowledge of librarians constitutes the subject knowledge of the field.

*Component 2: Efficiency and Effectiveness*

How can the costs and benefits of digital reference be measured and assessed? In this context, efficiency and effectiveness are defined in economic terms where an ideal state (the most effective service) may be defined as the most parsimonious use of available resources (e.g., time, money, staff, etc.). The  intertwined relationship between outcome and resources expended make this issue particularly difficult.  The  author posits  for further examination  that the proper balance between the  two variables is context dependent. The central research issue related to effectiveness and efficiency seems to  lie in   the identification of significant variables for both measuring these variables and  for identifying relevant context conditions to arrive at an optimal balance.

*Component 3: Information Systems*

What is the proper configuration of technologies and resources needed to produce a required output? The concept of "information system" used in the digital reference definition can be characterized as a special case of a general system (Bertalanffy, 1968) where the input to the system is a user question, the process involves human expertise, and the output is an answer. The author restricts the examination of information systems in the realm of digital reference to networked and digital systems. While so-called analog resources may be used  as part of a digital reference system, the digital reference system as a whole is seen in the context of a digital interaction where, at the very least, the input

to the system is digital. While to date digital reference research has regarded the information systems in digital reference as both rational systems (as typified in McClennen, 2003) and as complex systems (Lankes, 1998), no position is taken in this research agenda. Rather the question component refers generally to the discovery of the necessary and sufficient architecture of an information system (in respect to digital reference) and the means of interrelating these features.

*Component 4: Questions*

What is the nature of user input to a digital reference system? The examination of "questions" as expressions of a user's need or a user's cognitive gap (Dervin and Nilan, 1986) introduces a rich area for exploration. The question component refers specifically to the identification, classification, and use of questions. The author posits that questions are an imperfect representation of a user's information need. (Taylor, 1968). Research on questions might seek to identify the sufficiency of questions as expression of need (their isomorphism to cognitive state), the inherent nature of question types (an ontology of user needs and/or their expressions), and the means by which true information needs can be discovered and/or bounded (i.e., question negotiation).

*Component 5: Answers*

What set of information, and in what form, can information be bundled to satisfy an information need? Like questions, answers are n imperfect mediums used to transfer

knowledge from a recognized source of expertise to a recognized point of information

need. Unlike a question (operationalized as a user expression), answers involve two

parties, the transmitter (the "expert") and the receiver (the user). As such, answers would

seem to be extremely context sensitive. If answers are defined as "information that meets

a user need" they are operationalized by user determinations and evaluations. On the

other hand, if answers are  defined as "accurate data produced in response to user need" it

is the transmitter of information (human or automated) that operationalizes and evaluates

system results. This dichotomy of definition is often referred to as user perspectives

versus system perspectives. This research agenda presented in this article recognizes the

issue for further research without supporting one stance over the other.

Question components are derived from the expression of the question itself. As such, they

are explicit. The next section explores the implicit facets of the central question in digital

reference - the assumptions.

Assumptions

Assumptions are implicit components of the central research question in digital reference:

"How can human expertise be incorporated effectively and efficiently into information

systems to answer user questions?" Assumptions are necessary conditions for asking the

question, or at the very least, to see the question itself as significant. Just as with question

components, assumptions should be both testable and provocative. That is they should be

susceptible to theoretical and empirical scrutiny as well as able to provide a departure

point for further research and examination. The author identifies two assumptions in the central question of digital reference:

*Assumption 1: Human Expertise is Useful to Incorporate into Information Systems*

If human expertise is not necessary in the on-going functions of an information system, then there is no need for the exploration of digital reference. A few bounding elements are needed in this assumption. The assumption is not that all information systems require ongoing participation of human expertise. This would be false on its face. Clearly, the majority of information systems function without the inclusion of experts. From the use of search engines to automatic teller machines, information seekers are clearly able to engage systems successfully without the guidance or presence of a human intermediary.

This assumption is specific regarding inclusion of human expertise in the information system. In the exploration of digital reference, human expertise is the object of the system (users engage an information system to gain access to human expertise), and human expertise is a means of providing information to users. Every system utilizes human expertise behind the scenes in its design and construction. In digital reference the human expertise is exposed to the user for access and engagement.

Given this assumption, research questions could be posed that would attempt to discover the utility of human expertise. What value does the ongoing inclusion of human expertise add to the system? Some proposed values for further exploration include:

- Providing a familiar human touch in a complex, overwhelming or intimidating computing environment where the value is not simply the information provided, but the mode in which it is presented

- Taking advantage of humans' ability to provide synthesis where the user is able to span systems, information sources, opinions and presentations in order to provide context provision. The two aspects of this value would be operational, where humans can simply span system boundaries, and cognitive, where a human is able to match the user's cognitive framework to the system's framework.

- Using digital means to elicit tacit knowledge held by an expert. Tacit knowledge refers to information (facts, opinions, procedures, etc.) that has no documented form and is normally gained from human experience.

- Providing instruction and restatement where a human can offer a wide range of information coding and depth that a system may be unable to replicate. This includes the ability to not only decode information provided by a system, but to impart the methods of system operation to the user and relate that operation to some larger context or user pursuit.

The author does not attempt to make this list exhaustive. Rather he lays out current hypothesis and beliefs concerning values. The author anticipates that this list will be refined, augmented and possibly prioritized with future research. He also assumes that the value will shift based upon system context, and that research is needed to identify cogent contextual variables that relate to the value of human intermediation and expertise.

*Assumption 2: The Digital Nature of Digital Reference Systems Provides a Significant Differentiating Context*

There is a close relationship between the domain of digital reference and other allied domains such as information retrieval, digital libraries and reference theory. In many ways digital reference was born out of the marriage of several lines of investigation and practice, but assumption 2 implies that digital reference provides a unique set of questions, components and approaches. In essence, the whole of digital reference is greater (or in this case different) from its component progenitors.

This assumption does not preclude the adoption of knowledge from analog systems (so-called "traditional" library-based reference). It recognizes instead that digital reference differs from traditional reference in three significant ways:

- Whereas traditional reference work is founded primarily on an oral tradition with little concern for reference artifacts, digital reference is centrally concerned with reference artifacts from a primarily textual context. As such, much of digital reference explores the creation of reference artifacts (previously asked questions, knowledge bases, questions as quanta that can be transferred between institutions).
- Digital reference research and systems are defined and bounded by human participation and intermediation. Whereas traditional reference, primarily operationalized in library settings, spans intermediation, collection development

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(building and maintaining the reference collection), and resource creation (pathfinders), digital reference focuses on human intermediation, perhaps more accurately referred to as human answering. This is not to say that digital reference systems and services do not include aspects of collection development and product development (see Pomerantz), rather that the domain of digital reference is centered and bounded by human intermediation.

- Digital reference expands upon the central concept of traditional reference practice's emphasis on referral to include subject expertise and primary knowledge. While reference research has concentrated on evaluation and question negotiation, particularly in regard to human intermediation, there has been an implicit assumption that reference sources (the human expertise of the system) are process experts guiding users through a collection (a library collection, the Internet, electronic databases, etc.). Digital reference, due in large part to participation by the AskA community, has expanded upon, and in some cases, supplanted these assumptions to where the information seeker interacts directly with the collection. The collection in question being a collection of human subject experts. While this is not a fundamental difference of theory, it is a significant departure in practice.

The assumption of significant difference should be testable by comparing cogent variables in analog human intermediated systems with variables in digital reference systems. The author does not take a strong stand that digital reference is a fully distinct field from reference. Clearly, operational systems have demonstrated that existing

reference services can migrate and co-function in digital systems. Rather, the author argues that defining digital reference as a sub-discipline of reference provides little analytic power, ignores the stated sustentative differences in reference and digital reference practice, and fails to acknowledge digital reference in light of other "parent" domains such as digital libraries. Ultimately, every field can be seen as related to virtually any other domain of inquiry (after all, many would argue that biology is a sub-discipline of chemistry that is a sub-discipline of physics, that may well have its roots in philosophy). This complex relationship will be explored later.

One may ask what the difference is between digital reference and traditional customer service. The author suggests the primary difference between these two fields lies in the existence or absence of a common referent. In customer service, there is some common third party referent that is a vital part of the conversation. Be it a product (software, furniture, electronics, etc.) or a service (cellular service, a performance, plumbing, etc.) both the user and the expert share a common referent that binds their interaction. In digital reference, on the other hand, the only shared  entity is the question being asked. In many cases, the use of information must be negotiated along with the question itself. Digital reference must have at its center the creation of common context. In customer service, this framework is assumed. Customer service work concentrates on efficiency and re-use of answers, whereas digital reference focuses on issues of intermediation and question negotiation. Certainly methods of gaining efficiency may be shared between these two domains (particularly in terms of software development), but the core assumptions between the two fields diverge significantly.

**A Digital Reference Research Framework**

The combination of question components and assumptions constitute the digital reference research framework. This framework differs from a model of the digital reference process (Pomerantz, et. al.), or the systems view outlined by McClenon. Instead it serves as a scaffolding from which models, systems, research questions, methods, and studies can be derived, compared and, in some cases, combined to further a larger understanding of digital reference.

The framework can be further refined in two ways: by indicating significant approaches to the framework, and by relating  the framework to other domains of inquiry

Approaches to the Framework: The Construction of Conceptual Lenses

The author adopts the metaphor of conceptual lenses to discuss how different researchers and different communities might reflect and build upon the core framework of question components and assumptions. A "lens" embodies the values and concerns of a given community through which they act. The action may be in research, systems building, or simply in discussion.

The lenses presented in this section are meant to be significant, but are by no means complete. The author assumes there are a limitless number of lenses defined by the nature

of concern or preoccupation of a community  - where the community may well be a single person. There may be geographical lenses ("how does this question component work in Canada"), institution lenses ("what is the relationship of these assumptions to the work of Syracuse University"), and personal lenses ("how can I incorporate these research questions in my study") among others.

Significant lenses described in this article represent a set of clear and pressing issues (and values) in digital reference (as expressed by researchers and the practice community). The lenses also represent broad concerns encompassing a large potential audience of scholars, funding institutions and practitioners.

Lens 1: Policy

Whitlatch defines policy as

> "Policy can be defined as how an organization sets its rules under which services are offered.  You can also define policy as guiding principles or a course of action thought to be advantageous."

We see in this quote two aspects related to policy: process and product. Policy as a process is that series of events and decisions that guide the operation and governance of a system (what McClenon calls a procedure). Policy as a product is the outcome of this procedure, and constitutes the implicit and/or explicit rules by which system components are held accountable. Products are considered to be the instruments and artifacts that represent the end point of a deliberative process. The policy lens is concerned with both

the process and effect of organizational decision-making and the actual products. For example, privacy has been expressed as a policy concern in digital reference (Whitlatch). The policy community seeks to understand the needed concepts to protect privacy as well as privacy statements (policies) that explain an organization's stance on privacy to its user base.

Lens 2: Systems

The systems lens focuses on the means by which technologies can be used to improve both the efficiency and effectiveness of digital reference. One should note that this lens differs from the evaluation lens in that efficiency and effectiveness measures are often seen as secondary to the actual implementation of systems, standards, and procedures.

Two system models have been presented to provide a general means of understanding digital reference systems. The first by McClenon seeks to define a digital reference system as a series of roles and the interaction among these roles. Lankes, on the other hand, presents a General Digital Reference Model modeled as a special case of a complex system (see figure 1).
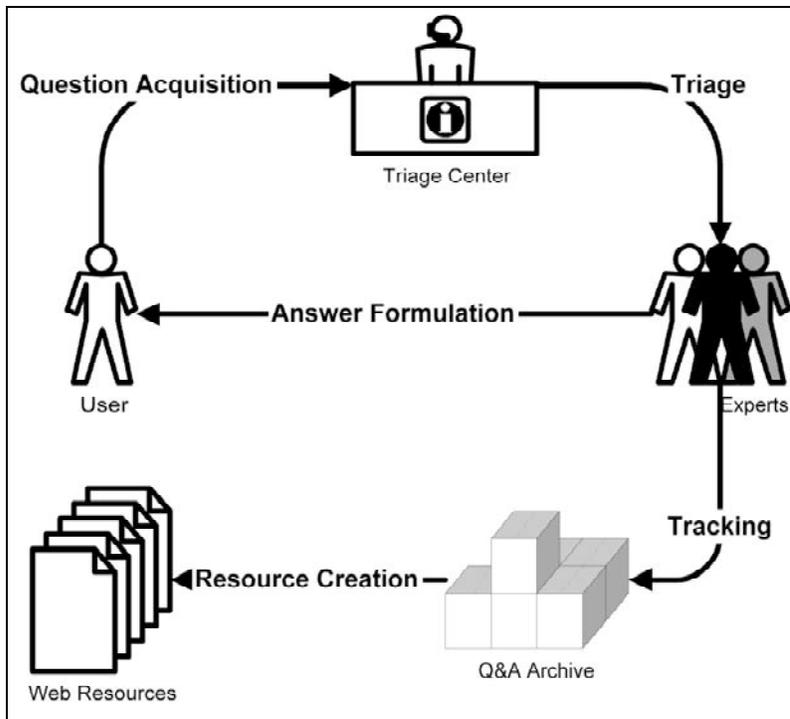
**Figure 1: Lankes' General Digital Reference Model**

A central concern of the systems lens in digital reference relates to mode of user/expert interaction. The mode of interaction is characterized as synchronous when the information seeker and expert interact in real-time and asynchronous when users forward a question to a system where it can be processed by an expert at some later point (Pomerantz, et. al.). The author asserts that this distinction is an artificial dichotomy. This assertion is based on a point raised by Bruce Croft at the Digital Reference Research Symposium. In any digital reference system, there are real-time components regardless of whether the human components of that system are available real-time. In a web based system, the user enters a question in real-time and the digital reference system processes the question (be it saving it to a file, transforming it into an e-mail or entering it into a database) in real-time as well. The fact that an expert component of the system may not

answer the question for some time can be seen as merely a lag in the total processing time of the system.

This view seems to be supported by Lankes' (Lankes and Shostack, 2002) examination of asynchronous systems where he sought to empirically test an assertion of Peters (2000):

> "Although all reference service involves some sort of time delay, it appears to be true that, for most users and most reference needs, delays of more than a few minutes significantly diminish both the usefulness and use of a reference service that routinely incorporates such delays into its service architecture"

Lankes found both high use and utility in at least one digital reference system, AskERIC, where delays of up to two business days are the norm.

The true question asked in the system lens is "What are the interaction requirements of the user in any given context?" Does the nature of the question require real-time interaction with an expert? Do information seekers need some form of immediate feedback (such as a "question received" message) regardless of expert interaction mode?

Lens 3: Evaluation

In this article, the author defines "evaluation" as the means of determining value. Value here is defined as the effect (impact either intended or unintended) of a given entity (a service, product, idea, etc.) compared to its cost (resources consumed such as money,

time, space, etc.). At the center of the evaluation lens is the determination of current balance between efficiency and effectiveness, discussed previously under Question Components.

The means of evaluation are assumed to be both qualitative and quantitative. They are also assumed to be 1) behavioral as they attempt to assess the impact of human behavior and change in both user and expert abilities; 2) technical as they assess the ability of a system to perform as designed and expected; and 3) economic as they assess digital reference systems' ability to account for and be effective stewards of the resources used in delivering service.

There are currently several exemplars of an evaluative lens approach to digital reference. The largest is the Quality study conducted by McClure et. al (2002). This study resulted in the development of a series of metrics, performance measures and quality standards to be used in the evaluation of digital reference services at a local level.

Lens 4: Behavior

The behavioral lens focuses on human attitudes and interactions with and within a digital reference system. These behaviors may relate to affective conditions or to the determination of trends in digital reference usage. Janes (2000) provides an exemplary behavioral digital reference study. He studied librarians' attitudes towards digital

reference work and found a significant link between positive attitudes towards digital reference and time spent engaged in answering questions online.

As with question components, lenses are not unique to digital reference. One may even believe that a combination of lenses and approaches will be found in many contexts. For example, a grade school could be examined through a policy lens ("the utility of high-stakes testing"), a systems lens ("the role of instructional management systems"), an evaluative lens ("performance on high-stakes testing as influenced by the use of instructional management systems"), an instruction lens (" the pedagogical approaches used in instructional management systems"), and a behavior lens("students attitudes to being required to use instructional management systems and then tested"). Because of the general nature of lenses and question components, these elements of the building framework provide excellent points of connection to other domains of inquiry.

**Relation of Digital Reference to Other Domains**

All fields have progenitors and relationships to existing domains. These linkages (to past practice and current research) situate the investigation of digital reference. The following section of the research agenda outlines these linkages.

Progenitors

The digital reference field has two progenitors. The first is library and information

science (LIS), particularly LIS practice. The second major contributor to digital reference

is the category of Internet services known as AskA services, or expert question/answer

sites.

Progenitor 1: Library Reference

The librarian's role in digital environments began with e-mail digital reference efforts.

Digital reference extended the traditional core reference function of the library past the

reference desk and to the desktop. Information seekers were able to ask reference

questions and consult with trained librarians through e-mail. Still & Campbell (1993)

provide excellent examples of early e-mail reference studies. This thread of digital

reference study includes examination of issues such as the role of the librarian in

cyberspace, the impact of distance service on the traditional reference interview,

evaluation, and the examination of new skills needed by the information professional

(Mardikian and Kesselman, 1995).

Progenitor 2: AskA Services

The second progenitor of the current digital reference arena is the AskA service. AskA

services (so-called because services tend to take on names such as Ask-A-Scientist, Ask-

A-Teacher and so on) are expert based question and answer services. They use networked

communities of experts to answer questions via the Internet. AskA services have been

extremely popular on the Internet, and have given rise to a separate set of issues concerning system development and scalability.

While these two lines of examination began in isolation, the author argues that the lines have effectively merged into a single research domain. While the practice of AskA services and the practice of libraries may still be somewhat distinct, their differences tend to be about staffing, business models and marketing. In terms of their core questions, there is an emphasis on common themes and both should find their issues addressed in this article.

Domain Linkages

Fields with a strong link to digital reference may be defined in pragmatic and opportunistic terms. A strongly aligned field is one where a clear linkage or application of research results has been demonstrated (such as digital libraries) or one where core theory is essential for examination of digital reference research questions (such as systems theory). The author places digital reference in the context of six domains of inquiry:

Domain 1: Digital Libraries

Collier (National Science Foundation, 2003) defines a digital library as "a managed environment of multimedia materials in digital form, designed for the benefit of its user

population, structured to facilitate access to its contents, and equipped with aids to navigate the global network ... with users and holdings totally distributed, but managed as a coherent whole." Pomerantz, in his paper, sees the domain of digital libraries to be focused primarily on the process, tools and theories in collections of digital materials. Recent digital library efforts, most notably the National Science Foundation's National Science Digital Library (NSDL) are operationalized as a set of distributed collections of resources with an available set of services that provide functionality (at its most basic access to the resource) and context to the collections. In this framework, digital reference can be seen as a service available to builders and users of digital libraries.

Digital reference draws from and influences digital library research. Certainly fundamental digital library concepts such as metadata, networked information discovery & retrieval, and protocols have been adopted in digital reference (see [NISO 2003] and Pomerantz). Recent history seems to indicate that digital reference concepts are also having an impact on digital libraries. This includes the adoption of digital reference as a core service of the NSDL as well as the subtle re-definition of digital library as a set of collections and services operating virtually in parallel, and the notion of a digital library as a set of resources accessed through services (from simple browsing services to complex visualization services). Discussions of this impact have happened within NSDL and as a result of the introduction of so-called web services architectures.

Domain 2: Information Retrieval

The World Book Dictionary defines information retrieval (IR) as "the science that is concerned with the gathering, manipulation, classification, storage, and retrieval of recorded knowledge." Operationally, information retrieval research has focused on the use of inherent textual and/or media elements of documents for location and manipulation. IR has also been solely concerned with the automation of this process through the use of software algorithms. Certainly there are strong parallels between the fields of IR and digital reference. The difference between IR and digital reference has already been explored under the central question of digital reference (specifically the inclusion of human expertise). However, much of the intermediation provided by digital reference requires the use of IR tools, and therefore these fields are closely akin. In addition, a portion of the digital reference literature (primarily using the "Systems Lens" outlined previously) is devoted to appropriate levels of automation. That is to say, while digital reference is founded on the principle of human intermediation (versus IR's focus on computer mediation), many researchers are attempting to isolate the unique human contribution to the system and use computing to handle repetitive or programmable functions within a digital reference system.

Domain 3: Reference and Library Science

As previously discussed, digital reference is closely aligned to library science and the practice of reference. Certainly, key concepts in reference research can be brought to bear on digital reference. Most notable of these concepts are question negotiation (Taylor, 1968) and open-ended questioning (Dervin). The existence of an open approach is one of

the strong differences between digital reference and traditional closed systems such as help desks and customer support systems.

There is also some guidance from library science practice and evaluation. RUSA's Behavioral Guidelines (RUSA, 1996) provide a template for the development of new online behavioral norms and studies. Likewise, library evaluation (Hernon and McClure, 1986) has already provided the basis for research in the digital reference environment (McClure et. al., 2002).

Domain 4: Computer Mediated Communication

Some groundbreaking work on digital reference in a multi-modal reference environment has been done using Computer Mediated Communication theory (Southwick, 2001). Southwick's study looks at digital reference within the broader concept of computer mediated communication, with reference intermediation as a special case of guided communication (versus free-form conversation). The author believes the expanding view of digital reference as a means of either communication or help will prove ripe for exploration and research.

Domain 5: Systems Theory

 Significant work has been done to date to tie digital reference to systems theory. This includes special cases of systems such as complex systems (Lankes, 1998). Much more

work can be done to look at subsets of the digital reference system. For example, research is already underway (Croft, et. al. 2002) on the use of complex inductive techniques to model expert profiles in digital reference. Similar approaches deserve investigation particularly in the areas of digital reference knowledge bases and routing systems.

Domain 6: Education

Education, as stated in Lankes, has been a widely supported arena for digital reference service. However, there is much work to be done to tie digital reference practice to education theory and evaluation. For example, can inquiry-based learning take advantage of digital reference research to improve learner performance? Can digital reference research help in a constructivist paradigm?

Ties to other fields are either self-evident, or have been identified as existent. For example, Janes (2000) examined digital reference as a social and behavioral activity by studying librarians attitudes concerning digital reference. Linkage of digital reference research to the fields of economics, psychology and law also present opportunity.

An Initial Digital Reference Research Framework

Taken as a whole, the question components, assumptions, conceptual lenses and domain linkages allow the author to present an Initial Digital Reference Research Framework. This framework maps out an initial set of investigations concerning digital reference. is

the author assumes this framework will be both augmented and revised as more work is done. The initial framework is seen in figure 2
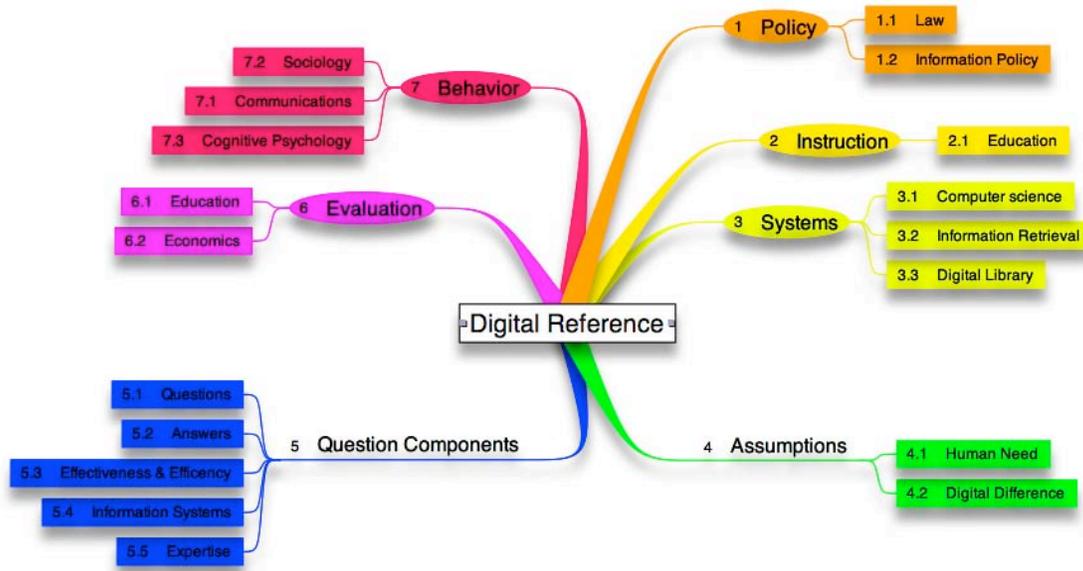


**The Research Agenda**

In previous sections of this article, the author created a map of ideas and relationships in digital reference. The ideas and relationships represent the intellectual effort of synthesis. They synthesize what is currently known and searched for in digital reference research. In this final section, the author will list identified research questions. The questions are derived from issues identified at the digital reference research symposium and from the general field of digital reference (primarily through the DIG_REF Listserv and the annual Virtual Reference Desk conferences). The following research questions are meant to be answerable relatively short term (i.e., achievable with data and systems already in place),

operationalizable.  They are sub-questions of the primary research question in digital

reference: how can human expertise be effectively and efficiently incorporated into

information systems to answer user questions?


The research questions are organized into a matrix drawn from the framework outlined

previously. While domain interconnections are not explicitly stated,  the author assumes

that these domains will aid in the determination of methodology, reporting, and

potentially theory development.

**Table 1: Research Agenda Matrix - Organized by Question Component and Conceptual Lens**

| | Policy | Systems | Evaluation | Behavior |
|---|---|---|---|---|
| **Human Expertise** | | | | |
| The Value of Human Expertise<br>What does a user and/or system gain by the inclusion of human expertise and mediation? | What level of staff expertise and training is required to provide high quality digital reference services? | How can the output of digital reference be incorporated into digital collections? | What are the perceived values of human expertise by the users (e.g., familiarity of a human voice, content expertise, process expertise, instruction)? | Do users phrase questions differently when they know a human intermediary is involved? |
| The Functions of Human Expertise<br>What is the scale and scope of human involvement in digital reference services? | | What is the relationship of question answering to other roles such as knowledgebase construction? | How are non-question answering functions of human expertise measured and evaluated? | |
| **Efficiency and Effectiveness** | | | | |

|  | **Policy** | **Systems** | **Evaluation** | **Behavior** |
|---|---|---|---|---|
| Cost<br>What is the cost of human expertise in digital reference system? | What are the limits to service provided to the users (e.g., providing answers versus citations)? What are the methods for determining these limits (e.g., are these limits context dependent, or universal to digital reference services)? |  | What are the metrics and standards needed to evaluate costs in digital reference? What factors must be considered in a cost equation (e.g., staff time, resource expense)?[1] Do these measures change with the digital reference setting (e.g., library, AskA) or scale (e.g., local settings versus consortium services)? | Does the knowledge of cost effect use of the system (e.g., are users willing to pay for digital reference services)? How can a digital reference market or service assign cost to a question a priory (i.e., before a question is answered)? |
| Benefits<br>What are the benefits of human involvement in digital reference systems? |  |  | What are the metrics and standards needed to evaluate benefits in digital reference (e.g., return use, satisfaction)? |  |
| Value<br>What is the necessary level of value demanded by users in digital reference systems? |  | What level of automation can be brought to bear in digital reference services? |  | Can users make value judgments in digital reference services? |
| Information Systems |  |  |  |  |

|  | **Policy** | **Systems** | **Evaluation** | **Behavior** |
|---|---|---|---|---|
| System Components<br>What is the proper configuration of technologies and resources to produce a required output? | What policies are needed to ensure the appropriate use of digital reference systems? How can digital reference systems be constructed to protect individual privacy, and licensing while achieving maximum benefit for an intended community? | What are the required components of a digital reference system? | What are appropriate performance metrics for system evaluation? | How do experts and users interact in a digital reference system? What is the needed skills and training for digital reference system acquisition? |
| System Models and Architectures<br>How can digital reference systems be represented and conceptualized? | | Is there a single high-level architecture that represents both real-time and asynchronous systems? What is the value of inductive versus deductive system construction? | | |
| Interoperability<br>How can digital reference services find and ensure proper levels of interoperability? | What policies and policy instruments are need for service collaboration? | What technical standards are needed to ensure service interoperability (e.g., NISO Networked Reference Committee[2])? | | |
| Questions | | | | |

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[2] See http://www.niso.org for more information

| | Policy | Systems | Evaluation | Behavior |
|---|---|---|---|---|
| Questions as Input<br>What is the nature of user input to a digital reference systems? | | Are there identifiable taxonomies of questions? Do these taxonomies provide functional and computational power in digital reference systems (e.g., for automatic question routing)? | Do questions to a digital reference service qualitatively change in nature over time (e.g., become harder, or more synthesis oriented)? | What digital aids can be provided to users to better phrase their information need? |
| The Reference Interview[3]<br>What is the role of the reference interview in digital reference? | | How do digital reference systems best illicit the information need of users (e.g., through human-to-human reference interviews, web forms, or serial e-mail)? Does this method change based on information need? | What is the current state of practice in digital reference question negotiation?<br>What are the best indicators and measures of success of the reference interview? | |
| Answers | | | | |
| Satisfaction<br>What set of information and in what form can that information be bundled to satisfy an information need? | What policies are needed to bound answer types in a service (e.g., copyright)? | How can systems automatically match user questions to appropriate answer types? | What measures are needed to evaluate "right" and "wrong" answers in digital reference? | What are the necessary components of an answer needed to met a user's information need? |

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[3] It has been a longstanding practice of librarians to conduct an interview constituted of a series of open and closed ended question to identify the compromised information need (cite Taylor). In a digital environment, some services have attempted to replicate this human-to-human exchange in so-called real-time systems. Other services, primarily asynchronous services, have sought to replicate this process through the use of web forms or iterative e-mails.

This matrix is far from complete. It represents an opportunistic view. Empty cells do not represent a lack of research potential, but rather a lack of immediately identifiable research projects. The author assumes this matrix will change over time as some research questions are answered and new questions are identified. The author hopes this matrix can be converted into a sort of road map, where researchers will fill in the cells with citation and data as digital reference research proceeds.

**Conclusion**

In this article, the author has drawn a map of uncertain terrain. It is a map of existing concepts and work in digital reference, and contains the fuzzy borders to the broader world of information and computer science. The map is a first step to the understanding of digital reference at a deep and fundamental level. While it does not provide an answer to Arms thought experiment, (What question did that "digital reference scholar" answer that was fundamental enough to define a field, and powerful enough to be recognized as significant beyond the field of digital reference?) it does set a starting point for reaching the answer to that question..

Digital reference is important. We know that based on the millions of questions information seekers send to digital reference services, and on the thousands of hours of work digital reference answerers spend to answer those questions. Digital reference is a

phenomenon that is firmly rooted and ever expanding in practice. It is vital that the research community keep pace with practice and bring its unique perspective to the field. Without careful, patient and thoughtful examination of digital reference by scholars and action researchers, practice will continue to evolve without full realization of the contributions and implications of research.

The time has come to put digital reference to the test. There are two questions in this test. 1. Does digital reference improve the information lives of its users? 2. Can the research community aid practice? The answer to the first question we hope is obvious. The second question is more political in nature. It reflects not only the continued tension between doing and understanding, it also touches at the often times tense relationship between practice and research. If the research community ignores the trends and resource allocation of practice (both in libraries as well as in the digital library communities), it will find itself marginalized. Such a split between practice and research hurts both.

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