

**User Perspectives Into Designs for Both Physical and Digital Libraries:
New Insights on Commonalities/Similarities and Differences from the
NDSL Digital Libraries and LibQUAL+™
Data Bases**

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Abstract

Utilizing data from the LibQUAL+™ and National Science Digital Libraries data bases—both quantitative and qualitative—users were compared on several different dimensions. The findings yielded several interesting results. Users of physical libraries (major research institutions) were extremely sensitive to physical aspects of libraries, including space, lighting, and reading and study rooms. Users of these libraries were sensitive only to digitized and electronic resources if they were uncomfortable or inexperienced at navigating them, although all users were extremely pleased with the ability to work from spaces other than their offices digitally and electronically. Physical library users were far less interested, however, in the concepts of community and culture. Digital science library users, developers, teachers and scientists, however, were extremely interested in the concepts of culture and community being created by the groups of individuals working with the science digital libraries. Developers in this latter domain were deeply involved in issues of meta-data, referring materials, and ensuring support for the digital libraries; physical library users expressed virtually no interest in these issues. The “symbols” associated with libraries were parallel, but different, for physical versus digital library users.

1. Introduction

Over the course of the past six years, researchers from both the Association of Research Libraries (ARL) (Washington, D.C.), a consortium of major North American research libraries attached to universities, independent scientific and national organizations including the Smithsonian Institution, and Texas A&M University, collaborated to adapt and create a Web-based administered survey instrument to evaluate service quality in university libraries.¹ Because there had been no major evaluation of library service across member libraries at ARL

(nor, for that matter, in any other kind of college or university), and because the context for research libraries had changed radically (a point to which we shall return later), and because the technology for administering a survey instrument broadly and widely throughout university communities at the lowest possible cost had now become possible, through Web-based initiatives, the potential for assessing service quality was now feasible and cost-efficient.

2. Objectives

The purpose of the work, with a grant from the Fund for the Improvement of Postsecondary Education (FIPSE) grant was creating an instrument for evaluating service quality, first, in the Association of Research Libraries (ARL) libraries, utilizing an adapted form of SERVQUAL, an instrument designed to measure customer satisfaction with service quality. This first purpose resulted in the development of LibQUAL+™, a Web-delivered survey assessing “library as place,” “affect of service,” and “information control,” regrounded from intensive interviews (qualitative data) conducted with library users from over 30 of ARL’s member universities in the U.S. and Canada.

The second purpose was to develop a Web-based survey from focus group intensive interviews in order to create a service quality evaluation form for the National Science Foundation national science digital libraries (NSDL), which is being constructed and pilot-tested now. This second Web-based survey is tentatively titled DigiQUAL.

3. Data Sources for this Work

Four original data sources have been utilized for this work. They include: a) interviews conducted at ARL member institutions in the U.S. and Canada (12 in all) for the purpose of re-grounding and revising SERVQUAL to serve in an academic library environment; b) focus group interviews conducted with groups from two of the National Science Foundation’s digital libraries administrators, developers, referees, users, product developers and other stakeholders (4 groups in all), during 2003; c) answers to open-ended questions gathered at the end of the Web-based library evaluation survey, requesting respondents to comment on the strengths and weaknesses of their own current library, and; d) selected Web survey institutional results. The first three data bases were subjected to formal content analyses, while the Web survey results were subjected to routine statistical analyses for the purpose of reporting back to individual institutions. At the heart of these projects was an interest and need in understanding how users of both academic (physical) library systems and users of the national science digital libraries (cyber-environment) orient themselves to retrieving critical information for research and teaching in radically reconfigured academic and digital—and text-based-plus-digital—environments.

4. Original Methods for Creating LibQUAL+™ and DigiQUAL

The original methodologies were quite similar. In order to revise SERVQUAL (Parasuraman, Berry & Zeithaml, 1988, 1991, 1993), which had been originally created for the measurement of customer satisfaction in the for-profit service industry sector, to fit with the research library environment, it was necessary to locate, identify and name dimensions of service quality critical to library patrons and users, primarily in the academic and scientific research arena. In order to identify these dimensions, to make possible the re-grounding of SERVQUAL's questions and service quality dimensions, in-person, in-depth, semi-structured interviews were conducted with faculty, staff and doctoral students from over twelve ARL member institutions, representing nearly two years of fieldwork. Those interview transcripts which seemed the richest, the most fertile and the most provocative were subjected to rigorous content analyses, and relevant and salient categories derived from the analyses. The analyses largely recreated the theoretical model of service quality originally developed by Parasuraman, et al. (1988), with "some modifications: Affect of Service subsumed the affective elements of SERVQUAL dimensions; Library as Place was supported as an expansion of SERVQUAL Tangibles; a proposed dimension of Self-reliance was subsumed in a dimension of personal control and a fourth dimension of Information Access subsumed Collections" (Cook, 1991, p. iv).

The Web-based surveys, with institutions' permissions, began to be delivered to ARL institutions in 2000. Its use was expanded as a mandate of the federal funding from FIPSE, and upon request, to non-ARL institutions shortly after that. As of the end of 2004, LibQUAL+™ had been administered at over 500 libraries, and has collected data from more nearly ¾ of a million users since its inception. The instrument has also been expanded internationally to Canada, Australia, Egypt, England, France, Ireland, Scotland, Sweden, the Netherlands, and the United Arab Emirates (Cook, Thompson, & Heath, 2004). The current survey instrument is now available in eight language variations (Kyrillidou, Olshen, Heath, Bonnely, & Cote, 2004).²

The rich data, both qualitative and quantitative, created by these data bases, encouraged the same set of researchers (Texas A&M and the Association of Research Libraries; see Heath, F.C., Cook, C.C., Lincoln, Y.S., Thompson, B., Kyrillidou, M., & Webster D., 2000, 2001) to apply for a research contract to develop a similar instrument for use by the National Science Foundation for its National Science Digital Libraries (NSDLs). After more than 10 years since first authorized by Congress, and a decade or more in use, NSF was interested in a means to evaluate the usefulness, applicability and broadness of appeal of the various digital libraries (originally 11 were authorized). Accordingly, NSF wanted some sense of who might be utilizing the digital libraries; how and for what purposes the digital libraries are being used, especially whether or not college and high school teachers incorporated the lessons, learning objects, historical documents, and/or scientific real-time data constantly being added

there; how the information, scientific data and documents within them are being deployed; and what users discovered to be the strengths and weaknesses of the various libraries, their meta-data, or their accessibility and navigation architectures.

The methodology for developing the Web-based survey for users of digital libraries was similar to that utilized to re-ground SERVQUAL for academic library settings, with one refinement. Rather than individual face-to-face interviews, focus groups were conducted at national meetings of two of the digital library groups, DLESE (Digital Library for Earth Sciences Education) and MERLOT (Multiple Educational Resources for Learning and Online Teaching). A team of qualitative researchers from both Texas A&M and ARL attended both annual meetings in 2003, and with the cooperation of the digital libraries' directors, conducted focus group interviews of developers, users, teachers, reviewers, and contributors. In addition to focus group transcriptions from audio tape, extensive notes were taken during the interactions, which lasted anywhere from 90 minutes to 2-1/2 hours each, and all data were again subjected to a formal content analysis.

Categories derived from these analyses were somewhat different from those in the original LibQUAL+™ survey, although the researchers expected this, given the non-physical, cyber-environment of all the digital libraries. Issues, for example, of navigability through the library became critical, as did ongoing concerns with meta-data, with a sense of "community," and with questions of the commitment of the federal government to continue funding the digital libraries. As well, issues of reviewers (for submitted lesson plans, documents, and learning objects) became salient, since it is the desire of digital library directors to ensure that all material has been reviewed for accuracy and sophistication.³ A new instrument, tentatively titled DigiQUAL, is currently being pilot-tested with three NSDL digital libraries: DLESE, MERLOT, and The Math Forum. Additional NSDL digital libraries have also expressed interest in participating in the pilot including the Core Integration Program at Cornell, SMETE.org, illumina and others. UTopia, a digital library funded and developed at the University of Texas, is also participating in the pilot. Last, a dozen digital libraries from outside North America has expressed interest in applying this instrument to their settings.

5. Major Premises

This work has been guided by several major premises, or hypotheses. First, the researchers were aware that service quality in the ARL and other research and academic libraries had not been surveyed or evaluated across institutions in a consistent and reliable fashion. During that last decade, the entire landscape of academic research libraries had shifted toward a much more evenly-balanced text and digital mix in the collection, and user access had moved partly from building-based to desktop base retrieval for many user needs. Second, "library as place" began to assume a secondary importance for information retrieval; however, it continued to have high symbolic value as the cultural center of the campus, fulfilling new roles as library patrons shifted demographics. Third,

during this same decade-plus, the National Science Foundation's national digital science libraries were created, and the knowledge base in the sciences and mathematics—as well as in the social sciences and history--shifted to a digital environment, accessible to virtually all of the world. Fourth, users' perceptions of the new text-cum-digital resources, and the services rendered to make them accessible, were unknown. The most efficient manner to collect a broad base of data on these users' perceptions was the manner most familiar to a new generation of users: the Web.

What was unknown were two critical data: How do library services respond to differences among and between the users of these systems, and how do digital libraries respond to differences in users of their systems? And, how do both physical library services and digital library services respond to similarities in users? As a consequence, we searched for commonalities in themes along the dimensions that LibQUAL+™ measures for physical libraries—library as place, affect of service, and information control—and are now searching for commonalities and differences among users of digital libraries.

6. Methodology

A multi-stage research process was designed, including qualitative and quantitative analyses. For the qualitative data base, formal content analyses were conducted on the intensive interviews conducted to re-ground SERVQUAL, and on the focus group interviews held with both DLESE and MERLOT users, developers and reviewers. Additionally, open-ended responses for certain of the LibQUAL+™ Web surveys were inspected and content analyzed, for insights into the issues which most affected user perceptions of service (e.g., access to stacks, delivery of interlibrary loan materials, and the like). We looked for high-density themes and categories, taking thick, crowded or “teeming” categories as evidence of commonalities and major issues, following Holsti's (1969) descriptions of one measure of high salience.

The open-ended responses derived from a segment of the LibQUAL+™ questionnaire for a peer group of institutions defined as peers of Texas A&M University Libraries. One of the members of the research team responsible for various quantitative analyses of the data, recognizing the value of the qualitative data collected through the comments box, referred humorously to the Web-based survey as “22 questions—and a *box*.” Since then the phrase ‘22 items and a box’ has become a marketing punch line to invoke the rich information collected through the LibQUAL+™ protocol which symbolically evokes and pragmatically collects both quantitative and qualitative data. The “box” in this instance was a section at the end of the questionnaire where respondents were invited to comment on the strengths of their library, the weaknesses perceived, issues which they hoped to see resolved, concerns with the collections, or any other matters which they felt would improve library service at their institutions. (All libraries, at all institutions where the survey has been conducted, have been provided with a notebook which records and analyzes all data from all Web surveys for their institutions. Among other kinds of data deliverables, the open-ended responses are downloaded and accessed in real time in their entirety by participating libraries, and provided to library

directors, anonymously except for the “position” of the respondent, i.e., faculty, staff, graduate student, undergraduate student. Thus, the data which the authors analyzed were first provided to the individual libraries for discussion and action.)

Open-ended responses were selected for analysis from institutions deemed most likely to be “peers” of Texas A&M University. That is, they were landgrant institutions⁴, or extremely large metropolitan, but state-funded, institutions. For the most part these peers were ranked among the top 20 state-funded institutions according to the ARL Membership Criteria Index – an index of resources and historical investments that universities have made to libraries. The index brings together into one index figure the following variables: volumes held, volumes added, gross and current serials which do include electronic resources, as well as library expenditures and professional plus support staff (Stubbs, 1981). All open-ended responses provided by users at these institutions were printed onto index cards organized along several categories such as: professors (assistant, associate and full); graduate students (primarily doctoral students, or postdoctoral students); professional library staff; and undergraduate students. In all, 5,160 users’ comments were brought together for analysis from a group of 17 libraries that have conducted LibQUAL+™ from 2002 to 2004.

If a library conducted the LibQUAL+™ survey more than once during this time period, the last time the survey was conducted was the instance from which we pulled the qualitative comments data. As a result, we ended up having in our pool of 17 libraries, four libraries that did the survey in 2002, four in 2003 and the rest in 2004. We did not include instances of health or law libraries that may have participated during this time period as independent libraries in conducting LibQUAL+™ but if health science and law faculty were surveyed as part of the larger campus survey and provided comments, their comments were included in this analysis.

The types of comments by institution and discipline are summarized in Table 1. From the institutions included here Penn State had the largest number of comments (838 users) and Engineering (764 users) from the disciplines representing 14.8% of all comments with Education following closely with 742 (14.2%). Table 2 shows the distribution of comments along the different discipline categories and Table 3 the distribution of comments by sex and user type. There were slightly more comments by women than men (52,4% for a total of 2,706 comments). Women were proportionately more in the undergraduate and graduate categories but less in the faculty category as Table 3 shows. The comments provided by faculty though were the ones where the analysis focused for the most part as explained in the next section.

As will be evident from the table, not all institutions have health science programs, and not all have agriculture programs. Each of the landgrant institutions has an agriculture program (a part of the original legislation called for such programs, still supported in part today by the Federal government), but not all institutions are landgrants.

The authors determined, from inspecting the open-ended responses, that the most fertile cards for analyses were those from the faculty of the various institutions. Indeed, one might make the assumption that these were the most productive responses intuitively, since it is faculty who are the most permanent “residents” of a campus, faculty are the most systematically engaged in research and teaching as a part of their load, and faculty frequently have experience at other institutions previously, as graduate students, as postdoctoral students (particularly in the hard sciences), or as faculty members elsewhere. Thus, faculty (representing well over 1,000 qualitative data points) were chosen for preliminary analyses. In turn, these data were compared to responses from the original qualitative (focus group) interview data gathered from users and developers in the digital library domains. Each set of data will be discussed below, and then comparisons will be drawn between the two data bases.

A special note should be made regarding graduate students as some of our data show that graduate students are the most intense users of library resources yet faculty are indeed more influential and to a large extent they can easily and decisively influence graduate students. So, a case can be made that we need to start from faculty in understanding the dimensions of service quality in a higher education institution although faculty perceptions may be more grounded in past experiences and as such tied more to the culture and traditions of the parent institution.

Table 1: Institutions and Programs for which Data were collected from all Groups of Stakeholders

Institution	Agriculture	Architecture	Business	Communications	Education	Engineering	General Studies	Health Sciences
Indiana University, Bloomington	4		13	6	12	2	1	4
Ohio State University Libraries	8	3	9	3	12	12	1	18
Penn State University Libraries	68	3	106	40	77	138	6	57
Texas A&M University, College Station	94	15	22		37	87	5	12
University of Arizona Library	17	6	8		16	13		4
University of Cincinnati Libraries	1	8	19	4	37	68	3	2
University of Illinois at Urbana-Champaign	11	2	13	3	18	31	3	9
University of Minnesota Libraries	10	6	10	14	25	13	2	16
University of North Carolina, Chapel Hill	2		5	16	11	5	3	11
University of Pittsburgh			9		16	29	10	
University of Texas at Austin	4	3	19	23	22	52	2	15
University of Utah		7	23	11	24	52	3	13
University of Washington Libraries	3	1	3	2	1	19	1	34
Wayne State University			13	8	28	23	1	75
University of California, Los Angeles		1	7	1	5	20		49
University of Wisconsin - Madison	40		17	9	30	188		76
University of Georgia Libraries	52		38	33	51	12		50
Column Total	314	55	334	173	422	764	41	445

Table 1: Disciplines continued								
	Humanities	Law	Other	Performing & Fine Arts	Science / Math	Social Sciences / Psychology	Unde cided	Military / Naval Science
Indiana University, Bloomington	30	7	12	16	19	28		
Ohio State University Libraries	28	3	17	5	21	20	2	
Penn State University Libraries	95	4	64	11	49	100	20	
Texas A&M University, College Station	82				44			
University of Arizona Library	26	1	15	25	26	39		4
University of Cincinnati Libraries	35	3	42	23	22	27		
University of Illinois at Urbana- Champaign	22	4	23	9	35	14	1	
University of Minnesota Libraries	20		8	8	15	34	3	
University of North Carolina, Chapel Hill	48	14	25	4	26	49	3	
University of Pittsburgh	69		15			18	1	
University of Texas at Austin	40	17	25	26	46	39	5	
University of Utah	36		8	12	52	56	1	
University of Washington Libraries	16	4	7	3	28	23	4	
Wayne State University	26	9	34	10	26	26	4	
University of California, Los Angeles	53	4	16	4	36	42	2	
University of Wisconsin - Madison	55	2	51	6	44	52	8	
University of Georgia Libraries	61	8	45	20	14	72	1	
Column Total	742	80	407	182	503	639	55	4

Table 1: Summary

Institution	Total All Disciplines
Indiana University, Bloomington	154
Ohio State University Libraries	162
Penn State University Libraries	838
Texas A&M University, College Station	398
University of Arizona Library	200
University of Cincinnati Libraries	294
University of Illinois at Urbana-Champaign	198
University of Minnesota Libraries	184
University of North Carolina, Chapel Hill	222
University of Pittsburgh	167
University of Texas at Austin	338
University of Utah	298
University of Washington Libraries	149
Wayne State University	283
University of California, Los Angeles	240
University of Wisconsin - Madison	578
University of Georgia Libraries	457
Column Total	5160

Table 2: Distribution of Disciplines for LibQUAL+™ comm

	Frequency
Agriculture / Environmental Studies	314
Architecture	55
Business	334
Communications / Journalism	173
Education	422
Engineering / Computer Science	764
General Studies	41
Health Sciences	445
Humanities	742
Law	80
Military / Naval Science	4
Other	407
Performing & Fine Arts	182
Science / Math	503
Social Sciences / Psychology	639
Undecided	55
Column Total	5160

Table 3: Distribution of Comments by Sex and User Type

	Female		Male		T1	
	Count	Row %	Count	Row %	Count	Row %
Undergraduate	858	31.71	672	27.38	1,530	29.65
Graduate	931	34.41	774	31.54	1,705	33.04
Faculty	608	22.47	843	34.35	1,451	28.12
Library Staff	93	3.44	39	1.59	132	2.56
Staff	216	7.98	126	5.13	342	6.63
T1	2,706	100.00	2,454	100.00	5,160	100.00

7. Quantitative Analyses

In the quantitative analysis, we selected the ARL organizations/universities, and searched for common issues, problems with areas where there are larger differences between the three dimensions which LibQUAL+™ measures. Selection of this particular subset of the population permitted some assumptions regarding the research orientation of the user base (because the ARL organizational membership consists of research libraries), an assumption we felt was consistent with a good portion of the NSDL digital library user base with some notable exceptions (Math Forum for example aims primarily at K-12). Simple statistical sorts were conducted to identify the dimensions where differences between “desired level of service” and “perceived level of service” were over two Likert-scale deviations apart.

For this part of the analysis we analyzed institutional scores for all libraries and for the ARL subset in 2003 and only for the ARL institutions that participated in 2004 as we explored the relation of the LibQUAL+™ scores with the ARL membership criteria index. There was a total number of 66 ARL institutions in the datafile in 2003 and a total of 57 institutions including the Smithsonian in 2004.

We examined the differences in the average scores across different dimensions in 2004. For the most part these differences were less than two points in the 9-point Likert scale LibQUAL+™ uses. A notable exemption is the large differences between the scores of Library as Place and Service Affect for a few of the law libraries that participated in 2004. Apparently library as place has a strong symbolic as well as aesthetic role with this user group and the desired scores for library as place are higher for these institutions than in other ARL libraries.

We also used the three LibQUAL+™ dimensions to predict the ARL Membership Criteria Index scores for (a) all participating libraries in 2003, (b) the subset of 66 ARL in 2003 and (c) the 57 ARL university libraries in the 2004 data. This replicates analysis done in earlier years. In 2001, this analysis was done for the 35 ARL participating libraries (Heath, Cook, Kyrillidou and Thompson, 2002) and in 2002 it was replicated for the 139 institutions that participated in LibQUAL+™ that year (Heath and Kyrillidou, 2004). The analysis that focuses on the ARL institutions is more comparable to the 2001 analysis since it is restricted only to ARL institutions as was done that year. But some interesting issues arise as we explore two different ways of doing this kind of analysis. The first method (called Method A here) where the ARL membership criteria index scores are calculated using the annual formula and raw data on volumes held, volumes added, gross, serial subscriptions, total expenditures and professional plus support staff as reported through the LibQUAL+™ data collection. This way for example, a small branch library that may have conducted the LibQUAL+™ survey and provided these institutional data was assigned an index score after applying the index formula on the raw data. The structure of the index formula was basically conceived as being invariant. Interested readers may find the ARL index formulas on the web at: <http://www.arl.org/stats/index/indxform.html>.

Method B on the other hand simply took the ARL membership index scores as already calculated by the ARL Statistics and Measurement Program and assigned these index scores to all libraries that are part of an ARL institution, i.e. for the same institution all branch libraries were assigned the same index score. This method basically assumes that the index scores for these institutions are invariant within a specific year. For a complete listing of all the scores for all ARL institutions, see: <http://www.arl.org/stats/factor.html>

Field Code Changed

Table 4 presents descriptive statistics for all variables in the four regression analysis performed and reported in Tables 5 and 6. Three sets of regression analysis were done on the 2003 data and one set on the 2004 data. The 2003 analysis includes four dimensions of library service quality whereas the 2004 analysis reduced the model into three dimensions. The dependent variable was the ARL membership criteria index in all regressions. The 2003 analysis was done first on all libraries that had provided institutional data on resources (volumes held, volumes added, gross, serial subscriptions, total expenditures and professional plus support staff). So, in the first set we had 245 libraries, in the second regression for 2003 we had 57 ARL libraries that provided resource statistics and whose index scores were calculated using the 2001-02 index formula, and in the third regression we had 66 ARL libraries where we assigned the ARL membership index score as calculated in 2001-02. One can easily see that the ARL membership criteria index score has a much lower mean value when calculated with Method A than compared to Method B. For example, the 57 ARL libraries whose index score was calculated with Method A had a mean index score of -2.623 whereas the 66 ARL libraries whose index score was calculated with Method B had a mean index score of -1.026. In other words, when using the assumption that the ARL index scores are invariant, the smaller branch libraries are assigned the scores of the larger institution. Interestingly enough these two different methods do produce results with slightly different emphasis and to a large extent the interpretation of these relations depends on the underlying assumptions one may want to make about a specific library.

The R is slightly higher when based on Method A for ARL libraries (see Table 6 where $R = 0.532$ for the 57 ARL libraries and $R = 0.399$ for the 66 ARL libraries). There is a stronger predictive relationship between the index score and the ARL membership criteria index when we include all libraries participating and when we use Method A for the ARL libraries compared to Method B. If one were to ignore the other variables and look at the relation between each dimension independently with the ARL index we see that the strongest relation tends to be with the service affect dimension in the analysis of all libraries and ARL libraries whose index is calculated with Method A. When one though uses Method B for calculating the ARL membership index score – basically assuming that users have access to all the resources at the larger institution – then the relationship between the LibQUAL+™ scores and the ARL membership index scores is almost non-existent and what exists as a relationship is almost all reflected in the Information Control dimension. This relationship is actually quite strikingly strong when examining the 2004 analysis.

The R^2 from the 2004 was .112 that shows less of a predictive relation between LibQUAL+™ subscales and the ARL index compared to 2001. In 2001 though

we should remember that there were four distinct dimensions of LibQUAL+™, whereas since 2003 the empirical analysis has indicated that three dimensions are sufficient as the Access to Collections and the Personal Control dimensions have collapsed and sustained themselves into an Information Control dimension. Although the regression analysis indicates low predictive relations, it is clear that the Information Control dimension is a very important dimension for ARL libraries as the structure coefficient for Information Control with the ARL Index is .909.

This basically means that in the absence of the other two dimensions the Information Control dimension explains as much as .826 of the variance explained in the ARL Index score. Clearly ARL libraries will want to monitor their performance on this dimension much more closely compared to other smaller libraries where the personal relations may be a lot more important. As the qualitative analysis below indicates researchers go to the librarian after they have exhausted their own ability to successfully identify the resources they need, so the ability of the library to facilitate this self-service attitude is critical in the research library setting. One may assert that the complexity of the information seeking in that environment is such that the more able and effective researchers, graduate and undergraduates are at identifying what they need, the more effective they perceive the library to be.

Table 4. Descriptive Statistics for Regression Analysis Reported in Tables 5 and 6

Descriptive Statistics - 2003				
	Minimum	Maximum	Mean	Std. Deviation
Total Perceived Score	5.700	8.288	7.098	0.373
Affect of Service	5.878	8.535	7.220	0.389
Library as Place	4.688	8.189	6.883	0.562
Personal Control	5.604	8.060	7.101	0.340
Access to Collections	5.580	8.151	7.011	0.368
ARL Membership Index 2001-02 (Method A)	-12.293	0.827	-	2.934
N=245				
Descriptive Statistics ARL - 2003				
	Minimum	Maximum	Mean	Std. Deviation
Total Perceived Score	6.122	7.761	6.994	0.291
Affect of Service	6.386	8.008	7.095	0.316
Library as Place	5.074	7.693	6.686	0.443
Personal Control	5.891	7.712	7.014	0.271
Access to Collections	5.880	7.573	6.985	0.289
ARL Membership Index 2001-02 (Method A)	-12.234	0.827	-	3.173
N=57				
Descriptive Statistics - 2003				
	Minimum	Maximum	Mean	Std. Deviation
Total Perceived Score	6.122	7.839	7.010	0.304

Table 4. Descriptive Statistics for Regression Analysis Reported in Tables 5 and 6

Affect of Service	6.386	8.377	7.121	0.352
Library as Place	5.074	7.693	6.724	0.438
Personal Control	5.891	7.712	7.018	0.281
Access to Collections	5.880	7.675	6.987	0.305
ARL Membership Index 2001-02 (Method B)	-2.860	0.900	-1.026	0.832
N=66				
Descriptive Statistics ARL - 2004				
	Minimum	Maximum	Mean	Std. Deviation
Total Perceived Score	6.321	7.471	6.935	0.276
Affect of Service	6.352	8.165	7.063	0.319
Library as Place	5.096	7.431	6.532	0.461
Information Control	6.145	7.553	7.022	0.260
ARL Membership Index 2002-03 (Method B)	-1.910	0.880	-0.741	0.756
N=56				

Table 5. ARL Membership Criteria Index Score 2001-02 as Predicted by the Four LibQUAL+™ Perceived Subscale Scores in 2003

	All libraries 2003			ARL Libraries 2003 – Method A			ARL Libraries 2003 – Method B		
	r	r s	□	r	r s	□	r	r s	□
Access to Collection	0.207	0.404	0.368	0.205	0.385	0.225	0.153	0.384	0.42
Personal Control	0.251	0.490	0.265	0.236	0.443	0.133	0.117	0.219	0.23
Service Affect	0.410	0.799	-0.638	0.493	0.927	-0.658	0.054	0.101	-0.20
Library as Place	0.356	0.694	-0.407	0.285	0.535	-0.127	0.120	0.226	-0.40
N =	245			57			66		
R			0.513			0.532			0.39
R-squared			0.263			0.283			0.15
DF			4/240			4/52			4/66
P			<.001			<.001			0.3

Table 6. ARL Membership Criteria Index Score 2002-3 as Predicted by the Three LibQUAL+™ Perceived Subscale Scores in 2004 (n= 56 ARL libraries)

LibQUAL+™ Scale	r	r _s	β
Information Control	0.304	0.909	0.470
Service Affect	0.197	0.590	-0.083
Library as Place	0.084	0.252	-0.175
Total LibQUAL+™ Score	0.236		
R-squared = . 0.112, df = 3/52, p = 0.1013254			

8. Findings

Several major conclusions could be drawn regarding similarities and differences in users between those whose primary relationship was to a physical library, and those who frequently utilize one of the digital libraries.

8.1 Academic Library Users

Keeping in mind that these data were drawn from evaluations of service quality in the individual libraries, and that primary users were determined to be faculty (that is, those users with the highest stake in library quality and library service), it is not surprising to discover that the largest category generated in this analytic sort was satisfaction with professional librarian services. From the original interview data, we learned that those more “permanent” scholars (i.e., faculty) tend to create long-term relationships with a single librarian, usually someone who has been determined by the faculty member to have special expertise in her/his specialty area, and who has a particular expertise in locating obscure materials, tracking down recondite sources, or acquiring copies of materials held in other libraries and archives. We hypothesize that the largest category—satisfaction with professional librarian services—is due to these professional relationships which are created over time, working together to meet the needs of scholars for their particular materials. Like their undergraduate counterparts, however, faculty are quick to note that when they ask, “...library staff are courteous, understanding, forgiving, knowledgeable, pleasant, and almost too anxious to help when it comes to tracking down reference and government documents materials. I ask tough questions, *because I have to be stumped myself before I ask.*” A culture which consistently values searching extensively for oneself before asking for professional help exists both among faculty, and among undergraduate students. We believe that this culture arose for several different reasons, but have analyzed it among students as a form of virtual reality puzzle, or “gaming,” which they call “a challenge” they enjoy pursuing (Lincoln, 2002).

Other faculty noted that:

The professional staff, however, are very solid—I just wish there was more opportunity to interact with them...

I think the staff at the library, in general, does a fine job with the resources available...

In addition to using our collections and data bases, I work closely with [name] and [name]...who are informative, up-to-date, smart, and really supportive of my research and teaching needs.

In a complex system such as this, the quality of library services can be expected to vary widely, as it does. The academic librarians, the subject experts, the reference librarians, are nearly all outstanding. They are knowledgeable, very helpful and pleasant to interact with.

A successful phone call to an experienced librarian can open marvelous avenues of information. Please keep some warm blooded humans accessible in your very useful and continuously updated technical network.

I have nothing but praise and respect for the library staff...

As the data show, both in tone and numbers of data points (more than 200), there is high respect and warm feeling for the job that professional librarians in the selected sample perform. There is, however, considerably less warmth for the student workers, who are deemed “disrespectful,” and unknowledgeable, fairly consistently. Faculty in general do not like working with student workers in the library, and hold them responsible for poor service, inability to retrieve books from storage promptly or with accuracy, and with widespread unhelpfulness. This finding only amplifies our hypothesis—borne out with both these data, and the interview data from the original regrouping of the SERVQUAL instrument—that carefully cultivated working relationships with professional librarians yield the most satisfaction from the permanent faculty.

Physical facilities. Faculty in particular are extremely sensitive to the physical aspects of research libraries. Their biggest complaint is with the hours libraries are open. Faculty frequently wish to do much of their own research work when they are not encumbered with the tasks of teaching, which means on weekends, during school holidays, and over various breaks in the school year. These are the times when they find the most minimal (or non-existent) library hours are in force. But even more serious students wish for longer hours of operation. One undergraduate plaintively noted that “I would just like it if the library was open until midnight on weekdays, and open later on Friday and Saturday nights, because it is a great place to study, and college students tend to study at late hours...” Faculty responses are slightly different, but circulate around the same complaint:

Break hours can be frustrating because I am often trying to put together a syllabus and I need to go to the library on weekends....Faculty need the library at odd times—

...Not open during holidays...

...on occasion, [discipline] library staff are late (over 1 hour) to open up on weekends.

One of my biggest concerns is that library hours are reduced (closing at 5 p.m.) [around] 10 days before each semester starts. This is EXTREMELY inconvenient for instructors, because it is precisely during this time that we all scramble to get our course materials together. [emphasis in original]

Weekend hours, and the limited hours at branch libraries like the Center for [name] are ridiculous for a Research I institution. [Note: I am deleting the reference to Creative Photography because the institution can be identified from this quote]

Keep the libraries open 24/7 every day of the year. A major research institution should have nothing less.

The way the library is used is critical to institutions planning for new facilities, or extensions of existing facilities. Strangely enough, both faculty and students alike agree on space usage, and the necessity for quiet study and research space. An undergraduate observed that “I also think it would be nice to have more tucked-away, quiet places to think and study,” echoing faculty who asked for more “study carrels”; for “a true graduate library with open and closed carrels for dissertation work and faculty sabbaticals”, because the [disciplinary] libraries are neither good places to go to study or work”. Another faculty member, a full professor, observed that his library “does need at least one quiet space.” Another, at one of the premier research institutions in the world, commented that “There is a SHOCKING (though perhaps unavoidable” lack of quiet, comfortable and relatively uncrowded reading rooms and similar spaces for study—the biggest difference that professors with experience at private universities often notice [emphasis in the original data].” Yet another at the same institution complained that “[at] night [library name] is too loud and there are not enough group study spaces. Quietness should be enforced as much as, if not more than, not eating.”

Other similar and typical comments included

...need to enforce the quiet rule on the fourth floor of the main library...

The one thing that bothers me most about using the library is the lack of courtesy other patrons have when using their cell phones. They are loud. On the library's side, I don't see many, if any, 'don't use your cell phone'-type signs. It would be nice to start implementing or enforcing that type of policy.

However, the space is terrible—there are no inviting places to sit and read. This library could really benefit from some comfortable chairs near a window...the space is so uninviting...

...there are problems that need attention, specifically increasingly frequent disruptions by students using cell phones or carrying on sustained, loud conversations...If I am in [library name] for more than two hours or so, at least one student will have decided the library is also a telephone booth. ...Library staff could do us all a favor by aggressively restricting cell phone use to some place on the first floor, as far away from study areas as possible. More aggressive reminders that quiet is expected would in general be appreciated.

Faculty and students alike complain about the general noise level, especially in the main libraries (as opposed to the disciplinary collections on campus). Many faculty simply collect the materials they need and take them elsewhere (primarily, back to their offices) in order to do work with them. Everyone—undergraduates, graduate students, faculty and staff—complains about the use of cell phones in work areas. It is unclear why libraries and librarians do not simply restrict cell phone usage to library main lobbies, as this appears to be a pervasive problem. It is, however, a problem in classes also; students must be reminded, and frequently need penalties applied to their grades before they will keep their cell phones off. Noise of all sorts, however, appears to be growing in libraries.

Faculty and students alike appear to want more quiet places to work. At the same time, the restructuring of learning tasks and classroom assignments make the necessity for group work space more necessary (Cohen, 2004). Teachers College-Columbia University, in designing its new remodeled Butler and Milbank Libraries, has redesigned the renovated space to include a great deal of space for collaborative and group project work, especially in providing glass-enclosed group study spaces. According to the libraries interim director, “the library is ‘moving from being a warehouse to a workshop’ ” (Cohen, 2004). The focus on “learning communities” and on the entrepreneurial and research team models from “Bell Labs and M.I.T.” where “research models that have gone on in medicine and technology and engineering have for years been group work” are a part of the architectural prompt to focus less on the extensiveness of the collections and more on the ways in which learning actually occurs. In physical libraries, it will be interesting to see how the deep desire for quiet study space and the need for group and collaborative work spaces is resolved.

Faculty remain sensitive to the idea of “library as place,” probably far more so than the typical undergraduate or even graduate student. From the LibQUAL+™ regrouping interviews, we know that faculty have often had research experiences in the great research libraries in Europe and North America (Oxford, Cambridge, the Sorbonne, the British and French national libraries, the Vatican Library, and the like), and frequently express the sense of history which overcomes them in such places, as well as the sense of the sacredness of learning that marches down through the ages (Krummel, 1999).

Faculty speak of their libraries sometimes as “ugly and uninviting,” or, conversely, as “beautiful, has a pleasant atmosphere, and is adequately up-to-

date". Some say that the "library space at [name of library] is uninviting for both faculty and students," while another faculty member at the same institution comments that she "love[s] the [same library as above] and visit[s] often...it's one of [her] favorite hide outs!" Yet another faculty member resented greatly that a TV had been placed in the reading room on the first floor of his campus's main library. He advised, "Instead of a TV on that wall, why not a large bookcase with librarians' recommended recently-issued books? This, along with several chairs or an additional couch, might encourage READING!" (emphasis in the original). Many faculty are especially fussy about the cleanliness of the library where they do the bulk of their work. Many called these places "a very dirty place," sometimes "covered with a thick layer of dust," which lack "ambiance," possessed of "visibly cold interior[s]," which "do not meet the human ecology needs of the users." As well, the lack of adequate lighting, the overall dreariness, the lack of comfortable seating, and the sheer need for "space" affects faculty, often in negative ways.

Clearly, faculty attribute far more symbolic value to physical libraries than many students do—although students appear to be as sensitive to the noise levels as faculty are. One faculty member commented, echoing the earlier regrounding interviews, "I never use the library as a place to work or study because I have a good office, but I think it's important that the library provide such places, in part because libraries are symbolic of the academic enterprise and we want to convey that symbol to students as part of their socialization." This allusion to the symbolic value of libraries has been repeated often elsewhere (see Lincoln, 2002, for a summary of the first set of qualitative data), and speaks to the value of the built environment in communicating messages about the purposes and values of academic life.

8.1.1. Information control for physical library users. Faculty appear to be evenly divided around issues of access related to information retrieval. A small number of faculty report, on the Web-based survey open-ended question, that working with the current electronic catalog system is "a nightmare" at their institution. In the same vein, some faculty do not like working with the OVID database utilized by some institutions, as it is "clumsy and frustrating to use." Orion II, faculty at one of the premier, top-ten ranked⁵ institutions in this sample, declare "difficult to use and richly deserves to be replaced." The electronic card catalogs are not always readily transparent in their organization, and both faculty and students alike occasionally have some difficulty navigating them; one faculty member commented this difficulty proceeded from "some holdings not being properly listed" (the researchers assume he means catalogued, although it is not clear what this might mean. In general, the search engines give some faculty trouble, particularly with respect to journals. Faculty just say, "The electronic card catalogue is difficult to search and gives many false positives." Various search engines are nominated as being problematic.

Faculty are greatly interested in ensuring off-campus access to online resources (particularly from their home studies, where faculty often retreat to write); in having more journals online (but more about print journals will come up later), and about the ability to retrieve the full-text article, rather than its abstract;

and in having search engines that lead them rather directly, via descriptors, to the article[s] in question. Even when faculty also want access to print resources, they consistently ask for more and more online availability, and sing the praises of e-Docs and other desktop delivery services of required research materials. Faculty have been swift to recognize that speedy acquisition of such materials enhances their work, and permits greater productivity in a shorter timeframe.

Despite their delight with online journals, and the ease with which materials can be retrieved in this format, faculty also say they need and want print copy journals. Across the country, faculty members in a variety of disciplines state their dismay: "I am very concerned about the erosion in hard-copy serials. Several long-running subscriptions in my specialty have been dropped." Another—different university—full professor mourned that, "The cutting of journals in the Science library is horrible. Mathematicians have as much need for journals published in one country as another. The fact that journals that we have subscribed to for years suddenly get cut makes keeping up to date and engaging in timely research very difficult." Another summed up the problem incisively and acutely when he remarked that

While [I] appreciate the advances made in electronic services, I do have the following concerns: 1) I perceive a de-valuing of other more traditional services, i.e., fewer new books, *fewer journals*, more spaces for computers and fewer light and comfortable spaces for quiet reading.

It would appear that even though faculty appreciate the ease with which they can access materials electronically, they still want, need, and appreciate the traditional functions and symbolic meanings of a library: the value of a good collection, the access to the wide variety of contemporary thought in their field available primarily via journals, and spaces for the quiet, comfortable, well-lit pursuits of learning through reading.

8.2 Digital Library Users

Digital library users appear to be a partially different group from permanent faculty at research institutions with physical libraries. While faculty are often the referees for material going onto the Websites of the digital libraries, and while occasionally, they are the creators of products and teaching problems and objects which are submitted, the digital library user group may not represent a one-to-one correspondence with faculty. In fact, one of the largest groups of users of some of the digital libraries are overseas users—scientists, researchers and other users who appreciate the real-time data, who want to access the scientific data base, or who synchronize their own research (e.g., research on tectonic plate movement, which correlates highly with earthquake activity) with that from the U.S. data bases. As a consequence, the focus group data exhibited different user orientations from the interview data with physical library users.

8.2.1 Design features. The total Web environment forces users to focus instantly on issues of attractiveness and design features, as well as accessibility and navigability. Users in particular are delighted with various aspects of the design of the various libraries' home pages, and annoyed with others, and the same holds true for navigability issues. For some developers and users, "Vocabulary is an issue," although one focus group participant was quite clear that "use and experience [in navigating through the Website] count for a lot." Participants from both sets of focus groups were clear that the websites are "fairly accessible once you are accustomed to the site." Many users, especially teachers, are happy with the fact that a pleasant surprise is that "...they open the gateway to other digital libraries."

Interoperability is an issue with some of the libraries and their learning objects. Many individuals who are training teachers to utilize the digital libraries for their teaching back in the kindergarten through high school domains (K-12) report that they have a hard time orienting teachers to the forms and activities of interoperability. One teacher educator observed that

I think there's a large group of educators out there that are certainly capable, knowing content, but actually using the computer, using things in that domain [the domain of inter-operability]—it's very difficult for them. Again, it's something new to them; not that they're stupid or something like that.

Others noted that

I've had mixed result in terms of either use [around inter-operability]. I had an easy time using it, but when I let them [the teachers] loose to go do certain thing, I had to do a lot of explaining; I had to kind of get them into the groove, so to speak, in order to be able to use those types of things.

And, again:

I think that the major complaint that I had...we do what we call a learning log. It's a little activity we do with teachers...and I ask specific questions about how they did some of the thing, and they [couldn't explain it]...it's not so much that the content is beyond them, but just some of the ways of going about using [interoperable functions].

While interoperability may not be an issue with physical library facilities, a sufficient number of faculty and students alike point to problems with the digital catalog, with vocabulary, with accessing and maneuvering various search engines, that location and retrieval of information in academic libraries is a problem as much as it is in the digital libraries. Although it may well be that "use and experience" will solve the problems of academic library catalogs, search engines and other location programs, it is equally clear that academic libraries are perched on a cusp, between users who enjoy navigating the digital catalog and other search engines, and users who find themselves frustrated by it.

8.2.2.Social and psychosocial aspects of the digital library environment.

Although it is initially difficult to understand how a digital library can provide a sense of community, it is nevertheless the case that users, developers, referees, and other stakeholders in the digital libraries see themselves as deeply involved in a learning/producing environment. We believe that these concepts of community and culture in the online environment may map to the the “library as place” dimension of the LibQUAL+™ survey instrument. For example, the LibQUAL+ item, “A getaway for study, learning or research” can easily be translated into “A gateway for study, learning or research” for the DigiQUAL instrument (online environment).

9. Conclusions

One, library-as-place has high symbolic and culture value (borne out in Krummell [1999]), even if patrons retrieve most of their library materials online or from the many scientific and humanities-oriented data bases. Many users of a campus-based library system view it as the “core” or the “heart” of a campus. Second, users of physical libraries are extremely sensitive to the relationships built with reference personnel; many feel this is a collaborative research relationship, and one which enhances their lives and work as researchers and scholars. Third, many such users see new uses for libraries as physical spaces, including study places for commuter students and spaces for student collaborative and group project work, but they continue to see the need for the traditional purposes of libraries: maintaining and increasing collections (of both books and serials), and providing many comfortable, quiet places for reading, writing, study and research.

“Culture” is a place where digital and physical libraries meet on common ground. The digital libraries appear to have created, simultaneous with building their collections, distinct cultures of users, including “teachers, students, and other[s]...such as parents, software developers”, content specialists and disciplinary members, “professionals and trades people” (Shumar and Renninger, in press). The sharing of a cyberspace environment creates a unique environment where interests converge, and where interactivity is valued.

Digital libraries are also intensely aware of their power to engage in “community building” as a central glue that holds together developers, reviewers, users, teachers and other educators, and scientific users. While physical libraries are less centrally concerned with their role in community building, and indeed, see themselves as retreats or refuges from a noisy world (Krummel, 1999), the digital libraries see themselves very much as working equally to build their collections, enhance interoperability, and build community. Digital library users, at least some of them, see community-building and community-maintenance as one of their two central concerns.

One striking difference between physical libraries and digital libraries is their concern for user differences. Digital library developers worry only about the navigability of their sites, assuming that user differences are trivial when the

topic is “science” and “science literacy.” Physical libraries, however, are sharply aware of the differences in users. These differences include a continuum along which students, in particular, spread themselves in terms of familiarity with navigating virtual realities and cyberspace. Where students possess high familiarity with virtual realities and cyberspace navigation, they are intrigued by the process of locating materials, insofar as they can, by themselves, seeking out a reference librarian only when multiple attempts fail. On the other hand, students who have little familiarity with navigating cyberspace (rural populations, international students from developing countries with little access to computers, for instance), the new digital environment is formidable, and requires a different level of service than formerly provided. Users of physical libraries, more so than the tech-proficient digital library users, spread themselves out necessarily along the electronic highway of “haves” and “have nots”. This will need to be taken into account as physical libraries create new forms of service more responsive to wide differences in user proficiencies. Both the qualitative and the quantitative data demonstrate clearly that more-proficient users of digital catalogs, indexes, and data bases are more pleased with library services than those who find navigating such online tools more difficult. More user-friendly navigational tools will need to be created over time, both to bring more senior members of library communities along with technological changes, and to respond to new users (such as entering students) who are less familiar with a virtual environment and library search tools which are digital.

Yet another concern for digital libraries is the user desire to have these sites and their links look more like Yahoo! and Google or other gateways that facilitate access to large amounts of information. Should the national digital science libraries look more like these sites, what is the difference between them? Ultimately, that is a question that resides, likely, in the vetting process and in defining quality information for digital libraries. And that is a process which is still evolving.

10. Afterthoughts

It is clear that the digitizing of vast collections, of card catalogs, and of other library materials, as well as the creation of the National Science Digital Library, with their multiple links, real-time data sets, mobile information (such as simulations), learning objects, and digitized documents and video resources, has altered the landscape of information retrieval forever. Information technologies are truly “instruments of social transformation” (Ruhleder, 1991), and represent new paradigms of knowledge seeking, including what must appear to some reasoned voices as “information glut” (Postman, 1992), wherein culture is surrendered to technology. Not everyone, however, is on board for this transformation; some users cannot navigate well enough to locate materials they need or want, and some can navigate, but only with great difficulty. “Conceptual maps” which function to orient users to data, documents, and resources prove to be intimately connected to user perceptions of the service quality of a given library. Digital libraries, on the other hand, may be theoretically universally accessible (and they are apparently utilized by groups of scientists worldwide), but their sheer navigability “quotient,” may lock out

some users with less technological experience, or older computer equipment. Put another way, the rich and dynamic culture which has been built around the national digital libraries may be a culture limited to a small set of users with more observers and readers and fewer contributors and writers at the moment.

Both physical and digital libraries will have to consider user accessibility and navigability more deeply if the technological revolution is to make possible democratic access to information and research materials.

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¹ The original survey was developed and piloted for Association of Research Libraries institutions (U.S. and Canada). Since the original survey of library service quality, however, the survey has been made available to all categories of postsecondary institutions in the U.S., including community colleges, and has also been tested and used overseas.

² Users were defined to include full, associate and assistant professors, graduate students, upperclassmen and freshman-sophomore cohorts, particularly Honors students, and fulltime, professional library staff. These groups were assumed to be the major users, research patrons and stakeholders of the original ARL institutions.

³ When the federal agencies submit data bases, such information has already been vetted by teams of scientists. One example would be the national oceanographic and atmospheric science agency, who contributes regularly to DLESE. Its data have been checked and re-checked by both agency scientists, and independent researchers from various academic institutions and research institutes. The same is the case for scientific journal articles included from the large variety of heavily reviewed scientific journals and abstracts. Not all data banks and learning objects, however, have been peer-reviewed, and consequently, directors feel they should be reviewed prior to their use.

⁴ "Landgrant" institutions refers to a group of large state-funded and -controlled institutions which were created pursuant to Federal legislation in 1857, 1862, and 1869, which provided large grants of federally-owned land to the states, to be sold for profits from which state institutions serving ordinary citizens who nevertheless might have academic and intellectual merit might be created. The establishment of these institutions corresponded roughly to what is termed the "meritocratic" period of American higher education. The institutions served a second purpose, also. They provided for a technical and scientific cadre of individuals who might direct and enhance the rapid industrialization of the U.S., in the wake of the European industrial revolution.

⁵ Utilizing the *U.S. News & World Report* institutional rankings published each year.