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THE GEOGRAPHY OF VIRTUAL QUESTIONING[1]

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This article explores the geography of virtual questioning by using geographic information systems to study activity within the Florida Electronic Library "Ask a Librarian" collaborative chat service. Researchers mapped participating libraries throughout the state of Florida that served as virtual "entry portals" for users as they asked questions of the statewide chat reference service and mapped users by their IP addresses to explore relationships between geographic location by IP address and online point of entry to the virtual reference service. Findings highlight the local nature of virtual reference services, as virtual users commonly asked questions about locally based library collections, policies, and services and also tended to access the statewide chat service through entry portals in the Web sites of their own local libraries. Implications are discussed for improvements to virtual reference

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services as well as for further uses of geographic analysis in digital reference service assessment.

Introduction

This study brings together two different research disciplines to better understand the geography of virtual questioning by using geographic information systems (GIS) to map questioning behavior of users of an online chat reference service. Chat reference, sometimes referred to as "virtual reference" or "digital reference," is the provision of online question-answering assistance to users by librarians in a synchronous or "live, real-time" text interaction over Web-based software, usually via commercial call center chat software packages such as Questionpoint (http://www.questionpoint.org), Docutek (http://www.docutek.com), and others. Staffing of these live chat services is often accomplished through libraries joining together in consortial or collaborative chat services. Although chat reference collaborations can be global, libraries often join in collaborative arrangements with other institutions based within a particular local geographic region, such as a statewide chat reference service.

Florida's "Ask a Librarian" statewide chat service is one of many collaborative chat services organized around shared regional geography in states such as Colorado, Kansas, Maryland, New Jersey, New York, North Carolina, Ohio, Oregon, and Washington, among others. Statewide virtual reference services are often supported via taxpayer-funded Library Services and Technology Act (LSTA) federal grants with a mission to target services to statewide or local users. However, as Jeffrey Pomerantz [1, p. 1292] has noted, "Most virtual reference services have no mechanism to determine the veracity of users' responses to questions such as their location." For statewide chat services, this lack of geographic data about chat users creates assessment problems including

- difficulty in determining whether the statewide users targeted for virtual services are in fact being served;
- difficulty in assessing the scope and penetration of the chat service throughout the geographic service area; and
- lack of basic knowledge about how the local geographic context of questioners impacts interactions with the collaborative statewide chat service.

To address these gaps in digital reference assessment for statewide collaborative chat services, this research examines the mapping of user IP addresses as a potential source of assessment data about the local geographic

context of chat users and explores what can be learned about the geography of virtual questioning.

Mapping of virtual questioning in chat reference involves geocoding the IP address of the user. The IP address, essentially a digital footprint left by the user within the chat reference software, appears as a sequence of numbers, such as 128.128.128.0. Various geolocation services offer free or fee-based geocoding that converts IP addresses into geographic data elements such as city, state, zip code, and possibly even the name of a specific institution or Internet service provider through which the user is accessing the Internet. In addition, some services offer geocoding of IP addresses into latitudes and longitudes, which can then be used in mapping. The geographic frame of analysis reveals key aspects of virtual user behavior in interacting with a collaborative statewide service and provides new perspectives on outreach, virtual questioning, and the changing nature of geographic service areas and institutions in the provision of online services.

Literature Review

Much of the existing literature on GIS and libraries has focused on organization and dissemination of spatial data to best facilitate GIS research in other disciplines [2–4]. Stephanie Haas et al. [3] argue for the inclusion of the latitude and longitude of specimens, while Mary Larsgaard [4] discusses adding latitude and longitude to MARC records in decimal degrees. The application of GIS in research for the mapping and studying of libraries and library users has been less commonly employed.

Among those studies that have utilized GIS as a system of analysis in studying libraries, there have been two primary research threads—mapping of the internal geographic spaces situated within the "brick-and-mortar" library building, and mapping of the larger external geographic spaces within which library buildings are situated in turn within neighborhoods, market areas, Census enumeration districts, Congressional districts, and other encompassing geographic boundaries.

In exploring the internal geography of libraries, Jingfeng Xia [5] used ArcGIS to map the physical locations of books on high, low, and middle levels of shelving in order to understand how users' in-library book browsing selections were influenced by the physical location of the books on shelving at different heights in the library and observed that books on the topmost and bottom-most levels of shelving were accessed least often for in-library browsing by users. In another study mapping the intensity of usage of library tables, sofas, carrels, and other interior study spaces, Xia [6] found high usage of study spaces located around tables with electrical and Internet connections, contradicting previous studies that suggested

carrels as the higher-usage study spaces within libraries. Other work has included mappings of the intensity of book usage from different call number ranges in library shelving [7] and a suggested model for utilizing GIS in conjunction with radio-frequency identifying tagging (RFID) of items in a library collection management system [8].

In research focused on the external geography of libraries by mapping libraries within a local, regional, or national context, GIS has been used as a marketing research tool [9], and it also has been used in a nationwide geodemographic analysis of library user market segments for minority and low-income neighborhoods [10]. Researchers have mapped library users in terms of residential distances from the library [11, 12], distances traveled to use the library, and ethnicities in the library service area [13] and have compared distances traveled by library users with book circulation statistics, finding, for example, that about half of the books circulated are loaned to users residing within two miles of the library [14].

While these earlier studies involved mapping of physical library visits, today's questioners can also "visit" libraries virtually through the library's Web pages, searching online catalogs and databases and questioning librarians through the library's online chat or e-mail reference services. The advent of the Internet has expanded the conceptualization of library service areas beyond local-area residents to potentially include statewide, national, and global users—from distance students living in other states or countries, to faculty traveling to conferences worldwide, to part-year residents who travel between summer and winter homes.

This new geography of virtual library users and virtual questioning has as yet been little explored by researchers. Judy Ruttenberg and Heather Tunender [15] pioneered in this new area of GIS as they sought to understand how virtual users approached the University of California, Irvine Libraries chat service from on-campus locations. By mapping users' IP addresses to known IP addresses of campus computing centers, dormitories, and university libraries, they found that in a two-year period of 2002–4, over half of the chats (995 chats, or 54.7 percent) were initiated from buildings on campus. Undergraduates were more likely to initiate a chat from within the university libraries, while graduate students were more likely to access the chat service from other campus buildings. These results established that virtual users can be geographically distant or may be situated within the library, and perhaps even in line of sight of the reference desk—a result that has also been seen in other reference research [16].

While Ruttenberg and Tunender used the technique of geocoding users' IP addresses to map chat users to campus-based locations, they did not explore the application of geocoding and mapping for off-campus chat users. This study of virtual questioning in a statewide chat service follows

up on their efforts but breaks new ground in geographic mapping of chat users beyond the boundaries of a single university campus setting.

Background

The virtual chat service that served as the focus of this study was Florida's Ask a Librarian service, a statewide collaborative chat service operated within the Florida Electronic Library (FEL, http://www.flelibrary.org/) with participation and shared staffing by the Florida State Library, the College Center for Library Automation (CCLA), the Tampa Bay Library Consortium (TBLC), and many other libraries statewide. An early impetus for statewide collaboration began with the recognition of increasing numbers of online distance students at Florida's universities, leading in 1997–98 to the Florida Distance Learning Library Initiative. By 2002–3, there were 111,327 public university students and 208,070 community college students enrolled in Florida distance education courses [17, 18]. Planning for a statewide Florida Electronic Library began in 2001, and in 2002 a federal LSTA grant was awarded to TBLC and CCLA to launch the Florida Electronic Library as a pilot project of the State Library and Archives of Florida through the Florida Department of State.

Meanwhile, many Florida public and university libraries had already initiated experimental chat reference services through a variety of software at University of Florida, University of South Florida, University of Central Florida, Florida International University, Broward Public Library, Gulf Coast Community College, St. Petersburg Community College, and Largo Public Library [19], thus creating a core group of libraries with expertise in staffing the collaborative chat service. Florida's Ask a Librarian chat service was launched in 2003 using Docutek chat software, and in the first twelve months of operation (July 2003–June 2004) it received over 5,000 questions from virtual users, expanding from fifteen libraries to seventy-six participating libraries statewide [20].

Matthew Loving et al. [21] described motivating factors at one local Florida public library to join FEL's statewide service as cost savings, improved technical support for the chat service, and the ability to offer extended hours through shared staffing while at the same time reducing demands on local staff time. By December 2006 there were eighty-nine participating libraries statewide, including public, academic, and special libraries.

In 2006, Florida's State Library asked the Information Use Management and Policy Institute at Florida State University's College of Information to conduct an analysis of the Florida Electronic Library for the five-year evaluation required by the Library Services and Technology Act. The FEL's

Ask a Librarian chat service was included within this analysis. The study team proposed mapping for analysis of the chat service and its virtual users in order to learn more about geographic usage of the chat service statewide.

Method

The study team developed the following research questions in seeking to understand how virtual users approached and asked questions of FEL's statewide collaborative chat service:

- Where are users of the Ask a Librarian service located?
- Where do Ask a Librarian users ask their questions?
- What types of questions do users ask the service?

To explore these questions, the researchers asked FEL's Ask a Librarian administrators to provide chat data from two different months for analysis. Selected months were to be those that the administrators running the service considered to be representative of typical months in 2006. However, FEL administrators were only able to provide full transcript and mapping data for one month. In March 2007, FEL Ask a Librarian administrators provided the researchers with 1,859 chat service transcripts and associated user data from the month of August 2006. The month of August represents a month when both K–12 and higher education institutions in Florida are in session with no major holidays that would interrupt or slow down service, and researchers found no reason to believe it to be atypical. The data set included

- chat transcripts: text transcripts of the user's chat question and the answer;
- library entry points: an identifier for the local library Web page through which the user entered the statewide Ask a Librarian service to ask a question;
- IP addresses: an identifier for the user's Internet service provider;
- user demographics: a user-selected self-identification as either "K–12 Student," "College or University Student," or "Other."

In the data analysis phase, researchers first prepared the data in two areas: qualitative coding of the chat transcripts for the types of questions that FEL's chat users asked and geocoding of FEL library locations and user IP addresses into latitudes and longitudes for use in GIS. For the qualitative coding of question type, researchers had noted that FEL's Ask a Librarian service lacked automated prompting to elicit user-defined question topics and user motivations for asking questions. Therefore, the re-

searchers developed and tested a typology of fourteen different question categories (see "Ask-a-Librarian Codebook" in the appendix).

Prior to Codebook development, the researchers had conducted an extensive literature review in previous digital reference research to evaluate the possible application of question taxonomies developed by other researchers. The literature review found that while many research studies used the "Katz categories" [22–28], this schema primarily highlights the actions of librarians rather than the information needs and motivations of the users. For example, Katz categories such as "directional" or "ready reference" demonstrate how librarians handled users' questions either by providing directions or by looking up the answer in a ready reference resource but give no indication of what the user was asking about or why the user needed the information. Matt Marsteller and Paul Neuhaus [26] referred to the Katz schema as categorizing "librarian activity." Researchers such as Debra Warner [25] and Deborah Henry and Tina Neville [29] described confusion and difficulty in applying the Katz schema due to different ways that categories such as "ready reference" could be interpreted, and Smyth [23, p. 30] discussed the schema's shortcomings in providing insights regarding users, such as "the user's level of competency or stage of any research cycle." While selecting this typology would offer some limited comparability of results with other studies (limitations being due to a tendency of researchers using the Katz schema to slightly adapt and adjust category definitions within each study), use of the typology would also shift the focus of the research away from users' questioning patterns to librarians' answering activities.

The researchers reviewed other question taxonomies that focused on actions of users, such as Arthur Graesser's taxonomy [30, 31], featuring question categories such as "concept completion," "feature specification," "causal antecedent," and "quantification," and Marie Radford's taxonomy of relational factors [32] with categories for "greeting ritual," "rapport building," "deference," and "closing ritual." However, these taxonomies emphasized either structural aspects of types of information requested (e.g., "quantification" questions asking "how many") or else focused on deconstruction of users' socio-emotional interactions with librarians rather than on revealing users' information needs and motivations for questioning. Therefore, to better understand questions and contexts motivating users to approach and ask questions of a collaborative statewide library chat service, the researchers concluded that a new typology for analyzing users' questioning was needed.

To design the question typology, the researchers used a grounded theory approach in which codes describing users' expressed information needs and motivations emerged directly from the data. The constant comparison

method [33], an iterative process of reading, coding, comparing, and refining of codes supported by repeated testing for intercoder reliability, was used in developing the coding schema. Chat transcripts used in initial coding and development of the Codebook were randomly drawn in sets of twenty from throughout the entire corpus of the data. Intercoder reliability testing for the data-coding categories was performed as coding and analysis continued, and intercoder agreement rates were calculated to test for coding scheme validity. To further test the dependability and confirmability of the emerging codes, four coders with differing backgrounds and levels of expertise in library reference services participated in intercoder reliability testing and in team meetings for discussing and redefining codes. Peer review and debriefing at various points during Codebook development subjected the developing Codebook to review and critique by peers as an additional test of coding scheme validity.

In the first intercoder reliability test, the initial agreement rate was 65 percent. Further testing and refinement of the Codebook found consistent intercoder agreement rates in the 82–85 percent range. Since a key component of credibility is whether the findings "ring true" for study participants [34, p. 290; 35, p. 30], member checking of the codes was undertaken both by review of the coding scheme by Ask a Librarian administrators, and by inviting intercoding participation of a fifth coder who was a librarian member of the Ask a Librarian chat service staff. Intercoder testing of the Codebook using randomly drawn transcripts with this fifth coder external to the research team achieved a 90 percent initial agreement rate. Coding of the full corpus of 1,859 chat transcripts was then completed by the four coders who had been trained with using the codes throughout the Codebook development and testing process.

The question typology developed within this study highlighted the information needs, uses, and motivations for which users approached the collaborative statewide chat service, demonstrating reasons why users asked questions and activities in which they were engaged through categories such as

- academic research (students doing class assignments such as researching a topic; writing a speech, paper, thesis, or report; answering test questions; finding definitions; and seeking proper formatting of citations);
- business (researching companies, business topics, statistics, or consumer and financial information);
- education (seeking information about classes, schools, testing, and transcripts);
- personal research/fact-finding (non-school-related hobbies, personal

projects, and tasks of daily living such as householders seeking "do it yourself" information on solvents, welding, and car repairs);
- recreation (e.g., tourism planning and finding concert information);
- readers advisory (advice sought on books with specific attributes such as awards, in particular genres such as mysteries, or for specific audiences such as children);
- library services (seeking help with library cards, library accounts, library hours, renewing checked-out items, making hold requests, library volunteer work or applying for library jobs, and donating books);
- library resources (seeking to obtain specific books, articles, videos, and other library collection items);
- government/law (locating government records, rules, laws and e-government information and services).

The transition of government information and services to online "e-government" has increased the burden on libraries to assist users with questions; in Florida, such e-government shifts have occurred on the state level as well, with state government employees directing users to visit libraries for help with government forms and applications [36]. By focusing on users' expressed information needs and motivations, the question typology in this study examines the role that libraries and statewide collaborative chat services play in supporting specific areas of users' activities and everyday information-seeking needs. The typology uses categories meaningful in communicating "what libraries do" to audiences unfamiliar with library jargon terms (e.g., "directional" or "ready reference"), including taxpayers, legislators, grant funders, and nonlibrarian researchers.

To prepare for mapping of the library entry points and users' IP addresses, the data were geocoded through conversion into latitudes and longitudes for use with the ArcGIS mapping software. The study team used two sources in geocoding the library entry points data: the GeoLib database (http://www.geolib.org), which is limited to public libraries, and Batch Geocode (http://www.batchgeocode.com) for the remaining library entry points. The users' IP addresses data were geocoded into latitudes and longitudes using IP2Location (http://www.ip2location.com). These latitude and longitudes were then used within ArcGIS to generate maps showing results for the Florida counties.

For statewide virtual reference services, mapping data at the county level offers a useful frame for geographic analysis of the service. Depending on the research question, a particular benefit of a county-level analysis is the potential for integration with other county-level geospatial and demographic data sets available from sources such as Geospatial One Stop (http://gos2.geodata.gov/wps/portal/gos). In addition, each statewide service may have relevant regional groupings useful in a geospatial analysis beyond the

county level. Within the state of Florida, county-level data from the Ask a Librarian service could also be recombined and explored at the level of the multi-library cooperatives (MLCs), in which the sixty-seven Florida counties are grouped into six MLCs representing northern, southern, and central regional areas of the state.

Researchers interested in pursuing a geographic analysis of virtual questioning should select the level of analysis carefully in order to avoid the issue of the modifiable areal unit problem (MAUP). Geospatial analysis is often based upon imposed political boundaries such as multi-type library cooperatives, counties, and congressional districts. A MAUP concerns the issue that any subsequent changes to boundaries, such as political redistricting or redefining of regional groupings, would result in different outcomes for analyses of points within areal units [37]. Thus, for a longitudinal geospatial analysis of virtual questioning, selecting areal units with consistently defined boundaries is essential.

In presenting the spatial data, a variety of classification techniques can be implemented such as equal intervals, quantiles, standard deviation, and many others [38]. Choropleth mapping with quantile classification was used in this study to visually represent the data with ArcGIS. A choropleth map is a thematic map with gradations of darker and lighter shaded areas corresponding to ranges in the observed frequencies of the phenomena being studied. Quantile classification divides the frequencies into ranges, where each range contains the same number of geographic units. In this case, the classification demonstrated ranges of geographic access patterns observed among Florida counties. Since each range contains an equal number of geographic units (counties), the percentage of observations that fall in each range will also be the same. Quantile classification was used in this case over other classification methods because the counties are about the same size; thus each range represents approximately the same area on the map. The percentage of observations in each range is the same, allowing geographic access patterns to be more easily discerned across the state.

Results

The geography of virtual questioning was found to involve a confluence of several distinct geographies:

- geography of the information service—location of the participating library through which the user approaches and asks a question of the statewide service;
- geography of the question—location of the participating library to

which a user's question may be rerouted, due to inherent aspects of the type of question asked;
- geography of the questioner—location of the user in terms of both the relevant physical and virtual location or "Internet geolocation" of the user.

Each of these geographic aspects influences virtual questioning and answering, from concerns regarding user eligibility for virtual assistance and resources to issues regarding how virtual questions are received, routed, and answered via chat reference systems and services. Findings in each of these three areas are further detailed in the following sections.

Geography of the Information Service

Florida Ask a Librarian operates as a geographically distributed information service in which libraries across the state participate in staffing a shared online chat reference service. Web-based home pages for each of the member libraries provide a Web form based virtual "entry portal" to the statewide chat service for their online users. When users click on the Ask a Librarian link in their local library's Web site, they pass through the local library's Web site into the chat queue for the statewide service, where a librarian from a different participating library might receive and answer their question.

During the study period in August 2006, ninety-one libraries were participating members and served as local Web-based "entry portals" into the statewide chat service. These libraries were geographically situated in thirty-nine of Florida's sixty-seven counties. For twenty-eight counties, although local libraries existed in those geographic areas, none were as yet participants in the Ask a Librarian collaborative chat service.

Mapping of Ask a Librarian online activity during August 2006 found that virtual questioners approached the statewide chat service through eighty-one of the ninety-one local library Web-based entry portals. Chat users accessed these local library entry portals in thirty-five Florida counties, showing questioning activity occurring at library entry portals in nearly 90 percent of the thirty-nine Florida counties with participating chat service libraries, as shown in figure 1.

Mapping of the information service geography further revealed the interesting issue of two online entry portals for which there was no clearly defined geophysical location. A total of 206 chat users had approached the service through these two virtual entry portals:

- 190 users entered via the Ask a Librarian home page (http://www.askalibrarian.org) and
- sixteen users entered via the Florida Virtual School (http://www.flvsgs.net).

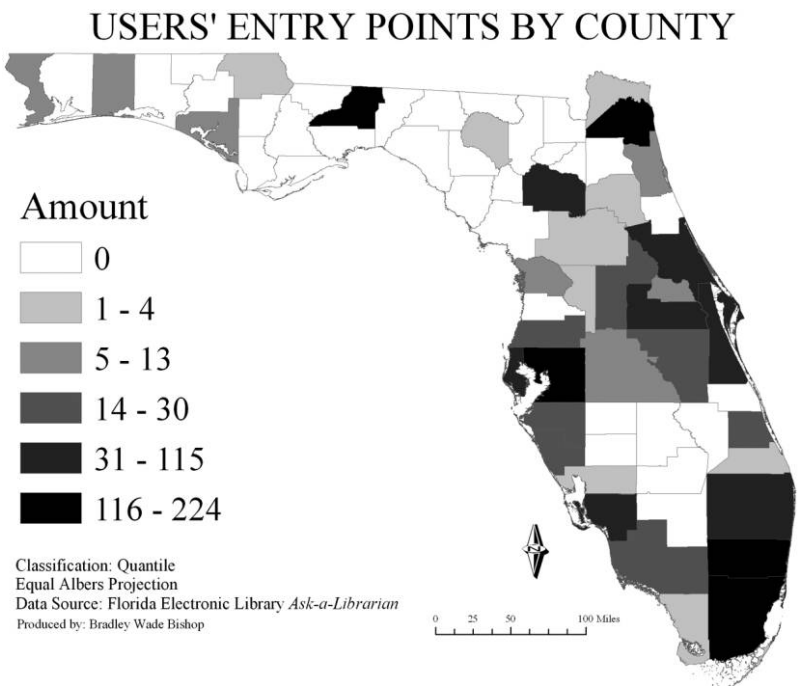

FIG. 1.—Questions by county for library entry points

The Ask a Librarian home page is the collaborative home page for the statewide chat service within the Florida Electronic Library. As an entry portal, it represents a mixture of geographic entities. Funding is provided by the Florida Department of State, Division of Library and Information Services, with technical support from the College Center for Library Automation, both situated in Tallahassee (Leon County), while project management is provided by the Tampa Bay Library Consortium in Tampa (Hillsborough County); question-answering services are contributed by librarians in institutions and counties across Florida. The distributed nature and functioning of this particular entry portal demonstrates the complexity that can be involved in assigning to some institutions a more narrowly defined geographic location beyond a general statewide attribution such as "Florida."

Similarly, the Florida Virtual School serves as a "state-wide Internet-based public high school," not limited to students in a particular Florida school district, but instead functioning as a distributed educational service for all sixty-seven Florida counties and school districts [39]. Although administration of the school is based in Orlando (Orange County), instructors and

students of the Florida Virtual School live in and teach and learn from counties throughout Florida as well as in other states. While Florida Virtual School is clearly identified with Florida, a narrower identification with "Orange County" or "Orlando" seems less accurate as a geographic description.

This finding highlights the difficulty of determining geographic affiliation in a virtual information service. In the past, people visited libraries in person to ask their questions, and institutions could use a turnstile to count users and their locations as they entered and asked questions at a main library or branch. Today's users visit libraries and ask questions in a variety of different ways, not only walking through a library's front door but also by entering virtually through the library's Web pages. In addition to gate counts, e-metrics are now being employed to count and track library users. With the advent of online collections, virtual services, and multi-institutional collaborations, the institutions themselves are changing as well, becoming a mixture of physical and virtual and thus redefining the geography of information services.

Geography of the Question

Geographic aspects inherent within users' questions offer an additional point of complexity in the mapping of virtual questioning. In collaborative question-answering services such as Ask a Librarian, some types of questions can be readily answered by librarians at any of the participating institutions, such as finding a quick fact or explaining in general how to conduct information searches. However, other question types have an implicit geography that is "locally based," requiring knowledge about a specific library's collection items, policies, or services. These "locally based" questions may necessitate redirecting the user's question to be answered by the local librarians.

In coding the types of questions asked by the Ask a Librarian users, the study team found that nearly half of the questions asked by the August 2006 chat users involved geographically "locally based" questions in seeking help with local library collection items, policies, and services. Thirty percent of the inquiries posed by chat users focused on Library Services (562 questions) in problems such as obtaining local library cards, accessing local library databases, and learning more about local library policies and services. Another 16.9 percent of questions focused on Library Resources (315 questions), with efforts to obtain specific items from local library collections, such as retrieving or placing holds on particular books, articles, and DVDs. Library Services and Library Resources questions together amounted to nearly half, or 46.9 percent of the 1,859 questions in the study, and represented two of the three most commonly asked question types as seen in fig. 2.

Collaborating librarians in other parts of the state could not necessarily

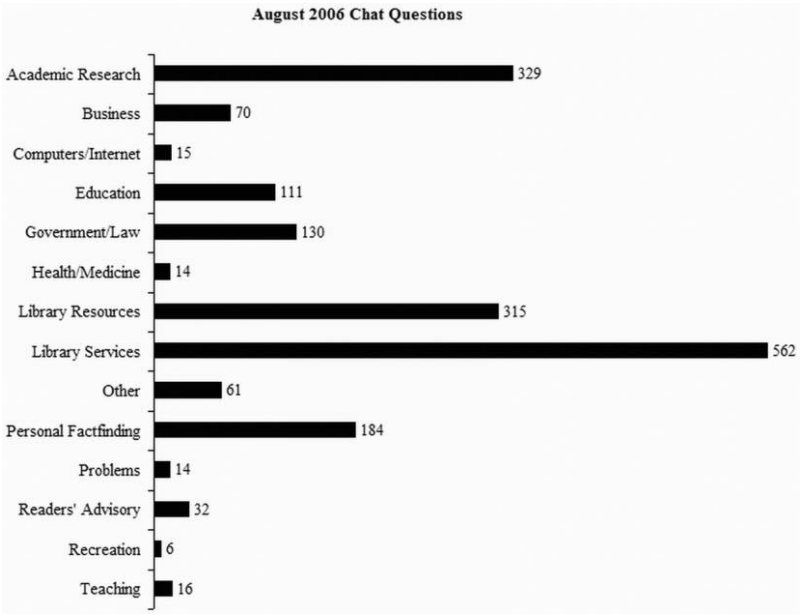

FIG. 2.—Types of user questions asked

give the assistance users needed with placing local holds on books, checking the status of local library card applications and fines, or explaining details of local library policies and services. Users therefore were sometimes redirected by statewide librarians to ask at their own local libraries, as seen in this chat exchange:

> *User*: Just a thought. . . . Maybe you should include that info in the ASK a Libraian [*sic*] area: that you can't assist with specific branch information.
> *Librarian*: It does say that we are a statewide service.

For users who had clicked on the Ask a Librarian link from their local library's Web page expecting immediate help with their questions, being redirected back to ask the local library could be a surprising response; however, from the librarian's perspective, it is a response necessitated by the inherent local geography of the question.

Geography of the Questioner

Although the geography of the information service provided insight into how local library entry portals served as gateways into the collaborative chat service, the data did not reveal geographic details about the questioners themselves. Therefore, to better understand the geography of the questioner, the study team mapped chat user locations according to their

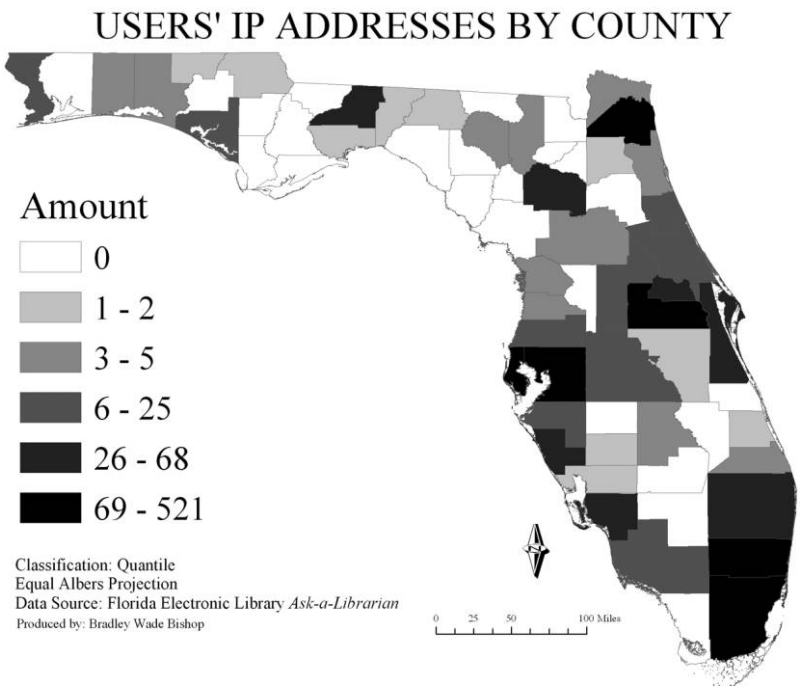

FIG. 3.—Questions by county for user IP addresses

IP addresses. Automatically captured by the chat digital reference software, IP addresses can be geocoded and mapped to show the locations of networked devices through which users are accessing the Internet. These IP address locations can indicate networked computers affiliated with universities, schools, businesses, government agencies, and commercial Internet services providers.

Entry portal data alone did not indicate the extent to which the statewide chat service had attracted usage by chat questioners from areas beyond those counties with participating local libraries. However, when entry portal data was compared with IP address data, it could be seen that while users had accessed library entry portals in thirty-five of the thirty-nine participating counties, users' Internet service provider locations had originated from forty-three Florida counties, as shown in figure 3. Among these forty-three counties with which users' IP addresses were affiliated were seven counties that did not as yet have local libraries participating within the statewide chat service.

Similarly unanswered by library entry portal data was the extent to which users of the Ask a Librarian service were affiliated with Florida-based IP

addresses. This can be a key issue for libraries, since expenditures for some information services may be intended primarily to support local users. Mapping users by IP addresses revealed that the majority of Ask a Librarian users were, in fact, affiliated with Internet service providers within Florida's statewide service area. Of the 1,859 chat questioners, 72 percent (n = 1,338) had IP address affiliations within the state of Florida.

Notably, the IP addresses analysis offered further insight into the 206 virtual questioners who had approached the chat service via the Florida Virtual School and the Ask a Librarian home page, two entry portals that, due to their online distributed nature, had a geographic affiliation that could not be specified more precisely beyond "Florida." When mapped by their IP addresses, more than half (n = 136) of these virtual entry portal questioners accessed the Internet from Florida-based IP addresses; further, their IP addresses were not limited to Hillsborough County, Leon County, or Orange County but instead were distributed among twenty-nine Florida counties.

Patterns of regional access around local library entry portals emerged as well from the analysis of users' IP addresses. Most Florida questioners entered the statewide chat service through library entry portals in the same county as their own IP addresses; in fact, only about one-third of users with Florida IP addresses entered the virtual questioning service through a library entry portal in a county differing from their own IP address (32.7 percent, or 438 questioners). Although Ask a Librarian users could potentially surf to any of the online participating libraries in asking their virtual questions, most apparently "stayed local" in directing their questions through libraries situated in the same geographic area as their own Internet service providers.

The IP address data also revealed the potential for some entry portals to attract greater statewide and out-of-state usage than others and to attract different types of questions from different demographic groups. The State Library of Florida's online library entry portal, for example, attracted chat questioners with IP addresses from nineteen Florida counties statewide as well as many out-of-state visitors; nearly half of the questions asked through the State Library portal (47.3 percent) were from visitors with out-of-state IP addresses. Demographically, the State Library entry portal to Ask a Librarian attracted a majority of nonstudent questioners (ninety-six of 110 virtual questioners, or 87.3 percent), and a high rate of business (8.2 percent) and government (57.3 percent) questions.

Overall in this study, nonstudent questioners were observed to ask 84.6 percent of all "government/law" questions and 71.4 percent of all "business" questions, while K–12 students dominated in asking "readers advisory" questions (62.5 percent). College and university students asked slightly more of the "education" questions (36.9 percent), but the topic

TABLE 1
August 2006 Chat Questions by User Demographics

Question Type	K–12 (%)	College/University (%)	Nonstudent (%)	N/A (%)	Total no. of Users
Library services	16.0	26.7	50.7	6.6	562
Academic research	44.1	35.6	17.9	2.4	329
Library resources	20.3	26.7	50.8	2.2	315
Personal research/ fact-finding	14.7	13.0	67.9	4.3	184
Government/law	2.3	9.2	84.6	3.8	130
Education	23.4	36.9	33.3	6.3	111
Business	5.7	21.4	71.4	1.4	70
Other	32.8	18.0	34.4	14.8	61
Readers' advisory	62.5	3.1	34.4	0	32
Teaching	0	12.5	87.5	0	16
Computer/Internet literacy	20.0	20.0	60.0	0	15
Health/medicine	21.4	28.6	42.9	7.1	14
Problems	50.0	7.1	35.7	7.1	14
Recreation	16.7	16.7	66.7	0	6
Total no. of questions	413	466	896	84	1,859

of education was of interest as well to nonstudent members of the public (33.3 percent) and to K–12 students (23.4 percent), as seen in table 1. Geographic analysis for these groups found that college and university students asked 466 questions via libraries in twenty-nine Florida counties, K–12 students asked 413 chat questions via libraries in twenty-nine Florida counties, and nonstudents asked 896 chat questions from libraries in thirty-two Florida counties as well as from out-of-state locations.

Out-of-state questioners represented a key concern for Florida's statewide service in terms of resource allocation, as well as a complex area of the results. Among the Florida Ask a Question users, 28 percent, or 521 chat users, had IP addresses that did not map to Florida geographic locations, including seventy of the 206 users who had entered via the Florida Virtual School and the Ask a Librarian service home page. IP addresses for these users either resolved to out-of-state locations or were not attributable to a specific location but instead defaulted to a general Internet provider name such as Verizon or Bell South without a specific geographic location given. Further complicating out-of-state results was that the large commercial Internet service providers such as America Online (AOL) may purchase "blocks" of IP addresses and route their users through those "hub" IP address locations, providing a dynamic IP address that can resolve when geocoded to a different location than where the user is actually

geographically situated. "Reston, Virginia," for example, is a known AOL user IP address hub location, and an AOL user in Florida could in fact appear to be from Reston, Virginia; in the study, this location was indicated for 102 of the "out of state" users. As seen in these results, geolocation for IP addresses is not yet 100 percent accurate, although the industry is continuing to work on these accuracy issues.

Limitations of This Study

While entry portal and IP addresses data provide useful evidence toward understanding the geography of virtual questioners, key limitations should be noted in interpreting the results of this data. Entry portal data demonstrates how users navigated the virtual landscape of the Ask a Librarian service, selecting a particular library entry portal as their initial access point for approaching and asking a question of the statewide chat service. However, Florida's Ask a Librarian service had not, at the time of this study, implemented service barriers such as requiring users to supply proof of affiliation (e.g., proxy authentication or a local library card number) that would block unaffiliated users from entering any particular library portal site. Thus, while the entry portal data maps a part of the users' virtual geography in approaching the service, it does not definitively prove the user's geographic or institutional affiliation with the selected entry portal.

IP address data provide a numerical identifier for the networked device through which users have accessed the Internet; these identifiers can be static (always the same assigned numbers) or dynamic (assigned at the time of connection to the Internet from a block of available numbers for that network). IP address data can be used by researchers to identify the network Internet service provider (ISP) through which users accessed the Internet such as a networked computer at a workplace, school, or commercial Internet service provider, which can also be geocoded to obtain latitudes and longitudes for ISP geographic locations. However, geographic attribution at the city level for IP address locations is not yet 100 percent accurate with any geocoding software due to the issue of large commercial ISPs such as AOL, which purchase blocks of IP addresses and route their users through these hub locations, providing a dynamically assigned IP address that may reflect a different location than where the user is actually geographically situated. Thus, while the IP address data map another key aspect of chat users' virtual geography via the location of the company, school, government agency, or commercial ISP through which the user accessed the Internet, it does not prove a user's physical presence at the ISP location.

As a final caveat, this study also tests the method of using a geographic information systems analysis to examine one month of data from the collaborative chat service, which represents only a limited view of activity patterns. Further research would be needed in future to explore whether activity patterns change from month to month and to examine the annual temporal cycle of virtual questioning activity.

Conclusions

This study explored the geography of virtual questioning by using geographic information systems to map and evaluate user activity in approaching and asking questions of Florida's statewide Ask a Librarian collaborative chat service. The use of GIS mapping and a question typology focusing on users' information needs and motivations for questioning provided new insights into digital reference user behavior and tested new assessment methodologies for researchers.

The local nature of chat reference emerged as a notable result in this study. Researchers observed that two of the three question types most frequently asked by users in this study concerned local library resources, such as obtaining specific items from the library, and local library services, such as paying fines and obtaining local library cards. These local types of questions are notoriously difficult for statewide collaborative chat librarians to answer.

Prior studies have indicated that some questions require local knowledge to be answered most effectively [40–42] although librarians at another location in a collaborative service may lack both the necessary local knowledge and the access to local resources. Jo Kibbee [43] observed that a majority of questions received by chat and e-mail focused on library collections and policies. Nahyun Kwon [44, pp. 83–84] found that in a collaborative chat reference service "local questions were less completely answered compared to non-local, generic questions" and "patrons who ask local questions tend to be less satisfied with the service than the patrons who ask non-local, generic questions."

In this study, researchers observed that the local nature of chat reference extended further into how users approached and posed their questions through the online portals of the statewide chat service. Although it was possible for users to approach any participating library portal, including the home page of the statewide chat service, users most commonly asked their chat questions via local library entry portals. Only about one-third of Florida users accessed the statewide collaborative chat service through libraries in counties different than their own IP address.

For users, asking a chat question via the local library's Web site only to

be told by a collaborative chat librarian that their question needs to be resubmitted to the local library is a confusing, time-consuming, and negative experience. Since the findings of this study demonstrate that users commonly approached Florida's statewide chat service through local library entry portals and frequently asked questions involving local library resources and local knowledge, methods of designing of statewide, national, and regional chat services to accommodate local-level questioning should be considered. These new interface and workflow designs should eliminate the need for chat users to pose the same question more than once in order to get an answer. Example solutions include

- designing question intake forms to "triage" questions, directing users to pose local questions to local librarians (e.g., "question about a library card? Click here!");
- implementing routing systems that allow collaborative librarians to locate and seamlessly transfer a chat user to a local librarian, if the local librarian is available;
- integrating automated routing that delivers chat users to an available local librarian based on the local portal through which the user entered the system; and
- providing staff training and implement policies requiring collaborative chat librarians to directly contact local librarians via phone, e-mail, instant messaging, or chat to directly relay users' locally based questions, rather than making it the user's responsibility to find and contact local librarians.

Results of this study in the observed tendency of users to "stay local" by accessing collaborative chat services through local libraries suggest that improving the geographic diversity of participating libraries would help to expand outreach to users. Recruiting new participating libraries from counties and regions not yet represented within the collaborative chat service offers a potentially effective method of outreach to local library users throughout a state or region. By mapping virtual questioners of a statewide or regional service in comparison with other available GIS data sets such as general population statistics, potential areas for focusing expansion efforts can be more clearly identified (see fig. 4).

For libraries and collaborative chat services, understanding the geography of virtual users particularly concerns the question of eligibility for locally funded resources and services. Important to the concept of "local users" is some means of verifying affiliation and entitlement to services and resources on the basis of membership in a local community for which tuition or taxes are paid. While academic libraries receive funding through tuition and the state, public libraries receive a majority of funding through local municipal or county property taxes, supplemented to a lesser degree

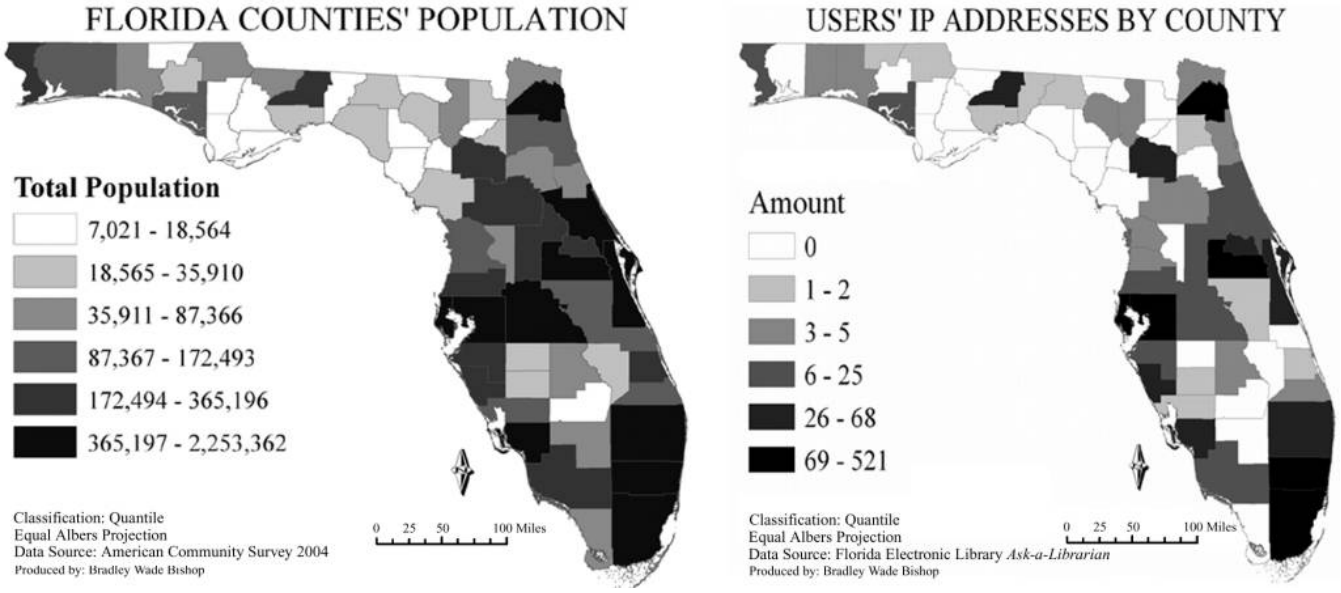

FIG. 4.—Florida population by county, and questions by county for user IP addresses

with state and federal funds [45, 46]. As Jennifer Wilding [45, p. 33] noted, "The property tax is more geographically based than libraries themselves." Without some level of automated checking on affiliation through proxy authentication and/or Internet geolocation services, any online user whether geographically eligible or not is able to access services.

The presence of out-of-state users in the study's findings raises questions as to why a user might choose to approach a geographically distant chat service with a question. Three examples from the chat transcripts demonstrated various scenarios in which out-of-state users were attracted to the statewide collaborative chat service due to perceptions regarding Florida-based availability of needed answers.

User: im looking for a obituary . . . he died in [Florida] I live in ny.
User: I owe a book to [Florida library]. I wanted to pay the fine for it, but i lost my library card also and i moved out of state.
User: What forms of Id is required to obtain a library card. I am a resident of California and will be staying in [Florida] till October.

As with other Sun Belt states, Florida has a large contingent of part-year residents or "snowbirds" who winter in Florida but travel or reside elsewhere during the rest of the year. Estimates from 2006 place these seasonal Florida residents at anywhere from 920,000 to 1.2 million [47, 48]. For the Sun Belt states in general, nationwide estimates for seasonal residents are 10 million, including about 1 million who travel year-round in RV motor homes [49], thus lacking any fixed local geography. A similar questionable status regarding local geographic affiliation and therefore entitlement for statewide collaborative chat services occurs for homeless state residents unable to provide proof of local residence, including new arrivals living in temporary locations such as hotels, motels, and youth hostels while seeking a home in the state, as well as distance students who pay tuition to attend local schools and universities but live outside of the state. The example of the Florida Virtual School in the results of this study, in which the geographic location of the institution itself can be perceived as fluid since the locations of its instructors and students are geographically dispersed, demonstrates how the changing landscape of education and distance courses already is having an impact on the nature of the educational institutions participating in statewide and regional collaborative chat services. Even "regular" state residents may travel out of state occasionally while still needing to access library services online.

Internet geolocation as a gatekeeping function is already being incorporated by libraries and collaborative chat services into virtual question answering and database access. Statewide library services in Connecticut, New Jersey, and Kansas are among those implementing geolocation software such as Quova (http://www.quova.com) to authenticate IP addresses

of virtual users; other software of this type includes Digital Envoy (http://www.digitalenvoy.com) and NetGeo (http://www.netgeo.com). However, results of this study suggest that precision of geolocation can be improved through collecting additional spatial data directly from the users to supplement to the IP address. Asking users to fill out a zip code, city/state, or county prior to beginning the chat would provide an additional geographic data point to counterbalance inaccuracies associated with mapping users by IP addresses alone. Some services already request this type of geographic data provision from users, such as Oregon's statewide consortial chat and e-mail service, which uses zip codes correlated to counties [50]. Collecting this additional geographic data point from users would improve understanding of the nature and extent of the geographic service area and better support decision making for both gatekeeping implementations and outreach efforts.

This study focuses on the situation and context of the digital reference user, an area often overlooked within digital reference research. Research agendas for digital reference [1, 51] touch obliquely upon users, as, for example, R. David Lankes's [51] discussion of "the question" as one of five key components in digital reference along with "human expertise, efficiency and effectiveness, information systems and answers." Pomerantz [1, p. 1291] discusses user aspects in more detail, including user affiliation, the impact of specific technology implementations on demographics of users, and factors that "affect a user's decision to contact a chat-based reference service." However, neither of these research agendas specifically call for research into the situations and contexts of digital reference users and nonusers, including questions of

- the geographic location of users as they access chat services;
- their unique situation and context in terms of disability, language, literacy levels, technology access, culture, and other factors;
- their individual expectations and past experiences with chat services;
- their motivations for asking the question and how they subsequently use the information provided;
- temporal factors influencing users' question-asking behavior, and other such factors that bring new understanding of how users' specific situations and contexts impact their interactions digital reference services.

In examining the geography of virtual questioning, this research study has probed the often unexamined substrate of contextual factors underpinning user access to digital reference services. Through a geographic analysis of how users access and ask questions of a collaborative chat service, this study lays the groundwork for future research efforts in the impact of geography-based affiliation and geolocation software on chat services and

offers evidence-based implementations to optimize the handling of locally based questions as well as to guide outreach efforts in expanding regional user bases for collaborative chat reference services. Future research in this area could expand analysis of geographic factors to digital reference services with a global scope, thus enriching our understanding of the geography of virtual questioning beyond the local and the regional and into the international level.

Appendix

FEL Ask-a-Librarian Codebook

Academic Research (Research Skills)—researching a scholarly topic or historic topic (subject focus—how to find information on research topic/issue; includes K–12, college, university help with homework/schoolwork assignments); how to produce a paper, write citations properly, spelling, grammar); how to conceptualize and undertake a research effort and produce the finished product of the research in an appropriate form and format. Excludes Business, Government/Law, and Health/Medicine unless directly stated as academic/school research. Also does NOT include technical access to homework help service (see Library Services).

Business—asking about a consumer issue, personal finance, or business topic; seeking information for business purpose such as selling, buying, advertising, companies, products, consumer issues, market demographics, getting a job, employment issues, getting grants and fund-raising; NOT where directly stated as academic/school research (see Academic Research).

Computer/Internet Literacy—help with computers and Internet such as how to search the Web, how to get an e-mail account, how to troubleshoot a computer problem; use only for questions about computers and Internet outside the library, NOT about library databases, library computers, or getting access to Internet at a library.

Education—finding information about schools/universities, classes, class requirements, e.g., syllabus/readings, workshops, study materials for standardized/occupational tests, other training, school/university rules, contacts and referrals at schools; find out textbooks needed for a class, how to purchase textbooks (see also Teaching).

Government/Law—how to get government forms and government services, find out where to seek information within government, find rules/laws/legal information, find representatives, find out what government is doing, file taxes/pay fees, finding out information about the government such as size, budget, staffing; NOT where directly stated as academic/school research (see Academic Research).

Health/Medicine—how to find medical information, find doctors/health

providers, or get a referral for medical/health purposes; NOT where directly stated as academic/school research (see Academic Research).

Library Resources—using library tools and resources such as databases and the catalog; finding or getting a specific database, book, video, map, DVD ("known item search"); which databases exist in the library's collection (format or item focus—looking for/getting a specific book, newspaper, article, journal, select a database).

Library Services—asking about library policies and procedures at the local library in getting set up to use the library and obtain services, such as getting a local library card, open hours, reserving a carrel or group study room, renewing a book, paying fines, events taking place at the library, how to get into a database—solving a technical issue or authentication/access issue to a subscription database; getting ILL; how to interlibrary loan a needed item; help in accessing the Tutor.com subscription-based homework help/tutorial service.

Personal Research and Fact-finding—finding information for self help, fix-it, home and auto repair, finding a quick fact, learning how to do it yourself, accomplish chores and tasks; finding information about hobbies such as knitting, quilting, etc. Also includes genealogy research.

Problems—disconnected without asking any question at all; nuisance questions/hassling the librarian. Does NOT include disconnects or incomplete/partial interactions (code those for the question asked, not as problems, regardless of whether there was a librarian response).

Readers' Advisory—recommendations and advice on book choices and reading, how to find an appropriate book for a particular age level, how to find a book that a person would enjoy.

Recreation—finding information about concerts, local movie times, tourism, arts, travel destinations for vacationing and recreation.

Teaching—finding information and resources for teaching a class, a workshop, a lecture or presentation; using the Ask a Librarian service in a demonstration for teaching (see also Education)

Other—use this sparingly and explain why the item does not fit into any category above.

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