Mathematicians and the Mathematics Library: A Librarian's Perspective

Sara Rutter

Today the mathematics research library exists in two modes: a tangible form of books, journals, and electronic media shelved in the library; and electronic data accessible through the Internet. By linking to local and remote servers, scholars can view resources anywhere and anytime if they have the necessary software. This article presents a librarian's view of the changing nature of the library and its users' needs.

The Library Defined

Ranganathan described the library as a dynamic entity composed of three different and interacting parts [1]: the collection, the users, and the library staff. Change in one component affects the whole. Paul Raabe described the library as "not only a public service organization, such as a post office; it is also, and always has been, an intellectual and cultural center, whose immediate environment and the changes it has undergone can throw light on the forces of change generally" [2]. Library collections are changing in size, format, and location of resources, and the use of the library is being reshaped. The "forces of change" are the ability to share files easily and to communicate results rapidly without the need for a distribution system (other than access to the Internet). New technology is facilitating and accelerating—"quickening" in Robert Lucky's characterization [3]—the way that mathematicians and scientists communicate their research.

Online bookstores that offer purchasing from the desktop and delivery to the doorstep have raised the service expectations of all consumers. Library patrons expect library catalogues to be as simple to use as online shopping interfaces and delivery of items to be as fast and convenient as obtaining merchandise from an online store. Desktop delivery of articles through interlibrary loan is now common, academic libraries are staying open longer hours, and library-to-library delivery of items is offered on large campuses with distributed library systems. These services emulate models developed outside of the library world.

Many researchers in the sciences are able to work almost exclusively from their desktops to access the literature they need for current research, but until all significant works are digitized, research in mathematics will continue to require a working relationship with the library. The transformation in the way researchers acquire the literature needed for their work is affecting, and is affected by, the changing nature of library collections. In turn, the work that library staff do and expect to do is shifting.

The core work of the mathematics librarian is to gather and to organize the resources that allow mathematicians to connect to the literature in their field. In 1957 Price [4] plotted the growth of scientific literature from 1700 to 2000 as an exponential curve, the number of papers doubling

Sara Rutter, former mathematics librarian, is Librarian for Biology, Natural Resources, and Astronomy at the Shapiro Science Library, University of Michigan, Ann Arbor. Her e-mail address is smrutter@umich.edu.

every ten to fifteen years. The increase in the number of records in *Mathematical Reviews* from 1940 to 2000 reflects a doubling time of mathematics literature of ten years. The locations where works of significance are to be found and the methods of securing them are metamorphosing. The traditional methods of learning about these resources no longer suffice. Librarians use Web pages, email messages, paper flyers, the library catalogue, and the grapevine to tell mathematicians in their institutions about new sources of mathematical literature. Effectively organizing these resources so that others can use them continues to be a challenge and is a problem on an international scale.

Ranganathan's Five Laws of Library Science

The modern library of open stacks, books shelved by subject classifications, and staff devoted to connecting users with the resources they need owes much to the developments of librarianship in the twentieth century. Shiyali Ramamrita Ranganathan, a mathematics lecturer before he was appointed University Librarian of the University of Madras, developed systems to organize library materials for better access. In his often-cited book *The Five Laws of Library Science*, first published in 1931, he eloquently expressed principles of librarianship that are still widely endorsed today: (1) books are for use, (2) every reader his or her book (books are for all), (3) every book its reader, (4) save the time of the reader, and (5) a library is a growing organism.

First Law: Books Are for Use *or* Where Are the Books and Journals?

"The library is the mathematician's laboratory." Mathematics librarians repeat this mantra, described by Frame [5], to explain the special needs of their primary patron group. Mathematicians need to be able to use the library spontaneously to check particular works in the course of their research. Frame noted a positive correlation between the presence of a departmentally located mathematics library and institutional success in the William Lowell Putnam mathematics competition. A 1995 survey [6] showed that of 45 top-ranked mathematics departments that responded to the survey, 73% had libraries in the same building as the department (a decline from 83% in 1990). Frame indicated that mathematicians are more productive when the books and journals they need to consult are located near their offices.

For many mathematicians, the act of downloading articles to the desktop is replacing visits to the library. For electronic items, a threat to the open-shelves policy has appeared through the licensing of resources for which libraries contract with vendors. A new model of collection management shifts acquisitions from purchasing to licensing, thus moving library materials out of the fair-use guarantees of copyright law and into contract law. Keeping access open to all library users is particularly important in libraries that house mathematics collections, because members of the scholarly mathematics community often visit other institutions and expect to use the associated institutional collections.

Technological hurdles too may impede access to needed literature. Software, platform, and Internet connectivity requirements necessitate another group of skilled workers to ensure access to the files that contain the literature. Mathematicians download articles in different file formats, depending both on the operating system they use and on the software in which they most commonly work. Some prefer DVI or PostScript, while others have only the resources to download PDF files or to open HTML files, and some need to use text-only browsers. Mathematicians vary widely in their comfort level in accessing information remotely, partly because of individual differences but also because the mathematics community is culturally, economically, and geographically diverse and the availability of networked access to information is still unevenly distributed.

Historical Literature

Unlike researchers in the laboratory sciences, mathematicians commonly travel back through time in their use of the literature, unconcerned about the date of publication. In their interactions with and expectations of the library, mathematicians combine characteristics of the humanist and of the scientist.

Mathematics journals indexed by ISI (the Institute for Scientific Information) generally have cited half-lives (a measure of how long articles within a particular journal are cited [7]) that are greater than ten years. Articles in mathematics continue to be cited much longer than do articles in scientific disciplines that build rapidly on current discoveries. Indeed, the citation data gathered from mathematics journals are off of ISI's time scale for measuring research impact. Mathematicians often face the task of tracking down works that were catalogued years before automation and finding them on the shelves once a call number is retrieved. Often historical materials are separated from the working library collection to preserve them from wear. Mathematics librarians face the challenge of balancing shelf-space constraints and preservation of fragile volumes with the knowledge that mathematicians do use these older materials.

Some projects are under way to keep the older literature accessible to mathematicians. One example is the retrodigitization of the *Jahrbuch über die Fortschritte der Mathematik*, now available over the Web with links to several online historical

Digitized Historical Mathematics Materials on the Web

The Jahrbuch Project
http://www.emis.de/projects/JFM/

Cornell University historical mathematics book collection
http://library5.library.cornell.edu/math.html

Mathematica collection at Göttinger DigitalisierungsZentrum
http://gdz.sub.uni-goettingen.de/en/

Gallica collection of the Bibliothèque Nationale de France
http://gallica.bnf.fr

University of Michigan historical mathematics collection
http://www.hti.umich.edu/u/umhistmath/

Numérisation de Documents Anciens Mathématiques (NUMDAM)
http://math-sahel.ujf-grenoble.fr/NUMDAM/Public/Projet/revues.htm

JSTOR's collection of mathematics journals (available at participating institutions)
http://www.jstor.org/

collections. The sidebar lists some of the globally available digitized mathematics collections that are enriching libraries worldwide.

Second Law: Every Person His or Her Book *or* How Mathematicians Affect the Collection

Because mathematicians rely more heavily on books than do scholars in other scientific disciplines, many mathematicians actively search out new titles in their fields and send purchase requests to librarians. Librarians know from the experience of helping struggling students at the reference desk that there is also a need for introductory mathematics books. Managing the collection within the constraints of the budget, the mathematics librarian depends on library users as one of the most important sources of information about the need for new resources, books, and journals. The collection is a collaborative effort.

Third Law: Every Book Its Reader *or* How Do Mathematicians Know What Literature Is Out There?

A recent survey of University of Michigan science faculty [8] found that to stay abreast of current research developments, mathematicians rely primarily on reading preprints, browsing recent print journal issues, attending conferences, and talking with colleagues. The heavy emphasis on both preprints and collegial interactions for current awareness differentiated the mathematicians from faculty in other science disciplines (astronomy, biology, chemistry, geology, natural resources, and physics).

Many mathematicians routinely check the most current journals and the newly arrived books in the library. The new-books shelf is one way that mathematicians connect with the library as a physical place. Delivering a list of new books to the mathematics department is a common service feature of mathematics libraries. The University of Michigan extracts a list of new books once a week from additions to the online catalogue and sends it to mathematicians who have requested the list.

The MathSciNet database (the online version of *Mathematical Reviews*) is a basic tool that mathematicians use to learn about books and journal articles in their field. Using a MathSciNet entry to find an item in the local library catalogue can be problematic. Most of the reference questions that librarians receive from mathematicians revolve around the problem of connecting a citation to the library catalogue and subsequently to the library shelves or links. Librarians can act as bridges between the sometimes arcane language of library catalogues or classification systems and the citations retrieved from indexes or research papers or received from colleagues.

Library instruction is an area that mathematicians who teach mathematics to undergraduate and graduate students rarely think to introduce into their classrooms. Unlike the humanities, which rely heavily on books and introduce students to the library early in their careers, mathematics generally does not offer the experience of using the library for in-depth research projects until graduate school. Though mathematics students need to become knowledgeable about the literature to perform doctoral research, library experience comes relatively late. A wide network of colleagues may substitute for up-to-date library skills for an established mathematician, but knowledge of how to access library resources and services in the currently dynamic information environment is essential to someone just beginning a career.

Because the paths to information are changing and the resources collected by the library are not all visible to the patron on a visit to the physical space, mathematicians must receive notification about changes to the collection. Finding effective means of communicating these changes is a challenge and a source of discussion among mathematics librarians.

Fourth Law: Save the Time of the Reader

Long open hours, the collection available on open shelves, and desktop delivery of current and historical literature all contribute to saving the time of the mathematician. At the University of Michigan, print journals are not allowed to leave the library, which ensures their accessibility to the

researcher in pursuit of a reference. Anderson and Pausch [9] mention similar loan practices at the mathematics library at the University of Illinois at Urbana-Champaign.

Instruction in the use of library resources and tours of the library can save novice researchers time. Graduate students and new faculty can make their use of the library more efficient by spending a few minutes with the mathematics librarian. Current instruction in libraries is focused on teaching time-saving research skills and helping researchers become more adept users of the available research tools.

Mathematicians rely on colleagues for much of their information about new resources or services, both local and distributed. New faculty, highly motivated to understand how things work in their new institution's library, are often a source of information to the department about the library. New faculty and graduate students can act as conduits for information to flow from the librarian to the department about time-saving services that are available.

Fifth Law: The Library Is a Growing Organism

The late nineteenth century and the twentieth century saw a growth in the amount of publishing, which is reflected in the collections of many of the members of the American Research Libraries. Over the last six decades the amount of literature published has grown, making possible the coexistence of two major mathematics indexes, *Mathematical Reviews*/MathSciNet and *Zentralblatt MATH* (formerly called *Zentralblatt für Mathematik und ihre Grenzgebiete*). Older mathematicians recall research libraries far less complex than the ones their students face today. To be an adept library user two decades ago, one needed to know how to use a card catalogue and a print index. In the intervening twenty years the total number of records in *Mathematical Reviews* has more than tripled [10]. To do research productively now, a library user must cope with more information, interpret different online frameworks, navigate a Web that adheres to few overarching organizational schemes, and understand how to access several portals or gateways. Because of the increasing complexity of the information environment and the growing requirement for specialized skills, scholars in mathematics need libraries and librarians today more than ever before.

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