Preliminary statistics and measures for ARL libraries to describe electronic resources and services

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Abstract

Overall, initial results of a study to evaluate the current state of the art of statistics and performance measures suggest there is much agreement on the need for standardized statistics and measures to describe networked services and resources. There is an evolving sense of agreement for specific statistics and measures that can be used for improved library planning and decision-making. The nature, definition and procedures for collecting data for these statistics and measures, however, are still in some flux. Finally, the study also has found a broad range of interest from a range of national and international organizations and professional associations in the development of such statistics and measures. Coordinating these organizations and associations to agree on specific statistics and measures will continue to be important as statistics and measures are proposed, tested, refined and used.

Introduction

Academic libraries increasingly require a range of data to describe the use and users of electronic and networked services and resources. These data are essential for collections decisions; cost analysis; justification of services; services planning and evaluation; and a host of other reasons.

The working definition of networked services is *those electronic information resources and/or services that users access electronically via a computing network 1) from on-site in the library 2) remote to the library, but from a campus facility, or 3) remote from the library and campus*. Examples of networked resources include local, regional, and statewide library hosted or authored web sites and library-licensed databases (e.g., InfoTrac, EBSCOHost, JSTOR, Project Muse).

Examples of networked services include:

- Text and numerical databases, electronic journals and books;
- Email, listservs, online reference/assistance;
- Training in the use of these resources and services; and
- Request for services via online forms (i.e., interlibrary loans).

The range and types of services accessible through and supported by networks will continue to evolve as network technology changes. While there is excitement with all the developments related to the provision of networked services, there are a number of challenges that require resolution in the area of statistics and measures for networked services.

In this paper, we report on the results from the study conducted to (1) identify and describe the current state of the art of statistics and performance measures, and (2) propose and field test a set of statistics and measures for networked services and resources at ARL (Association of Research Libraries) libraries. The study is being conducted as part of the ARL E-Metrics Project where a group of 24 ARL member libraries (Figure 1) funded the study and participated in it. Study goals, objectives, project documents, information on participants, and activities to date can be found on the project website at: http://www.arl.org/stats/newmeas/emetrics/index.html.

Figure 1. E-Metrics Study Participants

University of Alberta	Arizona State University
Auburn University	University of Chicago
University of Connecticut	Cornell University
University of Illinois-Chicago	University of Manitoba
University of Maryland-College Park	University of Massachusetts
University of Nebraska-Lincoln	University of Notre Dame
University of Pennsylvania	Pennsylvania State University
University of Pittsburgh	Purdue University
University of Southern California	Texas A&M University
Virginia Polytechnic Institute and State University	University of Western Ontario
University of Wisconsin-Madison	Yale University
Library of Congress	New York Public Library, The Research Libraries

The study used surveys and site visits to document the current state of data collection and use of statistics

related to electronic resources and services at the participating libraries. We also conducted extensive analysis of database providers' usage statistics to assess their offering and the level of comparability. Several iterations of surveys and focus group meetings produced the list of statistics for field-testing in which 16 libraries participated with varying degrees of involvement. It is important to understand that the participating libraries contributed not only financial resources but also significant staff resources and logistical assistance to make the study possible.

The study demonstrates that standardized statistics and measures can be developed to show the extent of networked resources and services, their usage, and investment in research libraries. However, due to the evolving nature of underlying technologies and shifts in the network environment, these statistics will need to be reviewed and modified in the future.

Survey Results

Analysis of the data gathered through a survey questionnaire and site visits reveal a wide range of data collection and use activities among the 24 ARL libraries. It appears that measures related to patron-accessible resources (e.g., # of electronic database titles, # of e-journals, and # of library web pages available) and costs (e.g., expenditure for e-journals, total cost of database subscription) are collected more consistently and systematically than measures related to electronic resource use or users of those resources. Due to the often inconsistent and non-comparable nature of vendor-supplied statistics, libraries seem to have considerable difficulty in tracking overall electronic database usage and use patterns.

Here are some of the main findings from the survey.

- The data collected by the libraries seemed to be shared widely among library staff and with parent institutions. However, the manner in which the information is communicated and the nature of the reporting process appeared to be limited.
- Data is most often used to make purchasing decisions for licensed vendor materials. People also indicated various uses of the data for the purpose of internal and external reporting and service assessment and evaluation.
- Regarding the most important issues related to performance measurement of networked resources and services, the majority of respondents cite the lack of consistent and comparable statistics from database vendors as the most serious problem.
- Relatively few respondents recognized or identified problems associated with the library's inability to process and utilize collected data.

Proposed Statistics and Measures

Based on the survey results and other findings, the study team developed a preliminary set of statistics and performance measures for the field-testing. In view of the fact that many of the proposed statistics and measures were never collected in a systematic way, we wanted to know 1) whether the statistics and measures could be collected; 2) whether the recommended procedures would facilitate data collection; 3) the estimated time and efforts to collect data; and 4) the utility of statistics given the amount of time and effort to collect them among other things. The initial list of statistics and measures was refined and modified through several iterations based on input from the study participants.

The following 22 statistics and measures were field-tested (Refer to Table 4 for the changes made after the field testing).

- Statistics Related to Patron Accessible Resources

R1 Number of electronic full-text journals (through institutional subscription)
R2 Number of electronic full-text journals (through consortia and other arrangements)
R3 Number of electronic reference sources (through institutional subscription)
R4 Number of electronic reference sources (through consortia and other arrangements)
R5 Number of electronic books (through institutional subscription)
R6 Number of electronic books (through consortia and other arrangements)

- Statistics Related to Use of Networked Resources and Services

U1 Number of electronic reference transactions
U2 Number of logins (sessions) to electronic databases
U3 Number of queries (searches) in electronic databases
U4 Items examined (marked, selected, viewed, downloaded, emailed, printed) in electronic databases

- Statistics Related to Expenditures for Electronic Resources

C1 Cost of electronic full-text journals
C2 Cost of electronic reference sources
C3 Cost of electronic books
C4 Library expenditures for bibliographic utilities, networks, and consortia
C5 External expenditures for bibliographic utilities, networks, and consortia

- Statistics Related to Library Digitization Activities

D1 Size of library digital collection
D2 Use of library digital collection
D3 Cost of digital collection construction and management

- Performance Measures of Networked Resources and Services

P1 % of electronic reference transactions of total reference
P2 % of electronic materials use of total library materials use
P3 % of remote library visits of all library visits
P4 % of electronic books to all monographs

The categories used in classifying statistics and the statistics themselves show that the current effort still focuses on library input-output framework of performance evaluation. Most noticeable is the attempt to construct statistics and measures of electronic resources and services that are analogous to their print counterparts. The statistics and measures proposed provide for research libraries means of accounting for resources and services delivered through electronic channels; thus a better view of or justification for the changing face of libraries.

Field-Test Results

Considerable preparation and effort by participating libraries and the study team went into the field-testing of proposed measures. A total of 16 libraries decided to participate in the field-testing. Among them, twelve (12) libraries were full participant sites and the other four (4) tested all but the library digitization statistics. A liaison at each institution was identified as primary contact during the field-testing. Detailed field testing instructions along with reporting forms were prepared and distributed to the field-testing libraries.

13 out of 16 libraries were able to compile and report data. Table 1 shows the level of participation, at least to the extent where numbers were reported by each library. The names of the libraries are suppressed, as the information is not integral for reporting purposes. Note that statistics U2 (# of session in licensed databases), U3 (# of queries), and U4 (# of items requested) were not included in the library field-testing as they were tested separately with database vendors (P2 is not tested either as it requires U4 for calculation).

Table 1: Field Testing Participation Results

	R1	R2	R3	R4	R5	R6	U1	C1	C2	C3	C4	C5	D1	D2	D3	P1	P3	P4
Library-01	•	•	•	•	•	•	•	•	•	•	•	n/a	•	•	n/a	n/a	n/a	n/a
Library-02	•	•	•	•	•	•	•	•	•	•	•	•	n/a	n/a	n/a	•	•	•
Library-03	•	•	•	•	•	n/a	•	•	•	•	•	•	•	•	•	•	n/a	n/a
Library-04	•	•	•	•	•	•	•	n/a	•	•	n/a	n/a	n/a	n/a	•	•	n/a	•
Library-05	•	•	•	•	•	•	•	•	•	•	•	n/a	•	•	•	•	n/a	•
Library-06	•	•	•	•	n/a	n/a	•	•	•	n/a	n/a	•	n/a	n/a	n/a	•	•	n/a
Library-07	•	•	•	•	•	•	•	•	•	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Library-08	•	•	n/a	n/a	n/a	n/a	•	n/a	n/a	n/a	•	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Library-09	•	•	•	•	•	•	•	•	•	•	•	•	•	n/a	•	•	n/a	n/a
Library-10	•	•	•	•	•	•	•	•	•	•	•	n/a	•	•	n/a	•	•	•
Library-11	•	•	•	•	•	•	•	•	•	•	•	n/a	•	•	•	•	•	•
Library-12	n/a	•	•	•	•	n/a	•	•	•	•	•	•	•	•	•	n/a	n/a	n/a
Library-13	n/a	•	•	•	n/a	n/a	n/a	n/a	•	n/a	•	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Library-14	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Library-15	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Library-16	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

• : data reported
n/a: not applicable (libraries who are not testing digital collection statistics) or unable to report
x : no submission

The table shows that even excluding highly experimental digital collection statistics (D1-D3), many libraries could not report quite a number of data elements. For example, library-04 is missing three cost statistics (C1, C4, and C5), two digital collection statistics (D1 and D2), and one performance indicator (P3). On the other hand, library 11 was able to report all but one cost statistic (C5).

It appears that although libraries were able to report statistics related to electronic resources (R1 through R6, in particular R1 through R4), they seem to have more difficulty collecting statistics related to expenditures (C1-C5, in particular C5) due to the fact that it is often hard to separate costs of bundled services. However, this can be misleading. Just because libraries were able to report certain statistics, the data collection was not necessarily complete and easy. Even a cursory reading of the comments in the evaluation forms leads us to believe that, in some cases, numbers were generated at a cost of many staff hours and development of local procedures to collect them.

A number of libraries have not made investments in electronic books, which resulted in many unreported R5 (# of e-books by institutional subscription) and R6 (# of e-books by consortia arrangements).

Electronic reference transactions (U1) were reported by a majority of the libraries. In the cost statistics (C1 through C5), C2 (cost of electronic reference

sources) was most readily available byfield- testing libraries whereas C5 (external expenditures for bibliographic utilities, networks and consortia) was reported by only a handful. The majority of missing performance measures data (P1, P3, and P4) is due to missing base statistics data elements (R3, U1, U2) required when necessary to calculate performance measures.

Table 2 shows another picture of the data collection efforts. It shows the number of staff hours spent to collect each category of data elements. While the field-testing instruction required that field-testing libraries keep track of staff hours devoted to preparing and carrying out data collection activities, we believe that the reported hours are an underestimation. We estimate that more stringent time keeping could have resulted in increased reported staff hours.

Looking at the total number of hours spent, we see a wide range from a mere 3 hours to 167 hours, which is equivalent to one staff member spending 4.5 weeks (based on 37.5 hour week) for field testing. It is difficult to tell, just by looking at the number of hours spent, which libraries were more efficient in executing field-testing.

Table 2: Approximate time taken to collect data

	Resource	Cost	Use	Digital	Performance	Total
Library-01	12	n/a	2	8	n/a	22
Library-03	13	17	1	16	n/a	46
Library-04	33	32	2	1	5	72
Library-05	13	4	2	8	3	30
Library-06	27	14	n/a	n/a	10	51
Library-07	32	n/a	n/a	n/a	n/a	32
Library-08	1	n/a	8	n/a	n/a	9
Library-09	1	n/a	2	20	1	24
Library-11	78	2	8	70	9	167
Library-12	3	n/a	n/a	n/a	n/a	>3
Library-13	15	6	n/a	n/a	n/a	21

n/a: not available or not applicable

Library-11, which was by far the most involved field-test library based on the number of hours spent, not surprisingly, reported the most complete data. It was clear from the reported data and the comments that the library had internal resources (such as an electronic resource management database) to support data collection, which are missing in many other field-testing libraries. Nonetheless, it tried to conform to the field-testing definitions and procedures, which resulted in high staff hours spent.

On the other hand, Library-12 was also able to report more statistics than average participants while spending minimal hours (> 3 hours). It was because library-12 used rough numbers that it already had without investing extra efforts to refine those and trying to conform to the field-testing instructions.

Simple comparison of staff hours spent does not permit any conclusive relationship between the completeness of data and the invested efforts. Library-4 spent at least 72 hours collecting data but had to miss quite a few statistics. One the other hand, Library-8 spent 9 hours and predictably, was able to report only a few statistics.

One clear conclusion from the results is that there is a varying degree or level of efforts. But it is not certain whether the same levels of effort at these libraries will remain in the production mode when these statistics become regularly collected and reported. Better internal systems that support this kind of data collection combined with more settled and consistent data collection procedures will certainly improve the efficiency of data collection operations.

Many libraries commented that a good portion of their time was spent to understand the field-testing instructions and establish local procedures and organizational arrangement. For example, library-01 reported "3 FTE staff spent 4 hours compiling the data for measures R1-R6. Initial 8 hours to develop the local in-house electronic resources spreadsheet."

A number of libraries also commented that it took them a lot of hours, probably because this was the first time they collected these statistics and that ongoing data collection would improve in terms of efficiency ("This was pretty much done for the first time here").

Field-testing was time consuming, partly due to the artificial requirements imbedded in the field-testing. For example, we asked more detailed information than necessary in an ongoing regular data collection, to make sure that there was consistency in reporting data. Without asking for detailed data, we would have no way of knowing, for example, that what one library treated as a full-text journal was treated similarly by other libraries. This created an extra burden on the libraries and may have contributed to some of the missing data. We believe that with more relaxed requirements, we could have avoided situations such as, "About 4 man-hours to verify that we could not do this," and "About 8 hours until the effort was abandoned." However, this would exacerbate the already

significant problem of inaccurate, inconsistent, and unreliable statistics.

The following points sum up what we have learned from analyzing the time taken to carry out field-testing and library comments.

- It is likely that libraries will spend a varying degree of staff hours and resources to do ongoing collection of statistics and measures related to electronic resources and services. The degree of effort depends on the library's capability (resources) and interest in data collection and use.
- With investment in internal information systems and establishing ongoing local procedures, the effort to collect these statistics can be decreased significantly.
- Standardized definitions and procedures will improve data collection and lead to consistent reporting of these statistics.

In the field-testing instructions, we asked libraries to assess the usefulness/value of each statistic relative to the amount of time and effort spent. The first thing we noticed was that there were not many outright rejections of statistics and measures due to unworthiness. As for the reasons why the statistics and measures can be useful, we could not find a wide range of answers. Typical examples of use were trend plotting, benchmarking, and reporting. Perhaps the question itself was not specific enough: we did not ask what kinds of questions could be answered by having these questions, only the degree to which a statistic was useful. Another explanation for the lack of specificity may have been that the statistics and measures tested were more or less gross figures and by themselves they may not directly relate to specific decision-making instances. One could also point to the fact that the comments and evaluations reflect the views of people who replied (librarians) and may not encompass others' views (such as library directors or university administrators) that exist in the context of evaluating statistics and measures of networked environment. Overall, it appears libraries saw these measures as good things to have in the absence of more detailed data.

Table 3 shows verbatim statements as they relate to the usefulness of statistics. It shows a range of reasons why a statistic or a measure can or cannot be useful. It also suggests that in some cases, a change in the definitions and procedures needs to be made.

Table 3: Examples of usefulness statements

Useful	Not Useful	Other
• Useful for benchmarking. (R1) • This is a very useful stat to keep as we anticipate the % of e-reference to total reference will be shifting. (U1) • Essential for fiscal accounting and reporting. (C1-C3) • A best buy in terms of benefit: cost. (C3) • Very valuable, as it captures a significant expenditure made on behalf of the library. (C5) • It is important and often asked for. (D2) • We were very interested in determining personnel costs and found the data gathering worth the effort. (D3) • Very useful. The stat will enable us to establish trends for our service areas that are useful for planning purposes. (P1) • Since ebooks are only recently becoming more prevalent, it will become an increasingly important measure, no doubt. (P4)	• We have an electronic journal database, so this was actually easy to get. I am not sure why it is important. (R2) • Not very useful, though not difficult. (R4) • It is of doubtful value. (U1) • I don't know. (C3) • It seems not worth collecting. As defined here it is too imprecise and it seems to be a very small cost compared to the other ones. (C4) • Not worth it. What we submitted here is a partial answer, and an incorrect one at that. (D3)	• For us, it isn't worth the time if we must separate institution subscriptions from consortia and other. (R1) • We do need to simplify these statistics. (C1) • The overall data is worth collecting. The time needed to prorate expenditures is cost-prohibitive. (C1) • Maybe of local interest only. Less useful for inter-institutional benchmarking. (D2)

** Notations in the parentheses refer to the statistic or measure to which the comment was made.*

Upon careful analysis of field-testing data and comments regarding management issues, we were able to revise the list of statistics and measures, and respective data collection procedures. Table 4 shows, side by side, the statistics and measures field-tested and the changes made to them after the testing.

Table 4: Changes in the make-up of statistics and measures

Field Tested Statistics and Measures	Statistics and Measures After Field Testing	Changes
R1 Number of electronic full-text journals (through institutional subscription)	R1 Number of electronic full-text journals	Eliminated institutional/consortium subscription distinction.
R2 Number of electronic full-text journals (through consortia and other arrangements)		
R3 Number of electronic reference sources (through institutional subscription)	R2 Number of electronic reference sources	
R4 Number of electronic reference sources (through consortia and other arrangements)		
R5 Number of electronic books (through institutional subscription)	R3 Number of electronic books	
R6 Number of electronic books (through consortia and other arrangements)		
U1 Number of electronic reference transactions	U1 Number of electronic reference transactions	Change the unit from questions to transactions.
U2 Number of logins (sessions) to electronic databases	U2 Number of logins (sessions) to electronic databases	Field-tested separately. No change
U3 Number of queries (searches) in electronic databases	U3 Number of queries (searches) in electronic databases	
U4 Items examined in electronic databases	U4 Items examined in electronic databases	
	U5 Number of virtual visits to the networked library resources	Newly created to calculate new P2. Was not accounted for previously.
C1 Cost of electronic full-text journals	C1 Cost of electronic full-text journals	Relaxed the expenditure prorating.
C2 Cost of electronic reference sources	C2 Cost of electronic reference sources	
C3 Cost of electronic books	C3 Cost of electronic books	
C4 Library expenditures for bibliographic utilities, networks, and consortia	C4 Library expenditures for bibliographic utilities, networks, and consortia	No change
C5 External expenditures for bibliographic utilities, networks, and consortia	C5 External expenditures for bibliographic utilities, networks, and consortia	No change
D1 Size of library digital collection	D1 Size of library digital collection	Emphasize local use of data and de-emphasize cross comparison.
D2 Use of library digital collection	D2 Use of library digital collection	
D3 Cost of digital collection construction and management	D3 Cost of digital collection construction and management	
P1 % of electronic reference transactions of total reference	P1 % of electronic reference transactions of total reference	No change -> See U1
P2 % of electronic materials use of total library materials use		Dropped because it has too many components that are not defined elsewhere.
P3 % of remote library visits of all library visits	P2 % of virtual library visits of all library visits	No change
P4 % of electronic books to all monographs	P3 % of electronic books to all monographs	No change

Issues

In general, despite the fact that many statistics are gross figures and concerned mostly with resource counts and costs, data collection was not easy. There are a number of issues and challenges that affect the library's ability to collect statistics and measures to describe its electronic resources and services. Here are several examples of them.

- Acquisitions, accounting, and cataloging systems are not set up to support this kind of data collection. Current bibliographic and management information systems, for the most part, reflect practices in the pre-Web, print-dominant environment. It appears that providing access to electronic resources is keeping many research libraries busy enough already. The lack of efficient information systems that pull together elementary data elements forced many field-testing libraries to resort to labor-intensive processes to collect data. According to a recent survey done by Tim Jewell at University of Washington Libraries, there are about 10 ARL libraries that have a production system for managing electronic resources, and several others in the planning or development stage (http://www.library.cornell.edu/cts/elicensestudy/home.html). While these systems are not developed solely for data collection purposes, they certainly facilitate the data collection efforts such as the E-Metrics project. In the absence of such fully developed information systems, we advise ARL libraries to develop, at a minimum, an in-house spreadsheet or database file to keep track of key data elements related to electronic resources and services.
- Prescribed definitions and procedures are not compatible with local practices. Several field- testing libraries independently have been collecting some of the similar statistics and measures but their definitions and promulgation of the methodologies differ from what the field-testing entailed. It seems that the majority of libraries want to build their local procedures in sync with the standardized ARL practices and such a sentiment is echoed in the following comment: "We will adjust our in-house practices to be able to report in this way." The data collection manual produced from this study is one step in that direction.
- The nature of electronic resources and services is still fluid and makes it difficult to devise clear-cut definitions and procedures. For instance, as several people have already argued (Snowhill, 2001; Sottong, 2001), the concept of electronic books is still evolving due to changes in technology, market, and use of resources among other things. As an illustration, think of the full-text search capability in most electronic books. It can be argued that there is no clear distinction between electronic books and reference sources, especially from the user's point of view. We observe that electronic access can trigger an entirely new conceptualization of a given information object as in the case of electronic books. Libraries need to deal with the implications of this changing environment and be more elastic and flexible. We acknowledge that the distinction made for different electronic resources in the study and in the current E-Metrics work is only temporary and has to be revised as we progress.
- The dispersed nature of resources in the networked environment makes it difficult to consolidate and manage statistics. It is also a growing source of frustration for many librarians who deal with electronic resources. Various listservs devoted to electronic resources and voluminous correspondence in the listservs reflect this trend. Traditionally, library materials, with a notable exception of government publications, are centrally managed through a library catalog. Also, library visit counts have traditionally been normalized by using turnstile counts whenever possible. However, in the networked environments, libraries have to deal with a whole range of resources and access points. This in turn creates more complexity in not only managing resources but also collecting data about the resources and their use. For example, with respect to usage statistics of licensed materials, while setting up a library database gateway may allow the library to collect a coherent statistic (e.g., attempted logins to licensed databases), it does not account for traffic that goes directly to vendor websites. On the other hand, usage statistics from database vendors are more complete in the sense that they capture all requested use of the database but the incompatibility of statistics from various vendors makes it difficult for the libraries to compare and aggregate usage data. Therefore, it is important that libraries need to deal with incomplete, incompatible data from multiple sources and make the best decisions based on the given data.
- There are a number of definitional and procedural issues among database vendors, library consortia (e.g., ICOLC), and other standards organizations (e.g., NISO, ISO) on how to report database usage statistics. Particularly working with major database vendors is one of the important areas to work in the future. The study initiated a good dialogue with selected vendors and their involvement was very useful and needs to be continued.
- The findings indicate that there are varying levels of resources and support available in the libraries

to support data collection and reporting. The degree to which libraries will be able to collect these data and use them is linked to the amount of resources they can commit.

- There is a range of situational factors and data needs/expectations that varies considerably from academic library to academic library. Individual libraries will need to determine which statistics and measures would be best to use, strategically and politically, in their own settings. They will also need to consider possible organizational structures and resources needed to successfully collect, manage, and report the data.

Conclusion

The explosion of networked information services has been relatively recent and the impacts from this increase of services and the corresponding technology are only beginning to be understood. An ever-increasing portion of library collections' dollars is committed to purchasing networked services. Yet relatively little is known about how these services are used, who uses them, and the overall impact and quality of these services. Many academic libraries simply have inadequate resources, staffing, and expertise to collect, manage, and report the data related to describing networked services.

The study we described in this paper provides one approach, a beginning approach, for describing and measuring some of the resources, uses and expenditures for supporting network services in an academic library setting. Given the rapidly changing technology environment, the changing milieu of factors affecting higher education; changing organizational structures within ARL libraries; and the complexity of measuring such networked services; it is likely that the statistics and measures proposed in this study will continue to evolve.

At the time of this writing, the study team has completed the draft Phase II report (Shim et al., 2001) that is under review by participating members. After the review, a revised report will be available at the project website (http://www.arl.org/stats/newmeas/emetrics/index.html). Some of the statistics and measures as reported in this paper may change in the final project report.

The study team has been investigating institutional outcomes and the role of libraries in these outcomes. We expect to submit a proposal for additional research in this area and further refinement and development of network statistics and measures.

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