Balance between more effectiveness and less intrusion: Will interactive Virtual Reference model work?, [1]

by: Xiangming Mu (U.S.A.)

Abstract
Virtual reference is a library service that uses the Internet to provide remote reference services. The benefit of virtual reference service is to provide help anytime, anywhere. One challenge for a current virtual reference service, however, is the low rate of usage. Towards this problem, we proposed a new interactive Virtual Reference (iVR) model. Instead of working inside the circle of the VR process, we focused on the user's actions before "initializing the VR service process." As a result, our interactive virtual reference model enables VR librarians to identify the "troubled" patron and then to offer prompt help. The help is automatically triggered by a set of criteria that are predefined in the system. A simple "no match" factor is selected to be implemented in our iVR prototype system. Other criteria are also analyzed based on our survey of 47 libraries. Two comparison studies using different iVR interfaces were conducted to evaluate their performance in terms of system helpfulness and interface satisfaction. Patrons' concerns concerns over potential privacy violation and intrusion were also investigated. We found that our pop-up interface design was helpful but should more fully consider users' concerns about the intrusion.

Keywords
Electronic reference services; Virtual reference desk; User privacy; Patron digital privacy; Prompt helps in interface design.

Resumen
Título del artículo en español: "Encontrar un equilibrio entre más eficacia y menos intrusión: ¿Funcionará un modelo interactivo de Referencia Virtual?" La referencia virtual es un servicio de biblioteca que utiliza el Internet para ayudar a proporcionar servicios remotos de referencia. La ventaja del servicio virtual de referencia es proporcionar ayuda a cualquier hora y en cualquier lugar. Un desafío para un servicio virtual actual de referencia, sin embargo, es su tasa reducida de uso. Hacia este problema, propusimos un nuevo modelo de Referencia Virtual interactivo (iVR, interactive Virtual Reference). En vez de trabajar dentro del círculo del proceso de Referencia Virtual (RV), nos enfocamos en las acciones de los usuarios antes de que inicializaran el proceso del servicio de RV. Consecuentemente, nuestro modelo de referencia virtual interactivo permite a los bibliotecarios de RV identificar el usuario preocupado y luego ofrece ayuda pronta. La ayuda es accionada automáticamente por un conjunto de criterios que son predefinidos en el sistema. Un factor sencillo de "No Hay Ninguna Coincidencia" es seleccionado para ser ejecutado en nuestro sistema de prototipo de RV. Otros criterios son también analizados basados en nuestra encuesta de 47 bibliotecas. Dos estudios de comparación usando diversos interfaces de RVinteractiva fueron conducidos para evaluar su funcionamiento en términos de utilidad del sistema y satisfacción de la interfaz. Las preocupaciones de los usuarios por la violación e intrusión potenciales a la privacidad fueron también investigadas. Encontramos que nuestro diseño de interfaz móvil (pop-up) fue provechoso, pero deberíamos considerar más profundamente las preocupaciones de los usuarios concernientes a la intrusión.

Palabras clave
Servicios electrónicos de referencia; mostrador de referencia virtual; Privacidad del usuario; privacidad digital del usuario; ayuda rápida en diseño de interfaz.

Introduction

Virtual Reference (also called digital reference, real-time reference, chat reference, live reference, etc.) is defined by Lankes as the service of "use of software and the Internet to facilitate human intermediation at

[1] Part of the paper is developed based a poster presented at ASIS&T 2006 annual meeting (Mu, 2006)

a distance." (Lankes, 2004) In other words, patrons can "chat" with a live librarian online without being in a library—the goal is "anytime, anywhere patrons." In addition, some VR systems allow the librarian to control the patron's web browser for co-browsing and "escorting"—i.e. librarians can show their patrons around the Internet or how to use the OPAC (Olivares, 2004).

In the past several years, a growing number of Virtual Reference (VR) services have been provided in libraries or public organizations (Coffman and Linda, 2004a; Jansen and Pooch, 2001; Lankes, 2004). As of January 2004, OCLC claimed its QuestionPoint service (www.questionpoint.org) was in use in over 1,000 libraries; other VR systems such as 24/7 Reference (www.247ref.org) and eLibrarian (eLibrarian.digi-net.com) also claimed about 1,000 or so libraries each. Adding the Docutek VRLplus (www.docutek.com), LivePerson Pro (www.liveperson.com), and Virtual Reference Toolkit (www.vrtoolkit.net), there could easily be more than 4000 libraries currently offering live online VR services (Coffman and Linda, 2004a). Virtual reference services are still a high priority for many libraries (Campbell, 2003).

Despite the advantage understood by librarians and the apparent wide support of VR services in libraries, research shows patron usage of VR services is quite low (several visits a day on average) and not cost/beneficial (Boyer, 2001; Coffman and Linda, 2004a; Coffman and Linda, 2004b; Tenopir, 2004). Accordingly, some libraries began to think about "pulling the plug"—removing their VR services and spending their money and efforts elsewhere (i.e., the defunct chat services at Vanderbilt University, MIT, and Los Alamos National Labs). Library of Congress had been one of the earliest proponents of digital reference services but has closed chat reference service in eight of its 11 units (Coffman and Linda, 2004b).

The low usage of VR does not necessarily mean remote patrons do not need help from the librarians nor that they do not like VR service provided. Borgman et al found OPAC systems were difficult to use due to high zero hit rates, inappropriate interface design, confusion regarding Boolean logic, and failure to use advanced features (Borgman, 1986; Bogman, 1996). Peters indicated that a 40 percent failure rate (zero hits) was normal for one-item queries (Peters, 1989). In addition, advanced features were rarely used to help to improve search quality (Jansen and Pooch, 2001; Millsap and Terry, 1993; Peters, 1989). On the other side, for patrons who have received help from a virtual librarian, a high level of satisfaction has been found. For example, the results of an obtrusive log data analysis of more than 3000 questions answered through a VR service indicated 19.7% answered questions received unsolicited thanks from users (David and Joseph, 2000).

A large volume of research has been conducted in an effort to improve VR usage in several areas: new marketing strategies, collaborative VR service, optimized routing, multimedia VR systems, new VR models, technical improvement, etc. (Lankes, et al. 2006, Lupien, 2006). From a different perspective, in this paper we propose a new interactive VR (or iVR) model, which turns the traditional one-way passive VR into a two-way interactive VR. In particular, instead of requiring explicit initialization from the patrons, iVR offers help for "troubled" patrons automatically.

Literature Review

Models were developed to achieve effective VR practice. One effort is to analyze the participant role in the standard VR process indicated that the patron, filterer, answerer, administrator, and coordinator were the five primary roles in a VR service (McClennen and Memmott, 2001; Pomerantz, et al. 2004). The functions of each role were defined with regard to the specific digital environment of VR (Mu and Luo, 2005). One important issue is how to effectively connect different components of a VR process. Lankes delineated such a connection as: "Users initialize the process by asking a question, which is triaged by the triage center and delivered to experts for answers" (Lankes, 2004). Arret (2001) further described the VR process as a workflow starting from "Accept request" through "Assign request," then "Work on Response," "Return Response," "Review Response Completeness," until "Clarify Request." This waterfall model

expanded by Lankes from a more broad perspective by indicating that any VR service needs to be viewed through a combination of multiple disciplines (or lenses) including policy, systems, evaluation, and behavior (Lankes, 2004).

These general VR models depicted a clear picture of the VR process. The limitation, however, is that they failed to provide solutions for patrons who fail, or are reluctant, to "start" the process—a fundamental problem in current VR practices (Coffman and Arret, 2004; Lee, 2004). In other words, how to increase the usage of the VR service?

Interactive Virtual Reference

Different from traditional VR services which are usually passively awaiting initial activation from remote patrons, interactive VR, or iVR, is designed to provide active VR service. For example, when a failure occurs when a patron is using an OPAC system to do information-seeking task, the iVR system will automatically capture the failure message and routes it to an available VR librarian. In other words, the "initialization" process will be activated automatically without any extra efforts from the patron side.
Our proposed iVR model is composed by a three-tier infrastructure, namely OPAC, VR assistant, and VR service tier (Mu, 2006). The OPAC tier refers to the library's online catalog system. The VR service tier is the current VR services (i.e., OCLC's QuestionPoint). The VR assistant tier is a bridge connecting the OPAC and the VR service tier. The major role of the VR assistant is to watch patrons' "irregular" behaviors when they are using OPACs. For example, when patrons could not find any returns from a search, the VR assistant will be triggered and acknowledge a virtual reference librarian to offer help. Actually, there are many behaviors can be defined as "irregular" or "trigger". Accordingly, we defined an independent module called triggering metric. Specific rules can be defined as the triggering factors. Triggering metric, which includes an array of criteria that will lead a patron to be regarded as in "trouble," makes the iVR easily be fitted into different application contexts (see Figure 1).

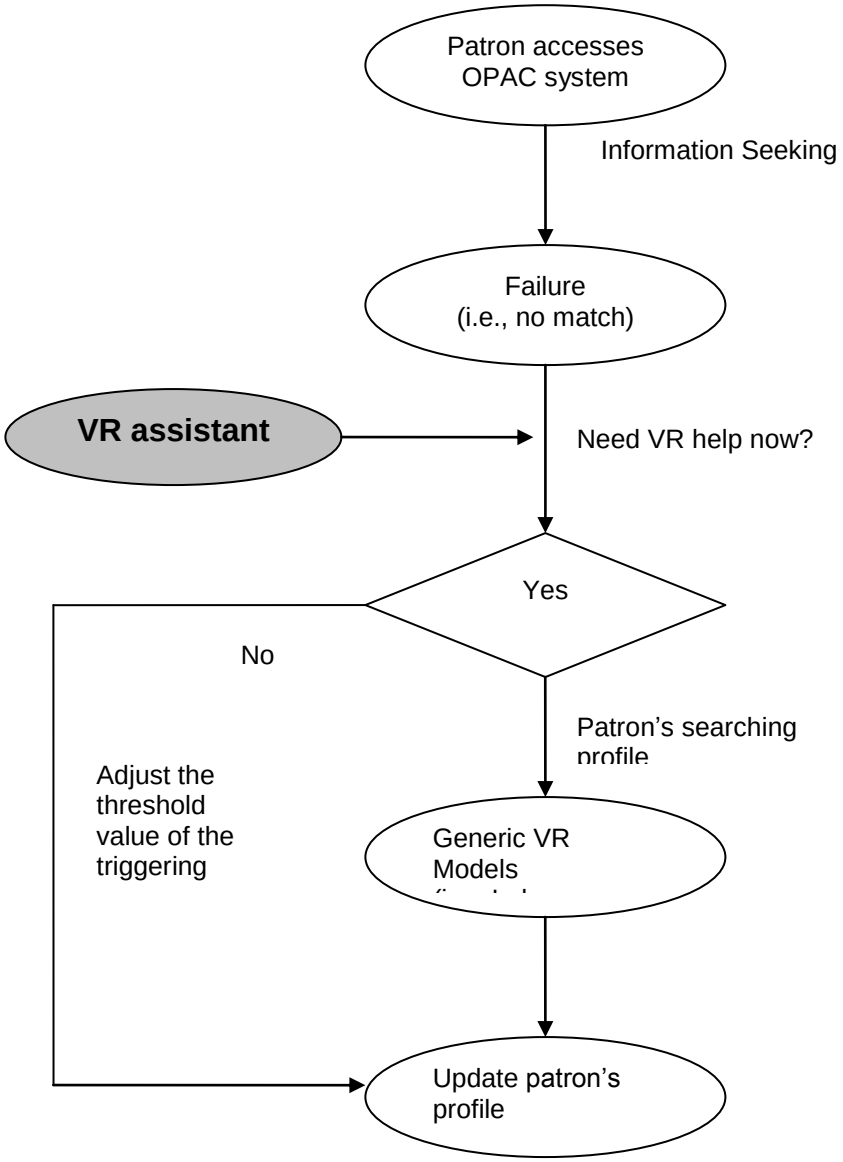


Figure 1: Flowchart of the iVR model

Interactive Virtual Reference Prototype

To exploit issues engaged in the interactive VR, we also designed and developed a set of prototypes. Corresponding to the prior three tiers in the model; we chose the PantherCat Online Catalog system (http://www.uwm.edu/Library/) as the prototypes' OPAC tier and the OCLC QuestionPoint system as the VR service tier, respectively. The VR assistant tire was developed separately. The prototype is currently available online for public testing. PHP code was used to create the system. The backend supported

database is MySQL. As the prototype was implemented as HTML format for presentation, it is independent from the user's operating systems.
When designing a software component such as the VR assistant, there are several design requirements that need to be considered. The following three principals were outlined as our requirements for the VR assistant.

- Compatibility: refers to the combination of the web compatibility, OPAC system compatibility, and VR system compatibility. A VR assistant needs to be a light-weight web-based component that is easily embedded into the current OPAC and VR systems via the Internet.
- Adaptability: the VR assistant needs to be open to modification. In other words, the VR assistant needs to be reconfigurable in order to fit to any customized triggering metric.
- Flexibility: the VR assistant needs to be supportable on heterogeneous operating systems.

The iVR prototypes were developed based on the above principles. As a prototype, a simple triggering metric with only one trigger, zero returns, was implemented. Figure 5 is a screenshot of one prototype design.

Virtual Reference Trigger

We instantiated the triggering metric with only one simple factor—patrons get zero return. According to our three implementation principles, the metric can be easily expanded by adding additional factors. These factors are usually built based on problems patrons' encountering when using the OPACs. As an important part of our study, we need to get a better understanding about users' behaviors in using OPACs so we can identify key factors that motivate patrons to turn to VR service.
Previous research has demonstrated that the difficulties of using OPAC could be caused by either knowledge problems or mechanical problems (Pomerantz, et al. 2004; Rice and Borgman, 1983; Tolle, 1983a). Some typical problems can be, for example, how to choose correct terms in subject search? How to broaden/narrow down the search results? How to use Boolean logic in an advanced search? Or, how to use index-browsing features?

No match error

Borgman analyzed the online catalog systems in five Ohio State University campus libraries and found that errors for logical and typing were 11-15% (Borgman, 1983). These mechanical errors can be easily solved by patron themselves if they gave a second look at their typing. But for knowledge problems, patrons might need help from librarians. Dickson and Taylor (1984) each analyzed data from the NOTIS system at Northwestern University and provided a zero return (no match) error distribution for different search (Dickson, 1984; Taylor, 1984) (see table 1).

Table 1: Error distribution from studies by Dickson (1984) and Taylor (1984)

Search type	Percentage of no match	Percentage
Title searches	37 %	39 % due to user's error no records in database
Author searches	23 %	51.3 % (or 77.6 % different sample of the same data) due to user's error no records in database
Subject searches	59 %	

From table 1, we find that subject search is more prone to errors as compared to title or author search. Actually, such no-match subject search error rates can range from a low of 35% to a high of 57% in the BACS system[20]. Dickson and Taylor further provided a more specific classification of the no-match errors and indicated major error types (Dickson, 1984; Taylor, 1984) (table 2).

Table 2: Classification of no-match errors

Sources of no-match	Percentage	
	Dickson's data	Taylor's data
Inclusion of initial articles	10.1 %	
Wrong name order	12.6 %	16.7 %
Wrong forename or incorrect inclusion of a middle initial	9.9 %	5.6 %
Searching title or subject terms in the author field		5.7 %

Advanced search

In terms of advanced search, Fenichel's findings based on the survey data from the CLR studies demonstrated that using advanced feature is still hard for many users (Fenichel, 1981; Mattews, et al. 1983) (Table 3)

Table 3: Percentage of using advanced search features

	advanced search features	search success
Low	20 %	33.3 %
High	33.3 %	50 %

Sequential errors

Triggering metric can also implemented time variable. We can add factors that describe a sequence of actions as one of the triggering criteria. For example, the fact that next error occurs after an error was made could indicate that the patron might really need VR help. Table 4 summarized previous research on this issue from several different systems. We find that the average percentage of next error after an error was made could reach as high as 40.6%. We also notice that only about 10.1 % of users ended the search session after an error was made. In other words, majority users would continue the search task and attempt to solve the problem either by themselves or by asking for help.

Table 4: Percentage of repeated errors in several studies

Systems	Next error after an error	Ending the session after an error
Scorpio	59.8 %	8.7 %
SULIRS	28.6 %	5.7 %
LCS	33.3 %	10.8 %
NLM		15 %
Average	40.6%	10.1%

Demographic information

It will be helpful to parameterize users' demographic information in the triggering metric. In studying the NLM Catline system, Tolle (1983b) found that infrequent VR users are more likely to end the search after an error (20%) as compared to frequent VR users (8%). In addition, infrequent users are also more likely to have input errors (9%) as compared to frequent users (4%) (See table 5).

Table 5: User demographic information and the percentage of ending the search after an error

	Ending the search after an error	Error input
Frequent users	8 %	4 %
Moderately frequent	11 %	4 %--9 %
Infrequent users	20%	9 %

OPAC problems

Findings from these studies provided a set of variables regarding key problems in using OPAC. But we cannot claim that these problems are the primary motivations making patrons to look for VR services. In order to exploit the triggering factors that are actually drive patrons to the VR service (Cummings, et al. 2007), we conducted a survey study. We developed 10 major OPAC problems based on previous research for this study.

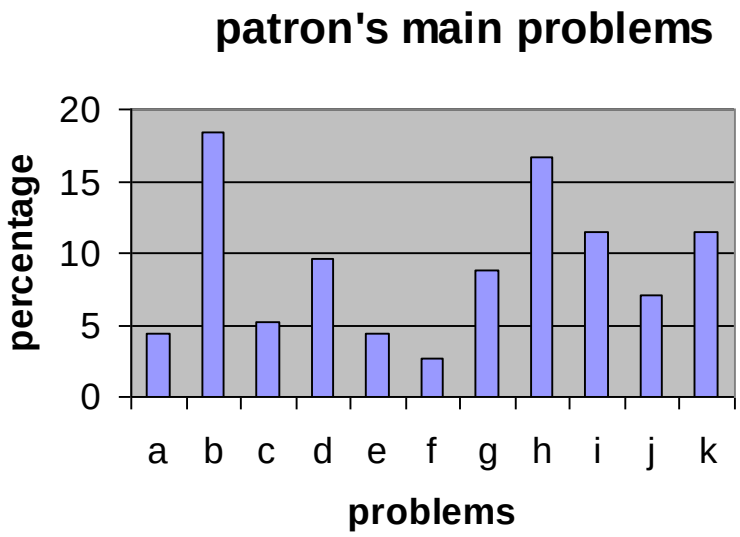
1) About the OPAC system
- Don't know benefits of using controlled vocabulary
- Have difficulty selecting the right controlled vocabulary
- Have difficulty selecting the right keyword search term(s)
- Don't understand what Boolean terms do
- Don't know how to use "advanced features"
- Completely new to the OPAC system

2) About the search results
- No Match" or "Zero returns"
- Too many returns

3) About the VR services
- Off-campus access
- Services (e.g., working hours, printer locations)

Survey Study

We selected 100 VR services in libraries in the United States and Canada to survey their VR librarians. One key question in the survey is to ask the librarians to identify three key VR problems from the above list of 10 OPAC problems. Due to technical issues (e.g., no active connections), access issues (e.g., student ID is required to use a campus VR service), and other reasons (e.g., very long waiting time), 47 libraries in the United States and five in Canada joined the survey study and returned their answers.

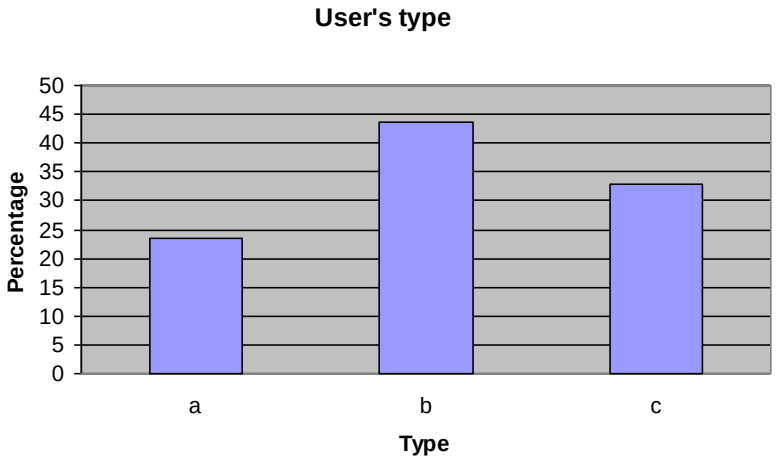


a. Use of keywords when controlled vocabulary would be better
b. Difficulty selecting the right keyword search term(s)
c. Don't know benefits of using controlled vocabulary
d. Don't understand what Boolean terms do
e. "No Match" or "Zero returns"
f. "Too many returns"
g. How to use "advanced features"?
h. Off-campus access
i. Services (e.g., working hours, printer locations)
j. Completely new to the OPAC system

Figure 2: Top VR problems from survey of 52 libraries

Figure 2 presents a bar chart of key problems identified by the libraries. We find that the top problems regarding the OPAC service are: keyword selection, off-campus access, OPAC services, other issues, and Boolean problems. To our surprise, "No match" was not on the list of top five. But as the "no match" could be the results of other issues (e.g., wrong keyword may lead to no match) and is easy to be track, we decided to use it as the triggering factor in the prototype designs.

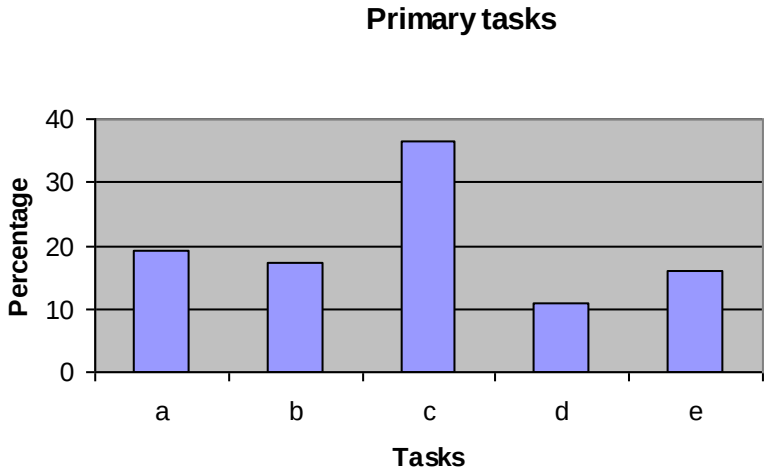
In terms of user demographic information, we find that most VR service users have some experiences on OPAC (44%). Novice users are more than the experienced users (see Figure 3).



a= Very experienced users
b= Moderate experienced users
c= Novice

Figure 3: Distribution of user types

Figure 4 provides a distribution of primary tasks when VR services are used. We find that the primary tasks are to find an article or a book. These survey results will also help us design our follow-up study tasks



a= Find a book
b= Find a journal
c= Find an article
d= Solve technical problems in using OPAC
e= others (please identify)

Figure 4: Primary tasks of using Interactive Virtual Reference Study

The goal of this study was to exploit issues related to VR and test our new iVR prototype design and interface. Figure 5 presents a screenshot of the new iVR prototype user interface. In the middle there is a pop-up Java applet window triggered by the VR assistant which asks a patron whether he wants help from a virtual librarian. The background behind the Java applet is the PantherCat Online Catalog system, which is an OPAC system for academic libraries. The Java applet pop-up window is activated by the "zero returns" when using the PantherCat system. Two options are available for the patron: if a "yes" button is clicked, a web page labeled "Ask a Librarian" will be loaded. "Ask a Librarian" allows a patron to communicate with a virtual librarian through either an email system (available anytime) or a real-time chat system, which is staffed by librarians only during working hours. If the "No" button is pressed, the pop-up Java applet will be closed and the patron will continue to use the OPAC system.

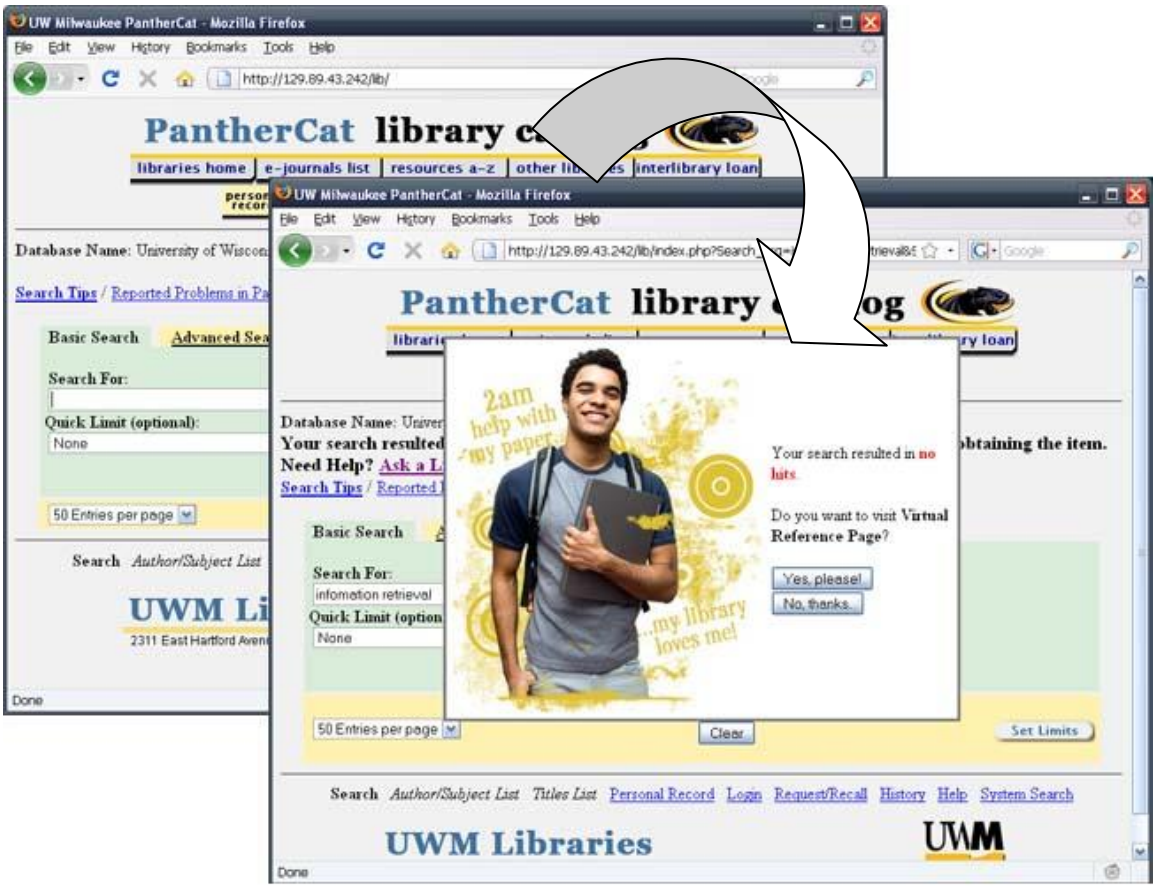


Figure 5: Screenshot of new iVR prototype

Research Method

The new iVR user interface was set up in one of the computers located in the library of a four-year university library. University students and staff were recruited to join the study. Subjects were asked to use the iVR interface to complete a set of search tasks and then answer the questions pre-prepared by researchers.

The study procedure is as follows. After the study was explained by one of our researchers, subject signed a consent form. A pre-experiment questionnaire asked for basic information about the participant and his or her experience with computers, reference services, virtual reference, and the OPAC system

(PantherCat). A post-experiment questionnaire (Appendix A) asked for users' assessment of the new iVR system. All surveys were available online and would be returned automatically when the participants clicked the submit button. $10 was awarded for participating and was not connected to whether they submitted their online surveys or not. Except for a randomly generated ID number assigned by the system, no other user identification information was collected in the study.

Considering the differences of student background as well as their interests, the search tasks descriptions are fairly general: 1) find an article of your interest using the system; 2) find a book of your interest using the system. The thinking aloud research method was adopted to record users' searching strategies.
In the post-experiment questionnaire, participants were asked questions about their satisfaction on the new interface. Selected participants were also given interviews after the experiment focusing on two issues: 1) the level of intrusion and 2) their concerns about the privacy.

Results

A total of 21 users were recruited. Three of them turned out to have no experience on virtual reference services. As we want users to compare the new system with their past VR experience, their data was discarded. The valid data includes 18 users with five male (27.8%) and thirteen female (72.2%). In terms of status, there were eleven undergraduate (61.1%), four graduate (22.2%) and three Faculty/Staff (16.7%). Most of them use computers and the Internet everyday (88.9% and 100% respectively).
In terms of the frequency of using VR service, five of them use daily (27.8%) and ten of them use less than once a week (55.6%) (see Figure 6)

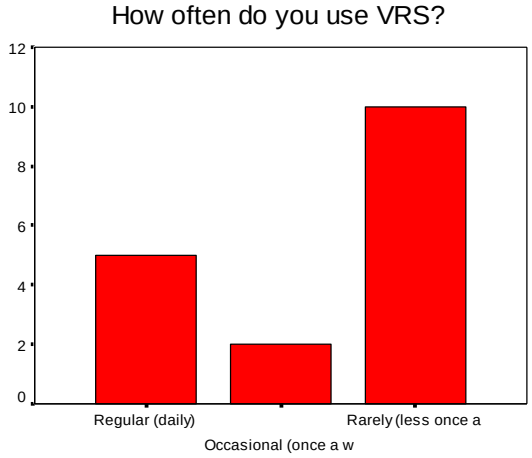


Figure 6 users' VR experience

The performance evaluation was based on an aggregation of first 14 questions in the post-experiment questionnaire (see Appendix B for the SPSS aggregation formula) regarding usefulness, effectiveness, satisfaction, future use, and pop-up design. Number 15-18 were open-end questions to solicit for additional comments. The statistical descriptions of the results are presented in Table 6. It is appeared that users who evolved in the surveys gave relatively positive evaluations on the new iVR designs regarding usefulness (5.6 out of 7), effectiveness (5.89 out of 7), satisfaction (5.43 out of 7) and future use (5.14 out of 7). About the Pop-up design, its score was not as high as other variables (5.01 out of 7). We can also find that the variance of the Popup variable was the largest as compared to other evaluation variable. Actually we do find that subjects' opinions on the popup are quite mixed.

Table 6: Results of the post-experiment survey

	Usefulness	Effectiveness	Satisfaction	Future Use	Pop_up
Mean (1-7)	5.6	5.89	5.43	5.14	5.01
Std. Deviation	1.53	1.67	1.33	1.36	2.37

In the open-end questions (15-18) and follow-up interviews, two key issues were raised. One is about the VR itself. For example: "I heard that I needed to install Java Virtual Machine to use it" or "Sometimes I would rather (using) Google." Another issue is related to the availability of the services. For example, "nobody seems to know it exists except those who work in the library." Some of them even proposed suggestions: "I think the virtual library should be taught to students sooner than college," or "Advertising, more links to it." But users do indicate the benefits from the VR services. In particular, one participant mentioned that it is helpful: "search specific articles when you have the names."

About the popup design, most users mentioned the helpfulness of the popup in terms of providing links to the VR service. "It is there, if you really need help." One subject commented.

For the intrusion and privacy issue, the responses were mixed. 8 out of 21 users mentioned they were concerned with the intrusion and privacy issues. For example, "I do not like the idea that I am watched" or "so a librarian is monitoring me?" While others gave relatively positive comments: "it is great to know that you have a librarian sitting beside you and offering help anytime".

Study on alternative VR designs

Realized the potential issues about privacy and intrusion in our new popup iVR prototype design, we decided to develop and test an alternative design without popup window following the IFLA's guidelines for OPAC displays (Battison, 2008). A comparison study of the two designs was conducted to evaluate their performances. In this study, two versions of iVR user interface prototypes were used.

a. Embedded Version (EV) (see figure 7): A hyperlink is automatically added on the result page when the "triggering" threshold value determined by the iVR assistant is reached (e.g., when zero return occurs).
b. Pop-up Version (PV) (see figure 5): A pop-up window with an icon image (or real image) of a virtual librarian is automatically presented when the "triggering" threshold value determined by the iVR assistant is reached.

Research method

A revised research protocol was implemented in this study. In our first iVR study we only had one task—let the user play with the interface and do article and book search with their own interests. In this study we decided to provide uniform search tasks so that the results from different users can be compared. Based on the findings from our prior survey study, we designed the following four tasks:

- Task one: a best match topic search. Imagine you are a graduate student working on a paper, and you are looking for current research on global warming. Locate at least three full-text journal articles on this topic.

- Task two: an exact match search. Imagine you are looking for the case outline for a specific court case, Shaw v. Hunt (154 F.3d 161) from August 19, 1998.

- Task three: a complex search. Imagine you are a student in the School of Business looking for market research to learn about the leading coffee shops in Taiwan.

- Task four: a geographic search. Imagine you are working on a report on discrimination in the workplace in Wisconsin. Locate at least three resources to aid in your research.

A total of 16 people were planned to be recruited for the study. However, after we had spoken with the first four subjects, we found that all the subjects ignored the links appearing in EV design. We interviewed these four subjects after the study and acknowledged that the designed link failed to provide an explicit hint or reminder for users about the VR service. Under such a circumstance, we decided to modify our research protocol and redesigned three new alternative interfaces for this comparison study.

The three new designs are as follows:

- No VR link interface (NV): A standard OPAC interface with no link to the virtual reference service. If users need to use the VR, they need to open a different page.
- Text VR link interface (TV): A text VR link appeared on the left side of the interface during the process of using the OPAC.
- Image and text VR link interface (IV): Both an image and a text VR link appeared on the left side of the interface during the process of using the OPAC (see Figure 7).

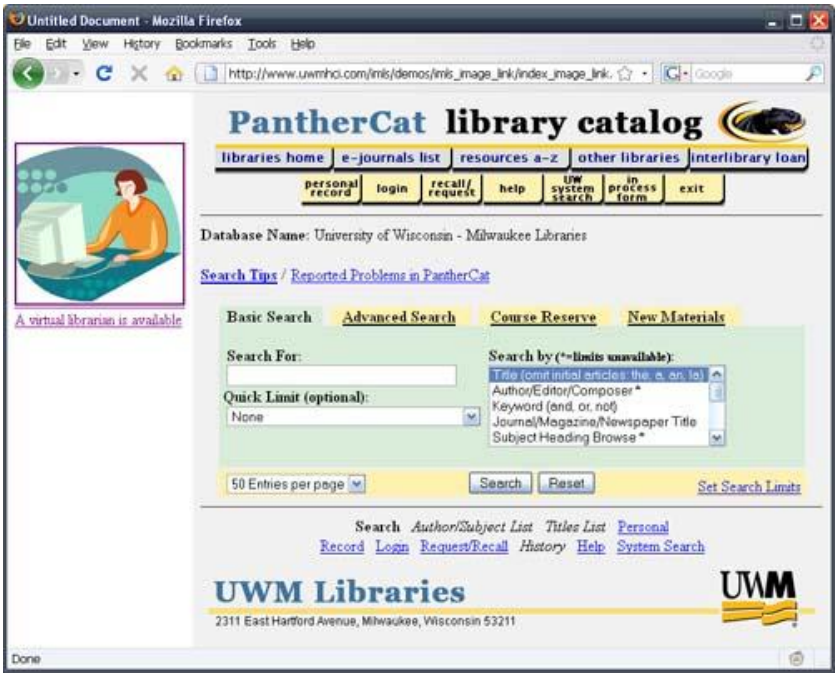


Figure 7: new iVR interface design with image and text link (IV)

As a result, the four designs of VR interfaces (PV, NV, TV, and IV) were used for our new comparison study. We adopted the within-subject design and each subject would use one of the four interfaces to answer one of the four questions. The order of questions and interface designs were well balanced in order to remove the learning effect. Similarly, after signing the consent form, each subject would first answer a revised pre-experiment questionnaire. After each trial, an in-experiment questionnaire (Appendix C) was given. Finally, after all four questions were answered, a revised post-experiment questionnaire (Appendix D) was given.

Results and Discussions

A total of 17 new participants were recruited and 16 finished the study. Among them 11 were female (69%); 15 students (11 undergraduates and 4 graduates) and one teaching staff. All used the Internet daily.

About the VR service, six of them never used it before and three of them only used it once or twice. Five subjects used it monthly and two of them more than once a week. In this study we did not require subjects' previous knowledge about VR service so all 16 data was valid.

The evaluation of the VR design is composed of four variables: helpful, interface, privacy violation, and intrusion. The results were given in table 7 for No VR link interface (NV), Text VR link interface (TV), Image and text VR link interface (IV), and popup VR link interface (PV), respectively.

Table 7: Average evaluation scores for four system designs: No VR link interface (NV), Text VR link interface (TV), Image and text VR link interface (IV), and popup VR link interface (PV).

	Helpful	Interface	Privacy violation	Intrusion
NV	4.63	4	1	1
TV	5.5	5	1	1.06
IV	6.06	5.31	1.13	1.13
PV	5.19	4.06	4.88	4.81

We find that apparently the popup design (PV) has much higher scores in terms of privacy violation and intrusion. As we talked to users in the post-experiment interviews, we confirmed that this might be affected by the VR service itself, particularly the technical problems. As one participant said, "it is nice to know that a librarian is available. But (it is) too long to load (the VR system)." Another participant mentioned: "I have tried the (virtual reference) service before and the connection was broken while I was using." The previous frustration experiences on VR service reduce the benefits of the popup links to the service.

The second reason for the failure of the popup design might because of the limitation of the test design. We observed that participants were reluctant to use the VR service, even when they came across difficulties. When the VR popup window appeared for the first time, they usually would click the yes button (87.3%). But when they were redirected to the VR service, most of them would end the service and went back to the OPAC (12 out of 15, or 80%). In addition to the previous unsuccessful VR experiences, another explanation is that subjects might hesitate to admit that they had to solicit help from virtual reference librarians to finish their tasks (Lee, 2004). To overcome this limitation, a field study is desirable and will be carried out as our next study.

Even though both intrusion and privacy violation were high for the popup design, subjects felt that they were more bothered by the intrusion issue. One subject mentioned that she felt "annoying by the jump-up window from nowhere". Another subject described the popup "reminds me of the Internet popup ads." But she then added that "maybe (it is) fine for a librarian" and suggested that the popup window only appears when she "really really needs help." Several subjects indicated that they felt uncomfortable for the virtual librarians to be there if they did not want to share the content they are searching, for example, the gay topic. One subject suggested that the popup design was helpful when installed in the public libraries, but not appropriate if they used it at home.

Results demonstrated that the alternative designs (e.g., the image and text design (IV)) had successfully reduced the intrusion and privacy concerns without losing benefits on helpful and interface satisfaction. But the follow-up interviews showed mixed responses on this conclusion. A number of subjects

mentioned that even though the salient VR link would improve their chances of using the service, they might still not click it. A popup window, on the other hand, will be more appreciated if appeared appropriately.

We believe that it is critical to further study when the virtual librarian needs to be available and the manner to present. A balance between the effectiveness in help and minimum intrusion and privacy violation would be desirable for the future VR system. Continued research efforts are still needed to further explore this issue.

Conclusions

Low usage of virtual reference services is a big challenge for libraries. In contrast to the traditional passive virtual reference model, we proposed an alternative interactive virtual reference, or iVR model. The iVR model encourages active virtual reference service via interactions between virtual librarians and "troubled" patrons. A Virtual Reference (VR) assistant component was developed so that patrons' unsuccessful information-seeking behaviors could be monitored. When patrons came across problems, the VR assistant would inform the iVR model to offer help by directing patrons to a virtual reference service. The VR triggering metric—a set of criteria that activate the VR assistant needs to be implemented in accordance with different application contexts.

The results of our two evaluation studies comparing different iVR prototypes designs demonstrated that even though popup design provides help promptly, the level of intrusion and violation of the privacy were also significantly high. This result implies that the popup design should not be unconditionally implemented. The benefits of active help for troubled patrons should be balanced with users' concerns about privacy and intrusion.

A design with image and text link to VR service achieved a better performance in terms of helpfulness and interface design but the differences are not statistically significant. Due to the limitations of experimental study, further field studies in more nature environments are needed to better understand the tradeoffs between effectiveness of the VR services and patrons' concerns about social (e.g., privacy) or physiological(e.g., intrusion) issues.

Acknowledgement
I sincerely thank all the students for their help in the user studies. This study is supported by IMLS grant LG-06-05-0155-05.

References

1. Arret, Linda. 2001. Process model for digital reference Q&A. *NISO NetRef Workshop*.
2. Battison, Susan, 2008, IFLA's guidelines for OPAC displays. Presentation to LIASA IGBIS, October 8, 2008.
3. Borgman, Christine L. 1983. End user behavior on an online information retrieval system: A computer monitoring study. *Proceedings of the 6th International ACM Special Interest Group on Information Retrieval Conference* 14 (4):161-176.
4. Borgman, Christine L. 1986. Why are online catalogs hard to use? Lessons learned from information retrieval studies. *Journal of the American Society for Information Science* 37 (6):387- 400.
5. Borgman, Christine L. 1996. Why are online catalogs still hard to use? *Journal of the American Society for Information Science* 47 (7):493-503.
6. Boyer, Josh. 2001. Virtual reference at the NCSU libraries: The first one hundred days. *Information Technology and Libraries* 20 (3):122-128.
7. Campbell, Nicole. 2003. Virtual reference demonstrations in Washiongton. *The Washington library association journal* 19 (2):15-21.

8. Coffman, Steve, and Linda Arret. 2004a. To chat or bot to chat — taking another look at virtual reference, part 1. *Searcher* 12 (7):38-46.
9. Coffman, Steve, and Linda Arret. 2004b. To chat or not to chat-taking another look at virtual reference, Part 2. *Searcher* 12 (8):49-56.
10. Cummings, Joel, Lara Cummings, and Linda Frederiksen. 2007. "User Preferences in Reference Services: Virtual Reference and Academic Libraries." *Libraries and the Academy* 7 (1), 81-96.
11. David, Carter, and Janes Joseph. 2000. Unobtrusive data analysis of digital reference questions and service at the Internet Public Library: An exploratory study. *Library Trends* 49 (2):251-265.
12. Dickson, Jean. 1984. An analysis of user errors in searching an online catalog. *Cataloging and Classification Quarterly* 4 (3):19-38.
13. Fenichel, Carol Hansen. 1981. Online information retrieval: identification of measures that discriminate among users with different levels and types of experience. *Journal of the American Society for Information Science* 32 (1):23-32.
14. Jansen, Bernard J., and Pooch, Udo. 2001. Web user studies: a review and framework for future work. *Journal of the American Society for Information Science and Technology* 52 (3):235-246.
15. Joseph, Janes. 2002. Digital reference: Reference librarians' experiences and attitudes. *Journal of the American Society for Information Science and Technology* 53 (7):549-566.
16. Lankes, R. David. 2004. The digital reference research agenda. *Journal of the American Society for Information Science and Technology* 55 (4):301-311.
17. Lankes, R. David, Eileen G. Abels, Marilyn Domas White, and Saira N. Hague. 2006. *The virtual reference desk: creating a reference future*: Facet Publishing.
18. Lee, Ian J. 2004. Do virtual reference librarians dream of digital reference questions? A qualitative and quantitative analysis of email and chat reference. *Australian Academic & Research Libraries* 35 (2):95-110.
19. Lupien, Pascal. 2006. Virtual reference in the age of pop-up blockers, firewalls, and service pack 2. *online* 30 (4):14-19.`
20. Matthews, Joseph R., Gary S. Lawrence, and Douglas K. Ferguson. 1983. *Using online catalogs : a nationwide survey : a report of a study sponsored by the Council on Library Resources*. New York: NY : Neal-Schuman.
21. McClennen, Michael , and Patricia Memmott. 2001. Roles in digital reference. *Information Technology and Libraries* 20 (3):143-148.
22. Millsap, Larry, and Terry Ellen Ferl. 1993. Search patterns of remote users: An analysis of OPAC transaction logs. *Information Technology and Libraries* 11 (3):321-343.
23. Mu, X.(2006). Approaching our patrons: From passive to active virtual reference. *Proceedings of the 69th Annual Meeting of the American Society for Information Science and Technology*, Volume 43.
24. Mu, X. & Luo, L. (2005). Virtual Reference for Video Collections: System Infrastructure, User Interface and Pilot User Study, *Proceedings of the 68th Annual Meeting of the American Society for Information Science and Technology*, Volume 42.
25. O'Leary, Mick. 2003. QuestionPoint fortifies libraries in Internet age. *Online* 27 (3):70-72.
26. Olivares, Olivia. 2004. Helping You Buy: Virtual Reference Systems. *Computers in libraries* 24 (5):25-29.
27. Penniman, W. D., and W. D Dominick. 1980. Monitoring and evaluation of on-line information system usage. *Information Processing and Management* 16 (1):17-35.
28. Peters, Thomas A. 1989. When smart people fail: An analysis of the transaction log of an online public access catalog. *Journal of Academic Librarianship* 15 (6):267–273.
29. Pomerantz, Jeffrey , Scott Nicholson, and Yvonne Belanger. 2004. The current state of digital reference: validation of a general digital reference model through a survey of digital reference services. *Information Processing and Management*. 40 (2):347-363.
30. Rice, Ronald E., and Christine L. Borgman. 1983. The use of computer-monitored data in information science and communication research. *Journal of the American Society for Information Science* 34 (4):247-256.
31. Robert, Brent. 2004. What libraries do best: Bringing warmth to virtual reference. . *PNLA Quarterly* 68 (3):8-9.

32. Taylor, A. G. 1984. Authority files in online catalogs: an investigation. *Cataloging and Classification Quarterly* 4 (3):1-17.
33. Tenopir, Carol. 2004. Rethinking virtual reference. *Library Journal* 129 (18):34.
34. Tolle, John E. 1983a. Current utilization of online catalogs: transaction log analysis. In *Final report to the Council on Library Resources*. Dublin, OH: OCLC.
35. Tolle, John E. 1983b. Understanding patron's use of online catalogs: transaction log analysis of the search method. *Proceedings of the 46th ASZS Annual Meeting* 20:167-171.

Appendix A: Post-experiment questionnaire

Your ID: _____

1) I think the VR system is easy to use in the experiment (strongly disagree; strongly agree;1-7)
2) The VR system is too hard for me to use in the experiment (strongly disagree; strongly agree;1-7)
3) I think the VR system is easy to learn in the experiment (strongly disagree; strongly agree;1-7)
4) The VR system is too hard for me to learn in the experiment (strongly disagree; strongly agree;1-7)
5) The VR system helps me a lot in this experiment (strongly disagree; strongly agree;1-7)
6) I'm not sure how helpful the VR system in this experiment (strongly disagree; strongly agree;1-7)
7) I enjoyed this experiment (strongly disagree; strongly agree;1-7)
8) This experiment was boring (strongly disagree; strongly agree;1-7)
9) I did not have fun during this experiment (strongly disagree; strongly agree;1-7)
10) I was fairly casual and relaxed (strongly disagree; strongly agree;1-7)
11) I don't think I will use this system in my next similar task (strongly disagree; strongly agree;1-7)
12) I will recommend this system to my friends (strongly disagree; strongly agree;1-7)
13) I did not like the pop-up window in the experiment (strongly disagree; strongly agree;1-7)
14) I understand the function of the pop-up window and it did not annoy me (strongly disagree; strongly agree;1-7)
15) What did you like about this experiment?
16) What did you dislike about this experiment?
17) The system needs to tack your searching behaviors (i.e., number of "zero-return" for your query) in order to provide interactive help. This might invade your privacy. What are your comments?
18) Are there any additional comments you'd like to make?

Appendix B: SPSS code for grouping evaluation variables

Q1 to Q14 denotes the values (1-7) for question one to question 14.

```
COMPUTE use = MEAN (Q1, (8-Q2),Q3, (8-Q4)) .
EXECUTE .
VARIABLE LABELS use "overall level of system usability"

COMPUTE effect = MEAN( Q5,(8-Q6)) .
EXECUTE .
VARIABLE LABELS effect "overall level of system effectiveness"

COMPUTE satis = MEAN(Q7, (8-Q8),Q9,(8-Q10)) .
EXECUTE .
VARIABLE LABELS satis "overall level of users' satisfaction"

COMPUTE future_use = MEAN(Q12, (8-Q111)) .
EXECUTE .
VARIABLE LABELS future_use  "recommended for next use"

COMPUTE pop-up = MEAN(Q14, (8-Q13)) .
EXECUTE .
VARIABLE LABELS pop-up  "perceived acceptance for pop-up windows".
```

Appendix C: In-experiment questionnaire

Please answer the questions after each trial

1) How **helpful** for your search did you find the system?
   1 2 3 4 5 6 7
   Not helpful at all extremely helpful

2) How did you like the system user **interface?**
   1 2 3 4 5 6 7
   Didn't like at all liked extremely

3) How strongly did you feel a violation of your privacy?
   1 2 3 4 5 6 7
   Not at all extremely strong

4) How **intrusive** did you find the Virtual Reference link in the result page?
   1 2 3 4 5 6 7
   Not intrusive at all extremely intrusive

5) How confident did you feel with the results you retrieved?
   1 2 3 4 5 6 7
   Not confident at all extremely confident

Comments? General impressions of the experience?

_____

_____

Appendix D: Revised post-experiment questionnaire

Which of the four trials would you rate as the best in terms of:

(Please circle one)

1. Satisfaction?
   Trial 1 Trial 2 Trial 3 Trial 4 No opinion

2. Helpfulness?
   Trial 1 Trial 2 Trial 3 Trial 4 No opinion

3. Privacy violation?
   Trial 1 Trial 2 Trial 3 Trial 4 No opinion

4. Intrusion?
   Trial 1 Trial 2 Trial 3 Trial 4 No opinion

Comments? General impressions of the experience? Which was your favorite/least favorite interface?

_____
_____
_____
_____

Do you have any suggestions or recommendations on how a virtual reference service might best serve your needs?

_____
_____
_____
_____ .CB