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TITLE: Impact and Opportunity of Digital Reference in Primary and Secondary Education

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PUBLICATION TYPE: Proceeding

DATE: July 15, 2002

FINAL CITATION: Impact and Opportunity of Digital Reference in Primary and Secondary Education. Lankes, R.David (2002). Commissioned white paper for the digital reference research symposium held at Harvard University

KEYWORDS: Research, K-12 Education, digital reference, Harvard, symposium, education

Impact and Opportunity of Digital Reference in Primary and Secondary Education

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Public Draft July 15, 2002

ABSTRACT

This white paper examines the domain of digital reference services for and by the primary and secondary education community. It begins by placing education digital reference services (later divided into library-based digital reference services and AskAs) into the larger context of digital libraries and digital reference services in general. It presents a wide range of models for examining digital reference services as well as providing exemplary services in the education domain. Data is provided to demonstrate the current understanding of education question types and education users in digital reference. Finally issues and future research areas are discussed.

Introduction

This white paper seeks to frame the research discussion in digital reference in primary and secondary education. As a general note to the reader, primary and secondary education refers to formal education of youth, normally in the age range of 5 to 18. In the U.S. Education system, this is often referred to as K-12 education as it covers Kindergarten through 12th grade. These grade levels vary internationally and are also called elementary and secondary education. The point is the basic and mostly mandatory education of the youth before they enter the work force or optional post-secondary education in universities and colleges.

This white paper also seeks to explore this discussion at the intersection of digital reference and digital libraries because, the author argues, digital reference is a particularly powerful tool for the building and maintaining of digital libraries, particularly in the field of primary and secondary education where a great deal of this work has been done.

The paper generally follows the outline proposed in the Digital Reference Research Symposium overview (<http://quartz/symposium/Overview.htm>) organizing itself around:

- **Scope:** specifically defining the issue and area under investigation, in this case digital reference in primary and secondary education. This will be accomplished by using the Lankes/Sutton model of Education Information Infrastructure (EII) to place digital reference in the context of digital libraries, and then using the General Digital Reference Model to present a clear picture of digital reference and

finally a new scheme of the primary and secondary stakeholders and their needs in a digital library environment.

- Current State of the Art: providing a picture of key projects in digital reference and education¹. These projects will not only provide the current thinking and work in education digital reference, but, the author feels, will also provide invaluable research environments for ongoing research based on the expected research agenda.
- Issues and Challenges that Need to be Addressed: will specify generally unique issues research will need to either focus upon, or take into account when studying digital reference in education. These issues are drawn from a wide range of inputs, not simply within the current digital reference literature and development work. They take into account general policy and legal issues, primarily within the US, that education information researchers have encountered.
- Recommendations for Future Research: proposes specific items for a digital reference research agenda. These build upon the previous section and attempts to lay out specific research questions, environments and methods.

The goal of the author is to present what is known and what needs to be known in order to prompt future research in this area. It is certain that some work has been missed in the writing of this document. The author's intention was not to be comprehensive, but rather to present a broad survey with special attention to the large scale and high-impact. Certainly this white paper draws heavily from the author's own work and background. Once again, this is not to downplay other's contributions, but is a reflection of the lack of wide scale scholarship in digital reference for education.

It is clear that primary and secondary education is a crucial environment for examination in digital reference. Not only due to the high priority service to students and young learners have in our cultures, but also in the advanced nature of their work. Digital reference, and digital library work in general has seen great advances in the education domain. Projects such as the National STEME Digital Library (NSDL) and AskERIC have garnered large resource bases, and have either generated a great deal of generalizable knowledge, or synthesized digital library work from a wide range of efforts. Put simply, the education domain presents a revelatory case rich with experimentation and development.

Scope

This white paper addresses the general topic of digital reference, as a specialized digital library service, targeted to the primary and secondary education domain. This statement of scope has three components: digital libraries, digital reference and primary & secondary education. There are two ways to present the relationship among these concepts. The first is to see the components as separate with areas of overlap. Each has a body of literature, colleagues, practice and history, however, all have common aspects of use and implementation. For example, while digital reference has its history clearly from

¹ Unless otherwise stated, education here will refer to primary and secondary education, also known as K-12 education in the United State of America

the domains of library practice and AskA services as opposed to the large computing science influence in the digital library community, both seek to serve users' information needs via digital networks. Both embrace the concepts of services and collections, and both often use common terminology and metaphors. Certainly primary and secondary education has a rich and long standing research tradition and has a preponderance of non-digital issues. Yet education too overlaps with digital libraries and digital reference in accessing digital information, and the ongoing efforts to incorporate information technologies into the classroom (and to use information technology to extend education far beyond the traditional classroom). Figure 1 seeks to present a thumbnail of these sets of relationships.

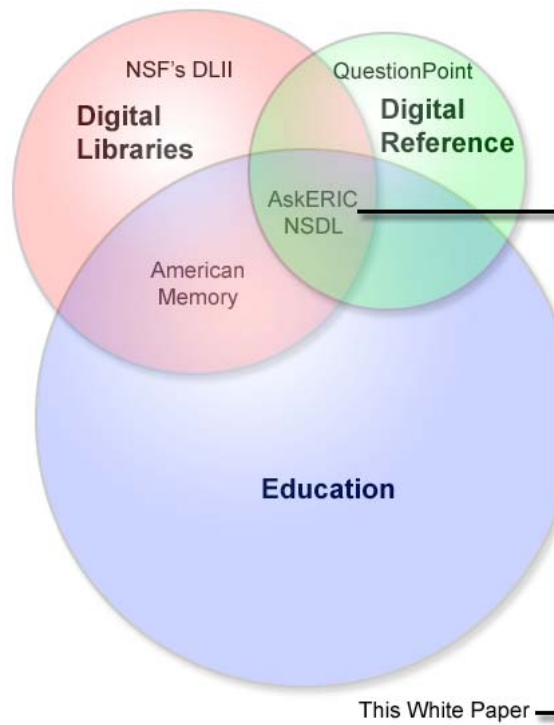


Figure 1: Setting the Scope of the White Paper

For the purposes of this white paper, and to coincide with the overall purpose of the symposium, the author will present these three components – digital libraries, digital reference and education – in a second way, as a hierarchy. Digital library is the largest concept encompassing services, collections and interfaces. Nested within digital libraries is digital reference as a specific type of service offered by the digital library. At the most concrete and highly resolved level is digital reference for education where not only is the service type defined, but the audience is as well. This hierarchical view is seen in figure 2.

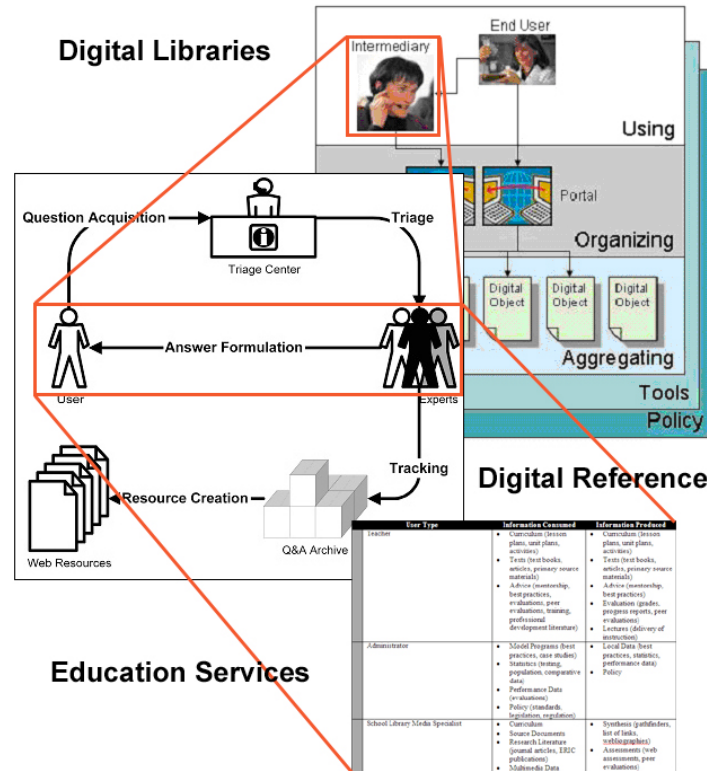


Figure 2: A hierarchical View of Educational Digital Reference Services and the Models used in this White Paper

By using a hierarchical approach it will be easier to familiarize diverse audiences with the relevant issues in digital libraries, digital reference and education in all three fields. This is simply a rhetorical tool, and not intended to dismiss work in any of the three areas as unimportant. The author begins with a definition and model of digital libraries.

Defining Digital Libraries

The NSF cites Collier's (1997) in defining 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.

While this definition emphasizes materials and collections, it also calls for a variety of services to "aids to navigate." This definition is also intentionally broad. In order to provide greater specificity for the reader, and to better orient the reader in the hierarchical approach used in this white paper, a more specific framework of a digital libraries is adopted from Lankes and Sutton's discussion of an emerging Education Information Infrastructure (Lankes and Sutton, 1999). The framework consists of five distinct core functions of the EII (analogous to a digital library): (1) aggregating, (2) organizing, (3)

using, (4) tool building, and (5) policymaking. The first three functions represent the core of the digital library infrastructure that connects users with needed resources. The last two functions may be viewed as enabling functions without which a fully operable digital library is not possible. The remainder of this section will describe the parts of this framework.

Aggregating

Aggregating is defined as “bit bucket” or digital repository that is agnostic towards file format, document purpose, or organizational scheme. The digital repository simply stores digital objects for use by some third-party agent. One could use the analogy of a computer hard drive, where it stores hundreds of different files (word processing documents, music, programs), as a set of 1’s and 0’s.

Organizing

Organizing is the creation of context, or creating a higher level, abstract view of the information stored in a repository. Where the repository is simply a collection of digital objects with no inherent structure, an organizer imposes some structure, or broadly, a point of view, on the objects. As Lankes and Sutton (p. 174) state, “the organizing function can be likened to the organizational functions of the traditional library—albeit a library that contains only metadata (data about data) and no primary resources.”

Using

Using is the application of some digital information or object, as housed in a repository and organized by some service or agent, to a given situation. Lankes and Sutton (p. 175-6) describe two aspects of information use:

- “(1) direct end-user information discovery and retrieval of educational materials through one or more of the mechanisms of organization, and
- (2) indirect information discover and retrieval performed for the end-user through digital agency.”

Digital agency is a form of intermediation by an automated agent or information consultant, such as a reference librarian or topical expert.

Tool Building and Policymaking

The enabling factors in the framework are tool building and policymaking. Tool building is “the design, development, and deployment of the enabling technologies for aggregating, organizing and using” (Lankes and Sutton, p.177). These tools can be “soft,” such as metadata and organizational schema, or “hard” such as code or hardware access devices. Policymaking is a human process for developing rules and guidance for building, maintaining and using the digital library. This framework is represented in figure 3.

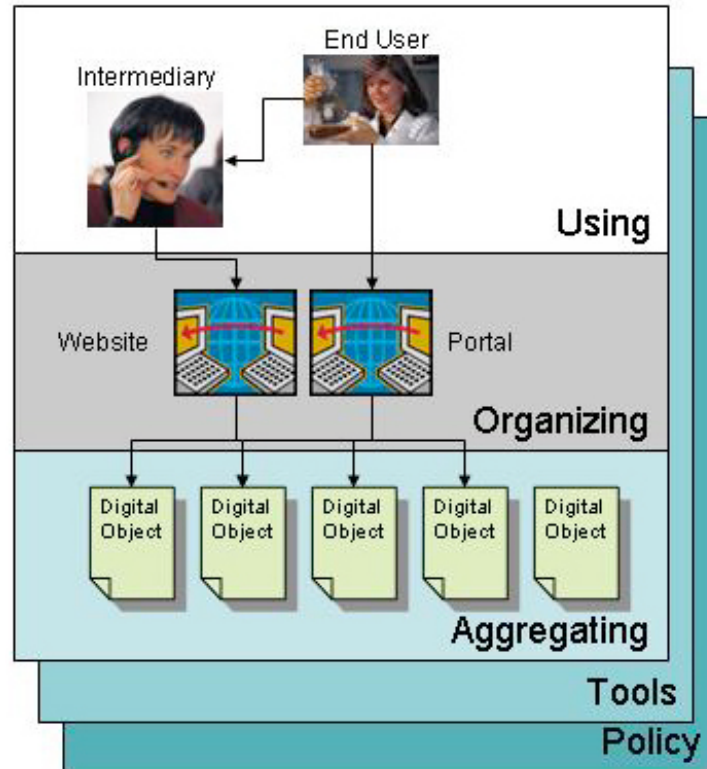


Figure 3: Lankes/Sutton Model of EII

While the Lankes/Sutton Framework acknowledges the existence of digital agency, little more than examples are presented to define the method of digital agency, or the interplay between digital agency and other components of the framework such as aggregation and organization. The next section explores one means of digital agency, digital reference.

Digital Reference as Digital Agency within the Framework

There will no doubt be many means of “indirect information discover and retrieval” in digital libraries. A great deal of work has been conducted on the research and development in agent technologies. These “intelligent agents” are seen as software programs that can scour a digital library’s resources searching for material of interest to a given end-user or situation. Of particular interest in this context is the use of human intermediation. The use of human agents in a digital library is digital reference.

Digital reference refers to a network of expertise, intermediation and resources put at the disposal of a person seeking answers in an online environment. The field of digital reference touches on metadata issues, human intermediation in a networked environment and quality determinations of networked resources. Some of these issues are shared with the field of digital libraries, yet little work has been done to bridge these two areas of investigation. Digital reference has remained primarily the province of practicing librarians and educators, while the digital library community has maintained strong roots in computer science and information retrieval.

It is important for the digital library community to work closely with the digital reference community. The use of human intermediaries within an information system is more than simply a tradition in the library world. Reference, particularly the ability to talk with information professionals, is seen as a core function of a library. Years of practice have shown the need for human-to-human communication to help a user identify an information need and the most appropriate resources to answer those needs (Mardikian and Kesselman, 1995). According to the Library and Information Technology Association (LITA), a division of the American Library Association, putting a human face on the virtual (digital) library is a key need (LITA, 1999).

“It's time to put a human face on the virtual library. What's the crucial factor in the success of the nonvirtual library? The people who work there and serve the user! What do libraries emphasize on their Web sites? Resources, collections, facts with no human guidance or presence! On many library Web sites, the user is hard-pressed to identify the staff, whose names, if they're there, are five levels down. The human factor is still important.”

The question in the LIS community is no longer whether to provide reference services in a digital environment, or human intermediation services on the Internet, but how to best provide such services.

Digital Reference Background

The digital reference field has two progenitors. The first is in traditional 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.

Library Reference

Digital reference as an examination of the librarian's role in a digital environment began with e-mail reference efforts. These efforts extended the traditional core reference function of the library past the reference desk to the desktop. Users were able to ask reference questions and consult with trained librarians through e-mail. Still & Campbell (1993) provide an excellent example of early e-mail reference studies. This thread of digital reference concerns issues such as the role of the librarian in cyberspace, the impact of distance service on the traditional reference interview, evaluation (McClure and Lankes, 2001), and new skills needed by the information professional (Mardikian and Kesselman, 1995).

AskA Services

The second progenitor to the current digital reference arena is that of AskA services (Lankes, 1999c). 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.

Current Issues in Digital Reference

As previously stated, some issues are common to both the digital library community and the digital reference community. For example, in the area of metadata and standards for interoperability both fields share related approaches to the issues of joint services and information re-use (for a discussion of metadata in digital reference see Lankes (1999a)). Certainly questions of intellectual property and re-use of digital products are common to both digital libraries and digital reference. Technology approaches, repositories, and all manner of networking resources are also common concerns. Some aspects of digital reference, however, are unique. These aspects center on the inclusion of human expertise (be it process expertise typified by the librarian, or subject expertise typified by the AskA expert) into information systems.

The author identified two issues that are specific to digital reference in the book “Digital Reference Service in the New Millennium: Planning, Management, and Evaluation” (Lankes, et. al 2000). They are:

- Scalability - how can a digital reference service grow (scale) to handle a large number of questions given that traditional scaling mechanisms such as service hours and geographical constraints run counter to users expectations on the Internet?
- Ambiguity – how can digital reference services identify a priori the amount of context and human intermediation needed to meet a user’s needs?

These issues are related (e.g.: by better identifying low-context questions, less human resources need be applied and more users can be served). These two issues are addressed in systems built and discussed by Janes (2000), and Kresh (2000).

Other issues being explored in the digital reference community relate to the transition from traditional in-person services to at-a-distance processes. These issues include quality measures for digital reference, the nature of the reference interview, real-time versus asynchronous intermediation, media selection in digital reference, and economics of human intermediation.

The General Digital Reference Model

Once again the previous sections present a broad definition of digital reference. In an attempt to provide more specificity for the white papers hierarchical approach, a more specific model of digital reference is presented.

The digital reference model, pictured in Figure 4, is a general process model developed through an empirical study of high-capacity digital reference services, primarily in the math/science area (Lankes, 1999b).

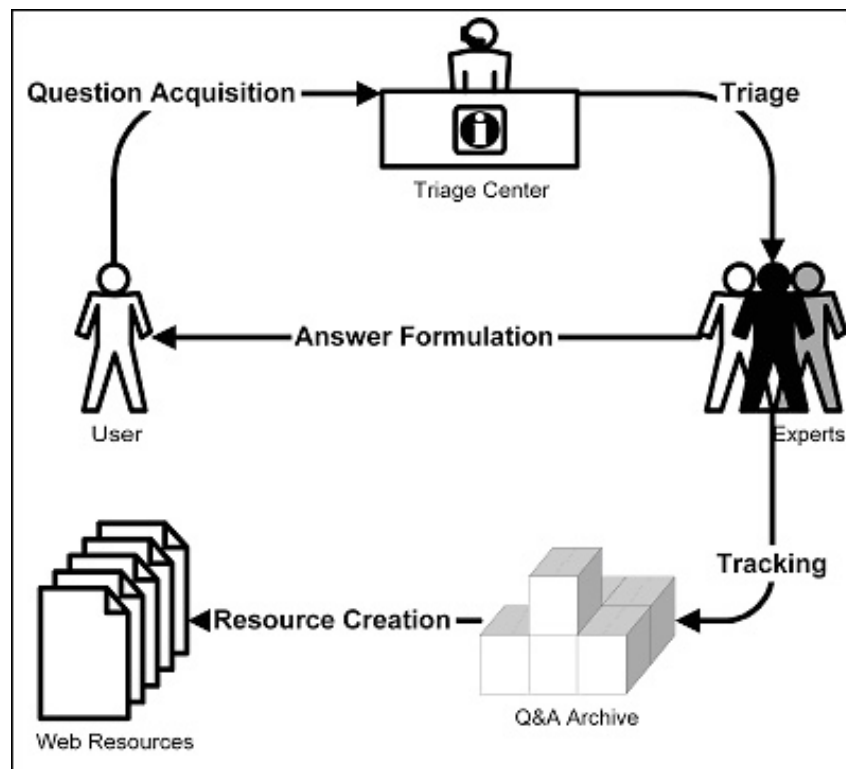


Figure 4: General Digital Reference Model

The model consists of 5 steps:

1. Question Acquisition is a means of taking a user's questions from e-mail, web forms, chat, or embedded applications. This area of the model concerns best practice in "online reference interviews" and user interface issues.
2. Triage is the assignment of a question to a process or topic expert. This step may be automated or conducted via human decision support. Triage also includes the filtering of repeat questions or out of scope questions.
3. Experts Answer Formulation details factors for creating "good" answers such as age and cultural appropriateness. Answers are also sent to the user at this point.
4. Tracking is the quantitative and qualitative monitoring of repeat questions for trends. Tracking allows the creation "hot topics", and may indicate where gaps exist in the collection(s).
5. Resource Creation concerns the use of tracking data to build or expand collections and better meet users' information needs within and outside of the digital reference process.

Every digital reference system uses this simple model. The important question, however, is how efficiently and effectively can the digital reference model be automated to deal

with ambiguity and scalability in a distributed environment? The concern of this paper is when the user represented in this model is either a member of the primary and secondary education community (a teacher, students, etc.) or is interested in access to expertise about primary and/or secondary education (represented by either the “Experts” or the “Web Resources” in the model).

Digital Reference for Primary and Secondary Education

There are several ways to represent the education community: topically, by education level, role, or even geography. In an attempt to be inclusive of the entire community, and to maintain a focus on digital reference, the author adopts concepts presented as part of the “sharium” put forth by Marchionini (1999) in which he states that populations will not simply be users of digital libraries, but consumers as well. In this view any given community would give information as well as take resources. This creates the basis of a matrix to model the education community: member of the community, what they consume (take from a digital library for application in their particular context) and what they produce (move from their given context to the larger digital library and community).

In the following table, users are matched to the information they either consume or produce. The user types are a simple taxonomy broken into:

- **Professional Population:** this class includes the paid staff of an educational institution whose purpose is to deliver education content or their equivalent (such as a parent who home schools).
- **Student Population:** this class covers members of the education community who are primarily receiving education information.
- **Affiliated Population:** these are stakeholders who are indirect users and beneficiaries of the primary and secondary education system. They include parents/guardians who are tasked with ensuring youth learn, as well as education researchers who study the education system. Also included is the higher education community that draws from the primary and secondary student population as well as prepare the education professional population.

User Type		Information Consumed	Information Produced
Professional Population			
	Teacher	<ul style="list-style-type: none"> • Curriculum (lesson plans, unit plans, activities) • Texts (text books, articles, primary source materials) • Advice (mentorship, best practices, evaluations, peer evaluations, training, professional development literature) 	<ul style="list-style-type: none"> • Curriculum (lesson plans, unit plans, activities) • Texts (text books, articles, primary source materials) • Advice (mentorship, best practices) • Evaluation (grades, progress reports, peer evaluations) • Lectures (delivery of instruction)

User Type		Information Consumed	Information Produced
	Administrator	<ul style="list-style-type: none"> • Model Programs (best practices, case studies) • Statistics (testing, population, comparative data) • Performance Data (evaluations) • Policy (standards, legislation, regulation) 	<ul style="list-style-type: none"> • Local Data (best practices, statistics, performance data) • Policy
	School Library Media Specialist	<ul style="list-style-type: none"> • Curriculum • Source Documents • Research Literature (journal articles, ERIC publications) • Multimedia Data 	<ul style="list-style-type: none"> • Synthesis (pathfinders, list of links, webliographies) • Assessments (web assessments, peer evaluations)
	Counselor	<ul style="list-style-type: none"> • Career Data (job availability, career trends) • Higher Education Data (entrance requirements, school rankings) • Research Literature 	<ul style="list-style-type: none"> • Synthesis • Trend Data (student performance, career choice, alumni data)
	Specialist Educator	<ul style="list-style-type: none"> • Training (topical education for technology, special education, etc) • Best Practices 	<ul style="list-style-type: none"> • Best Practices • Assessments
Student Population			
	Primary Student	<ul style="list-style-type: none"> • Lessons (activities, online activities, simulations) • Fiction (story books, educational television) • Primary Source Material • Texts 	<ul style="list-style-type: none"> • Projects (multimedia materials) • Fiction
	Secondary Student	<ul style="list-style-type: none"> • Lessons • Nonfiction (biographies, histories) • Higher Education Information (college brochures, school rankings) • Primary Source materials • Texts • Evaluations (tests, assignments) 	<ul style="list-style-type: none"> • Projects • Papers • Fiction • Field Data • Synthesis

User Type	Information Consumed	Information Produced
Gifted Student	<ul style="list-style-type: none"> • Enrichments (further readings, college courses) • Lessons • Nonfiction (biographies, histories) • Higher Education Information (college brochures, school rankings) • Primary Source materials • Texts • Evaluations (tests, assignments) 	<ul style="list-style-type: none"> • Projects • Papers • Fiction • Field Data • Synthesis • Advice
Special Education Student	<ul style="list-style-type: none"> • Added Assistance (tutoring) • Lessons • Nonfiction (biographies, histories) • Primary Source materials • Texts • Evaluations (tests, assignments) 	<ul style="list-style-type: none"> • Projects • Papers • Fiction • Field Data • Synthesis
Affiliated Population		
Education Researcher	<ul style="list-style-type: none"> • Statistics • Case Studies • Research • Professional Produced Materials (curriculum resources) • Student Produced Resources • Evaluations • Peer Assessments 	<ul style="list-style-type: none"> • Research Results (articles, data sets, lectures) • Research Tools (methodologies, apparatus) • Assessments • Advice
Parent/Guardian	<ul style="list-style-type: none"> • Assessments (school performance data, teacher performance data, student performance data) • Curriculum (assignments, topics) • Texts 	<ul style="list-style-type: none"> • Advice • Assessments
Pre-Service Educator	<ul style="list-style-type: none"> • Curricula • Texts • Assignments • Research 	<ul style="list-style-type: none"> • Assignments
Higher Education Teacher	<ul style="list-style-type: none"> • Case Studies • Curriculum • Statistics • Research 	<ul style="list-style-type: none"> • Case Studies • Curriculum • Statistics • Research

User Type	Information Consumed	Information Produced
Policy Maker/Government	<ul style="list-style-type: none"> Statistics Best Practices Assessments 	<ul style="list-style-type: none"> Policies (law, regulation, rules)
Public Librarian	<ul style="list-style-type: none"> Source material 	<ul style="list-style-type: none"> Synthesis
Business Community	<ul style="list-style-type: none"> Assessments Statistics 	<ul style="list-style-type: none"> Assessments
Media	<ul style="list-style-type: none"> Best practices Statistics Research Synthesis 	<ul style="list-style-type: none"> Synthesis

This list is not meant to be exhaustive, but rather to demonstrate major information types and a manner of modeling the education community. It also demonstrates that the members of the education community can not only be users of digital reference services (such as users of AskERIC discussed below), but providers as well (as evidenced by KidsConnect discussed below as well). Issues examined in this white paper and later research must take this dual role of consumer and producer into account.

Current State of the Art

In order to present a picture of digital reference for education, the author first presents two major types of services in the education domain. Each type is then illustrated with an exemplar service.

Types of Digital Reference Services in Education

Taken from the previous discussion of digital reference progenitors there are two obvious, though often overlapping, categories of digital reference services in education: library-based services and AskA services. The author further divides the AskA services into general services that may be of use to the education community as part of a more general mission (such as Ask Joan of Art that answers questions concerning American art for anyone who asks, but is particularly useful in art education) and services targeted squarely at the education community (such as AskERIC, though it covers all levels of education including higher and continuing education). The author will concentrate on education AskA services for this paper.

Library Reference

For the purposes of this whitepaper “library reference” refers to digital reference services either centered in a public, academic, school or special library or with primary reliance on library programs. With the advent of digital reference a great number of libraries are now offering reference service to remote patrons (Janes, 2000). These services take a variety of forms from e-mail systems, to real-time chat systems. In the library context digital reference is referred to as virtual reference, e-reference, networked reference, live reference, online reference and even chat reference. While some in the community make a distinction in the mode of delivery and the synchronous nature of the service offered, most agree that these are all part of a single larger concept of digital reference.

The library reference community also provides the most in-depth discussion of policy, evaluation (McClure and Lankes, 2001) and the largest set of documented digital reference services (as opposed to the body of systems and development work out of the AskA community discussed later). Much of this work is encapsulated in the proceedings of the annual Virtual Reference Desk Conferences (Virtual Reference Desk, 2002) that has a strong library emphasis. In fact, this paper and the larger symposium was an outgrowth of this conference and work.

As a result of this intense interest in digital reference by the library community there are several large-scale digital reference projects available to the research and scholarly community for examination. The Collaborative Digital Reference Service (CDRS) spearheaded by the Library of Congress that has evolved into the QuestionPoint service run by OCLC in cooperation with the Library of Congress certainly demonstrates the breadth of library-based digital reference services spanning public, academic and international libraries. The National Library of Canada's recent introduction of Virtual Reference Canada to work with Canadian digital reference services also promises to be a major source of digital reference activity and development. Other prominent digital reference efforts in the library world include KnowItNow from the Cleveland Public Library, the 24/7 Reference service that acts as a statewide digital reference network for the State of California, and the recent efforts of the State Library of Washington. Also of interest to researchers in digital reference are digital reference vendors in the library domain including LSSI's Virtual Reference Service. One special case that should not be overlooked is the Internet Public library, for while it is not based in a library setting (it is part of the School of Information at the University of Michigan), it has its roots and traditions firmly planted in the library community.

Library Reference Exemplar: KidsConnect

While many library services that serve the education community (of course academic libraries serve a higher education population and public libraries answer questions of students), few target primary and secondary education exclusively. One exception is the KidsConnect service. KidsConnect is a question-answering, help and referral service to K–12 students on the Internet (KidsConnect, 2002, see also Bennett, 1998). It is a project of the American Library Association's American Association of School Librarians (AASL). It has three missions. The first is to educate school library media specialists in the use of the Internet and digital reference as part of the larger ICONnect project. The second is to promote information literacy in students through digital reference (Mancall et. al, 1999). The third is to promote local School Libraries (and school library media specialists) as valuable sources of information and instruction.

The KidsConnect model uses a large number of volunteer school library media specialists (primarily in the United States). Each volunteer is trained using an in-depth mentoring process, then answers questions (ranging from 1 a day to 1 a week). The service is targeted at the primary and secondary student population. The digital reference transaction is conducted through email and web forms.

Data from the KidsConnect service provides valuable insight into the types of students using digital reference services and the types of questions they ask. The service has been widely advertised to schools and teachers as well as school library media specialists. This advertising has been done through the professional association for school library media specialists (AASL), as well as through the Internet. It is generally available.

The data presented is from 1996-1998, however, recent data (following) will be used to estimate the current validity of these numbers.

Figure 5 shows the number of questions answered by KidsConnect for the years 1996-1998:

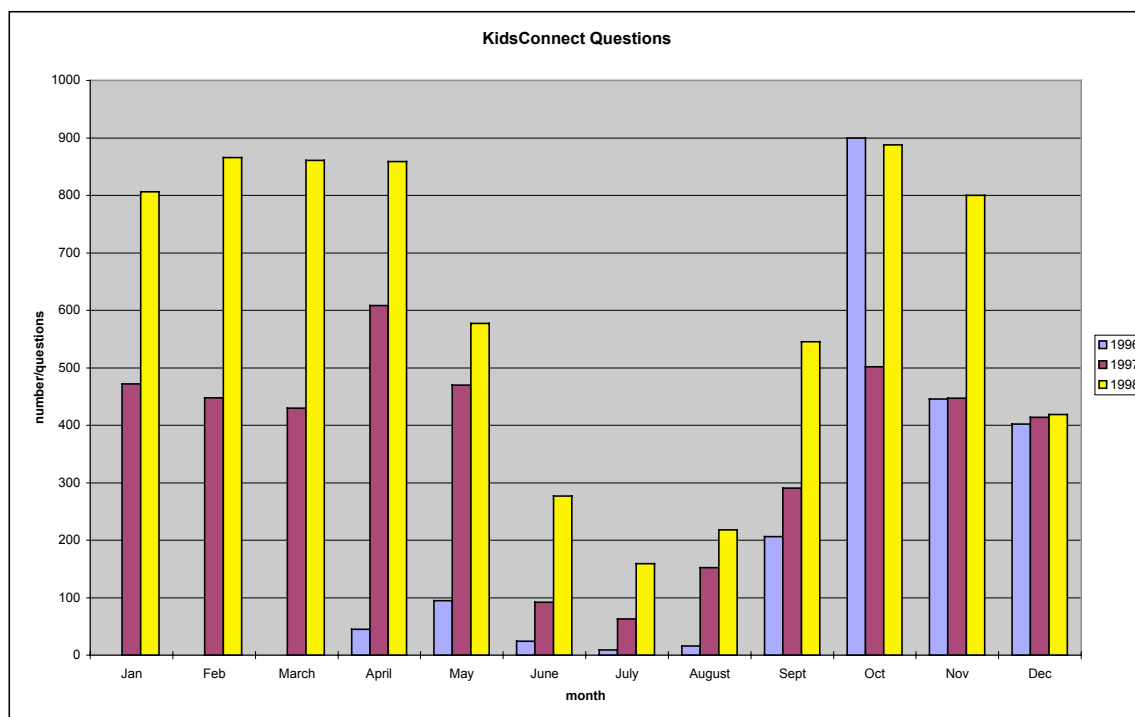


Figure 5: Number of KidsConnect Questions

These numbers are very much inline, though on the high end, with current numbers of library-based digital reference services as reported at recent library meetings including the annual American library Association's Conference.

Figure 6 shows how these questions were distributed across differing student and adult populations:

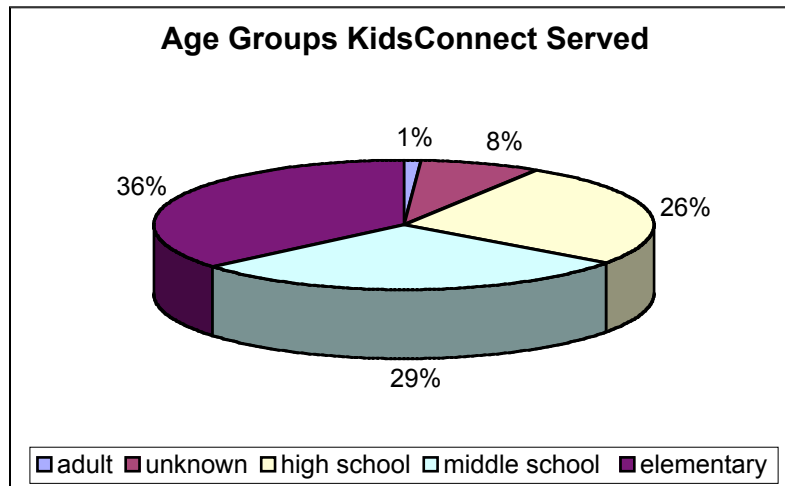


Figure 6: KidsConnect Users by Education level

These figures demonstrate a rough equivalence between primary (elementary and middle school) and secondary education (high school). The low numbers in “adult” are easily explained not only by the focus of the service, but the knowledge that at the time of these statistics teacher questions and question on the process of education were routed to the AskERIC service.

A more interesting finding, however, was the gender distribution of the questions as seen in figure 7:

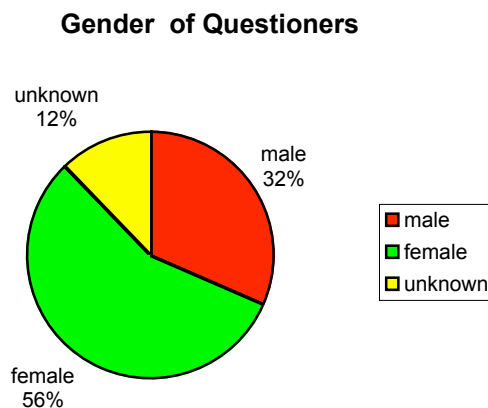


Figure 7: Gender of KidsConnect Users

One interesting finding of the KidsConnect staff was the prominence of girls asking questions. While many hypotheses were put forward to explain this situation (e-mail providing a “safer” environment to ask questions than the well documented male dominated classroom for example), no formal research was conducted to follow-up on this finding.

The other interesting finding from the KidsConnect data related to the topics, or subjects of the questions asked of KidsConnect. The KidsConnect team utilized a “Subject Line Analysis” technique whereby the subject lines of a random sample of questions were examined and classified inductively into a subject scheme. If the subject lines were felt to be uninformative (they did not indicate topicality like “Hello” or “Please help”) the underlying question was examined. The results of this analysis is shown in figure 8:

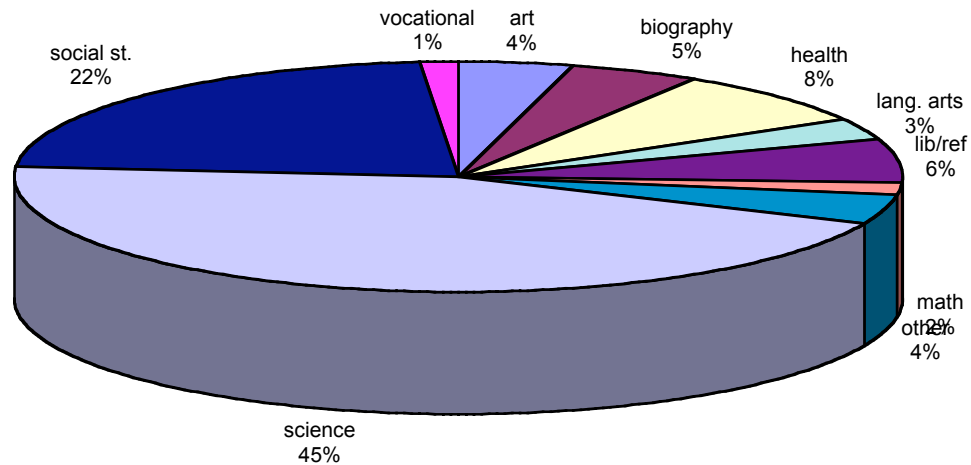


Figure 8: Subject Distribution of Questions

It is clear from this figure that science constituted the bulk of questions received. In order to provide a clearer picture of this category, it was further refined by “type of science questions” shown in figure 9:

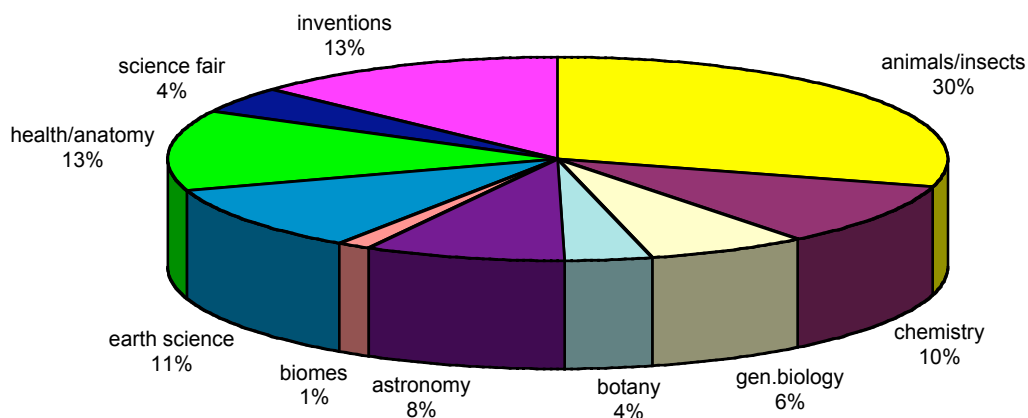


Figure 9: Further Analysis of Science Subjects

Data such as this should prove of great use to new digital reference services geared towards education, most notably the NSF's National STEME Digital Library (NSDL, 2002).

As mentioned before, these statistics represent somewhat dated analysis (4 years old). In 1999 operation of the KidsConnect service moved from Syracuse University to Drexel University (the previous statistics are based on Syracuse data). Syracuse then transferred much of the staff and processes of KidsConnect into the Virtual Reference Desk Learning Center. This project had a slightly different aim (it had a broader focus and also worked in a network of AskA services with general foci). However, the main concentration of the service was still school library media specialists answering the questions of the education community.

Statistics from the VRD service show a strong correlation between older KidsConect Statistics and more recent VRD usage. For example, figure 10 shows the user populations of the VRD service:

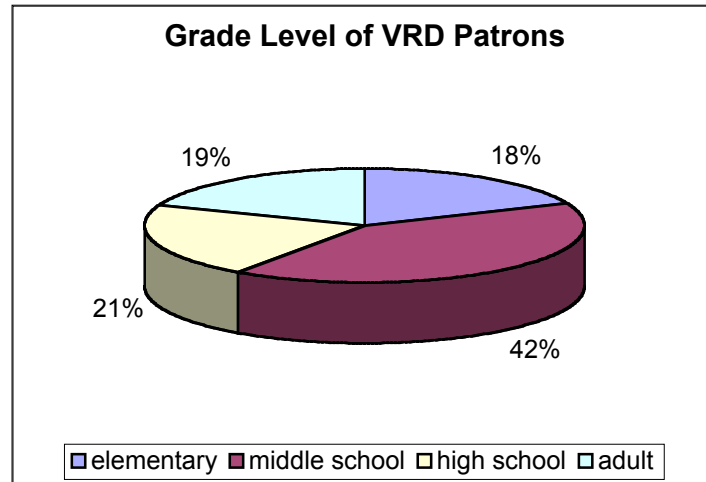


Figure 10: Grade Level of VRD Patrons

Note the higher “adult” population reflecting the broader focus of the VRD Network members. However, with this result removed, the distribution in primary and secondary education remains roughly equivalent with a greater number of “middle school” questions. Also note in figure 11 that science questions still dominate the service:

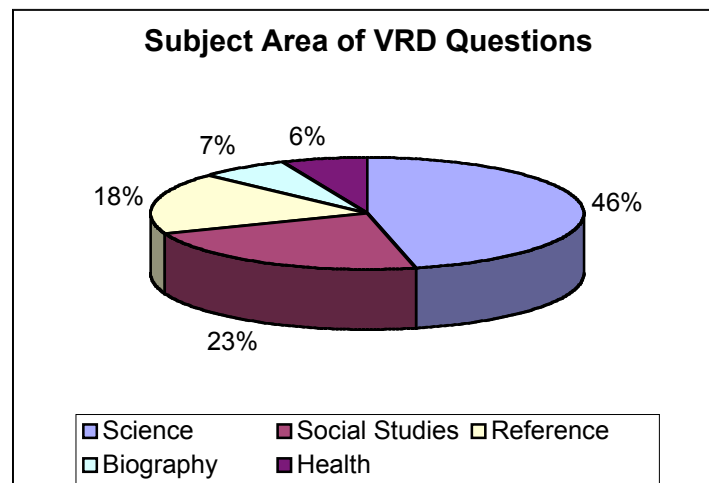


Figure 11: Subject Area of VRD Questions

Once again figure 12 provides a more fine-grained analysis of science questions:

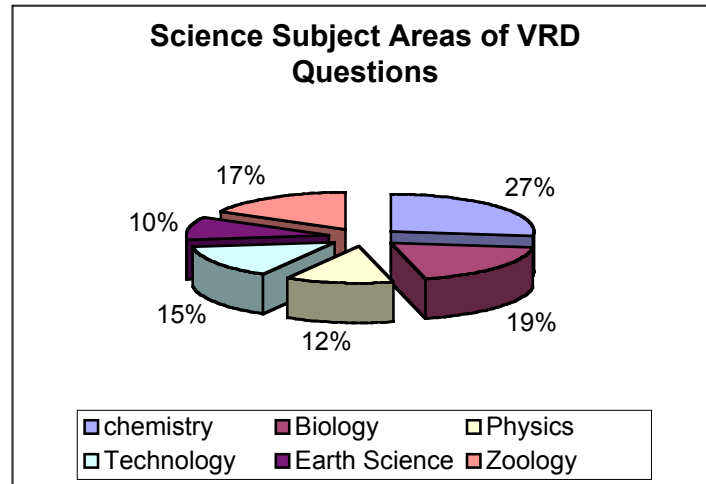


Figure 12: Science Subject Areas of VRD Questions

This distributions seems to hold over the three most recent years of the service (as seen in figure 13):

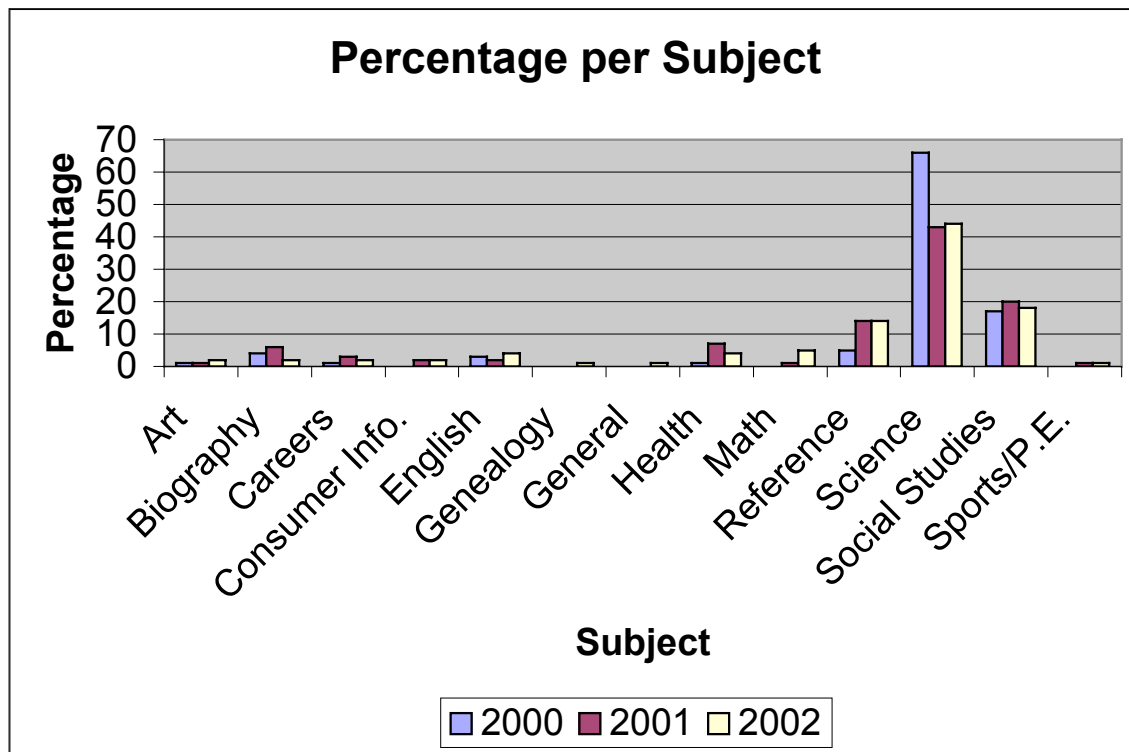


Figure 13: VRD Subjects over Time

From these more recent statistics it seems difficult to argue that there has been a massive shift in the types of education users asking questions, or the types of questions they ask.

What is also clear from these two services is that the library community has many contributions to make to the digital reference research agenda in respect to education and in general. It is also clear that the library community contains large-scale digital reference efforts that make excellent research environments that can be utilized in the search for generalizable knowledge.

Education AskA Services

The second progenitor of current digital reference systems is AskA services. AskA services take their name from expert question and answer services that tend to adopt names such as “Ask A Scientist” and “Ask A Volcanologist” (Lankes, 1999b). These services tended to originate without interaction with formal library systems, and emphasized topical expertise (as opposed to process expertise such as a librarian’s ability to search for information).

A fuller picture of AskA services can be drawn from two studies conducted by Lankes (see Lankes, 1999b and Lankes 1999c) and White (1999). Lankes presents an in-depth analysis of the structure and commonalities of “exemplary K-12 digital reference services.” Specifically this study sought:

- to build and apply a conceptual framework based on complexity research, literature and the researcher's experience;
- to use this conceptual framework to empirically describe how organizations, specifically K-12 digital reference services, build and maintain services in the dynamic Internet environment; and
- to seek commonalties across these descriptions.

The outcome of this study included detailed “blueprints” and a tuned framework of AskA services grounded in complexity theory as seen in figure 14:

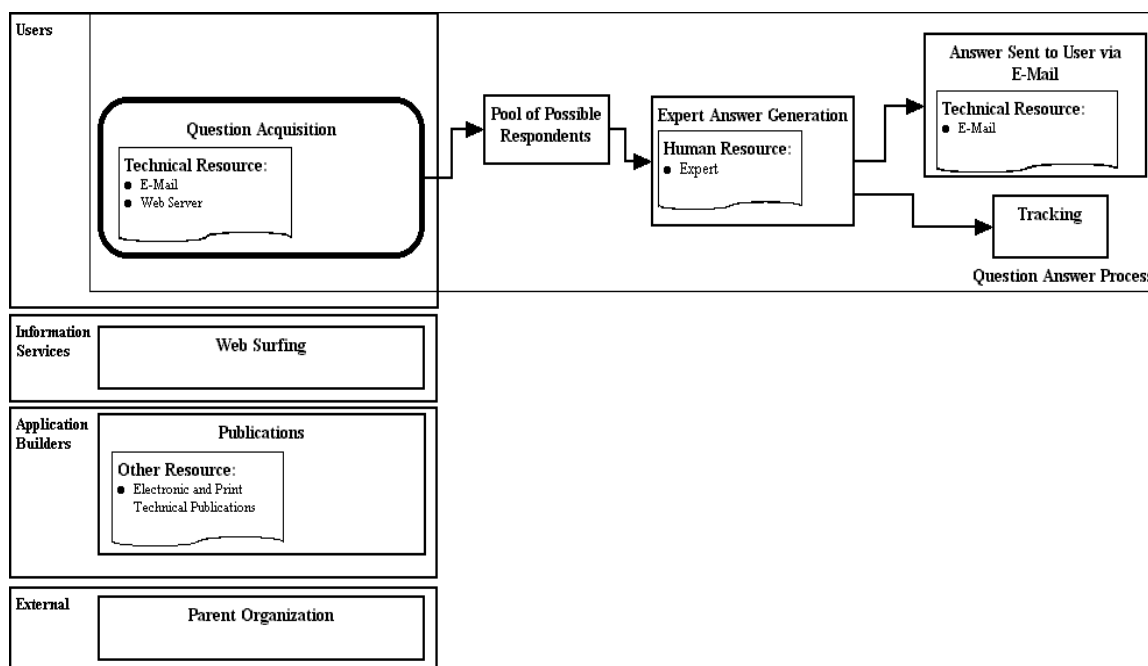


Figure 14: Tuned Framework of K-12 Digital Reference Services

White developed an analytical framework based on systems for evaluating AskA services. This framework was then applied to 11 services in a variety of services (including library based services).

Unlike library digital reference services that have seen to this point modest usage, AskA services in general have begun with large usage and seen dramatic increases. The most recent Virtual Reference Desk survey of AskA services done in 1999 demonstrates this situation. This table shows an average 44% increase in use of these asynchronous services from 1997 to 1998, with an average answer rate of 77% in 1998 (Lankes and Shostack, forthcoming).

Table 1: Virtual Reference Desk Survey of AskA Service Usage

GEM Subject	Service Name	Questions Received Per Week in 1997	Questions Received Per Week in 1998	Percent Difference in Questions Received	Percent of Questions Answered in 1998
Multiple Subject	ScienceNet	500	1200	+140%	100%
The Arts	National Museum of American Art Reference Desk	60	108	+80%	75%
General Education	AskERIC	800	833	+4%	100%
General Reference	KidsConnect The Internet	125	225	+80%	100%

Health		Public Library	150	150	0%	62%
		Ask the Dentist	50	85	+70%	1%
		Ask the Diabetes Team	48	70	+46%	100%
		Dr. Greene's HouseCalls	300	250	-17%	10%
Language Arts		The ESL Help Center	75	150	+100%	100%
Mathematics		Ask Dr. Math	270	867	+221%	35%
		Ask The Math Tutor	35	50	+43%	75%
Religion		Ask an Amish Expert	50	30	-40%	100%
Science						
	Astronomy					
		Ask an Astronomer	10	20	100%	50%
		Ask a NASA Scientist	20	70	+250%	60%
		Ask the Space Scientist	150	190	+26%	70%
	Engineering					
		Ask Professor Construction	5	10	+100%	90%
	General Science					
		The MAD Scientist Network	250	450	+80%	88%
	Geology					
		Ask-An-Earth-Scientist	50	125	+150%	65%
		Ask-a-Geologist (Geological Survey of Canada)	100	10	-90%	100%
		Ask a Hydrologist	5	12	+140%	100%
		Ask a Volcanologist	125	150	+20%	100%
	Natural History					
		Dino Russ's Lair	27.5	15	-45%	95%
	Oceanography					
		Ask Jake, The Sea Dog	200	200	0%	100%
		Ask Shamu	300	55	-82%	100%
Social Studies						
		Ask The Harkster (Canada)	10	15	+50%	50%
		Total Questions	3715.5	5340	44%	
		Averages	148.62	213.6	44%	77%

Compare these statistics to the libraries studied as part of McClure and Lankes' Quality Study, "In all cases the volume of digital reference question is low, ranging from three to 33 per day" (Gross, et. al, 2001 p. 5). This study covered a range of libraries in terms of size and scope (academic, public, federal, state).

One result of the large volume encountered by AskA services has been an emphasis on process, software development and automation. Where many library services have quickly adopted real-time technologies where one-to-one interactions require full human intervention, AskA services have looked to asynchronous technologies (at least at their onset see figure 15 for the distribution of questions received by AskERIC by mode of digital reference as an example of the predominance of asynchronous means – note that "web" and "e-mail" are both asynchronous modes), and means of shunting users to resources (see Lankes, 1999b for a richer discussion of AskA services and their architectures). These techniques run the gambit from sophisticated techniques such as automated searching of previously asked questions (as in the MAD Scientist service), to forcing users through a list of frequently asked questions before they are able to submit a question (as in the Ask A Volcanologist service).

Question Breakdown January 1 - April 30, 2002

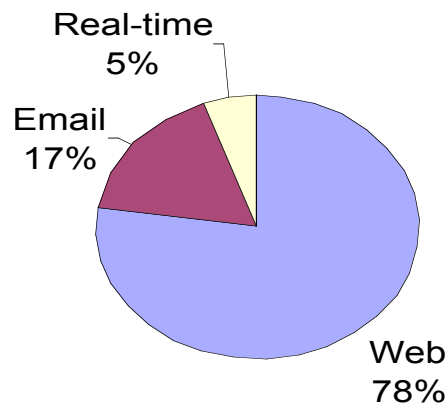


Figure 15: Mode of Asking AskERIC a Question

AskA services have tended to also develop more in terms of software and systems. Early examples include Ask Dr. Math, the MADScientist Network and How Things Work. Though there are excellent examples of software development in the library arena (Meola and Starmont, 2002) library services have by and large adopted software from the help desk and e-commerce community such as LSSI and 24/7 Reference's use of eGain and

the common use of LivePerson and NetAgent. While this may be changing, such as the use of Remedy in CDRS being replaced by original software development in QuestionPoint, AskA services still remain a hot bed of systems development.

Another common attribute with AskA services is their attention to the primary and secondary education community. In the case of some services this attention is part of a larger view of the general Internet population, but in many cases it is a special attention where education is foremost, and the general population is welcome as well. This can be seen in Dr. Math and MAD Scientist network's attention to students. It can also be seen in services such as AskERIC and their focus on education professionals.

Education AskA Service Exemplar: AskERIC

While the KidsConnect discussion shed light on digital reference use by primary and secondary education students, AskERIC can shed light on use of digital reference by education professionals.

AskERIC is project of the U.S. Department of Education's ERIC program. It began and is still operated by the ERIC Clearinghouse on Information & Technology, though nearly all ERIC components (Clearinghouses, ACCESS ERIC, the ERIC Processing Facility and even the parent institution of ERIC, the National Library of Education) are involved in answering questions. AskERIC has two primary components, a question/answering service staffed by ERIC, library and education professionals (see figure 16 for the volume of questions), and a Virtual Library of lesson plans, pointers to reviewed sites on the Internet and an archive of previously asked questions. A more in-depth description, though slightly dated, can be found in Lankes (1999b).

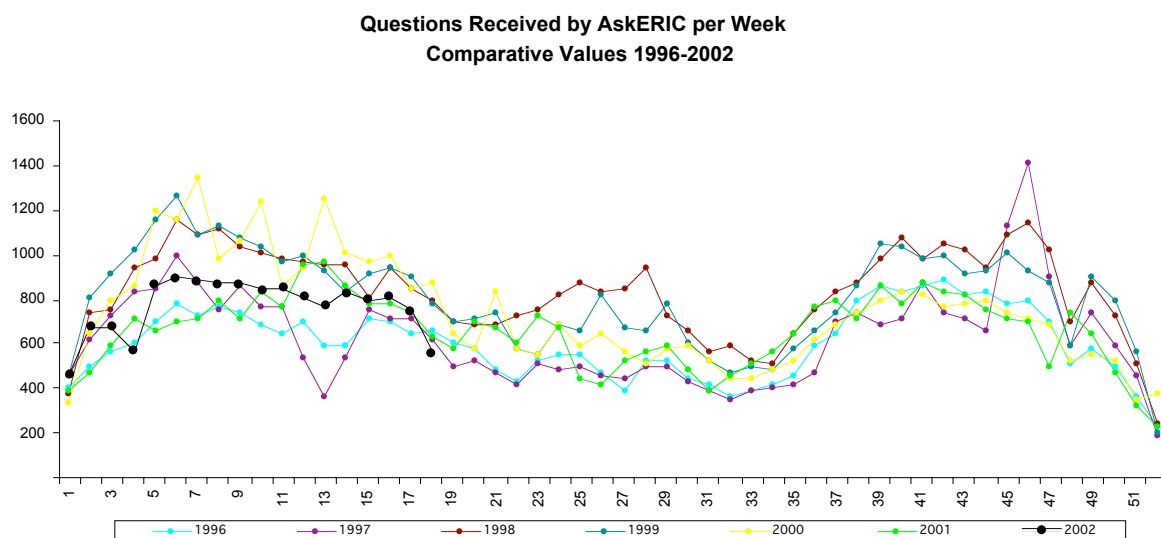


Figure 16: Volume of AskERIC Questions over Time

The purpose of AskERIC is to answer questions related to all areas of the process of education. The emphasis on education professionals can be seen in AskERIC's mission as well, as seen in figure 17, by AskERIC's users.

Capacity

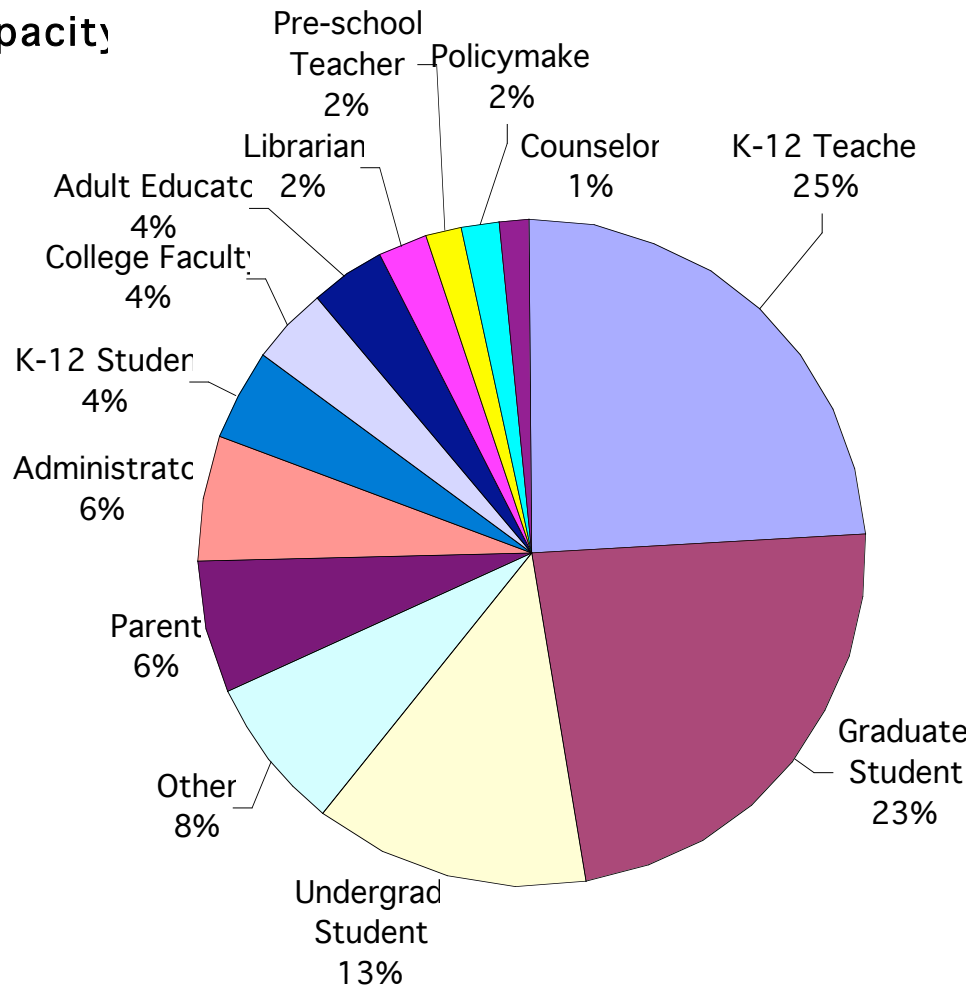


Figure 17: capacity in Which AskERIC Users Asked Questions

This distribution of users, with the majority being K-12 teachers followed by graduate students (with pre-service educators being traditionally heavy users of any ERIC service) is in line with AskERIC's stated mission:

AskERIC is a personalized Internet-based service providing education information to teachers, librarians, counselors, administrators, parents, and anyone interested in education throughout the United States and the world. (AskERIC, 2002)

In fact AskERIC explicitly does not answer:

Thank you for visiting the AskERIC Web site! If you are a K-12 student with a homework question, AskERIC may not have the resources to respond to your question.

AskERIC is designed to provide education information to teachers, librarians, counselors, administrators, parents, students, and others throughout the United States and the world. Our focus is not on the specific things you are learning in school; instead, we specialize in research and ideas about how students of all ages learn best. As an example, we can respond to a question such as "What is the best time of day to teach math?", but not "What is the formula to determine the radius of a circle?".

If you are looking for information in other specific subject areas or need homework help, you probably won't find AskERIC very helpful. Instead, you may want to investigate the following sites which are designed specifically for students. (AskERIC 2002a)

If any student questions are received by AskERIC they are forwarded to other services such as the Virtual Reference Desk.

What can one determine about AskERIC users beside their educational roles? First one can determine the education level users were asking about (a K-12 teacher was asking a question about high school for example) as seen in figure 18:

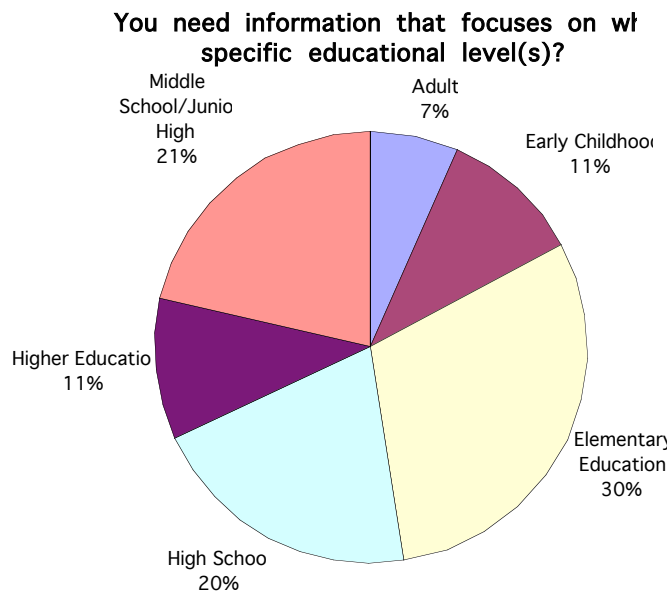


Figure 18: Level Focus of AskERIC Questions

One can also analyze the nature of the questions being asked by the professional community. AskERIC user surveys provide the anticipated use of the information gained as seen in figure 19:

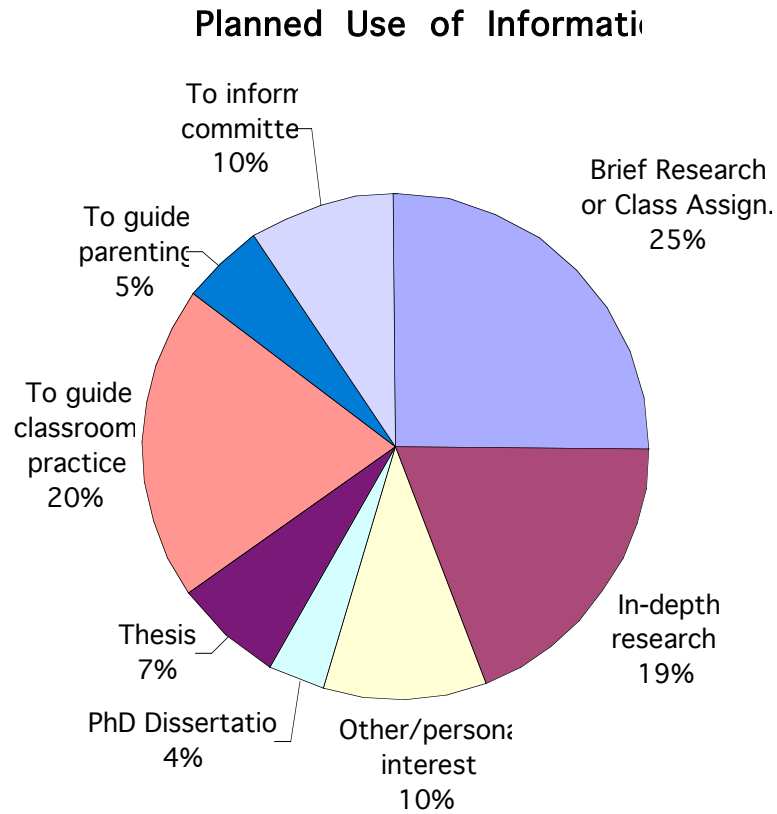


Figure 19: Planned Use of AskERIC Responses

Using subject line analysis once again, figure 20 shows question types identified in AskERIC questions:

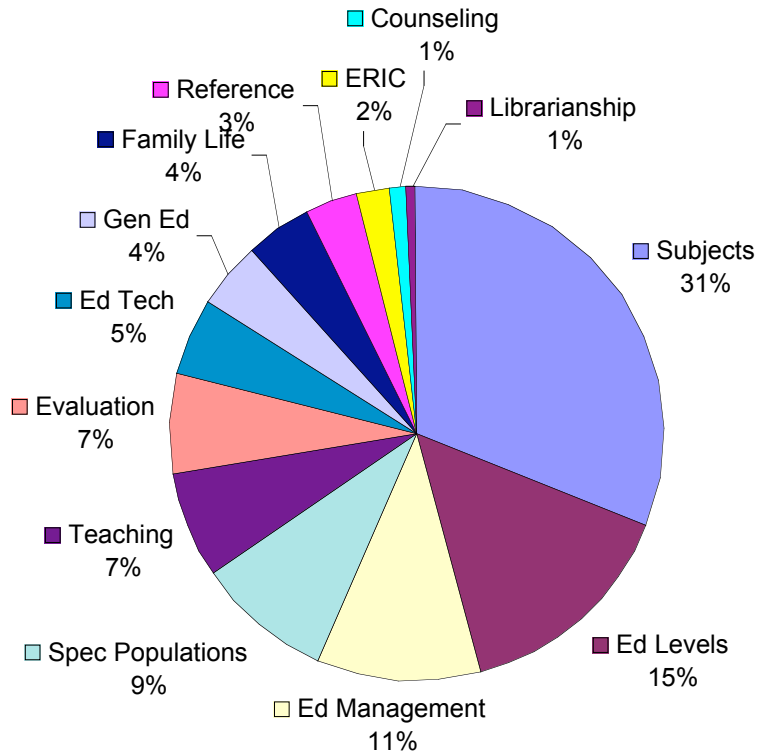


Figure 20: Subjects of AskERIC Questions

Figure 21 shows the relative stability of this question distribution over time:

Top Level Breakdown - Year by Year Comparison

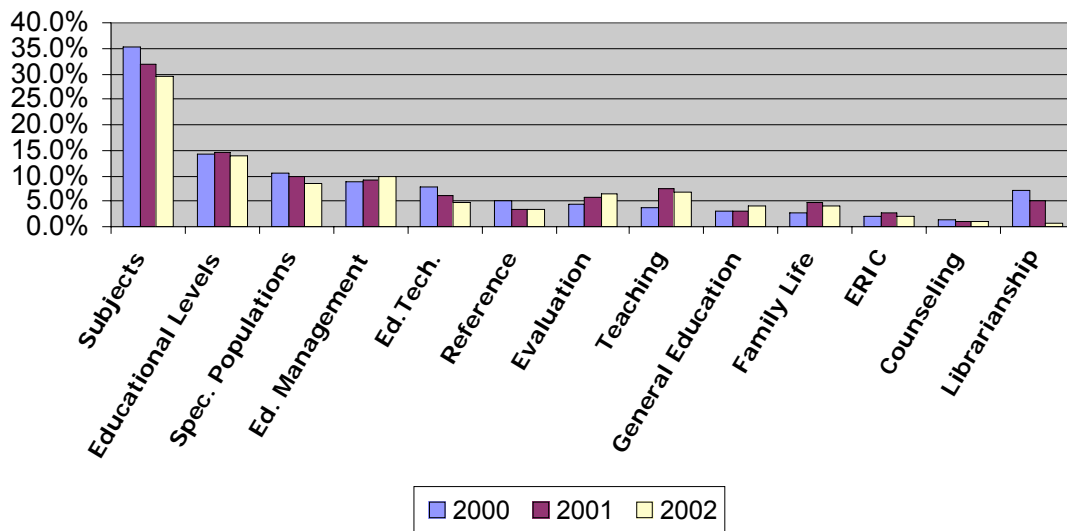


Figure 21: Subjects of AskERIC Questions over Time

In these figures (20 and 21) “subjects” refers to particular topics or academic disciplines taught in the classroom (note information from AskERIC responses may be used in higher and continuing education contexts as seen in figure 23 where 18% of answers were intended for higher or adult education):

Figure 22: Breakdown of "Subjects" in AskERIC Questions

Figure 23 shows the relative stability of these subjects over time:

Subject - Year by Year Comparison

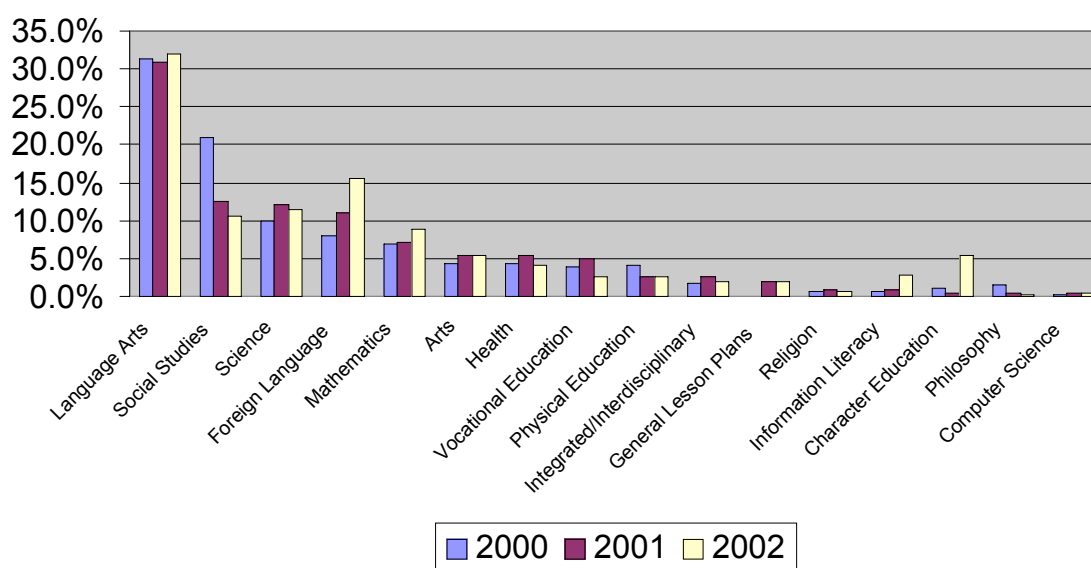


Figure 23: AskERIC Question Subjects over Time

Of particular interest is the predominance of “language arts” as a topic for educators versus “science” for students as seen in figure 8 of the KidsConnect sample. One possible reason for this difference may be the abundance of science material, particularly education-related science material, on the Internet versus instructional resources in language and English instruction.

Aside from the information AskERIC provides on digital reference use by the education professionals, it also provides an exemplar of reference authoring (Lankes, 2001). Reference authoring refers to the capture of information in the reference process and the transformation of this information into resources that can be used outside of the reference process as part of a larger digital library context. This authoring process can be from the simple, say the creation of frequently asked questions on a web site, to a complex, say the creation on the MAD Scientist Knowledge Base (<http://www.madsci.org/circumnav/circumnav.html>), to the central as in the AskERIC Resource Collection.

The heart of the AskERIC website consists of a resource collections:

In response to questions we've received at AskERIC, our network information specialists have compiled over 3000 resources on a variety of educational issues. This collection includes Internet sites, educational organizations, and electronic discussion groups. (AskERIC, 2002b)

This resource collection acts not only as a set of Internet links for end-users, but AskERIC digital reference specialists as well. As digital reference specialists constantly comb over this collection of Internet resources, ERIC citations, discussion groups and more they are also finding new resources to add and old resources to delete. This means that it is the digital reference process itself that is used as collection development, annotation and expert review.

AskERIC is only one example of AskA services geared specifically to the education community. It does, however, serve as a revelatory case. In the AskERIC exemplar we see the predominance on asynchronous technologies, the high-volume usage, and the interconnection of the reference process with systems and digital libraries. With these two exemplars, and the larger concepts raised in the operation of both services the author now proceeds to outlining issues and challenges facing digital reference services in primary and secondary education.

Issues/Challenges that Need to be Addressed

Many of the issues and needed research in the education domain exist in other contexts as well. For example, issues of scalability and ambiguity (Lankes et. al, 2000) seem universal to digital reference. Certainly issues of copyright, authority and evaluation are crucial in education as well as government, business and the general population. The author does not intend to duplicate these issues here. Instead, the author will concentrate on issues either unique to primary and secondary education, or aspects of more general topics of special concern to the education community.

The first and foremost challenge facing the education digital reference community can be encapsulated under the broad header information literacy.

Information Literacy

Although alternate definitions for information literacy have been developed by educational institutions, professional organizations and individuals, they are likely to stem from the definition offered in the Final Report of the American Library Association (ALA) Presidential Committee on Information Literacy, "To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information"(1989, p. 1). In the primary and secondary contests information literacy has become the primary curricular focus of the school library media specialists, and in general can be summed up as "helping people find answers, not simply giving them the answer." Following this model services such as

KidsConnect and AskA services like Dr. Math seek not simply to answer the questions of students with straightforward answers (e.g., “Mount Everest rises 8.9 kilometers above sea level”), but rather seek to impart information skills to find the answer (e.g., “try looking this up in the encyclopedia”). The idea is not homework help in the classical sense, but rather an educational endeavor.

This concept can be complicated by the ahistorical nature of the Internet itself. Simply put, it may be impossible to tell who is asking a question. This factor is important in that AskA services, while not seeking to be “answer” machines used to answer homework questions, they do tend to serve the education professional community in a slightly different manner. Services such as AskERIC want to give answers to teachers. This can create a conflict when a digital reference service doesn’t know who is asking the question. It is much like selling a teacher’s copy of a text books with the answers included to students by mistake. The issue is: how do digital reference services both teach effective research skills to students, while best serving the education professional population? In many cases this is a shared problem with academic libraries who seek to teach information literacy skills to undergraduates and graduate students while providing more direct answers to faculty and researchers.

The debate, while in a higher education context, can be seen in internal ERIC discussions concerning pre-service educators. Several ERIC Clearinghouses commented that they were receiving AskERIC questions that, at least on first inspection, were assignment questions from graduate students (e.g., “please discusses the relative merits of the inclusion of computers in the classroom and cite any detractors in the research literature”). To provide an answer (though AskERIC responses are not quite so in-depth) may well alleviate a student’s need to do his or her own research. However, how can ERIC be sure that this user is not in fact a school superintendent asking this question, or a school board member? With only a question and an e-mail address how can any service determine the intention or eventual use of an answer and therefore differentiate answer types? The final result of the ERIC debate, by the way, was to provide the same service to all users regardless of perceived use. The argument beyond the practical one of not knowing who a user is, was simply that pre-service educators should get to know what ERIC has to offer for when they become teachers.

With the advent of better forms of identity representation in cyberspace and the implementation of user profiles in certain systems perhaps response differentiation may be possible, and may be preferable. This remains an open question. Of course with greater identity information, comes a whole host of new issues that can be labels of privacy.

Privacy

Privacy certainly has general application across digital reference environments and digital library applications, but it takes on a keen sense of importance when discussing youth (in an education context or not). Certainly the recent spate of legislation in the United States (e.g., the Children’s Internet Protection Act, and the Children’s Online Protection Act)

has caused a serious discussion of children's identity information on the Internet. The heart of digital reference is an information exchange. The end-user must disclose information (a question) in order to use the service. While this information may not be of a personal nature (a general interest question, or a class assignment), it may well be very personal (e.g., "where can I find information on effective drug treatment programs"). The problem with questions is that they often require personal information in order to provide an effective answer. While a service may not seek to gain personal information through a deliberate form or set of database fields, this information may be embedded in the text of the question itself ("where can I find effective drug treatment programs for 15 year olds in the Syracuse area").

Many digital reference services rely on old norms of library and research to preserve the privacy of end-users. They may not make archives publicly available. They may destroy reference transaction at their close. Some services even enter into a prolonged editing process to weed out personal information in public archives (to this point no automated means of doing so have been readily available). Other services have opted for end-user choice over a blanket privacy policy (e.g., "by clicking here you acknowledge this information will be made public," or "anything entered into the following box will be made public"). This has worked mostly due to the nonprofit nature of digital reference services (COPA currently applies to for profit organizations in the United States).

Another force, however, complicates the privacy situation further. That is the advent of digital reference networks. Education digital reference networks such as the Virtual Reference Desk project link diverse digital reference services together. Questions from users flow freely from service to service crossing a variety of contexts (not for profit to for profit, university to public library, etc). Currently no systems or standards are in place to enforce the original policies across the network. In many cases end-users are not even informed that questions asked at a service may be routed to other services. While to date there have been no problems in this type of open exchange, this is a new environment with little precedent. The education community to this point has always operated under a sort of open information doctrine that information can be freely exchanged so long as it has education merit. Will this doctrine survive in a more examined and structured Internet environment?

Privacy is only one of a panoply of difficult issues related to identity in cyberspace. Another key identity issue in education concerns expertise and credentials.

Credentials and Expertise

The story of Marcus Arnold has become something of a legend in digital reference circles. The New York Times did an article (Lewis, 2001) revealing that the top rated legal expert on the commercial AskA service AskMe.com had little legal expertise. In fact he was a 15 year old with no legal background that relied heavily on common sense and legal television shows for his advice. Arnold is often used as a cautionary tale for digital reference services.

The issue of origin or authorship, so-called provenance, is not unique to digital reference by any means. However, expertise in the classroom has special meaning. The problem lies in students' ability to evaluate expertise and education professionals' ability to vet sources of information. While linked to the information literacy discussion above, evaluation of expertise is certainly a special case. Many services feature prominently the credentials of expertise whether it is organizational association such as AskERIC's association with the ERIC system and U.S. Department of Education or individual's background and credentials such as Louis A. Bloomfield of the "How Things work" service where he highlights his Ph.D. from Stanford and his professorship at the University of Virginia. However, many services have no such credentialing. In fact, other than a University of Virginia URL, there is nothing that actually certifies that Bloomfield is a professor, or where his Ph.D. is from.

Related to provenance is the question of bias. Libraries have a long-standing tradition of non-bias information. Where there are multiple views on a given topic, libraries and many AskA services seek to provide information on all or many of these views. However, much of what defines expertise is a specialized form of bias. The WorldBook Dictionary defines expertise as "expert opinion or knowledge, often expressed on some matter submitted to consideration by experts." Much of what one seeks from an expert is their opinion. What makes one expert is often not the breadth of one's knowledge, but the depth. A case in point is the Ask Shamu service offered by SeaWorld/Busch Gardens (<http://www.seaworld.org/AskShamu/asintro.html>). Ask Shamu answers questions concerning marine biology and wildlife. They are recognized experts on the topic. However, they have a clear bias or opinion on the value of marine animals in captivity and preservation of species through marine parks.

Rhetorical Levels

Aside from issues concerning "what" to tell education users issues of "how" to communicate information is also a large issue in education. These issues relating to the rhetoric used in digital reference interchanges include:

- Sophistication of language and terminology: when providing a factual answer the level (grade, knowledge level) of the intended receiver is crucial. Explaining why the sky is blue to a first grader is a markedly different experience than explaining it to a secondary school physics student. While this is related to issues of identity in knowing who asked a question, it is also very much related to the experts providing the answer. University professors are simply not used to (in most cases) explaining topics to primary school students. How answers are generalized or made simpler is not a common skill.
- Sophistication of Procedures: particularly in the math and science domain often the most efficient and effective answer is either a formula or equation. Aside from the limitation of current digital reference systems (and indeed web browsers) to present complex formulae, the original end user must be able to understand and process this information. This is a special case of the preceding bullet.

- Primary language affiliation: while language (in this context spoken and written languages like English, French and Spanish) is a general issue in digital reference services, it can be of particular concern in an education setting. Even in the United States where there is almost a presumption of English proficiency, this is far from a guarantee:

State Education Agencies in the United States and Outlying Areas respond to an annual survey regarding limited English proficient (LEP) student enrollment and services. Based on the most recent survey results, it is estimated that 4,416,580 LEP students were enrolled in public schools (Pre-K through Grade 12) for the 1999-2000 school year. This number represents approximately 9.3% of total public school student enrollment, and a 27.3% increase over the reported 1997-98 public school LEP enrollment. (Kindler, 2002)

- Motivational Aspects of Communication: The answer is only one part of the information communicated in a digital reference transaction. Aside from terminology and procedures, a related issue in communication might be called the “style” of communication. These often “softer” portions of an answer relate to how the presentation motivates a student (or any user) to pursue the topic further, or how satisfied they feel with the transaction. A simple statement like “look it up in a basic text” may provide the best reference, but does it support the learning efforts of the student that asked the question?

It is clear that many of the issues in primary and secondary education concern identity and attributes of the users. However, these are not the only areas in need of research and further investigation. The next section seeks to outline further items for a research agenda in digital reference as it concerns primary and secondary education.

Recommendations for Future Research

In many ways digital reference in primary and secondary education is a well researched topic. The presence of large and relatively stable funding for education, at least in the United States, has lead to in-depth empirical study of education users’ interactions with digital libraries and digital reference in the form of AskERIC, the National STEME Digital library, the Virtual Reference Desk, Ask Dr. Math, and The Library of Congress’ American Memory Collection among others. This work has resulted in systems, technical standards, quality standards, and even forums for the continued discussion of digital reference activities. However, much of this work has been of a general nature, applying to all of digital reference, with little attention to the direct impact of services in the primary and secondary education field.

In addition to the questions and issues raised above the author identifies three areas of needed investigation that are uniquely applicable to the education community (primary and secondary first and foremost, but possibly to higher and continuing education as well).

Motivation

A key area of research in education is in motivation and shaping instruction for maximum effectiveness. The questions center on what gets and keeps a student's interest. Certainly it has been hypothesized that talking to experts and indeed simply other people on the Internet is motivational (what student wouldn't want to talk to an astronaut), but there has been no work to assess how motivational. Does the presence of human intermediaries motivate students to ask more and/or better questions? In what way does it motivate students: to continue investigations outside of the traditional classroom or within the confines of the curriculum? Is the information transferred within an answer motivational, or the interaction itself?

Impact on Assessment

There is a current emphasis placed on assessment of student performance in the United States. Testing initiatives have seen widespread adoption at national, state and local levels. While there is a great deal of controversy over how to assess students performance, and the effectiveness of standardized testing, there is little question that determining the benefits any educational activity is important. In digital reference as discussed here, there are both direct and indirect means that digital reference may have an impact of student performance. In a direct way, does the presence of digital reference services as part of an educational agenda have an impact on student performance? In an indirect way, one might ask if giving education professionals access to digital reference services such as AskERIC, improve a professional's ability to deliver or assess educational material?

Classroom Integration

Related to assessment are questions related to the means of integrating digital reference services into the curriculum. Currently digital reference, as with most digital library initiatives, is seen as enriching standing curriculum. How can digital reference services be more directly tied to what is taught in the classroom? Two possible avenues for exploration can be labeled as reference authoring and what the author will call transactional education.

Reference authoring, as previously discussed, would generate new resources as part of a digital library that could be used in classroom instruction and enrichment. Transactional education refers to the concept of learning a topic through a series of digital reference transactions as opposed to a directed delivery of instruction such as a lesson plan or unit plan. Imagine a student learning a new concept in science not by sitting through a formal presentation of materials, but rather by asking questions, reading suggested readings from the answers, asking more questions, and self experimentation. This is linked to education concepts such as guided education or discovery learning, but where expertise was always present to the self-learner. Would this mode be effective?

Resource Type Delivery to Education Professionals

Another research area relates solely to the education professionals served by digital reference. The questions centers on the types of information that should be used in answering professionals' questions. Should teachers, for example, only receive information (articles, lesson plans, etc.) that has been peer reviewed? Should administrators only be made aware of websites and education interventions that have been fully vetted by some official source? Who, in essence, provides quality assurance in education information?

This is not a complete list, but seems to capture the main concerns of the education community in terms of digital reference. Certainly education-oriented digital reference services will also benefit from the results of other, more general digital reference and digital library research as well.

Conclusion

Digital reference for primary and secondary education has a rich and well documented tradition. It serves as a revelatory case for other digital reference research and can provide valuable insight into digital libraries serving the education community as well as other digital reference services.

What is apparent from this small examination of the education context is that all levels of education use digital reference services, and that their questions, while covering the gambit of topics, concentrate on science (in the case of students) and language arts (in the case of education professionals). Also apparent is the usefulness of education digital reference services as research environments. AskA services and library reference services alike hold large data sets of questions and answer transactions. These data sets can be used in evaluating how questions are asked, topics of interest to the education community, language use by the education community and a myriad of other facts that can be examined. Some of these datasets are publicly available on the Internet, while others remain locked in services due to privacy concerns.

From this examination of digital reference services some methodological techniques can be added to the digital reference research discussion. First among these is the concept of subject line analysis. This technique seems to provide excellent exploratory power, and may provide a rapid way to compare question types across services.

Lastly, digital reference services targeted towards the primary and secondary education community (or at least the study of these services) provide a wealth of models, theory and frameworks that can be brought to bear in future research. From The Lankes/Sutton Framework, the General Digital Reference Model (a result of Lankes' complexity framework) to White's evaluative framework there are rich analytic tools that can be used in the broader digital reference and digital library domain.

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