Sudden Selectors Guide to Mathematics

By

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Foreword

Is subject-area knowledge for collection development still necessary or even important in these days of tight budgets, vendor selection, patron-driven acquisitions, and nearly-instant access? My answer continues to be a resounding "Yes!" It is vital for selectors to have an understanding of how their subjects "work" in terms of research, publication, and selection; selectors link a library's collection to its local audience, meeting the needs of researchers and faculty as well as the broader community. Selection by vendors, in the form of approval plans, can indeed create workflow efficiencies, but it takes a knowledgeable selector to set up an effective plan that can account for local needs as well as budgetary and space restrictions. The time saved by such plans allows selectors to both hone the margins of a collection to strengthen it and to conduct increasingly valuable liaison work with user groups. Patron-driven collections fill immediate demands and can indicate trends, though a selector needs to keep track of the overarching goals of a collection—something individual patrons rarely, if ever, think about. Thus, the need for selectors familiar with their disciplines as well as the production and dissemination of information in it is imperative. The ongoing purpose of the Sudden Selector's series is to provide current information on selection in specific subject areas in order to assist selectors in creating a manageable process in unfamiliar subject territories.

Helene Williams
Editor, Sudden Selector's Guide Series
March 2012
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Preface

On the Sudden Selector's Series

The Sudden Selector series was created by the Collection Management Section (formerly Collection Management & Development Section) of the Association for Library Collections & Technical Services (ALCTS) division of the American Library Association. It is designed to help library workers become acquainted with the tools, resources, individuals, and organizations that can assist in developing collections in new or unfamiliar subject areas. These guides are not intended to provide a general introduction to collection development but to quickly furnish tools for successful selection in a particular subject area. There are many tools that are pertinent for all subject areas and although not explored in detail in the guides, the following should be mentioned.

Guides to Collection Development

Evans, G. Edward, and Margaret Zarnosky Saponaro. *Collection Management Basics*, 6th ed. Westport, CT.: Libraries Unlimited, 2012.
This text serves as an authority on all areas of collection development, from user assessment, collection development policies, evaluation, deselection, and legal issues. This popular resource, in its many editions, has served as a standard text in collection development training.

Johnson, Peggy. *Fundamentals of Collection Development and Management*, 4th ed. Chicago, IL: American Library Association, 2018.
This guide by one of the key authorities in collection development covers many of the same areas as Evans and Edward. Johnson provides a comprehensive overview of the issues such as policies, planning, developing and managing collections, marketing and outreach activities, and collection analysis. The writing is engaging and its information is useful for both beginning professionals and seasoned selectors.

Disher, Wayne. *Crash Course in Collection Development*, 2nd ed. Westport, CT: Libraries Unlimited, 2014.
This title is part of the Crash Course series from Libraries Unlimited and is aimed toward a new selector without any selection experience or for those with little to no professional experience.

Although the general concepts covered may be useful for beginning academic librarians, it is focused toward the needs of public librarians.

Gregory, Vicki L. *Collection Development and Management for 21st Century Library Collections: An Introduction*, 2nd ed. Chicago, IL: American Library Association, 2018.
This approachable guide provides brief introductions to the major issues and workflows in collection development and management, and also includes examples of vendor lists, an assessment report, and an e-resources license.

Burgett, James, John Haar, and Linda L. Phillips. *Collaborative Collection Development: A Practical Guide for Your Library*. Chicago, IL: American Library Association, 2004.
This guide provides first-hand experience and advice for successful collaborative collection building. The guide provides models and strategies for research, budgeting, promotion, and evaluation.

Alabaster, Carol. *Developing an Outstanding Core Collection: A Guide for Libraries,* 2nd ed. Chicago, IL: American Library Association, 2010.
This handbook provides instructions on how to build an adult public library collection from the ground up as well the tools to maintain an existing collection. The guide provides a wealth of resources for public library collection development as well as sample core lists.

Review Sources

Choice
www.ala.org/acrl/choice
Reviews in *Choice* magazine, published monthly by the American Library Association, and *Choice Reviews Online* are targeted to academic library collections and reviews emphasize the importance of the title in collection development and scholarly research. *Choice* includes approximately 600 reviews (per month) organized by subdiscipline for books, electronic media and internet resources and as well as publisher advertisements and announcements for new and forthcoming publications. *Choice Reviews Online* provides access to issues from 1998 to the present. There are added features to the online version of the magazine including personalized profiles and title lists and an advanced search screen.

Library Journal Book Reviews
http://reviews.libraryjournal.com
Library Journal Prepub Alert
http://reviews.libraryjournal.com/category/prepub

Library Journal magazine provides brief reviews of titles on all topics and is aimed at both public and academic libraries. The reviews provide a brief summary of the title and recommendations for library audience and selection. Reviews are available in print issues of the magazine and online through various databases and as a weekly email for new review title alerts.

Booklist
www.ala.org/offices/publishing/booklist
www.booklistonline.com
Booklist, a publication of the American Library Association, publishes more than 8,000 recommended-only reviews of books, audio books, reference sources, video, and DVD titles each year. *Booklist* also provides coverage of ALA award winning titles and is available online with enhanced content such as advanced searching options and personalized profiles and lists.

Publisher's Weekly
www.publishersweekly.com
This magazine is also available through an online subscription and serves as a trade publication for professionals in the library and publishing fields. Its coverage includes industry news, trends, events and book reviews. More than 7,000 book reviews are published annually and written by both freelance reviewers as well as well-known authors. The reviews are divided by fiction and non-fiction.

Electronic Discussion Lists and Web Sites

COLLDV-L
http://lists.ala.org/sympa/info/colldv
COLLDV-L includes issues of acquisition but also covers more broad issues of collection management, such as policy development, deselection issues, and collection evaluation. It is a moderated discussion directed towards library collection development professionals, bibliographers, selectors, and others involved with library collection development.

ERIL-L
www.eril-l.org
ERIL-L's purpose is to cover all aspects of electronic resources in libraries. In addition to collection management librarians, participants include reference personnel, systems librarians, and vendors with topics ranging from usage statistics to product issues to licensing. The list is moderated and archived.

Association for Library Collections& Technical Services (ALCTS)
Collection Management Section (CMS)

www.ala.org/alcts/mgrps/cms
The purpose of CMS is to contribute to library service and librarianship through encouragement, promotion of, and responsibility for those activities of ALCTS relating to collection management and development, selection, and evaluation of library materials in all types of institutions. The section develops publications, online courses, and other tools for the training and further development of collection management.

This list is not meant to be exhaustive, but simply an introduction to some of the resources available for getting up to speed in collection development. As the Sudden Selector's guides are subject-specific, most of the above resources are too general for inclusion in the main text. However, personnel responsible for collection development should ultimately be familiar with most of them. Additionally, for the most exhaustive bibliographies for further research, consult the guides to collection development listed above.

Doug Litts
Smithsonian Institution Libraries
American Art Museum & National Portrait Gallery
Editor, Sudden Selector's Guide Series 2006–2009

Helene Williams
Editor, Sudden Selector's Guide Series, 2009-2018
Updated 2018

Chapters

Introduction and Overview

This book is meant to provide the new librarian, the new-to-math librarian, or the general reader interested in mathematics libraries at colleges and universities an overview of how modern library collections are created to serve mathematics students, faculty, and researchers. This is also more than a collection development book. All aspects of our job as contemporary librarians are interconnected so we address topics like information literacy instruction, scholarly communication, and general liaison work. We also acknowledge and try to explain broader issues in higher education such as math in general education, women in mathematics, and social media in academia. Throughout the text, the terms mathematics and math are not capitalized and used interchangeably ("maths" is often used in non-US English speaking countries in lieu of math).

Of all faculty served by libraries, mathematicians are universally fierce defenders of the library. In our experience, everything is potentially an important book, journal, or resource for mathematicians. Yet, we do not have unlimited budgets and time, so this book will help you focus on the core needs of your users through an understanding of the profession, your institution, and your library. Mathematicians also value and use older materials and print, so weeding materials is a greater challenge for math than other sciences. In addition to this book, there are 3 earlier works that are essential companions for a math librarian:

Using the mathematics literature. Kristine K. Fowler New York: Marcel Dekker, 2004
This edited volume was created by Kris Fowler with contributions from librarians, mathematicians and other academics. While over a decade old, it is still useful for new researchers in mathematics as well as librarians serving mathematical audiences. The first few chapters provide an introduction to the field and a review of information sources including databases, though most do not exist in the same form today. The later chapters recommend resources about branches of mathematics from History of Mathematics to Number Theory to Mathematical Biology. http://www.istl.org/05-spring/review2.html

Guide to information sources in mathematics and statistics. Martha A. Tucker, Nancy D. Anderson Westport, Conn.: Libraries Unlimited, 2004
This annotated collection of books, journals, and other information sources in mathematics was authored when academic resources were first becoming available online. Most chapters address a specific type of library material, such as dictionaries, encyclopedias, books, series, and journals. Some materials are in print and others online, though many of the URLs and links are no longer reliable, and some publishers and societies have changed. Particularly useful for librarians even today is the chapter of resources for math librarians and a review of scholarly communication in mathematics at the time the book was published.

A guide to library service in mathematics: The non-trivial mathematics librarian. Nancy D. Anderson, Lois M. Pausch Greenwich, Conn.: JAI Press, 1993
The signature book on the role of the mathematics librarian, this edited volume begins with

three chapters on math librarians in academic libraries, public libraries, and special libraries. The remainder of the book lists resources by library type: journals, monographs, and reference materials. Those categories are subdivided by branch of mathematics, such as linear algebra or real analysis, and codes are used to indicate the most appropriate library for the materials (academic, public, special). The breadth of this book and especially the first three chapters have enduring value for librarians wishing to familiarize themselves with math.

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Chapter 1: Know the Discipline

"There is geometry in the humming of the strings. There is music in the spacings of the spheres." Pythagoras (Murchie 1967)

History of Mathematics

Mathematics is the foundation of science both in ancient origins and in modern discoveries. Understanding math is essential to be a functioning member of society. It is also astonishingly elegant. From the construction of the pyramids in Egypt to the search algorithms of Google and forecasting in the New York Stock Exchange, mathematics lies underneath almost every common and extraordinary human endeavor. There is an entire field that studies the history of mathematics. It is "the only universal language" that communicates across all national boundaries (Changeux and Connes 1999). In fact many mathematicians find themselves historians by hobby if not by training, particularly later in their careers. For this reason it is a good idea for math librarians to understand the basics of historical research and cultivate relationships with history librarians.

Mathematics began in ancient civilizations around the world. Archeological evidence and ancient texts contain simple yet significant mathematical history. The earliest known mathematical writings are 70,000 years old. Clay tablets that are thousands of years old from Babylonian civilizations included fractions, quadratic equations, and algebra. Formal study of mathematics and theory in the western world began in Greece around 500 BC (Pickover 2009). Mathematics and philosophy intermingled during this time. Different civilizations gave birth to mathematical concepts that were then joined through commerce and communication: Arabic numerals and algebra came from the Middle East and the concept of 0 developed in Mesopotamia, while independently China developed negative numbers and decimals. Learn more about these developments by exploring the literature in the classics and area studies. There are also many rich histories of mathematics to consider, and while these are outside the scope of this project, Sarder, Van Look and Ravetz's *Introducing Mathematics*, as well as Grower's *Companion to Mathematics* are excellent places to start (Sardar and Ravetz 2015, Gowers, Barrow-Green, and Imre 2008).

Mathematics in all of its forms has overlap with other academic disciplines. The closest departments are computer science and statistics, which often developed from or may still be part of math departments. Engineering, economics, physics, and other sciences use mathematical formulae and techniques frequently. Now that computers are used in almost every academic discipline in some way, from digital humanities to bioinformatics data analysis, math is a pervasive, albeit hidden foundation across all departments at colleges and universities.

The archetype of the mathematician as a solitary genius who is inspired to discover great mathematical truths, as depicted in the movie "A Beautiful Mind", is only one part of the whole

story. Mathematicians are creative, hard-working scientists who study for many years to have the skills to create proofs and ideas that improve our understanding of the world. Librarians should not be intimidated by mathematicians since they are also human. They value the library as their lab space. Most collaborate a great deal with other mathematicians, scientists, and researchers. The pursuit of knowledge in mathematics is a conversation that often starts with the statement of the problem (or an unproven truth called a “conjecture”) and the use of current mathematical methods (or development of new methods) to create a proof.

Within mathematics departments there are many fields of study. They have historically been divided into two groups: pure mathematics and applied mathematics. Pure mathematics is "motivated by its intrinsic interest or elegance rather than its application to solving problems in the real world" (Clapham and Nicholson 2009). Most mathematical theories or methods begin as pure mathematics with the only intention to solve a mathematical problem. Applied mathematics uses mathematical methods to solve a "real-world" problem.

Pure vs. Applied Math

The difference between pure and applied mathematics is not actually quite as wide as it appears at first. It is more a product of intent rather than function. Both approaches attempt to create mathematical tools to solve problems, with the primary difference being that applied mathematics already knows how the tools will be used. A method from pure mathematics can seem abstract and later be used by engineers and scientists in application. Most mathematicians agree that it is a diverse field and they appreciate areas of cross fertilization. Though at a recent university graduation ceremony, a pure mathematician tried to describe what graduating seniors had learned, and joked that it could result in no weapons nor anything else harmful or practical. While these various kinds of math should support one another and make them stronger, understanding how different areas of mathematics diverge in interests and usage will be an important part of making the collection work for local users.

At a 2006 international meeting of mathematicians there was a conversation about applied and pure mathematics (Manin 2007). Some of the luminaries in the field make the point that in an academic setting in addition to pure and applied, mathematics also has an additional dimension. Lennart Carleson calls them three different faces: pure, applied and finally general education. It is worth pointing out this distinction here because while we like to think of math as one monolithic entity, there are many complex facets to consider. When thinking about math librarianship, the best answer might depend on the audience. Following the ACRL Framework for Information Literacy that “scholarship is a conversation”, learning to communicate and use mathematical vocabulary is like learning a foreign language (Association of College and Research Libraries Board 2015). Starting with a list of keywords that reflect the research interests of local faculty is important. A more senior faculty member of the department should have a sense of the breadth of the work being done. Visiting the department’s homepage or newsletter would also be great places to start.

While a list is a relatively easy way to do this, another method is to create a concept map or web

with the major areas in one large bubble and the different aspects of each area underneath. The benefits of this kind of visualization include seeing possible overlaps between subjects, and a better sense of the proximity of related subjects.

INSERT FIGURE 1-1 APPROXIMATELY HERE.

Figure 1-1: Example concept map for algebraic topology

Some Areas of Mathematics

Below is an incomplete list of major areas of mathematics. Each one will have different levels of granularity within them. Many subjects overlap, so it is always interesting to ask where there are emerging or longstanding connections in research. It is important to look up unknown terms as an exercise in learning the vocabulary and syntax of a new language (James 1992).

- **Accounting Math & Actuarial Science:** Accounting Math is the use of the principles of mathematics and statistics for business and financial data processing and decision making. Similarly, actuarial science is the use of mathematical and statistical principles to determine business risks. Actuarial scientists are often practitioners working in insurance and finance.
- **Algebra:** Mathematicians who are algebraists study field theory, polynomials, matrix theory, and group theory. This area uses letters and symbols to represent functions, numbers and quantities. This advanced use of algebra goes beyond basic algebra that many students in other majors struggle to understand.
- **Analysis:** Used in research on real functions, sequences, operator theory, integration, and potential theory, mathematicians in this area study real and complex numbers. Analysis proceeds from the development of calculus and often involves geometry. It has applications in physics, such as quantum mechanics, as well as signal processing, including Fourier analysis.
- **Applied:** While many areas of mathematics can be applied there are various methods to do so including calculus, numerical analysis, game theory, systems, and operations research. This area encompasses primarily real-world applications of mathematics and frequently involves other disciplines like physics and engineering. This could involve a collaboration between mathematicians and scientists from other disciplines, or it could be a mathematician that has expertise in applying mathematical methods on their own. Applied math can also be found in biology, financial trading, economics, medicine, meteorology, nanotechnology, sports, and various social sciences.
- **Differential Equations & Differential Geometry:** There are actually many areas that use ordinary and partial differential equations (PDE) and integral equations to solve problems with applications from nanotechnology to astrophysics. Similar to Analysis, differential mathematics use the derivative aspects of calculus in advanced methods geometry or algebra.

- **Discrete Mathematics:** This area uses numbers (such as integers) that have distinct values to study combinatorics, programming, and operations research. Discrete mathematical functions operate on these sets of numbers rather than infinite or continuous functions and operations. This explains why it is often studied within the context of computer science and cryptography.
- **Geometry & Topology:** Geometers and Topologists can study general and differential geometry, manifolds, and spaces within the context of space, planes, points on a plane, and surfaces. They can study these "shapes" either in traditional geometry or in curved space and higher dimensions.
- **Logic & Foundations:** Logicians study language, reasoning, statements, and proofs. Many say this area is the foundation of mathematics, as it addresses ambiguities that have been caused by using natural language to describe pure mathematics. Logicians are close to philosophers in their methods and may even overlap in publication and correspondence, so they have unique needs. This area also resembles and overlaps with theoretical computer science.
- **Mathematical Physics:** Physicists use math as a tool, and many mathematicians build these tools. The area includes the mechanics of solids, quantum theory, statistical mechanics, and fluid dynamics. This is one of the younger mathematical fields, and is often included within applied mathematics.
- **Number Theory:** This area of mathematics studies the relationship of numbers and variables, specifically integers. Combinatorics is one of the ways integers, including infinite sequences, are used to find minimum or maximum values. Number theorists work most frequently with other pure mathematicians.
- **Statistics & Probability:** Probability is the study of the likelihood of an occurrence, measured in a ratio of likelihood of it happening and not happening. Statistics is the science of collecting and processing data to make inferences about real-life and/or complex scenarios. There may be statisticians in the Math department or a separate Statistics department (more on this later), and probabilists could be in the Math department or a Statistics department. There are a wide variety of applications of statistics, so research in this field is often multidisciplinary. Some faculty working in this field may have dual appointments to other departments or collaborate frequently with others.
- **Math Education*:*** Rather than work in a distinct field of mathematics, some mathematicians choose to focus specifically on the teaching of mathematics to K-12, undergraduates, and graduate students. Sometimes math outreach and engagement with the public is also included under this umbrella. Math Education and pedagogy are useful to graduate students and faculty in any area when they also have teaching responsibilities.
- **History of Mathematics*:*** Finally, there are some mathematicians who focus (or dabble, as mentioned before) in the area of the history of mathematics, including studying the works of major mathematicians. Although this group may be small, it is worth noting here because of the evolution of mathematical science as a discipline and the fact that math seldom goes out of date. One will find that mathematicians appreciate and highly value their disipline's history.

Other than the two main types of mathematics, pure and applied, there are not a standard number of the other areas. The arXiv project (http://arXiv.org) has 32 categories for math papers, while the official Mathematics Subject Classification scheme (MSC http://www.ams.org/msc/msc2010.html) has 63 main subheadings. Even the areas we list above cannot always be grouped into either pure or applied mathematics, and some can be described as either depending on the particular faculty member or research project. A mathematician may identify themselves as a logician, combinatorialist, or algebraist. It is more likely that they will identify with a small set of areas that align with their particular research interests. There may also be defined research groups in the local department, such as a Fluid Dynamics research lab.

When you begin your work as a math librarian, it is important to know enough to tell the difference between the different areas of math such as algebra and geometry and develop a sense of how they are related, such as algebraic topology which uses abstract algebra to study the structure of shapes or sets of points. Familiarity with the fields will increase over time, though there is never a perfect distinction for all cases. Mathematicians cannot always agree either. For example, at a recent discussion of “Big Data” at Penn State two faculty argued whether “homology theory” was grounded in probability theory or was part of algebraic geometry.

Where math fits (or doesn’t) into the university

Mathematics as a discipline relates closely to other departments on a university campus. The closest two are Computer Science (CS) and Statistics, which often emerged from mathematics departments and may still be connected (America Statistical Society and Royal Society of Statistics 2019). When these newer departments were created in the mid-20th century, some professors operated on the “margins” between the departments. Today there may be faculty positions shared between an ever expanding number of departments (i.e. math and biology). A math librarian will likely be working with other related fields, which may include computer science and different forms of applied math. The exception to this is when there are large engineering programs which may or may not contain computer science, but not the math departments. Historically, these collections have been split due to their needs for a space large enough to hold sizable collections. While this is changing as formats and departmental needs are being reconfigured, there are some interesting differences and odd splits of collections that may be due to local context and historic relationships.

Although mathematics is arguably the foundation of hard sciences, technology, engineering and medicine, interestingly mathematicians do not act like researchers in the other sciences. In our experience their research practices resemble those of the faculty and students in the humanities. Certainly how they use library resources, especially in theoretical math, makes them resemble the information seeking behavior of those in the humanities, rather than other researchers in STEM (Science, Technology, Engineering, and Mathematics) fields. Even though peer reviewed journals are the primary mode of scholarly communication for mathematicians,

they consistently use books more often than other STEM fields (Dotson and Franks 2015). Until recently, there was a heavy reliance on print and browsing journals of interest in their subdisciplines. As of now, arXiv.org has replaced the reliance on print for journal articles. Mathematicians use it to browse for items of interest and pursue important articles from journals in their field (Nelson 2009).

Mathematics is clearly and obviously an important part of computer science, statistics, large parts of engineering, and specific aspects of physics. Without a sound foundation in mathematics, advanced study in any of those fields would be difficult. However, the way mathematics is currently taught in K-12 schools in the United States has been unsuccessful for the vast majority of students for many years. Nationally, our understanding is that about 60% of incoming college students need some sort of remedial math (Grubb 2011). Until these issues can be addressed and remedied, colleges and universities will continue to struggle to place students in a wide variety of “introductory” math courses. Research by scientists and educators Carl Wieman and Eric Mazur, who are encouraging profound changes in the large introductory lecture classes, suggests that we have the tools to change how we teach this material. The redesigned classes, emphasizing active learning and a decrease in class time spent on lectures, are of particular benefit to women and minorities, who are even more underrepresented in STEM fields than in other areas, and particularly so in mathematics (Wieman 2014, Freeman et al. 2014).

In many academic departments the mathematician’s work is at odds with the bulk of the teaching expected from the department. This tension sets up an interesting dynamic, as the department is usually interested in very different topics than the remedial and lower division classes that constitute the large part of the courses offered. And while some departments value having research faculty teach the lower division classes, at least some of the time, they are not given much guidance on how to teach the material to beginners who have little interest in what they think constitutes math. Though math faculty tend to have smaller research grants than those in other STEM fields and may also have fewer graduate students, they focus primarily on upper level classes. Most universities hire a combination of adjunct faculty, graduate students and instructors to teach the bulk of lower level mathematics courses, often called “service” courses that are taken primarily by non-majors.

Role of the library in mathematics undergraduate education

The library can be a place that helps students learn about how mathematics is done. Throughout high school even the best students do not need to read their textbooks closely to do well, the textbook being largely the repository for the required homework problems. Upon entering higher education, students sometimes need to be taught that a college math textbook is an important resource for learning and reviewing concepts covered in class. Usercentered libraries in academic settings will have multiple print copies of the (large, heavy, expensive) class textbooks on reserve, especially for the large or multi-section iterations of required math courses (such as Calculus). Even when a class moves to a new edition of a textbook, which may happen frequently, the older editions are heavily circulated for a number of years afterward.

This could be due to the fact that little changes in the actual content of the book between editions, but it also indicates the fundamentally unchanging nature of mathematics. Universally, students like that the books are on reserve in the libraries on campus. Our users appreciate not having to carry such large, heavy books all the time, and those who are on a limited budget may appreciate not having to purchase these expensive resource themselves. We also encourage libraries to consider having additional resources to help students with math homework when possible. The University of Oregon math program offers homework help in the library space, although there are several other tutoring labs elsewhere on campus (Schaack and Zeidman-Karpinski 2017). The public computers are frequently used for online homework rather than for accessing the collection (WebAssign 2019). The library may therefore offer a variety of learning resources for a wide range of users, including students learning the basics as well as sophisticated researchers.

More broadly, the mathematics department and its associated library resources can play an important role in supporting all undergraduate education. The success of students in math is the focus of the Mathematical Association of America (MAA) Committee on the Undergraduate Program in Mathematics (CUPM) and has some applicable sections for libraries (more about the MAA can be found in Chapter 3) (Schumacher and Siegel 2015). According to the 2015 CUPM Curriculum Guide to Majors in the Mathematical Sciences, “having librarians, financial aid experts (including those who can help students to make reasonable budgets), tutoring coordinators, and peer mentors speak with students can make the department seem accepting of and interested in them”. The guide also recommends “providing spaces where students can gather in small or large groups to work (or play, or eat lunch) together; by placing comfortable seating areas near faculty offices; by providing blackboards, journals, a coffee pot, and refrigerator in student areas.” A math library or library with math materials can serve this function admirably.

Women in Mathematics

Our impression is that while the library profession is strongly female, STEM librarianship has a wider mix of both men and women (NSF 1994). While most institutions are working on gender equity in the sciences, mathematics is one area that has remained intransigent despite well meaning efforts to change this. As Meier has noted in his research about awards in mathematics (Meier 2017), the first woman to be honored with a Fields medal was the late Maryam Mirzakhani in 2014 for her work in geometry and making a “major advance in dynamical systems” (Union 2014). By contrast, Nobel Prizes have gone to more women and sooner, although few of them have been in science and medicine. The age limit restriction for the Fields Medal may have played a part as medalists have to be under 40 years of age and women once took a longer time than men to get PhDs. The newest research shows that women now get PhDs in the same amount of time as men (Van Noorden 2015), however fewer women are getting PhDs in math overall (Cleary, Maxwell, and Rose 2011).

No matter what does or does not change, women in math are facing unique difficulties. We cannot possibly do them all justice here, but some of the challenges include:

- stereotypes about what women are capable of (Bahadur 2013, Manin 2007);
- disapproval in the face of the challenges of teaching, research and publishing;
- as visible minorities in their field they may be asked to take on more mentoring responsibilities, both formal and informal (i.e. female students gravitating to them for advice or check ins);
- experiencing more requests to represent the department on diversity-related committees (Mayock 2016)

Recently, a popular blogger, Piper Harron wrote (2017):

> "Statistically speaking, you are probably taking up room that should go to someone else. If you are a white cis man (meaning you identify as male and you were assigned male at birth) you almost certainly should resign from your position of power. That's right, please quit."

While that might not ever happen, it was certainly noticed in mathematical circles. The blog on the American Mathematical Society titled "inclusion/exclusion" at http://blogs.ams.org/inclusionexclusion/ maintains an ongoing dialog to try to address issues of diversity in math. We hope that by being aware of some of these issues, librarians can lend our support to students and faculty and try to make our collections and spaces inclusive. One never knows who will find the book or journal that inspires a career or helps when it is needed most. We'll speak more about diversity within the field in the next chapter.

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10 helpful math pronunciations

1. LaTeX - LAY teck or LAH teck. A way to tag a document so that math equations are formatted correctly – “The LaTeX template for the [university] masters thesis isn't working! Do you know someone who can help me fix it, so I can file my thesis and get out of here?”
2. Lie Groups - LEE Groups. It’s no lie: Sophus Lie was an excellent mathematician. Lie groups combine algebra and geometry all into one fun subject. Who knew one could think about the shape of collections of matrices?
3. Euler - OY ler. A Swiss mathematician from the 18th century and the hardest working man in the math-business. Euler contributed to pretty much all of math, but had special fun with series such as 1 + 2 + 3 + 4 =….-1/12.
4. Euclid - YOO klid. You may think the Euclid and Euler were contempories… but you’d be wrong, by something like 2000 years. Euclid gave us axiomatic mathematics, geometry, infinitely many primes -all before indoor plumbing was even a dream.
5. Homotopy – HOMO toe pee OR HOma top e. Homotopy is a fancy word for deformation. Supposedly, homotopy theorists can’t tell the difference between coffee cups and donuts, but we’ve observed them navigate the two just fine.
6. Abelian - ah BEE lee an. Adjectiviting weirds language. Abel is a person and thus a noun. Abelian refers to the fact that you can add or multiply in any order you choose.
7. Cauchy - KO she. One of the founders of analysis, which is the careful development of calculus – so Cauchy helped make calculus kosher - , now Cauchy’s name is associated with convergent sequences.
8. Riemann - REE mann. A giant contributor across mathematics, fortunately Riemann set the foundations of differential geometry just in time for Einstein to use them to describe the workings of the universe.
9. Lebesgue - luh BAYG. Lebesgue was another mathematician who worked through details of calculus, and has a type of integral named after him. His arguments were anything but vague.
10. Ramanujan - ra MA nah jin – You may remember that movie about the prodigy mathematician Ramanujan from India who credited the goddess Lakshmi for giving him solutions in his dreams.

This list was developed in collaboration with Dev Sinha, Associate Professor of Math, University of Oregon, Additional name pronunciations can be found at http://pronouncemath.blogspot.com/

Chapter 2: Know the Users

The library is the mathematicians' laboratory - Paul R. Halmos (1985)

Mathematics departments and the importance of a library for their work

With most journals and many books available online, most libraries have seen lower door counts from faculty and graduate students in the STEM fields. While math faculty and graduate students place a high value on print and older materials, even their habits are changing. With a wide range of materials available online through legal and not-so-legal channels, we can surmise that mathematicians can now more easily find what they need by simply downloading articles or e-books to their personal or work computers. Since the library is one of the few institutions dedicated to preserving access to both historic and current collections, it is an essential component of the scholarly communication environment. As an example, mathematicians may scan arXiv.org to see what work is being produced yet still want a final peer-reviewed copy. Even researchers who prefer to read journal articles electronically may also prefer books in print form.

Operating a small branch library has a different set of challenges than working in a well staffed larger one. Since small math libraries located close to math departments seem to have more lasting power than libraries in many other disciplines, we will discuss some of the difficulties we have encountered working in these libraries. In these branches it is possible that qualified members of the department have after hours access. Usually this privilege is reserved for faculty and instructors as well as graduate students who have passed their comprehensive exams. If this is the case at your library, consider a system that both protects the privacy of patrons and allows them to record the books they have taken to their offices after hours. One way to implement security is to require that the faculty and graduate students meet with a librarian or staff member before getting a key or key card for after hours access. At that meeting review how to physically get to the collection and record after hours check outs and remind them not to let anyone else use the space. Sadly, there may still be a fair amount of the collection that needs replacing periodically due to poor compliance with these procedures. In one case a faculty member died unexpectedly. A few weeks later his friends in the department cleaned out his office and returned a stack of unaccounted for library books that had long since been declared missing and replaced at the expense of the mathematics library budget.

In addition to the print journal and monograph collection, textbooks are an important use of the physical space of the library. Undergraduates, Graduates, and Faculty alike cherish the textbook collection for in-course use, research, and for historical value (AMS 1990). For example, in one author's recent experience, a Math graduate student group asked for a special collection of seminal textbooks for their graduate student lounge (the lounge is located within the Math Library). Again, these are local concerns for consideration at individual math libraries.

Those who have math collections interfiled with larger STEM or general collections have their own set of challenges. Space and budget allocation are usually the top concerns. Math is the foundation for many other science disciplines. The department may have large enrollments in

the introductory and required classes, but it may not have a large number of majors. Most math departments also fail to generate much income or media coverage for the institution. Math departments are some of the oldest collections and departments on campus and sometimes may have to compete with new and “sexy” departments for resources and support, including subscriptions and print space. With the long standing history of the knowledge of math research, it can be hard to make the case for the newest, say, algebra book, much like it can be hard to make the ask for the newest bible commentary. The long historical nature of math materials can be a drawback when vying for space and resources in the general collection.

Identifying institutional needs

The following are suggested steps for identifying the collection development needs of your institution:

1. Assess current collection
2. Assess needs of users
3. Align with strategic directions
4. Share with others
5. Review and assess impact
6. Repeat steps 1 through 5

When selecting library materials in mathematics, it is important to regularly evaluate the unique needs of the local university. The first steps are to assess both the current collections and user needs. Other sections of this book will help you compare what is in the collection to core resources of the discipline, but it is more important to tailor the collections to local users. There are a number of methods to use including direct contact with constituents and indirect information gathering.

In order to assess the research focus of the local mathematics department, it is often good to start with their department faculty website. Information about the department and its mission may vary greatly, depending on the size of the institution. In order to get a more detailed look, search for research groups and centers that are focused on certain fields of mathematics. Then investigate the department directory where most faculty will have their research areas listed. These may be easy to compile and review, but it may take some time to become familiar with the groupings they use. Also look for endowed or post-doctoral positions, as they may indicate an area of excellence in the department. Another option is to look at the strategic plan of the College or School that the Department of Mathematics is within. Looking at the strategic plan will give a high-level view of the emphasis of the math department, and high-impacting math-related initiatives on campus. For instance, there may be a goal of opening a new center or enrolling more undergraduates. That type of information is important, both directly and indirectly to the math library.

Bibliographic analysis (or citation analysis) is another way to quantitatively assess the focus of the mathematics department. Databases can be used to find the journals in which the most

faculty publish and searching the citations of those articles can help you estimate what they read most frequently. MathSciNet, the primary abstracting service for math, can be used to find the papers of individual faculty member and the works they cite. In order to save time, it is better to use large, comprehensive science databases such as Scopus and Web of Science that you can search by author affiliation. Google Scholar has even improved in this area in the past few years. There are also research tracking and profiling tools that many universities use such as VIVO, SciVal, InCites, ORCID and similar tools that can show the research output of an entire department or school (see chapter 5 for more about these tools).

The most direct way to gather input is to simply ask the department and users what they want and need. This is a great opportunity to learn more about their research since mathematicians are used to explaining their work. The benefit of showing interest in their work makes it worth the effort. We often make decisions with anecdotal information or because of top-down mandates, but we can make better informed decisions by talking to the very patronage for whom our math libraries exist. There is a wide spectrum of ways to gather feedback. It can be as simple as putting a suggestion or feedback box in the library with slips of paper for users to complete. We have sometimes asked departmental representatives to write out a list of topics that the department is interested in and how extensively they want to collect in that area. This list can be useful for setting up approval plan profiles and is revised regularly with departmental input. If the library does not use approval plans, collecting faculty research interests is a good way to make an informal plan for collecting books.

On the other end of the spectrum, you can create a formal print or online survey with collection and space questions asking users what they value most and cross-reference the replies with their demographic data. Asking visitors informally about why they are visiting the library may help you find unexpected needs or uses. Consider website usability tests to determine what parts of the library website are being used, or look at access statistics to find out what databases and links are visited and for how long. Again, this type of information gathering provides feedback and data about users that is sometimes overlooked. One of the authors distributed a survey via departmental email and within the library to face-to-face users about their use of the space and the materials in the library (Witt et al. 2014). From these results she was able to ascertain the importance of the print and online collections, as well as plan a space modernization project.

Outreach Strategies for Liaison Librarians

The following are some good routine practices for math liaison librarians to help them stay informed as professionals.

- Daily – read email and social media updates from publishers and societies and departmental listservs, chat with patrons who most frequent the library.

- Weekly – visit the department, they sometimes have a tea or other social event, or a guest speaker. Go to websites for math and science news. Check the week's journals for

book reviews.

· Monthly – visit Amazon.com for new books. Check with book vendor or approval plan for new ebooks and monographs. Email the department with library news or simply ask for book or journal recommendations. Send a newsletter of new books and library information to the math department. Post new books on the library webpage. Scan monthly journals and magazines.

· Annually – attend conferences to talk with vendors and other librarians, Do a review of all journal subscriptions, Search for new faculty appointments and add their research interests and publications to a list of subjects areas to acquire and retain the collection.

Connecting with faculty, students, and staff

"How can you tell an introverted mathematician from an extroverted mathematician? An introverted mathematician stares at their shoes while they talk to you, and an extroverted mathematician stares at your shoes." (Hale 2003)

In order to build a successful collection, a librarian needs to build good communication with their users. The physical library collection is still more important to mathematicians than it is to other scientists. Mathematicians appreciate the ability to browse both for a specific proof or subject, much like researchers in other disciplines used reference materials in the past. It is simply easier to browse materials in print than online and scan for the information needed. Studies also show that reading dense information is faster and easier on paper (Singer and Alexander 2017). Librarians need to go outside the library into the spaces and events where they can connect with math faculty and students, to learn more about their habits and needs.

Interestingly, the local Mathematics department may have more international professors than other disciplines in the sciences. The diversity of nationality, ethnicity, and gender of Mathematics departments can vary greatly between institutions, and the demographics of faculty are changing as more women and international scholars advance in the profession. There are a number of historical events that have impacted the composition of math departments over the past century. In the 1980s and 1990s, a diaspora of Russian mathematicians fled the U.S.S.R. (Soviet Union) for Western Europe and the United States. Thus many U.S. mathematics departments have a significant number of Russian faculty of a certain age range (Vladlen 2015). There is also an expanding number of Asian faculty members, in addition to Western European, Indian, or South American graduate students and faculty. It is important to think about their unique needs and interests especially if the collection has not focused on collecting international, foreign language, or translated materials from these areas in the past. Be mindful of the many different cultural backgrounds and learn to pronounce names from various nationalities. For professional development in cultural awareness, seek your diversity and inclusion office, human resources, or the international students office.

Many departments have regular seminars and lectures on specific topics. The math department

might have something like a weekly tea, with beverages and snacks. At Purdue the department has a *daily* coffee and tea in the library. This might have been more widely practiced at one time, but seems to remain a tradition in some departments. Sometimes these social events are also followed by or preceded by talks or discussions. While it is not mandatory to attend the talks, the teas are a great place to meet people and ask them about their research. Even though some of these interactions with faculty and students can be awkward as you search to find common interests, we have also enjoyed hearing to terrible puns, dry jokes and developed an appreciation for a certain razor sharp sense of humor that is usually both self-depricating as well as insightful.

Another important contact to make in the math department is the administrative assistant to the department head and other support staff. These are the individuals that keep the academic machine moving; they keep the faculty organized, they run many of the programs and events, and they know all the faculty and students in the department very well. Regular conversations at the beginning and end of the year can be helpful in finding out about new faculty and departing ones as well. Department support staff also know about new positions and other departmental changes. Depending on the size of the math department there may be one to a dozen support staff. There are opportunities for regular interaction with them, such as setting up a meeting time with the department head or graduate student coordinator. It is also useful to greet them one on one as often as possible. If they know the librarians and their expertise, they will call on the library more frequently. This notion holds true to the traditional expectations of what a librarian is: a friendly and knowledgeable face.

Strategies for communication with math faculty

Expect that your department will have a standing in-person faculty meeting. Before asking for time to present at one of these you should understand the dynamics of a department very well. Initially we thought attending a meeting would be an easy way to introduce ourselves to everyone at once and let faculty know what we can do to help. We have found that faculty meetings tend to involve complicated departmental dynamics. Exceptional situations, like you are aquiring or cancelling a large collection, a significant change in the library catalog or another similarly large project may be a reason to try to meet with the full department. If you do present or attend a faculty meeting, keep in mind that you are walking into an ongoing conversation between department members that started before you arrived and will continue after you leave.

Working with any group of faculty will present challenges, as a math librarian will find out while working with a math department committee on the library or a math faculty liaison to the library. If neither exist, the Mathematics Department Chair is the best contact for instituting a group or establishing a relationship with an individual person. When dealing with a formal liaison within the math department, it is best to communicate library news to them and encourage them to share it with the entire department. Be prepared for possible negative reactions, such as concerns and gripes about the library and the collections. Depending on the institutional culture

and the history of the relationship with the library, a library committee in the department (or liaison faculty member) could be considered either a coveted appointment or a low effort, meaningless position. In the case of the formal library representative, build a strong relationship with this person so they can be an advocate in the department. It is important to find out who they are and what they value, but also to communicate to them the value of librarians and the evolving nature of the library. In one university, the Library Committee was described in a math department meeting by a former committee member as “who [librarians] come to when they want to cut journals”. It took a few years to change the conversation to library services, scholarly communication issues, and new uses for library space.

Some faculty in the mathematics department may be interested in a regular way to learn about new books. Considering the love shown for libraries and books by mathematicians, this should not be surprising. Traditionally libraries have had “New Book” shelves to showcase recent arrivals. However, since many books now come as e-books our new book shelves may look empty most of the time. One alternative or supplement to the new book shelf can be a weekly or monthly email announcement of new books in the library. This could also include new journal subscriptions, databases, or library guides. If there is a regular newsletter or a new library service announcement, these can be combined into a single communication to the math department. It may be possible to email all faculty, graduate students, or the entire department directly, but an intermediary such as the department head, faculty liaison, or administrative assistant can also distribute it.

Hopefully, the math department will allow librarians to join its general email list. If something goes out that might be library related, it can be replied to immediately and directly by a librarian. However, it’s important to find a balance between keeping in touch and overloading faculty with messages they will start to ignore. Try to limit emails to regular announcements or important and pressing news. You may find that you can limit communication to one email per term if you stay in close touch with the departmental representative. Don’t be afraid of visting offices for in-person follow up if you’d like to interact and get additional faculty responses.

User Engagement

In an effort to create a welcoming space, many of us have worked on outreach activities in addition to the daily activities of the library. March 14th is often celebrated as Pi day because March is the 3rd month and therefore the date can be written as the first few numbers of the mathematical constant Pi. Math libraries, and libraries with math collections, have hosted activities including providing puzzles for patrons to assemble, supplying math or Pi themed coloring sheets (check Pinterest for ideas), and serving food like pizza (pie) as well as sweet and savory pies of all kinds. Giveaways are popular and have included shirts, items that are printed on a local 3D printer like pins or cups, or anything else math related the library has collected over time. Of dubious utility are applications that can find the numbers of a person’s birthday in Pi. Activities such as window decorating contests throughout the library or math department can also be engaging. Feel free to think big, try new ideas, and use the occasion as a chance for outreach in the math department.

One of the goals of user engagement and outreach is to promote collection and services strengths to our most important audiences. Remember to keep a connection to the collection through books or surrogates (such as book cover displays or fake books with URLs) for other material. It is often possible to solicit giveaways from math publishers or electronic resource vendors (major math publishers and vendors are listed in later chapters). The library could also develop promotional materials that can be given away and serve as a physical connection between users and the library. These activities should be assessed for impact either by attendance numbers or user feedback. Keeping our users involved in the library creates a dialog that can inform all of our decisions and planning.

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First things to do as a math librarian

1. Introduce yourself to the math department office staff.
2. Find your departmental liaison, if there is one. If not, find an informal one, perhaps at the water cooler, tea or break room.
3. Figure out what the major areas of research are in your department. Likely the department's web page will have a lot of good pointers.
4. If you're new to math, learn some of the vocabulary. Make a list of vocabulary words, just like you'd do if you were learning a foreign language.
5. Update your circulating/textbook/reserve collection to the most recent editions for the large classes.
6. Review your reference and print book collection for common themes and gaps.
7. Match your journal collections to the expertise and priorities of your math community.
8. Look for gaps, embargos, and missing years of coverage in your electronic journal collection.
9. Attend math departmental functions - picnics, teas, talks and other gatherings.
10. Ask questions. Mathematicians are used to explaining what they do even to other mathematicians. They really do like to talk about their areas of interest.

Chapter 3: Know the Profession

"The most persistent myth of mathematics education is that what is covered is the same as what is learned. We didn't cover much, but we sure did learn." (Mitchell 2002)

This chapter will discuss professional resources for math librarians and those that have collection responsibilities for mathematics. Librarians are always eager to help others, including other librarians, and there is no exception in the Science Technology Engineering and Mathematics (STEM) librarian community. Going beyond the local library and math department is essential for increasing your expertise and keeping up to date with collection development for math. We will start with professional associations for librarians before moving on to mathematician groups, and finally look at other resources for professional development.

Major societies and organizations for librarians

Because there are few librarian oriented groups within mathematical professional societies and organizations, many math librarians find most of their professional development and participation within professional librarian societies. The American Library Association's (ALA) largest division, the Association of College and Research Libraries (ACRL), has a Science and Technology Section (STS). The Special Library Association (SLA) has a Physics, Astronomy, and Mathematics Division.

Physics, Astronomy and Math (PAM) Division of SLA https://connect.sla.org/pam/home

The librarian organization that is most focused on mathematics is the Math Roundtable of the PAM division of SLA. During every SLA Annual conference, one of the PAM events is the Math Roundtable Discussion. Often a mathematics publisher, librarian, or mathematician will present on a topic related to mathematics libraries. Other PAM division events include topics of interest to math librarians, including the All Sciences poster session and related roundtables (such as Computer Science). With only a few hundred members, the PAM division is a close knit group that welcomes new members and provides support through activities beyond the conference. Membership is diverse, as is SLA as a whole, with librarians representing government agencies or labs, corporate libraries, and academic institutions. There is a PAM newsletter where math librarianship is often covered.

In mid 2016, due largely to financial pressures, SLA made the decision to restrict access to some online content and networking opportunities to paying members only. Members of each unit within SLA decided how much they rely on having conversations with other SLA members and non-members. PAM has found this cross pollination to be useful and the listserv has been run independently of SLA software support for over 17 years (see section below on the PAM

electronic discussion group).

Science and Technology Section (STS) of ACRL
http://www.ala.org/acrl/aboutacrl/directoryofleadership/sections/sts/stswebsite

The STS Section of ACRL requires membership in the parent organizations of ALA and ACRL, both larger "tents" of librarians in the profession. Because STS is larger than PAM, fewer events and discussions address mathematics specifically though there are a number of math librarians active in the organization. STS has programming during two annual conferences, the ALA Annual conference and Midwinter Meeting, as well as at ACRL's biennial conference. At ALA Annual, the organization holds a large program, a poster session, a research forum and multiple discussion groups. At the Midwinter meeting the main session is a discussion group. STS organizes online chats on STEM librarianship topics throughout the year as well. STS publishes a newsletter, primarily for organization, business, and conference news. They also publish the journal Issues in Science and Technology Librarianship (ISTL, www.istl.org) which often features math related library literature.

Electronic discussion groups

SLA PAM: pamnet@listmgr.nrao.edu

SLA's PAM discussion group hosted by the National Radio Astronomy Observatory (NRAO) does not require membership in SLA or PAM to join. Since the division has a math roundtable and many active math librarians, the discussion group is a great forum for asking questions and learning about the job. Besides the business of the organization such as conference events, newsletters, and membership news, PAMnet also has job postings, academic and publishing news, and some discussions of issues in the profession. Some publishers are members on the list and will engage librarians in discussion of materials cost, access, and quality issues. Discussions follow news of open access, scholarly communication, or other news of interest to librarians. Librarians also discuss specific books or journals that may have questionable quality or editorial review. Other collection development support available through the list are discussions of space management and weeding, core mathematics collections, and methods of engaging with math faculty and students.

STS-L: sts-l@lists.ala.org

Many emails are cross-posted between PAMnet and STS-L, the electronic discussion group for STS, but not all are so membership on both lists is recommended. Membership in STS-L is not limited to members of STS. In addition to general business, the ACRL STS officers and committee members promote online discussions that are open to any participants. Beyond the association, the email list is active with job postings, discussions of professional news, and

research projects by librarians. Because STS has a broad STEM subject coverage, few topics are specifically math librarian related, but are rather broader science librarian issues. Also, in comparison to SLA's PAMnet there seems to be more discussion around information literacy and research, rather than collection development.

Mentoring Programs

SLA's PAM Conference Buddy program & PAM Division Mentoring program
https://connect.sla.org/pam/resources/mentoringexperts

The PAM division of SLA has two types of mentoring: the Conference Buddy Program and formal mentorships. Even experienced librarians can use help when orienting to a new conference. Using the Buddy Program is a good way to take full advantage of what makes SLA different from other conferences. A new math librarian would find the formal mentoring program valuable, as it is explicitly designed for new librarians or experienced librarians with new roles in physics, astronomy or math. The program tries to match librarians with a mentor who shares job responsibilities and works in a similar type of library when possible.

ACRL STS Sci/Tech Library Mentors Program
http://www.ala.org/acrl/aboutacrl/directoryofleadership/sections/sts/stswebsite/mentors/mentorinfo

Similar to PAM's program, the ACRL's Science and Technology Section has a mentoring program based in their organization. It also matches science and engineering librarians with a mentor who has similar job experience and communication preferences. STS also holds a welcome for new member and first time conference attendees at its membership meeting and breakfast during the ALA Annual Conference.

NMRT Mentoring Program
http://www.ala.org/nmrt/oversightgroups/comm/mentor/mentoringcommittee

The New Member's Roundtable (NMRT) of ALA is a great way for new librarians with diverse backgrounds and job titles to get acquainted with ALA and the profession. Their mentoring program includes shorter-term opportunities for help at conferences, like the Conference Buddy program, as well as more formal, longer-term career mentoring, and is not restricted to librarians of any particular type. It is less likely that they will be able to match librarians of the same job responsibility, but since the NMRT is a very large organization there may be a rough match for broad interests. With regards to attending the ALA conference, NMRT, arguably, does some of the best conference orientations in the organization for both the Annual Conferences and Midwinter Meetings.

Major societies and organizations for mathematicians

Librarians can benefit from attending conferences and activities of mathematical societies to engage and network with mathematicians on the issues they care about. These events can also

be useful for librarians who have a mathematics or statistics background and want to keep current with those professions. While none of these groups have a specialized membership category for librarians, some have collection development information resources, or special conference rates for librarians. They also hold regional, national, and international meetings that can provide an immersive experience for librarians and may offer programming on some scholarly communication topics. These are listed in order starting with the organizations with the most opportunities and information tailored to librarians.

American Mathematical Society (AMS)
http://www.ams.org/publications/librarian

The AMS was founded in 1888 and is the largest organization of mathematicians, with about 30,000 members from both within and outside the Americas. The annual Joint Mathematics Meeting with the MAA (see below) is the largest conference of mathematicians in the world. Programs and presentations often cover high level mathematics, but occasionally there is programming on scholarly communication and math education that may be of interest to librarians. Librarians also benefit from a reduced registration rate for the meeting. The AMS holds meetings in regional sections throughout the U.S. which may not have content for librarians but are good networking opportunities. The AMS also provides a portal for librarians on their website that goes beyond the society's role as a publisher of books and journals to engage and support librarians in their jobs. They have done profiles on math librarians and published some scholarly articles by librarians.

The Combined Membership List (CML) is a list of names and addresses, updated monthly, of all persons who are members of the American Mathematical Society (AMS), Mathematical Association of America (MAA), Society for Industrial and Applied Mathematics (SIAM), American Mathematical Association of Two-Year Colleges (AMATYC), the Association for Women in Mathematics (AWM), and the Canadian Mathematical Society (CMS). This directory is also available in print as the Combined membership list of the American Mathematical Society and the Mathematical Association of America. Print editions are updated annually and could be useful for outreach and marketing of library resources.

Mathematical Association of America (MAA)
http://www.maa.org/press/information-libraries

The MAA is focused specifically on mathematics at the undergraduate level, and is roughly half the size of the AMS. Historically it split from the AMS in order to provide a home for research focused on the teaching of mathematics. Members include high school teachers and university faculty, undergraduate and graduate students along with many mathematicians, statisticians and those with a general interest in mathematics. Librarians can benefit most from the promotional materials the MAA produces celebrating mathematics, promoting math awareness, and math literacy. They also present math at a very approachable level for the general public, which is a great benefit to librarians without experience in the subject.

Society for Industrial and Applied Mathematics (SIAM)
http://www.siam.org/journals/librarians.php

The Society for Industrial and Applied Mathematics (SIAM) is an international community currently numbering more than 13,000 individual members. There are over 500 organizational members, including universities and libraries which receive discounts for the society's electronic products and publications. SIAM specifically focuses on applied mathematical and computational methods and how they are applied in many different areas. Applied mathematics in partnership with computational science is essential in solving many real-world problems.

Engineering librarians and libraries also work with SIAM as a publisher and society due to the large amount of applied mathematics in the engineering field. SIAM holds a large annual conference and also sponsors many smaller regional and specialized conferences.

American Statistical Association (ASA)
http://www.amstat.org/membership/index.cfm

With over 18,000 members, the ASA focuses mainly on the discipline and profession of statistics. While this focus is broad, encompassing everything from health sciences to business and engineering, many of the fundamentals are based in mathematics. Mathematical statistics faculty and graduate students along with those working in computation may be interested in the conferences and communications of this professional organization.

Blogs and Websites

What's New by Terence Tao
https://terrytao.wordpress.com/

Terry Tao is a Fields Medalist and professor at UCLA, who posts to his blog 3-5 times monthly. Most of his posts discuss (and perhaps prove) mathematical theorems and problems. Occasionally he will write about events and issues in the mathematical profession. Other mathematicians contribute to the blog and some books have been published as a result of discoveries that have been made there.

Gowers's Weblog by Timothy Gowers
https://gowers.wordpress.com/

Timothy Gowers is a British mathematician who has become a leader in scholarly communication issues in math. Gowers was the focal point of a 2012 Elsevier boycott, when mathematicians pledged not to publish with or review for the commercial publisher until its journal prices became more reasonable. It is primarily a blog of math problems and theories, but

Gowers is still instrumental in many new publishing initiatives in math.

New and Noteworthy by Edward Frenkel
http://www.edwardfrenkel.com/about/

A strong advocate for math in society, Frenkel is a University of California - Berkeley mathematics professor who has written a bestselling book about mathematics for a wider audience. His website is professionally designed and fun to explore. It contains some recent popular essays and videos of his work.

AMS Blog inclusion/exclusion
http://blogs.ams.org/inclusionexclusion/

Individual members of the American Mathematical Society contribute to this relatively new blog on underrepresented and marginalized groups of people in mathematics. They tackle difficult subjects related to the math community, teaching mathematics, and encouraging new students. It gives a voice to mathematicians from underrepresented groups and their allies. We mentioned Harron's popular blog post about the field's lack of diversity in the discussion on math and diversity in Chapter 1.

Starter Pack
http://blog.mrmeyer.com/starter-pack/

Dan Meyer, a former high school teacher of mathematics, blogs weekly about teaching math using new technology and pedagogy. His blog is useful for college math teachers as well for examples useful for lower level undergraduate instructors. Dan also covers conferences, trends, and current issues in math.

Devlin's Angle
http://devlinsangle.blogspot.com/

Mathematician Keith Devlin from Stanford University is also know as "The Math Guy" on National Public Radio (NPR) and blogs semi-monthly on this website. The focus is on applying math to everyday questions, but also occasionally on how to teach or learn mathematics. The goal is to make mathematical thinking possible for more people.

Carnival of Mathematics
http://aperiodical.com/carnival-of-mathematics/

This "blogging round up", where posts from around the Internet are collected, is sponsored by a different math-related blog each month. The purpose is to bring together contributions from different blogs and math websites on a theme or topic into one collection. The best thing about this blog is that it helps spread awareness of other math-related websites and blogs.

Quanta Magazine
https://www.quantamagazine.org/

The "Abstractions" blog, **https://www.quantamagazine.org/ ,** is part of the *Quanta Magazine* website and covers topics from Astronomy to Physics to Math. Not all of the weekly posts will be about mathematics, but there are enough that it is worth checking regularly. The magazine is

also a good source for news about math discoveries, and an even better place for profiles on mathematicians and statisticians among the multiple sciences covered.

Chalkdust
http://chalkdustmagazine.com/

Chalkdust is a magazine that covers mathematics applied to real world problems and explained in an accessible manner. The weekly blog, **http://chalkdustmagazine.com/ ,** highlights good examples for teaching mathematical concepts and having fun with math.

Information Literacy

In general, undergraduate mathematics students' use of the library even at the highest levels, does not involve much more than checking out textbooks. However, there is some concern in our profession that if students do not need to do research as undergraduates then they are not prepared to do research when they become graduate students. It is worth considering ways to have conversations about library resources with the students and faculty in the department. Bussman and Bond's work on this suggests that everyone could use instruction in basics such as how to use the catalog, getting journal articles, and using interlibrary loan for material the local library does not own (Bussmann 2015). It may be worth expanding your understanding of who your collection's stakeholders are. This may include Math Education students, future actuaries, undergraduate researchers, K-12 students in summer "future scientists" programs, and the like. Each of these groups present an opportunity to engage with the collection, print and online, in different but important ways that should not overlooked.

A new librarian should research the course offerings in the Math and Statistics departments. Math librarians who have a math history course in their departments generally found that those courses required the most use of research material. Other assignments most relevant to the library could include: a research paper, biography of a mathematician, summarizing math or statistics in the news, and short student presentations on a class topic. These assignments all provided a good entry point to teaching information literacy. Several others found that applied math and statistics classes might have more need for instruction than pure math. Specifically classes where the instructor has students using news or journal articles and finding flaws with the presentation, studies, or methods used. Math education classes may be more receptive to instruction around library resources, although education librarians may provide that information. Quantitative reasoning courses also present an opportunity to provide instruction around data literacy. Curriculum mapping with an emphasis on information literacy and informed learning that includes the math department is a good idea when exploring opportunities to collaborate and embed instruction (Buchanan et al. 2015).

Some math librarians feel that focusing their efforts on graduate students is the most productive way to reach patrons. These students will likely get training from their peers, mentors and others in their department. Some of the instruction will be informal and some will be more formal, generally in "beginning of the year orientation" settings. Beyond reaching graduate students informally, it is a good idea to work with whomever is organizing these orientations to arrange

for math librarians to participate as a presenter. The mathematics graduate student associations are good to work with as well. There may be several groups in just one department, usually there is at least one general group with additional groups for women and/or other minorities in mathematics. Likely there will be groups for those with interests in specific fields like applied math or other more focused topics. These groups normally meet regularly and may be interested in knowing about library resources. Even short presentations can be effective at giving a quick introduction to the librarian and core library resources. Graduate students have an invested interest in the core collection, as well as learning about best practices in data and research management.

An example of a successful presentation could be the librarian helping the local chapter of American Women in Mathematics find resources for women in math. Other invitations have come about when a student attended a more general workshop and then asked for something specifically for the math students. Librarians have had success with providing instruction on the following topics: covering sources for proofs, using LaTeX and the library catalog, finding theses and dissertations as well as other collected works, searching MathSciNet and/or arXiv, managing citations, and finding information about careers for math majors.

The new ACRL threshold concepts for information literacy are as useful for Mathematics as they are for any other field. Two threshold concepts are inherently central to mathematics: “authority is constructed and contextual” and “scholarship as conversation.” These are the foundational principles of how mathematical proofs are written, published and verified. For example, where would the previously unknown Indian math prodigy Srinivasa Ramanujan have been without the well know English mathematician G.H. Hardy inviting him to Cambridge? His work done in isolation in India could have remained in obscurity. These two principles undergird and gave the context to his mathematical authority.

Another instance of the importance of authority being constructed and contextual is the prominence of a site like *mathoverflow* (http://mathoverflow.net/). This website enables math questions to be raised by anyone and answered by the community. The quality of the answers is extremely high and even working mathematicians think carefully about posting and follow the threads in their areas of interest.

The concept “research as inquiry” in mathematics can also be interesting and complex, such as the publication of the solution to the Poincare conjecture, a famous topology problem first proposed in the 19th century. Grigori Perelman published his solutions without peer review on arXiv.org but never in a journal, so the highest cited article on the Poincare conjecture is another mathematicians explanation of his proof. It is worth noting that while research is certainly a conversation and anonymous peer review is still a valuable part of the research process, we have noted that true anonymity in many fields of mathematics can be difficult to achieve when a small number of other mathematicians in the world can understand some papers. Even fewer can verify the work.

We maintain that the relatively high cost of mathematical books and journal subscriptions for a relatively small audience of readers demonstrates the ACRL frame “Information has value.” Both “scholarship as conversation” and “information has value” are evident in the publication of

the book Uncle Petros and Goldbach's Conjecture (Doxiadis 1992). The book itself is a proof with a story, and the book's publisher offered a million dollars in prize money to the first person to solve the problem within two years of the announcement. While the prize went unclaimed, this scenario shows how strong the community is as well as how vital it is to maintain an ongoing dialogue within the discipline.

Research Data Management

An emerging field of interest for math librarians is finding and accessing data sets. Much like finding and accessing books, locating data sets is becoming commonplace for librarians (Witt et al. 2014). Notably, it is also an area of increasing interest for mathematicians, as is realizing that libraries have the expertise to assist with this level of research support. Mathematicians often create algorithms that process data rather than producing or collecting data themselves. However, locating others' processes can be helpful to the overall research design.

In statistics, there are many interdisciplinary topics that involve genomics and other data projects with established data management practices, but the statistician is often not responsible for that aspect of the research project. The federal mandate of Data Management Plans (DMPs) does affect many mathematicians who often look for funding from the National Science Foundation (NSF) Division of Mathematical Science (DMS) or even on collaborative project through the National Institutes of Health (NIH) or Department of Energy (DoE). Math librarians are assisting with those DMPs at pre-proposal and post-proposal stages.

It is more difficult to help pure mathematicians who usually do not produce or use data. Statistics and applied mathematics may have some data, but often they are in interdisciplinary projects where the data maintenance is done by another researcher on the project (or involves another discipline). So the data may wind up on digital repositories like the commercial venture Figshare (https://figshare.com/) or the grant funded Archaeology Data Service (ADS) or even the internationally funded Human Genome Project. There are opportunities to help math faculty that are developing code and algorithms that need something more persistent than open source code hosting like GitHub. During and after the project, there are opportunities to code the project data or formulae for preservation and findability. Math faculty can be wonderful advocates with their research collaborators on aspects of research data management (RDM), preservation and access that librarians value too. Librarians should be proactive with the service and information they can provide in support of RDM. One of the authors contributed metadata to a set of MATLAB code being deposited to their university repository.

Researcher Identification (ORCID et. al.)

One new tool that is part of the modern scholarly communication system is the unique research identifier. Traditionally authors on papers and presentations or principal investigators on grants were only identified by name. In some disciplines, names were also abbreviated using mainly the surname and the initials of other names (ex: G. H. Hardy). With the digital publishing revolution, print space may no longer be an issue but what started as a scholarly convention in

the field has been maintained and it is now difficult to disambiguate authors from each other. With more availability of international literature and a massive growth in the amount of published research, there are more authors every year. To address these demands, digital platforms have been set up to provide unique author identifiers for multiple systems: publishing, citation, grants, and even university administration.

The leading common platform is the ORCID (Open Researcher & Contributor ID) system where researchers can sign up for a unique, persistent code that can be connected to a large number of systems including publisher platforms and funding agencies. While ORCIDs are becoming more integrated, they are not required by many publishers or grant agencies nor are they used in all citations or other traditional scholarly communication author references. This may be changing partly due to pressure by university administrators, who are interested in quantifying the scholarly output of their institutions. Additionally, with the growing number of international authors and prevalence of international collaborations, it is important to distinguish researchers with common names. For librarians, the fact that ORCID identifiers are interoperable with Elsevier's Scopus author identifier and Thomson Reuters ResearcherID systems make them very useful for citation tracking. Mathematics is already a leader in this practice. In MathSciNet a specific record is set up for each mathematician and arXiv.org also has an author records system that can be matched to the other identifying IDs.

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Top 10 resources of help for math librarians

1. Special Library Association (SLA) PAM listserv
2. Association of College and Research Libraries STS listserv
3. Guide to Reference: Math Section
4. Magazines for Libraries: Mathematics Chapter
5. Math Department Chair
6. Math Department administrative assistants
7. Math Department Faculty
8. Math/STEM library support staff
9. ALA Conferences specifically Science and Technology Section of ACRL events
10. SLA Conference specifically the Physics, Astronomy, and Math (PAM) events

Chapter 4: Know the Publishers

"The book of nature is written in the language of mathematics." – Galileo

In this chapter we will focus on collecting books including textbooks, research monographs, series, and e-books. We will start with the history and background on the different types of math books in libraries. Then we will cover many of the publishers of mathematical material including professional societies, university presses, and commercial publishers. Math shares some commercial and academic publishers with other STEM fields, but it has unique characteristics among those. We will discuss the use of approval plans and book reviews for help in making selection decisions. In chapter 5 we will discuss serials and databases, while in chapter 6 we will talk about weeding materials, gift books, and multimedia.

Books

Acquiring books for mathematics is often a balance between teaching and research, reflecting the twin missions of the university. Depending on the size and nature of the institution, the library, and the mathematics department, the balance will shift between what are considered textbooks (including study materials) and monographs (detailed and specialized research works). As seen in the previous chapter, most publishers in mathematics focus on research monographs and series, while textbooks are less frequently published. In addition to those textbooks published by math or STEM publishers, many general textbook publishers like McGraw-Hill have textbooks in mathematics. Research monographs tend to be less expensive than in other STEM fields.

If the math department is small or mostly made up of teaching faculty, the library's main role will be to provide textbooks, reference books, study guides (such as McGraw Hill's Schaum's Outline series), and popular mathematics books. As mentioned in Chapter 1, when more research faculty and graduate students are present, the library will also need to collect books in their major research areas and fields. While it was common to say "just buy everything" a few decades ago, weaker budgets require every factor considered: type of book, format of book, publisher, topics covered, and cost.

[TextBox – Title "Case Study: University of Oregon"] At one of our campuses the math department administrative staff keeps the librarians up to date on the new textbook adoptions for the classes and, when possible, supplies copies of the textbooks to put on hold. Since these can be returned to the math department when the course moves on to a new textbook, it is an ideal way of keeping the reserve collection current and avoids purchasing new textbooks that are not needed for the permanent collection. The math department also donates textbooks and on request, has provided instructor solution manuals for the reserves collection. While we sometimes purchase student solution manuals for textbooks in high enrollment classes, the full instructor solution manuals are usually not easily available for purchase. Solution manuals are always popular with our patrons, and can be so heavily used that they require repair (which we wouldn't normally do for material that we aren't planning to keep) or frequent replacement. The

library always checks with the current instructors before placing the materials on reserve, especially instructor solution manuals. Solution manuals do not age well and we rarely recommend adding them as permanent collection items. Because the library and math department share physical space, we have helped each other with operational support like package delivery and issues that inevitably arise (leaks, security, etc.). The library can also rely on the math department to maintain information about additional support that students use, like a keeping a master list of office hours, updated each term. Clear documentation about who is doing what, like having a memoranda of understanding (MOU) and regularly scheduled meetings have been vital to keeping the relationship productive.

There can be overlap between the categories of research monograph and textbook in math, particularly at the graduate level. In some large research universities librarians have collection development policies (or common practices) that explicitly discourage purchasing textbooks for the collection. In some subjects textbooks become outdated quickly, but once again, mathematics is somewhat unique. Textbooks in math are read closely and contain important ways of explaining the discipline that are often timeless. Some highly regarded series like Springer's excellent *Undergraduate Texts in Mathematics* may contain introductory explanations of concepts in mathematics, but are also used by mathematicians of all levels.

Teaching undergraduate students how to read and use a math textbook may take some explicit instruction. In most non-math textbooks an aside or "fun fact" is presented as a box offset from the body of text. Conversely in math these boxes often contain crucial content needed for solving the homework problems or understanding the core concepts. Student study groups at both the graduate and undergraduate level are vital for understanding the math as they work through problems in order to gain understanding and try to achieve mastery of the material. These study groups may also read the text word for word out loud to each other to enhance understanding. With some guidance, everyone especially lower division undergraduates, can use the resources productively.

How mathematical concepts are explained may change from textbook to textbook and over time, but most textbooks in math will not age as poorly as in other fields. A general rule is that it is fine to keep a single copy of a class adopted textbook in the permanent collection. However, if the textbook is for a topic that is not a big area of research in the department there is no need to purchase research monographs in that area. For example, while most departments teach a lot of calculus it may not be an area of focus for research. In that case, keep only a few carefully selected calculus textbooks.

Classification and Organization

Most mathematics books are in the LC Classification "QA" or Dewey Decimal Classification 510. Computer science is included in the QA section at QA76 but in a class of its own in Dewey at 000. Some book series are classed together, since it was simpler to catalog and shelve. Now it may be possible to classify them according to their topic, so that a user browsing the library shelves can serendipitously discover books on the same topic more easily. In some cases the

math and science material may be separated from the main library collection in smaller branch libraries. This makes assessing the collection easier, since there are fewer materials overall, and the physical collection is relatively uniform.

Course Reserves

As mentioned earlier, undergraduate mathematics courses are very textbook driven. Some libraries provide one or more copies of textbooks through course reserves in order to reduce the financial burdens on students. Particularly in large “service” courses such as calculus, which have thousands of students, the overall savings to students can be very high. Course reserves can include solutions manuals, provided in collaboration with the department. Some of these items may become subject to very high use and need frequent repair because of wear or replacement due to loss. Course reserves can be one of the most popular services provided by the library.

Unfortunately for libraries many textbook publishers will create new editions every 2-3 years with only minor changes in order to maintain their profits. This means that libraries need to plan for recurring budget costs when committing to providing textbooks on course reserves. The math librarian is often responsible for the decision to keep textbooks for classes in the regular collection. Collection development policies should explicitly state whether only the latest edition, a single copy, or all copies are usually retained. Textbooks collection parameters are a good starting point for a new collection development policy. Fortunately, course reserves can sometimes be supplied by the campus bookstore or by the department or a faculty member. The department or faculty member may ask the publisher for additional copies for their teaching assistants and graders. The library should utilize both of these possibilities for building the course reserve collection. Some may only be temporarily loaned to the library and partial catalog records can be created for these items.

E-book versions of textbooks may provide the option of allowing more than one student access to a book at one time. Due to high enrollment in some foundational math courses, unlimited user licenses are preferred so that no students are denied access while attempting to access the book. While the initial investment is more expensive than single user licenses, the benefit is greater in accessibility. Librarians should negotiate for less DRM (Digital Rights Management) and other restrictions since students may want to print sections for reading or homework. Many textbooks are not available to libraries as e-books even though students can buy individual electronic copies. Some publishers even separate their textbook publishing divisions from the rest of the company so textbooks are not included in e-book packages. Due to the complex nature of the topic, some students may still prefer print textbooks to e-book textbooks, so libraries should supplement print with electronic (Baron 2015).

Some faculty are exploring Open Educational Resources, or Open Textbooks, which are free or reduced price course materials. These resources are particularly popular in introductory, large-enrollment classes such as algebra or precalculus. Librarians should support this effort both to benefit students and library budgets through reduced costs. Sites with high quality content are

growing, thanks in part to a national movement to make education affordable and reduce student debt. Some is hosted locally on university specific servers others are posting content on google drive accounts. It is best to connect with local OER resources. As of this writing, here are some reputable sources of Open Textbooks in mathematics:

- Open Text Book Store http://www.opentextbookstore.com/catalog.php
- Stitz Zeager Open Source Mathematics http://www.stitz-zeager.com/
- Open Textbook Library https://open.umn.edu/opentextbooks/subjects/mathematics
- OER Commons https://www.oercommons.org/curated-collections/407
- American Institute of Mathematics https://aimath.org/textbooks/
- OpenStax https://openstax.org/subjects/math
- FlatWorld http://catalog.flatworldknowledge.com/catalog/disciplines/5/titlesO

An innovative approach to both online textbooks and homework is LON-CAPA (LON-CAPA 2019). LON-CAPA stands for Learning Online Network with Computer-Assisted Personalized Approach. It is an open source, open network interactive course management system. It was created by Physics faculty at Michigan State University in the 1990s and has grown to include nearly 150 institutions worldwide. Purdue University (Purdue 2018) is using the system to integrate a three course calculus sequence with online textbook content, homework assignments, and student quizzes. When they began this project, existing publisher-created online textbooks systems fell short of meeting all of the instructional needs of the students and allowing for the requested customization by the instructors. It is worth knowing about this option and other open publishing options like it being developed in math departments across the country.

Conference Proceedings

Mathematics conferences publish their proceedings both as print monographs and electronic documents online. They may also be published as special issues of journals, though this is less likely than in other fields. Over the years many conferences have followed the pattern of starting with print publishing, then moving to electronic files on CD, and now to digital publication on the web. Depending on whether or not the sponsor of the conference relies on the publication of the proceedings for income, they may only sell a print or electronic version. Many smaller conferences simply publish the papers presented by posting them to the conference website. A book series published by a society publisher may be the proceedings from a conference, such as the AMS publication of “Conference Proceedings of the Canadian Mathematical Society” (1981-2000). The conference name may be a subtitle, where the main title describes the conference itself. For example, the American Mathematical Society and the Canadian Mathematical Society (CMS) have published a book that is the collected proceedings of the CMS. The title of the work is “CMS Conference Proceedings: Constructive, Experimental, and Nonlinear Analyses” (Théra 2000). This makes it difficult for librarians to ensure they are

collecting all the proceedings of a particular conference, since the titles are not uniform.

Similar to some library conferences, abstracts are submitted for the talks that are presented at mathematics conferences. It is likely that a talk given at a conference will become a journal article, apart from the original conference presentation, perhaps with reference to it. For example, in 2012 Professor George Andrews, the outgoing president of the AMS, gave a lecture during the Joint Mathematical AMS/MAA meeting entitled “Our Challenges”. It concerned the challenges arising from the intersection of Science/Math research, Common Core Standards, and higher education. Later that year, he published an article “Drowning in the Data Deluge” (Andrews 2012), which was a written version of that talk. This is one reason conference proceedings are viewed as being less significant than standalone research products like peer reviewed journal articles or books in the mathematics literature.

Reference Books

Reference books in mathematics have served patrons in many ways over the years. Though much like the evolution of the general reference collection, math reference books have changed to be more useful to more people. For some resources this means moving them into the circulation collection, migrating to e-book versions, or withdrawn completely. The increase of Internet reference sources, both publisher and community driven, have reduced the need for many types of reference materials. Given that math has relied heavily on paper books and that many math collections are still in print, we will describe the main types of reference books that are still useful in the modern math library. We will also point out some of the core works that are still important even in the most streamlined math reference collection. Overall, most math reference books can be moved into the circulating collection and then assessed for weeding or retention based on similar criteria to other materials (see Chapter 6 for more on this).

For a more comprehensive review of reference books, the *Guide to Reference: Essential General Reference and Library Science Sources* (Whitlatch and Searing 2014) from the American Library Association (ALA) is a useful source. ALA has also archived the web version of the Gui

de to Reference at http://wayback.archive-it.org/6087/20160223151512/http:/www.guidetoreference.org/HomePage.aspx

[Textbox - Title “Wikipedia in Mathematics”]
Librarians have varied opinions on the value of Wikipedia as an information source, and mathematicians also (Mathematics Stack Exchange 2014). Certainly, for social and political issues there is controversy regarding its reliability. With scientific topics, there may be a lack of depth or users may have difficulty identifying the primary sources used for the articles. However in math, Wikipedia can be an extremely useful source of information for librarians, students, and even mathematicians. Perhaps because of the complexity of mathematics and the intense specialization and focus of the field, articles in Wikipedia are detailed and accurate with almost

no controversy. Sources are often math books or journal articles and are well cited in the articles. There are few news stories or opinion pieces and the explanations are reliable.

Encyclopedias

Before Wikipedia, there were print encyclopedias and still today there are mathematical encyclopedias that are worth collecting and keeping in the reference collection. Some "encyclopedias" in math are not like their analogues in the humanities, so be sure to investigate the content of each set. For example, they may be more like research monographs with collections of articles about fundamental topics or recent advances in the field.

- *Encyclopedia of Mathematics and its Applications* (1973-2019) is a book series with over 150 volumes from Cambridge University Press, each focusing on a particular topic.
- The *Encyclopedia of Mathematics*, formerly published by Springer, contained basic entries and also longer survey articles in multiple volumes. It is now an open access project with the European Mathematical Society online https://www.encyclopediaofmath.org/
- *On-Line Encyclopedia of Integer Sequences* is a collaborative collection of number sequences with references to papers on each entry as well as how to generate them mathematically https://oeis.org/
- *Graphopedia* is a project to create a database of graph types and names, current in a static PDF form https://sites.math.washington.edu/~billey/graphlopedia.html
- *MathWorld* was started in the 1990s by Eric Weinstein, now owned by Wolfram Research, it remains a reputable and continuously updated free dictionary and encyclopedia http://mathworld.wolfram.com/

Biographies

Collected biographies are a type of reference book that could easily be moved to the circulating collection. Students doing biographical research for course assignments may need multiple biographical sources so keeping these in reference may also be necessary. Certainly the importance of history to mathematics makes biographies useful no matter how old they may be.

- *Biographies of Women Mathematicians* contains biographical essays with both alphabetical and chronological indexes, it features the first women PhDs before 1930 and prizes, awards, and honors for women mathematicians. This is an ongoing project by students in mathematics courses at Agnes Scott College in Atlanta, Georgia, to illustrate the numerous achievements of women in the field. https://www.agnesscott.edu/lriddle/women/women.htm

- *Great Mathematicians* (Thomley and Greenwald 2013) covers more than fifty of the best known figures in mathematics from all world cultures, from antiquity to modern times. Examples include Euclid, Pythagoras, Blaise Pascal, Joseph Fourier, and Alan Turing.

Each entry includes a portrait, date and place of birth and death, biographical details and a discussion of the person's significance, and suggested sources for further reading. Entries were selected from the larger set entitled *Great lives in history* (Salem Press 2000-2017). This work has a bibliography and an index.

Handbooks

Handbooks in mathematics often have collected formulae and equations useful to mathematicians, physicists, or even other STEM users for quick access. Since they are often topically, or conceptually organized it is possible to browse for a potential mathematical tool whereas most internet sources require that the users know the formula name. One exception is Wolfram Alpha (https://www.wolframalpha.com) created by the same company that owns MathWorld. Wolfram Alpha is especially useful as a tool for natural language computations and serves as a great online resource for formulae.

- *Handbook of Writing for the Mathematical Sciences* is a reference tool primarily for those learning to write research mathematics for publication (e.g., graduate students). Included are chapters on standard English usage, writing papers and talks, the publishing process, and using computers for writing and research. There is also a glossary and bibliography though it is now dated. There is a subject index and an appendix on TeX and LaTeX, languages used for rendering equations and other characters unique to math. Both AMS's *Mathematics into Type* or *Handbook of Typography for The Mathematical Sciences* provide better coverage of those topics. It is a good selection for those serving graduate programs in mathematics, and is also available as an e-book. http://www.maths.manchester.ac.uk/~higham/hwms/
- *CRC Standard Mathematical Tables and Formulae* contains formulas, tables, figures, and descriptions, including many diagrams, group tables, and integrals not available online. This new edition incorporates important topics that are unfamiliar to some readers, such as visual proofs and sequences, and illustrates how mathematical information is interpreted. Material is presented in a multi-sectional format, with each section containing a valuable collection of fundamental tabular and expository reference material.
  https://www.crcpress.com/CRC-Standard-Mathematical-Tables-and-Formulas/Zwillinger/p/book/9781498777803

Directories

Print directories in mathematics have been made essentially obsolete by the Internet. Now information on membership is usually available on the website of a professional association. An important resource is the *Combined Membership List (CML)* listing members of the largest mathematical societies in the U.S. which is now only available online https://www.ams.org/cml There is a strong incentive to archive directories for historic research purposes. Directories of graduate programs in the discipline may also be valuable to the collection. All of these kinds of

directories may be useful to bibliographic researchers, historians, librarians, or university or department administrators. One example is the https://www.crcpress.com/CRC-Standard-Mathematical-Tables-and-Formulas/Zwillinger/p/book/9781498777803

Bibliographies

Libraries also have a number of reference books in mathematics that are bibliographies of mathematical works. They are lists of books or articles on a subject, by a mathematician, or for use for collection development.

- *Bibliography and Research Manual of the History of Mathematics* (May 1973) is a bibliography of published writings on the history, biography, and bibliography of mathematics. Librarians, historians, mathematicians, and students will find this resource useful for tracking items published before 1973. The first part of the book is a research manual that consists of brief comments on information retrieval and storage and historical analysis and writing. The methodology is very dated and based on printed cards. The second part is a bibliography of about 31,000 entries, alphabetically arranged by author within sections such as: biography (which is the strongest section), mathematical topics, historical classifications, and information retrieval.
- *The History of Mathematics from Antiquity to the Present: A Selective Annotated Bibliography* (Dauben 2000) lists works that span and cover the history of mathematics. The online version contains over 4,800 entries, about double the number of items in the print edition it replaces. The contents are divided into 52 Adobe PDF files. There are author and subject indexes, and correspondence information. The book is organized both chronologically and by mathematical and historical topic. The scope encompasses primary sources, histories, and general reference works. It has been compiled with the assistance of 38 contributing editors. This edition of the work is currently only available for purchase as compact discs. Given the format, it is difficult to decide how useable it might be at this time.

Dictionaries

Like encyclopedias, print dictionaries have largely been replaced by online dictionaries and Google. However, certain types of specialized dictionaries such as translation dictionaries, quotation dictionaries, and concise volumes are sometimes simpler to flip through in print rather than searching online.

- *Mathematically Speaking: A Dictionary of Quotations* (Gaither, Cavazos-Gaither, and Slocombe) contains over 1,000 quotations from mathematicians, non-mathematicians, and some fictional characters. Sources are from over 800 historical and 20th-century journals and books in mathematics, works in fiction, and standard authors. Quotations are grouped by broad subjects, such as calculation, analogy, deduction, and topology. The bibliography lists quotes by source, with rather extensive author and subject

indexes. The source is available online through NetLibrary and CRCNetBase.

- *Concise Oxford Dictionary of Mathematics* (Clapham and Nicholson 2009) is a standout when compared to other mathematics dictionaries because of its detail, depth of entries, and breadth of scope. This work covers pure and applied mathematics, including statistics and areas such as fractals, game theory, and chaos theory. The 2009 Web edition has been updated from previous print editions with more terms used in college-level mathematics, an expansion of computing terms, and the addition of biographies of prominent mathematicians, including Nobel prizewinners and Fields medalists.

Translation Dictionaries

As was mentioned earlier, English was not always the main language of mathematics publications. In addition to a strong history of German writing, French and Russian mathematicians were published in their native languages. Translations of these classic and contemporary works are important to the future study of mathematics, since fundamental proofs and theories can last a long time (ex: Fermat's Last Theorem of 1632). While translation is happening increasingly online and electronically, there may still be a place for the multilingual mathematics dictionaries that are in many math library reference collections.

- *A. J. Lohwater's Russian-English Dictionary of the Mathematical Sciences* last published by American Mathematical Society in 1990 had over 15,000 Russian mathematical terms with English equivalents and translations. It includes stress markings on Russian words and contains a brief Russian grammar section with appendixes that contain noun declensions, verb conjugations, lists of numerals, and root lists. (http://ega-math.narod.ru/Quant/AJL.htm) A similar alternative is also the *CRC Russian-English Dictionary of Mathematics* by Oleg Efimov (1992).
- *Elsevier's dictionary of mathematics: English, German, French, Russian* by Keti Georgieva Peeva (2000) published by Elsevier contained over 11,000 entries with more than 4,750 cross-references. This very large monograph covers all the major fields of mathematics from elementary to advanced: arithmetic, geometry, discrete mathematics, logic, algebra, applied mathematics, and game theory. It also includes commonly used terms in computer architecture, hardware, communications, system and application software, and programming. It does not yet have an electronic version available.
- *ISI Multilingual Glossary of Statistical Terms* (http://isi.cbs.nl/glossary.htm) was created by the International Statistical Institute and last updated in October 2009. This multilingual glossary of statistical terms includes more than 3,500 terms with each term available in multiple languages (as many as 28). Almost all European Union languages, plus Afrikaans, Persian, Russian, Turkish, and Ukrainian, are covered. Entries range from basic to more advanced terms encountered in graduate studies and research, including applied mathematics and specialized fields of statistics such as biostatistics. Translations are contributed by specialists from several countries; users can offer suggestions for any missing translations (these are vetted by editors before being added to the glossary).
- *Mathematisches Fachwörterbuch: English-Deutsch, Deutsch-English* by Lewisch and

Posamentier (2014) is a good aid for native English speakers reading mathematics texts in German or native German speakers reading such texts in English. A smaller less comprehensive dictionary, it focuses on the basic terms of mathematics. It was designed to supplement general language German-English dictionary and assumes the reader has basic working knowledge of both languages. The two main parts are the alphabetical term translation chapters, English/German and German/English. It includes additional material such as suggestions for speaking and writing mathematical expressions or idioms, and notes on the differences between British and American English.

Other Translation Resources

There are some resources that were translated from Russian to English regularly during the Cold War era, either published as journals by commercial publishers or by U.S. government agencies as technical reports. It is possible to find a direct mapping of these publications; for example, the Soviet publication *Akademiya Nauk SSSR. Doklady* was translated and published in the US as *Soviet Mathematics - Doklady*. This is useful for researchers looking to obtain a translation of the original article or determine if one exists. It is also useful for correcting erroneous or confusing citations, where the original Soviet (U.S.S.R.) journal name is translated but the English volume and edition are used. Some unique reference books that can help with this are listed below.

- British Library. Lending Division, and International Translations Centre. 1982. *Journals in translation*. 3rd ed. United Kingdom: British Library Lending Division.
- National Translations Center. 1969. *Consolidated index to translations into English*. New York: Special Libraries Association.
- National Translations Center. 1986. *Consolidated index to translations into English II: 1967-1984 cumulation of Translations register-index*. Chicago: National Translations Center. 3 volumes.

Tables

Before there were computers and scientific calculators, slide rules were used for calculation. Engineers and physicists would come into a library to consult logarithmic tables that were kept in the reference section. Many libraries still have these tables as well as other artifacts of an earlier age. These volumes have very little practical value, even as artifacts of their time. Unless they are rare or in a foreign language, there are few reasons to retain these books even in storage.

Publishers

Mathematicians can be very opinionated about publishers, trusting some and recommending the library purchase as many books as possible from them. Librarians need to balance budget realities with this input, so it is necessary to be familiar with the key publishers in mathematics.

We start with society publishers, since mathematicians generally hold them in higher regard than purely commercial publishers. Professional societies are important to mathematicians, as mentioned in Chapter 3, so mathematicians publish with and read society publications quite frequently. Next are university presses that may be small in the market, but have high quality publications. Finally commercial publishers are addressed in the order of their reputation among mathematicians, which is somewhat related to the number of books published.

Society publishers

Mathematical societies are among the most popular and recommended publishers by mathematicians and researchers. Perhaps their success is not surprising given that their members are loyal and are often both the authors and audience for the publications. Here are many of the same societies previously mentioned in Chapter 3.

American Mathematical Society (http://www.ams.org/publications/librarian)

The AMS publishes between 75 and 90 books per year. At press they had 27 active book series, including 10 co-published series with partner presses. While everything published by the AMS is of high quality, a library should first purchase the items of particular interest to the local math department. The AMS has added a number of e-book collections over the years, starting with their earliest volumes through the current year. They are available as frontlist subscription or backfile purchases, and librarians can decide based on their budget which option works the best. E-books are DRM free and accessed via IP authentication. Exemplar series to start with are *Graduate Studies in Mathematics, Student Mathematical Library,* and *the University Lecture Series*. Purchasing an e-book series also allows libraries to put older books into storage since these are backfiles, but many mathematicians will still want to browse and read the print.

Society for Industrial and Applied Mathematics (https://www.siam.org/books/)

SIAM publishes research monographs, textbooks, and 17 book series. The SIAM e-book collection can be purchased or leased annually and provides book chapters as unrestricted PDF files. Institutional membership with SIAM affords the library a discounted rate on books and journals, so it works out in favor of most libraries to have such membership. Since applied mathematics overlaps frequently with engineering and other sciences, it is usually possible to purchase these resources collaboratively with other subject librarians.

Mathematical Association of America (http://www.maa.org/publications/books)

The MAA publishes about 15 new books each year, which frequently focus on teaching mathematics and research at the undergraduate level. They publish 8 series of which *MAA Notes* and *MAA Textbooks* are the most significant. Most libraries can afford to get all of the MAA books published in any given year due to their affordability. The MAA sells individual e-book downloads via their website. Libraries can also purchase access to some current and past MAA e-books through University Publishing Online, a service of Cambridge University Press. The American Mathematical Society (AMS) acquired the MAA Press books as an imprint in 2017.

European Mathematical Society (http://www.ems-ph.org/books/book_series.php)

The European Mathematical Society (EMS) does not publish many books; its entire catalog dating from 2004 has nearly 200 titles. Within its dozen book series, the EMS mainly publishes collected works and conference proceedings, but also a few research series. Recently the publisher has offered e-book access through subscription to universities with IP authentication.

University presses

Many universities and higher education institutions of varying sizes and statures also host publishing houses. We list here three of the longstanding and most renown of the national and international presses.

Cambridge University Press
(http://www.cambridge.org/us/academic/subjects/mathematics/)

Cambridge publishes about 45 books annually in mathematics, including the respected series the *London Mathematics Society Lecture Notes*. Along with their own e-books, Cambridge provides the University Publishing Online platform for publishers without their own e-book service (similar to the MAA). Titles can be ordered individually or as a group of e-books.

Oxford University Press
(http://ukcatalogue.oup.com/category/academic/mathematics.do)

Oxford University Press publishes a number of mathematics reference books, research monographs, a few popular science titles, and over 80 book series. They publish an average of 20 academic titles annually for higher education. Their online website Oxford Scholarship Online (OSO) also hosts books from 17 smaller academic presses. Their textbooks are marketed separately and may not always be available as e-books through OSO. Librarians can work directly with Oxford to identify individual titles or groups of e-books to purchase at any time, though there may be some delay between the publication of a book in print and its online availability.

Princeton University Press
(https://press.princeton.edu/catalogs/subjects/title/mathematics-general.html)

Princeton University Press publishes research monographs, textbooks, and books on popular science topics in mathematics. Princeton publishes approximately 20 books in mathematics annually with 9 current series. These series may be new research volumes or collected works; some have new titles only every few years. *Annals of Mathematics Studies* has been published for almost 80 years by the Press, and it is now available with some of their other series through the publisher DeGryuter. Their non-series titles are mainly for general science readers with several offered annually. They also publish textbooks for undergraduates and graduate students. One outstanding book in their catalog is the classic “Princeton Companion to Mathematics” (Barrow-Green, Gowers, and Leader 2008).

Commercial publishers

Springer (http://www.springer.com/mathematics)

Springer is the foremost commercial publisher in mathematics with over 500 books annually. It has almost 100 book series in mathematics including the important title *Lecture Notes in Mathematics*. Between 80-90 textbooks are published each year, often in series such as *Undergraduate (and Graduate) Texts in Mathematics*. Springer will also publish a few large reference works every year, such as handbooks and encyclopedias. Springer has been historically the strongest publisher in mathematics and is highly respected by mathematicians. Most of their books are published in English, but a sizeable minority of their books (especially historic volumes) are in German and occasionally French or Italian.

Their *Springer Book Archive* offers online access to their extensive historic collection (dating from 1842 to 2004) as e-books, which is especially beneficial to mathematicians but may not be affordable for all libraries. Springer also publishes the Kluwer and Birkhauser imprints, and these may be excluded from their large book packages. Presently, electronic access to *Lecture Notes in Mathematics* can only be purchased as part of a package with other electronic math books. Similarly, the important *Lecture Notes in Computer Science* is essential for that field, as there is overlap with Math, but it is sold as part of a different collection. The cost of these packages is significant and for many, unavoidable. Springer gives some options and it is possible to get the series either as a subscription or a one time purchase for perpetual access. The backfiles are also available in sections divided by decades as well as subjects.

One of the nicest features of Springer's e-books is that patrons have the option of paying a minimal fee ($24.99 in 2019) for a personal print copy of any electronic book that the library has purchased. These books are regularly assigned as class texts as well. In a field like Mathematics, this is a useful and popular way to address both the needs of our users for different formats and the space constraints of many of our library spaces.

World Scientific (http://www.worldscientific.com/page/mathematics)

World Scientific is a publisher that began in 1981 as a small house in Singapore but is now international. They publish 75 series in mathematics with about 100 books annually. Though they started publishing mainly advanced research monographs, the publisher has diversified into a wide range of topics including pure and applied mathematics and mathematics education. Their authors had typically been from Asia, but now include European and American authors and institutions. The quality of the proofreading and editing has improved with time. Not everything from World Scientific is of the highest quality, but it can increase the depth of a collection. They publish some series based on mathematical awards, such as the Fields Medal and Wolf Prize, which are mainly reprints. All of their titles, except textbooks are available in electronic format, either through their own platform or third-party e-book vendors.

Wiley (http://www.wiley.com/statistics)

Wiley publishes research monographs and textbooks in mathematics, some through their Wiley-Blackwell imprint. While they have a stronger focus on statistics, there are a number of books

for pure or applied mathematicians including five notable series: Pure and Applied Mathematics; Probability and Statistics; Statistics in Practice; Computational Statistics; Discrete Mathematics and Optimization. Wiley is not necessarily a major publisher in mathematics. Their book quality is good but the frequency of math titles is low. Wiley can be a source of additional books in a particular mathematics topic. The Wiley Online Library provides access to their e-books with book chapters as unrestricted PDF files.

Elsevier (http://www.elsevier.com/physical-sciences/mathematics)

Despite being a large STEM publishers, Elsevier publishes less than 50 books in the mathematical sciences annually, although their editors are visiting university campuses frequently as part of an effort to increase the number of books in mathematics they publish. Elsevier also owns the imprints Academic Press and North Holland. Despite having less than a dozen book series, some are important to the field such as the *North Holland Mathematical Library*. Their monograph catalog includes textbooks and a few popular mathematical titles, but is primarily focused on research materials. E-books are available through ScienceDirect as a frontlist each year in the math subject collection with backfiles for previous years. The *Heritage Collection* of books dates as far back as 1580, which may be of particular interest to those studying the history of math and science.

Elsevier has had a troubled relationship with mathematicians, primarily due to the high costs of their journals. Since 2006 when the editorial board of *Topology* left to establish a new journal, mathematicians have had a negative view of the publisher. As mentioned in Chapter 3, in 2012 Tim Gowers organized a boycott of Elsevier by mathematicians who wrote, refereed or edited for Elsevier journals. Despite many concessions from the publisher, such as making most of their pre-2008 journal articles Open Access and other policy changes, there is still a stigma associated with Elsevier among math faculty. Librarians should beware that title changes and other gaps may exist in Elsevier math journal runs.

De Gruyter (http://www.degruyter.com/browse?t1=MT)

De Gruyter annually publishes about 60 books in mathematics and along with partner presses has over 30 book series. Their most significant series are *De Gruyter Studies in Mathematics* and *Expositions in Mathematics*. The majority of their books are published in English, but almost a quarter over the last ten years were in German. A few of their books are used as textbooks in undergraduate and graduate classes.

Taylor and Francis (http://www.taylorandfrancis.com/books/subjects/SCMA/)

Formerly a small publisher, Taylor and Francis has grown through many acquisitions of other publishers. They have the large science and engineering book catalog of CRC Press, which includes hundreds of reference books and textbooks. The Routledge imprint also publishes a few books annually.

Free Online Books

Users may have the expectation that the full text of most items is available online, and are frustrated that books under copyright are not freely available. Most books published prior to 1923 are in the public domain, meaning online versions can be downloaded in their entirety for free. As noted previously, mathematicians often find older works useful and many classic mathematical texts are in the public domain. The following are platforms for accessing free, public domain books online.

Google Books http://books.google.com

In the past decade, the Google corporation has partnered with libraries to scan their collections for digital preservation and access. Google makes titles in the public domain accessible via its Google Books platform, and is sometimes allowed to display “snippets” or excerpts from those that are still under copyright. These snippets can still be useful for finding a particular theory, portion of a proof, quote, or definition.

Hathitrust http://www.hathitrust.org/

Hathitrust is the partnership of libraries that curates the digital collection resulting from Google’s scanning and the Internet Archive including special collections. For works that are not completely accessible, Hathitrust may be used to confirm citation information by searching in the full text of these books.

Collection Development Tools

Approval plans

Approval plans specify the books that a library receives automatically from a book vendor, sometimes called a “book jobber”. Librarians meet with a vendor representative to develop criteria for automatic ordering, book slips (formerly print, now electronic), and exclusions. These criteria include classification range, book type and price, publisher, and series. It is a good idea to review an approval plan immediately when starting a new liaison position, since it contains detail on past collecting patterns. Approval plans should also be reviewed regularly by meeting with the vendor representative. Plans can be impacted by publisher changes or large package purchases made by the library as a whole. Some approval plans can also generate regular alerts when new books are published. These are useful both for librarians but also for key users that can identify books for purchase.

In mathematics, approval plans can help librarians acquire books from many of the main commercial publishers as well as most academic presses. There may even be small publishers handled by a robust approval vendor. There are some publishers you will want to exclude due to poor quality of editing (Nova Science) or because they primarily publish reprints (Dover).

Especially in mathematics where books are kept longer by libraries and reprinted often, reprints should not be purchased automatically. Another type of material to review prior to purchase are festschrifts, which are collections of articles in honor of an individual. These may already be available to patrons through journal subscriptions or the previously printed versions of the individual articles.

Because many mathematics publishers will identify books or series as “textbooks” some approval plans will mark these in a textbook category that may be excluded from the approval plan. Math librarians should remove these blanket exclusions so textbooks for course reserves or miscategorized research monographs are not missed. One way to receive book series is to have a standing order with the publisher, but an approval plan is an alternative.

If the library annually purchases large e-book collections, approval plans in those subjects should exclude books from those publishers to avoid duplication. Math librarians may still get requests from some faculty for print versions of e-books that were previously purchased. It is unwise to rely on leased or aggregate e-book collections instead of print books, but they can be an occasionally useful supplement to the collection.

There is some overlap between math and other subjects within approval plans due simply to the call number ranges. In Library of Congress Classification, Computer Science (CS) is embedded in the math range, but most approval vendors will separate it out. This is not a problem if math and CS are the responsibility of one librarian. It is a good idea to consult with engineering librarians, and occasionally other science librarians, on applied mathematics books or other interdisciplinary topics. Be aware that logic books may be classed in philosophy (LC: “B”) since they may be more popular with logicians than the local philosophers.

Patron Driven Acquisitions/ Demand Driven Acquisitions (PDA/DDA)

Due to a variety of reasons, many libraries are moving towards building collections through patron driven acquisitions programs, which rely on the purchasing of materials directly requested by patrons. These items may be discoverable through the online catalog, or by usage statistics collected from e-book collections. Some libraries track ILL requests and database link redirects to inform acquisitions, as well. Whether through a formal program, or via link redirect statistics, the goal is for the collection to reflect the needs and interests of the patrons.

Mathematics has not been significantly affected by PDA, since most of the society and commercial publishers do not publish with this model. There are some textbooks and study manuals that are available through PDA, and math librarians can leave the purchase of these relatively inexpensive books to their patrons. Occasionally there may be duplication between print and e-books, but since mathematicians and students still prefer print there is more benefit than cost in that case.

Book reviews

Book reviews are very helpful tools for making informed collection decisions, particularly in a complex subject like mathematics. Luckily, mathematics publishers have a tradition of including book reviews in the core journals in the field. The reviews are often written by mathematicians in the same field who are indicated in the review (a “signed” review). They can range in length from short (under 500 words), to medium (500-1500 words) to very long (3000+ words). These book reviews are most commonly found in mathematics education journals, review journals, or general interest research journals. Though now there are other methods of discovery including online book retailers and Internet search engines, book reviews in journals can be a great way for both mathematicians and math librarians to find new books to purchase. Below is a list of core journals with the type and length of book reviews that they include. For a more exhaustive list, please see the Mathematics chapter of *Magazines for Libraries* (LaGuardia and Katz 2018).

- American Mathematical Monthly (1-2 medium, signed book reviews)
- Bulletin of the American Mathematical Society (4-8 very long, signed book reviews)
- College Mathematics Journal (1-2 medium, signed book reviews)
- Mathematical Gazette (10-25, short to medium, signed book reviews)
- Mathematics Magazine (6-8 short book reviews)
- Mathematics Teacher (5-10 short, signed book reviews)
- SIAM Review (5-15 short, signed book reviews)

Most of the journals above are now available electronically, which makes it easier to regularly check for new book reviews. The index *MathSciNet* (covered in depth in Chapter 5) is very important for collection development, since it includes reviews of almost every math book published. These reviews, written by mathematicians, tend to highlight important proofs and information rather than focus on the quality of a book. Another great source for book reviews is *MAA reviews* (https://www.maa.org/press/maa-reviews), a large database of books and book reviews. It includes the MAA’s list of books recommended for undergraduate libraries, which is useful for collection development. Access requires either a MAA membership or a subscription. MAA reviews also posts new book reviews on Twitter using the handle @maareviews.

Major Prizes

It is useful for the mathematics librarian to track major prizes in math in order to collect the most vital works in the field, as many popular mathematics books focus on a major discovery or award. Some prizes are given for a particular discovery, which may be tied to one or more specific research papers. Others are given for excellence or promise in a particular area of mathematics. Collected papers of math prize winners are often published as books in the years following the award. Some publishers, such as World Scientific, have also gone back into the past and collected the papers of one or multiple prize winners. The following are the most prestigious prizes in the field of mathematics.

- The *Fields Medal* was established by the International Mathematical Union in 1924, and is awarded every four years to one or more mathematicians under the age of 40 (Albers 1987). It is the longest established award in mathematics and the most notable, although

it does not have the same high monetary value as the Nobel Prize. Since there is no Nobel in mathematics, this is the oldest and most prestigious award in the field (Meier 2012). http://www.mathunion.org/general/prizes/fields/details/

- The *Wolf Prize in Mathematics* is awarded by the Wolf Foundation in Israel, has been awarded annually since 1978. http://www.wolffund.org.il/
- The *Abel Prize*, established by the Government of Norway and modeled after the Nobel Prize was first awarded in 2003. are six, previously seven, unsolved problems in mathematics whose solutions carry a cash award and international recognition. http://www.claymath.org/millennium-problems
- Elsevier awards a number of prizes associated with their journals which are intended to support young researchers in the physical sciences and mathematics. Arising from the boycott mentioned previously, they include an award of money to support publishing of research. https://www.elsevier.com/physical-sciences/mathematics/long-term-commitment-and-support-for-the-mathematics-community#award

International books

Mathematics may seem at first glance to be a universal language of numbers and symbols, but in practice mathematicians communicate in words. English is the current *lingua franca* of mathematics, taking over from German which took over from Latin and Greek. Russia and France have also been historic powerhouses in mathematics, so many classic texts are in those languages. Though mathematics books are still published in many non-English languages, even international scholars will ask for English language translations over versions in their native language due to the universality of English. An exception may be special, unique collections of non-English language mathematics books. While many books and research articles published internationally are in English, there are venues for ordering non-English language material and publications from smaller international presses, some of which are listed here.

Harrasowitz (https://www.harrassowitz.de/)

Harrasowitz is a book and periodical vendor for academic libraries specializing in materials from Germany, Austria, and Switzerland. Their service, OttoEditions, provides regular updates on new publications based on parameters set by the library. For mathematics they cover research monographs from the main European publishers like Springer and the EMS, but may also include smaller press titles that are not covered by U.S. approval plans and book vendors. Different types of books including conference proceedings, research monographs and occasionally textbooks are included. Books may be in German or English or contain multiple languages, which is indicated on the notices Harrasowitz provides. E-book availability is noted separately for books available in multiple formats.

Casalini Libri (http://www.casalini.it/)

Casalini Libri is an Italian book vendor for academic libraries, which regularly handles a few titles in mathematics. Their monographs are primarily in Italian, but a few are published in

English or in multiple languages. Many of their titles are the proceedings of conferences or workshops in Europe, but there are a few textbooks and dissertations handled as well.

D.K. Agencies (http://www.dkagencies.com/)

D.K. Agencies is a South Asian book vendor that focuses on India but includes many surrounding countries. They can offer notifications via email or paper of books only in mathematics, though sometimes books on physics or other STEM titles may appear on this list. Most of these books are not available through other vendors or approval plans.

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Top 10 daily sources of math news

1) Webcomic - http://xkcd.com
2) Number crunching (formerly Nate Silver's blog) - http://fivethirtyeight.com/
3) Scientific American - http://www.scientificamerican.com/
4) I Freaking Love Science (there is also an additional word to search also starting with the letter F) - https://www.facebook.com/IFeakingLoveScience
5) Science Daily - Math section - http://www.sciencedaily.com/news/computers_math/mathematics/
6) Reddit - Science - filter by field for Mathematics - https://www.reddit.com/r/science/
7) Math Overflow - http://mathoverflow.net/
8) Math Digest (AMS) - http://www.ams.org/news/math-in-the-media/mathdigest-index
9) Bedtime Math - http://bedtimemath.org
10) Twitter Hastags #math #maths #mathematics #mathchat and more

Chapter 5 Know the Material

"Mathematics does not require laboratories or equipment....It will be impossible to maintain a first class research mathematics department...with a third class library"
- University of Oregon Mathematics Department letter to Library Dean, 2009.

In this chapter we will focus on subscription and licensed materials including serials, databases, and software. We also discuss commercial indexes and abstracting services, but also include some freely available sources. While Google Scholar and the preprint server Arxiv.org are increasingly used by mathematicians and students, there are a few math specific databases that are still valuable for their unique and curated metadata. Journals will be covered to help librarians manage their subscriptions to print and electronic serials. Finally the chapter will close with a highlight of some of the field's widely-used software, both free and licensed.

Scholarly Communication in Math

A good background on the history of scholarly communications in math was written by Robert G. Bartle (Bartle 1995). The lifecycle of math research often begins in peer collaboration, partnerships with graduate students, or during local discussions called seminars. It may evolve to presenting a sketch of a proof or theory at a conference, often with no more than an abstract having been written. Presentations often lead to a full length publication in either a journal or book, though any step in this process may not happen at all. The most valued academic product in mathematics is the peer reviewed research article in a prestigious journal. Depending on the branch of mathematics, the research publication process may have more in common with that of the most closely associated discipline. For example, applied mathematics may involve lab work that leads directly to a journal publication, while a lecture or seminar in theoretical computer science may eventually be published as a book chapter. The resources in this chapter support the process of information discovery and publication of research.

As journal costs rise almost every year, lower income generating departments like Math can see heavier subscription cancellations. In addition to their support of arXiv.org, several math journals have moved from for profit publishers to much lower cost alternatives. Most recently, this happened with the *Journal of K-Theory* (k-theory is a subset of algebraic topology). The entire editorial board resigned and started the journal *Annals of K-Theory* at a fraction of the cost.

Open Access

Mathematicians are staunch advocates for Open Access (OA) which aspires to make the products of scholarly work free for all to read. Some OA publishing models shift the costs of scholarly publishing to authors, which is a significant deterrent. Mathematicians typically do not have the large research grants of other STEM faculty to cover author fees. In support of our math departments, it has become increasingly important for libraries to advocate for OA initiatives either through consortial partnerships (such as arXiv.org, discussed later in this chapter), negotiating lower author fees, providing author funds, or supporting new funding

models for journals. Recent trends suggest that more math publishers are softening their positions toward the idea of open access.

Indexes to the periodical literature

There are only a few bibliographic databases used in mathematics, so it is easy for the math librarian to focus on licensing and teaching these core resources. They are also relatively low cost compared to other abstracting and indexing databases in the sciences and engineering. Librarians should balance the costs and benefits of each indexing database in light of the available full text searching systems including library discovery search engines. While most mathematics journals will be indexed in these systems, it is hard to focus the results on only the math literature. Indexing and abstracting databases may also have controlled vocabulary, higher quality metadata, and greater historical coverage.

MathSciNet
http://www.ams.org/mathscinet/

MathSciNet is one of the most frequently consulted databases taught by librarians to students in mathematics (Brown 1999). Pure mathematicians and certain fields find it particularly useful because of its focus on the math literature, while excluding other STEM and humanities journals. It is based on the American Mathematical Society's Mathematical Reviews (MR) serial publication, which began in 1940. In addition to being the primary index of the mathematical literature, MathSciNet provides reviews of journal articles and books. These reviews summarize the key research findings of the paper or book and may even contain links to related entries in MathSciNet. Full text articles are linked to publisher websites and a library link resolver can be added. It now contains citation information as well, which enables citation based exploration. Each journal indexed also has an impact rating called the mathematical citation quotient (MCQ).

At press, MathSciNet indexes almost three million items, 750,000 authors and 1800 journals. It uses the Mathematical Subject Classification (MSC) scheme with over 6000 categories, which was last updated by the AMS in 2010 in collaboration with zbMATH (see section below). It has accomplished author disambiguation since its founding and has detailed author pages that include all alternate names, publications, citation, co-authors, and other useful data. MathSciNet terms have been used to code data for archiving, and preserving. The AMS has added links to historic math books, many of which are freely available online due to library digitization projects. They continue to partner with other mathematical societies to bring additional citations and full-text links into the system (Dunne 2015). The AMS employs many librarians and metadata experts to keep up with new publications. For news on MathSciNet including historic background information and current updates, subscribe to their blog *Beyond Reviews* http://blogs.ams.org/beyondreviews/

Zentralblatt MATH (zbMATH)
https://zbmath.org/

This longest running indexing service began as *"Zentralblatt für Mathematik und ihre Grenzgebiete"* in the 19th century and is now an online database licensed through the publisher

Springer. It has about 4 million records and has indexed over 3000 journals along with 180,000 books. Similar to MathSciNet, it uses the MSC classification scheme, links to full text, citation information, and provides summaries of each article rather than a review. These summaries tend to be a discussion of the article rather than a review of the mathematics. Although summary contributors are international, the summaries and metadata are in English.

Due to overlap, it is not usually necessary to have access to both zbMATH and MathSciNet. It should be noted that because the two databases use the MSC classification independently, results may vary in some cases. The free version of zbMATH displays only three search results but will display the entire entry for each. It will show the most recent results in chronological order first, and while this cannot be changed, the search terms can be manipulated to find a particular known item. Therefore, a non-subscriber can use it to confirm a citation.

Jahrbuch Database: Electronic Research Archive for Mathematics
http://www.emis.de/MATH/JFM/JFM.html

This free online database is an enhanced version of the print serial Jahrbuch über die Fortschritte der Mathematik (JFM) that was published between 1871–1944. JFM comprehensively indexed mathematics literature, both books and journals, and was the premier bibliographic index to mathematics literature until renamed in the 1930s by Zentralblatt für Mathematik (See above). When JFM was moved online, entries were improved to normalize names, source titles, and provide missing publication dates.

The search interface is similar to the one previously used for Zentralblatt MATH. All of the Jahrbuch Database entries are now included in and searchable from Zentralblatt MATH itself. It provides links to more than 17,000 retrospectively digitized full-text items indexed in JFM. These resources are being digitized as part of the Jahrbuch Project and through several other retrospective digitization initiatives loosely federated under the rubric World Digital Mathematics Library (WDML; http://www.ceic.math.ca/WDML/index.shtml), sponsored by the International Mathematics Union.

Web of Science
http://wokinfo.com

Web of Science is considered an authoritative source for measuring research impact and determining citation information, though it is not used in the mathematics community as often as in other fields. Since Web of Science only indexes a core set of “premier” journals, it may exclude journals that mathematicians would want to include in a literature search (such as Annals of Mathematical Logic). However, if graduate students or math researchers are looking for the top papers in the highest ranking journals in math, this database is very useful.

Scopus
http://www.scopus.com/

One of the newest citation databases, Elsevier’s Scopus database can also be used to search journal articles (and some conference papers) by title, by author, by citation count or by the

citation network of recent articles and foundational papers. Scopus has some advantages over Web of Science for mathematics, since it indexes many more sources. However, since Scopus is a newer system, the majority of journal data is from the past decade or two. Elsevier is continually adding historic coverage of journal issues, but it varies by title with some math journal coverage starting in the 1970s while the majority start in the mid-1990s. Few libraries can afford both Scopus and Web of Science, so many may have one or the other. It would be important to distinguish if a local math department has a preference.

Google Scholar
http://scholar.google.com

Google's index of the "scholarly literature" has become more and more useful in mathematics since many articles are available through the open access repository arXiv.org (see below), which is indexed by Google Scholar. Since it also indexes books from the Google Books project, particularly older materials, mathematicians benefit more than many other disciplines from the mix of scholarly literature included here. Citation information from Google Scholar can be very beneficial since it includes mathematical conference talks and proceedings as well as books and journals. Some mathematicians have set up Google Scholar profiles to highlight their work, but author searching can be difficult with common names. For collection development, Google Scholar can help locate books and journals that may have poor citations and give multiple paths to locate full text resources online, links to libraries that own a resource, or vendors to purchase a resource from.

ERIC
https://eric.ed.gov/

The Education Resources Information Center (ERIC) database is often a part of the library's database collection for education majors and teachers. Mathematics students, especially those who are researching teaching and pedogogy, and faculty, when focused on effective teaching methods and best practices, can also find ERIC useful for many reasons. The database contains other education related topics and publications, for example magazines published by the National Council of Teachers of Mathematics (NCTM).

Preprints and Other Grey Literature

A preprint as defined here is an author's early version of their research paper before it is submitted for peer review to a scholarly journal. Even before the prevalence of online preprint repositories, math faculty have practiced the sharing of early manuscripts. Mathematicians often loaded their articles on their own personal or departmental websites, sharing drafts and finished papers, and even publishing preprint series of their own, such as the University of Reading *Applied Mathematics Reports*. Now many institutional repositories (IR) or disciplinary repositories (such as the arXiv) can host preprint articles. Mathematicians are often willing to share their research findings as early as possible to establish primacy for their idea, proof or theory. This can result in multiple versions of a paper existing in some form, whether that be a blog, preprint or published article. The final journal article is still considered the publication of record, but the preprint may already have achieved high recognition. Preprints are often shared

widely, often via Wikipedia, online science news outlets, or Google Scholar.

It is possible that a popular preprint may be significantly rewritten for journal review, or not at all. One example of this is Perelman's proof of the Poincare Conjecture, which was only ever published in preprint form. It was reviewed and cited by multiple papers published in journals, including corrections to a number of trivial errors. Publishers are also increasingly cautious about duplicate submissions to avoid deliberate or inadvertent self-plagiarism. Each publisher or individual journal may have a different policy related to the author's dissemination of copies or preprints. Publisher policies may only allow the preprint on certain websites like an Institutional Repository (IR) that their home institution has set up to store faculty works. Other policies may only allow this after a certain period of time has passed. Librarians could be consulted before an author shares their articles or when they needs to determine what their copyright allows. A good resource for helping to determine a publisher's or journal's policy is the SHERPA/RoMEO database (http://www.sherpa.ac.uk/romeo.php) for most English language materials.

arXiv
https://arxiv.org/

Only second to physics in volume of articles, mathematics is the fastest growing subject of the arXiv preprint repository. Beginning in 1991, authors have been submitting articles to arXiv before journal review, though many are eventually published in peer-reviewed journals. arXiv strongly appeals to mathematicians because they value early public sharing of their discoveries and have few reasons to keep discoveries secret (for example, the proof of the Poincare conjecture mentioned previously). ArXiv provides the benefit of immediate publication, while a paper may take months or years to make it through the peer-review cycle. Arxiv.org is free but is supported by Cornell University Libraries and annual contributions from many other libraries. There are some questions about the sustainability of this funding model, but it has worked so far. The results of the arXiv@25 survey suggests further enhancement of the platform for stability and improve search functionality is needed (Rieger 2016).

Journals

The number of peer reviewed journals in mathematics has been growing for centuries. Despite not growing as rapidly as some STEM fields like chemistry, the number of articles and journals in math doubles every decade (Larsen and Ins 2010). This explosion has increased the number of possible publication options for research but also presents new challenges. It is hard for busy mathematicians to track new journals and determine their quality and editorial oversight. One new role for math librarians is to vet journals for faculty that invite them as potential authors or editors. Journals with little editorial oversight that exist primarily to collect author fees are sometimes called "predatory" journals. Some services and websites with information on journal reputation exist, such as *Ulrich's Periodicals Directory* (http://www.ulrichsweb.com/ulrichsweb/faqs.asp), Cabell's *Journal Whitelist/Blacklist* (https://www2.cabells.com/), or the ThinkCheckSubmit project (https://thinkchecksubmit.org). The Retraction Watch project (http://retractionwatch.com/) can also spot systematic problems with a publisher or journal.

Mathematicians should also be proactively protecting their reputations by scanning for their names on the editorial boards of journals. Some librarians have discovered faculty who did not realize their name was associated with a journal, where they were named on the editorial board without permission. Plagiarism has also become an issue, particularly with international journals where the language difference can make copying difficult to detect. There are many other nuances of math journal publishing that were well reviewed during a workshop on the topic in 2011 at the University of California-Berkeley (Crowley 2011).

New faculty in mathematics will often ask which journals are the most prestigious in the field, since promotion and tenure criteria still take into account the reputation of the journals in which their research is published. Some may also ask about the impact factor, which can be found on the journal website or from *Journal Citation Reports* or the acceptance rate, available either from the journal website or by contacting an editor. Another new role for librarians is helping math faculty start new journals. Either the library or university itself may be a journal publisher or more likely, the library can help faculty find either software (such as Open Journal Systems https://pkp.sfu.ca/ojs/) or funding to support their new journal.

Magazines for Libraries (mentioned in Chapter 3) provides an overview of the core research and general interest journals and magazines in mathematics. Published annually as both a large single volume work and an online database, it covers many of the titles listed in this chapter in greater detail and provides information on topics covered and appropriateness for local math departments. Another way to find information about journals is the *AMS Digital Mathematics Registry* (http://www.ams.org/dmr/) which lists electronic journals and series. It provides the years available by journal title or publisher and uses a symbol to indicate whether a resource is open access (free), subscription access, or a hybrid of both. Librarians can use it for quick reference in making decisions about format type when selecting journals or for considering what to do when weeding or storing older journals. A similar source for digitized books is the Bielefeld DML: Digital Mathematics Library (https://www.math.uni-bielefeld.de/~rehmann/DML/dml_links.html).

Only the major publishers in mathematics are listed here, but there are many smaller publishers in the field including small societies and university presses. Project Euclid, http://projecteuclid.org, is a platform for small publishers in mathematics and statistics that is jointly supported by the Cornell Library and Duke University Press. Some Project Euclid partner publishers require a print subscription to gain online access. There are also a few smaller publishers and societies in mathematics that do not yet make their journals available online. In addition to mathematics focused publishers, many of the large aggregators like Proquest and EBSCO include a core set of mathematics magazines and journals. For libraries with small budgets or no set budget for math, explore which aggregators provide the most access to journals that fit into the teaching and research areas of the local math department. Every librarian should focus on a few key journal subscriptions to balance out the content in the general article databases leased by the entire library.

[Textbox – Title “Top 10 Math Journal Publishers”]

Top 10 Math Journal Publishers

(most journals in math, alphabetical order)

1. American Mathematical Society
2. Cambridge University Press
3. Elsevier
4. International Press of Boston
5. Mathematical Association of America
6. Mathematical Sciences Publishers (MSP)
7. Society for Industrial and Applied Mathematics
8. Springer
9. Wiley
10. World Scientific

Math journals can be classified into two major types: general “flagship” journals that publish from all areas of mathematics and specific journals that focus on one field. Below are examples of some of the best flagship journals as well as important journals in some of the major fields of mathematics. With mathematicians there is much less consensus on what are essential journals, since they focus on very specific fields. In a recent survey of faculty at one institution, the librarian found that while many respondents held similar views regarding which prestigious journals are most essential, between faculty in different research groups there was little agreement about which journals were most crucial to them. In other words, while there is consensus on important journals for mathematics in general, the most important journals for any individual mathematician are based on their research focus. Citation studies within a single institution show that the top-cited journals by faculty include flagship journals as well as some journals focused on a specific field, mostly due to the focus of the mathematics department on a certain field.

Bibliographic studies have also indicated a wide reading selection by mathematicians. For example, a large math faculty at a research university will cite hundreds of different journals. The list below is by no means comprehensive, but is included to give readers a sense of the diversity of journals, both general and specialized, that are useful to mathematicians and students.

General Science Journals Core to Mathematics

The preeminent journals listed below are desirable venues for mathematicians to publish their research results when the theories or methods discussed could have an impact beyond mathematics. These general science titles are also read and cited by mathematicians more than any other non-math journals.

- *Nature*
- *Proceedings of the National Academy of Sciences*
- *Science*

Flagship Journals in Mathematics

These journals are core to any mathematics collection as they are used by almost every branch of math. Each has a broad scope and general readership, though any given article may fit in a small niche area of mathematics or only be understood within a particular branch. Most mathematicians will read these journals and many want to have their research published within them. The *Bulletin of the AMS* is very useful for undergraduate students looking for topics in math.

- *Advances in Mathematics* (Elsevier)
- *Annals of Mathematics* (MSP)
- *Bulletin of the American Mathematical Society* (AMS)
- *Communications on Pure and Applied Mathematics* (Wiley)
- *Duke Mathematical Journal* (Duke University Press / Project Euclid)
- *Inventiones mathematicae* (Springer)
- *Journal of the American Mathematical Society* (AMS)
- *Proceedings of the American Mathematical Society* (AMS)
- *Transactions of the American Mathematical Society* (AMS)

Journals particular to certain areas of mathematics

Librarians should consider these journals only if faculty or students are doing research in these specific areas. Only a few areas of mathematics are covered here, though there are dozens of journals for each specialized area of study. Within each area, the titles were chosen to represent the diversity of publishers and platforms.

Applied Mathematics

There are many titles not in this list published by the Society for Industrial and Applied Mathematics (SIAM), notably *SIAM Review* that broadly covers the field and provides some digest summaries of articles from other SIAM journals.

- *Advances in Applied Mathematics* (Elsevier)
- IMA Journal of Applied Mathematics (Oxford)
- *Journal of Applied Mathematics* (Hindawi)
- *SIAM Journal on Applied Mathematics* (SIAM)

Computational Mathematics

Also useful for computer scientists and some engineers, these journals publish papers dealing with computer algorithms, computer optimization, and even statistics.

- *Applied Mathematics and Computation* (Elsevier)
- *Foundations of Computational Mathematics* (Springer)
- *Mathematics of Computation* (AMS)
- SIAM Journal on Computing (SIAM)

Differential Equations

Journals in this area cover fields as dynamical systems, mathematical physics, and other applied mathematics, but may also include pure mathematical papers.

- *Dynamics of Partial Differential Equations* (International Press)
- *Journal of Differential Equations* (Elsevier)
- *Journal of Differential Geometry* (International Press)

Logic

Similar to the discipline of philosophy within the humanities, mathematical logic is one of the purest divisions of mathematics. It also has applications in computer science and many other mathematical fields. One of the major professional societies in this area is the Association for Symbolic Logic.

- *Annals of Pure and Applied Logic* (Elsevier)
- *Bulletin of Symbolic Logic* (Cambridge University Press)
- *Journal of Symbolic Logic* (Cambridge University Press)
- *Journal of Mathematical Logic* (World Scientific)

Mathematical Analysis

Advanced uses of calculus comprise the field of mathematical analysis, which is considered a subfield of pure mathematics but may have some practical applications as well.

- *Geometric and Functional Analysis* (Springer)
- *Journal of Functional Analysis* (Elsevier)

Mathematical Physics

These titles primarily focus on the applied mathematics subfield of mathematical physics. They are often published by commercial publishers or professional societies in physics, such as the American Physical Society (APS). For additional titles consult *The Sudden Selector's Guide to Physics Resources* (Fosmire 2013).

- *Communications in Mathematical Physics* (Springer)
- *Journal of Computational Physics* (Elsevier)
- *Physical Review Letters* (APS)
- *Proceedings of the Royal Society of London A: Mathematical, Physical, and Engineering Sciences* (Royal Society)

Topology

This is a field of pure mathematics that studies the properties of space when it is deformed or transformed.

- *Annals of K-Theory* (MSP)

- *Journal of Topology* (London Mathematical Society)

Other Institutional Memberships

As mentioned in chapter 3, it is possible for a library or math department to become an institutional member of a mathematical professional society. Benefits can include discounts on publications, access to databases, and membership for math faculty and students. Librarians should inquire if the math department is an institutional member of any societies and who pays the membership fees. Details the library and department may wish to negotiate include which organization pays for the membership, acts as the official contact to the professional society, and receives copies of print journal issues. In some cases, the library may be able to receive complementary journal subscriptions through a math department membership. Be aware though that in the case of electronic journals, the terms of membership may limit online access only to members of the math department.

One great icebreaker when meeting new faculty is to ask about their professional memberships in societies. In small professional societies, even international ones, it is likely that these faculty know how these "publishers" really operate and the history behind the associations. They may even be involved in the publishing activities of the society or be a current or prior editor, leader or officer. In one example, when a librarian asked a faculty member why electronic access was not available for a certain professional society's publications, they revealed that the three journals were published by a single person from their home.

Math faculty and students may also have membership benefits that could save the library money. For example if there is only one logician on campus, who is already a member of a society in mathematical logic that publishes a journal, they may receive a free copy and online access. The library does not need to subscribe to that journal if there are no other users who need it. For multiple faculty, graduate students, or even undergraduates that are studying in a particular field it makes more sense for the library to provide access to the publications of relevant societies either through subscription or institutional membership. In some cases an institutional membership will include free memberships for students or faculty. Investigate if this is the case and work with a contact in the department to help determine who benefits from the complimentary memberships, because it could be for the department alone rather than the entire institution.

Journal Exchanges

There are sometimes standing agreements between libraries at different universities known as "journal exchanges." These usually involve the library sending extra issues of a print journal, obtained through multiple subscriptions, to an international university in "exchange" for issues of an international journal from that country. This was important when it was difficult to obtain international journals or subscribe to foreign journals. Many of these arrangements may no longer be necessary as journals have gone online and political barriers have changed significantly, removing prior postage and shipping difficulties. Math librarians should initially and regularly review such exchanges to determine if they should continue. One reason to continue an exchange would be logistics, for example, there may be some journals that are still difficult to

obtain through a subscription with a publisher or journal aggregator.

General Software

Occasionally the cost of mathematics software licenses may be assigned to library collections or operating budgets though they can be expensive. In some cases central library or campus wide software funds are available and are worth investigating. The math department or central IT may provide the software in their labs or give students and faculty a discount on purchasing the software. The following are used by mathematicians in various fields and might be useful to have available to patrons:

LaTeX
http://guides.lib.wayne.edu/latex

LaTeX is a markup language and document creation software system that makes it easy to type mathematical symbols as text for constructing papers in math. Similar to XML and HTML, markup tags are used to indicate formatting, metadata, and interpretations of codes representing mathematical symbols. LaTeX was developed in the early 1980s when postscript files were required by printers and typewriters were still in use. Based on the TeX typesetting system, documents are compiled from multiple files including “libraries” of additional information such as BibTeX (see below). While difficult to learn historically, there are now web and GUI (Graphical User Interface) based clients for LaTeX, though many mathematicians and other scientists still use the Open Source software. The open source version of LaTeX (http://www.latex-project.org/) is available for Linux, Windows, and Mac OS.

Though originally developed for the fields of computer science and mathematics, many other sciences and engineering researchers use LaTeX for document preparation. Many journals require submission of articles in LaTeX format (Olver 2011). It is an acceptable file format for submission of scientific papers for arXiv.org and an increasing number of journals, including those of the American Mathematical Society. As the underlying programming language, TeX has a large user base and many online communities such as Com-pre-hen-sive TEX Archive Net-work (http://www.ctan.org).

BibTeX
http://www.bibtex.org/

BibTeX is a companion software to LaTeX for bibliographic management. It uses the ubiquitous ".bib" format for files, which contain a bibliography that can be linked to a ".tex" file. It has both platform independent software interfaces (JabRef http://jabref.sourceforge.net/) and platform specific programs (Mac OS BibDesk http://bibdesk.sourceforge.net). Many citation managers and databases export or import to the BibTex standard. Other bibliographic management tools (i.e. RefWorks, EndNote, Mendeley, Zotero, Papers, etc.) can synchronize or import/export to BibTeX. It is worth understanding that once again mathematicians will be outliers, as they tend to rely on BibTeX instead of those other products.

One noteworthy collaborative project based on this open platform is Overleaf

(https://www.overleaf.com/). It allows for planning, working, and publishing online, real-time using LaTex. The local math department or institution may have a membership, which would make it free to all users. Similarly, Collaborative Calculation in the Cloud (CoCalc https://cocalc.com/) also works with LaTex and is great for collaboration. There are also LaTex templates available for theses and dissertations. It is often used for teaching courses using Jupyter Notebooks (https://jupyter.org/) a free, open-source platform for creating and sharing code.

Mathematics Computational Software

There are a number of licensed computational software packages for math that libraries can provide for their users. Engineers as well as mathematicians use these tools for their work. Campus information technology departments may support these or the library may need to buy licenses separately.

Mathematica
https://www.wolfram.com/mathematica/pricing/colleges-universities-groups.php

Mathematica is a powerful math platform available as a desktop client or cloud-based interface. It focuses on computation and has both a simple interface and the ability to create programs. It has been used in computation of data from basic geometry to complex neural network modeling. It can be very difficult for libraries to install on multiple computers, as the cost is high per license. The entire campus, engineering department, or math department may have separate contracts from the library. The vendor, Wolfram Research, requires different licenses based on number of users, which may be prohibitively expensive for some units. Wolfram Reserach also operates Wolfram-Alpha, mentioned earlier, which has premium version called Wolfram-Alpha Pro with some additional features and no ads. For a small fee there is an app version for smartphones.

Maple
http://www.maplesoft.com/

Maple is a simple programming environment where users can either enter problems using simple mathematical notation or program user interfaces and graphics for computation. While it has less functionality than Mathematica, Maple also has a simple user interface mode where students can simply build programs by clicking buttons. It can also visualize problems and compute large scale algorithms.

Matlab
https://www.mathworks.com/

Another computational software option created by MathWorks is Matlab. This software is based on matrix computations and has added a more visual interface “Simulink” to its traditional scripting window, where programming commands are typed and executed. Matlab can be used in signal processing, medicine, and even aerospace applications. Since each science or engineering user may have a need for any of these tools, the library should work with campus IT

to provide access to them.

Statistical Software

These software tools are developed by statisticians and can be applied in many fields. There is also growth in the use of predictive modeling in industry, so there is high demand in multiple academic departments on campus for the software and books that support it. Occasionally user manuals are freely distributed by the software company either as e-books, cds, or promotional print materials. Investigate the software vendor's website to see if you can purchase these materials. Though adding them to the collection may not be the ultimate goal, doing so will put them directly in the hands of users. Be aware that there can be dramatic jumps in functionality between different releases of software versions, so these books may become outdated more quickly than many mathematics books.

R
https://www.r-project.org/

R is an Open Source system for statistical computing and visualization. Free to download and install on UNIX, Windows, or Mac OS, it is used pervasively in statistics and frequently in other STEM fields. Many textbooks and research monographs will include R code or examples and often include "R" in the title. It is essential that libraries collect, either as print monographs or e-books, titles that support this language. Be aware that those books may be classified in computer software or computer science. Older R books can be useful for a long time since R code hasn't really changed over time, and new releases are developed with backward compatibility in mind.

SAS (statistical analysis system)
https://www.sas.com/en_us/software/analytics/stat.html

There are also licensed software solutions for statistics, many that provide more of a Graphical User Interface (GUI) based experience. It is more important to update these books and manuals to the most recent edition, since the interface changes more often than low-level programming interfaces such as R. SAS (statistical analysis system) has a web and Windows based tool for analysis and visualization of data.

SPSS Statistics from IBM
http://www.ibm.com/analytics/us/en/technology/spss/

SPSS (Software Package for the Social Scientists) is frequently used by social scientists for population analysis, and can even be useful for librarians performing user studies. The complexity of the GUI interface can be customized based on the expertise of the user. For a novice, simply loading files and performing tests is possible, but the software also allows advanced users to manipulate the data directly in more complex ways.

Minitab
http://www.minitab.com/en-US/default.aspx

Minitab is frequently used in engineering and computing for analysis of data. The range of tests and analysis available within this one software platform is great. It can go from simple classroom exercises to predictive analytics on big data.

Multimedia

There are many videos that can make excellent additions to a mathematics collection. Depending on the audience of the library this could include popular fiction movies such as *A Beautiful Mind* or non-fiction documentaries such as *The Story of 1*. Some of these DVDs come with public performance rights, so the library can show them at a movie night and lend them for classroom use. Streaming video versions of these films may also be available, and there may be videos in streaming video collections that include math topics.

There are also many online sources for free videos, some of which are created and hosted by libraries. One example is the Banff International Research Station for Mathematical Innovation and Discovery (BIRS), which digitally preserves thousands of mathematics lectures from famous mathematicians (https://www.birs.ca/videos/). It has almost 3,000 items in the archive and each has a digital object identifier (DOI) and other metadata associated with the video.

[Textbox – Title "Patents in Mathematics"]

Under U.S. patent law, pure mathematical expressions, such as a formula, have been ruled unpatentable since they may be considered abstract ideas or laws of nature. However, applications of formula can be patented, such as software or processes based on algorithms. Depending on recent U.S. case law, the line between pure mathematical algorithms and patentable inventions has shifted over time, so it is important to examine recent U.S. patent law and court cases when doing background research in this area. A majority of mathematicians use copyright to protect their ideas by self publishing them as early as possible, thereby establishing priority as the first person to solve a proof.

But there are mathematicians and statisticians with patents to their names. For example, James Z. Wang, and others have a patent for Image-based Captcha generation system, US Patent # US 7929805 B2. However, since software is one of the ways in which mathematics can be patented, the students and researchers most interested in patents will be those developing code. Most information sources on patents are freely accessible, since they are government documents. Google Patents, https://www.google.com/patents, as well as the US Patent and Trademark Office, have free search engines that can be used to find mathematics patents and software (Meier 2015). The library can invest in the limited number of books on searching and applying for patents, which will benefit researchers in all fields, but otherwise librarians would do well to know how to do this, as there aren't very many reference materials available.

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Top 10 Journals for math librarians to read

1. Issues in Science and Technology Librarianship (ISTL) http://istl.org
2. Science and Technology Libraries https://www.tandfonline.com/loi/wstl20
3. Notices of the American Mathematical Society (AMS) https://www.ams.org/notices
4. Scientific American https://www.scientificamerican.com/
5. CHANCE https://chance.amstat.org/
6. College Mathematics Journal https://www.maa.org/press/periodicals/college-mathematics-journal/the-college-mathematics-journal
7. American Mathematical Monthly https://www.maa.org/press/periodicals/american-mathematical-monthly
8. Mathematics Magazine https://www.maa.org/press/periodicals/mathematics-magazine
9. College and Research Libraries https://crl.acrl.org/
10. Online Information Review https://www.emeraldinsight.com/loi/oir

Chapter 6: Know the collection

"I could certainly never settle for something I considered ordinary, a great impetus for me to continue to try to find my way in mathematics." - Dusa McDuff (2017)

In this chapter we will discuss assessing your current print collection, which helps to inform collection decisions including weeding. Weeding, or deselection, is an important aspect of collection management. We will also address less common collections topics such as special collections and dealing with gifts from faculty.

Assessing the print collections

When first gaining responsibility for a mathematics collection it is a good idea to assess its current state before starting the process of collection development (covered in earlier chapters). Start with the licensed databases and journals in the library subscriptions. Next review any approval plan profiles that cover mathematics books. Then examine the print collection including: reference books, current and bound journals, reserve books, and the circulating collection.

One resource to consult first can be a core collections list. The MAA last published *Library recommendations for undergraduate mathematics* in 1992 (Steen 1992). It listed about 3,000 recommended math books for the undergraduate or early graduate levels. Most of the 25 chapters are major subject categories with 230 subcategories, each with a list of recommended journal/periodical subscriptions and an author index. Entries include author, title, publisher, and date. The lists were decided by a committee of 100 math faculty at colleges and universities. Books considered "essential" are given between one and three stars based on their importance. This amended list was based on MAA's Basic library list, which is available today as an online document. (http://www.maa.org/press/maa-reviews/the-basic-library-list-maas-recommendations-for-undergraduate-libraries).

There are likely unique math collections in the library, which can be identified either through an analysis of the collection or a more informal review. If the library has access to a collections evaluation tool such as OCLC's WorldShare Collection Evaluation use it to generate a report that identifies titles that are unique to the local collection or to only a few libraries in mathematics. It is also possible to compare items from the local catalog to a combined catalog like WorldCat manually, but this can be very time consuming. Not all old books are unique or valuable. In math it is not uncommon for a 19th century textbook to be held by hundreds of libraries and freely available on Google Books. Experienced library staff will also know about unusual items and collections of books or papers that the library is "known" for. A thorough search of the collection may yield its hidden strengths.

Some materials will not fit into the major categories we mentioned earlier or are not from the traditional publishers. Examples we have seen are: Russian language monographs donated by a faculty member when they immigrated to the US, paper preprints of research published by the

department before the Internet, print copies of departmental theses and dissertations, CDs containing Zentralblatt and other resources of interest to math faculty and students, books with math games, etc. These collections might be located in the regular collection, placed in the reference section to limit circulation, or hidden in the staff workroom in a cardboard box on the highest shelf. Consider the value of these materials to current users, then investigate if they have archival value. Your institution's records management office, archives, or special collections library are valuable partners in these collections matters.

Weeding

As previously stated, the information seeking behavior of mathematicians is much like their colleagues in the humanities fields. Unlike in disciplines such as technology and medicine, most mathematics literature does not become dated quickly, if at all. And because the symbolic language of mathematics is universal, mathematics can be done in many different languages. Mathematics research is a cyclical process, and problems can be introduced and contemplated for years and across decades. Because of this, collections of journals and books on historic topics in the field continue to be of use. While weeding a collection to focus on sources that are highly regarded is generally a good practice, remember that being new is not necessarily an indication of utility to the discipline.

Weeding books

As we have mentioned, mathematicians value print books and rely on older materials more so than users in other STEM disciplines. Where a biology collection may only need the most recent 10 years of research available, mathematics students and faculty will regularly consult books up to 45 years old. This means that there are also larger amounts of print with less flexibility to weed. It is likely that the math collection has not had books removed from the collection or has had very limited weeding because of this fact. Since the math collection will invariably grow, as the need for new books does not diminish, weeding will likely be required to create shelf space at some point. Choosing which portions of the collection to have on site and which to move to remote storage can create opportunities to use library spaces in different ways.

According to research, weeding is a good idea and healthy for a collection (Butkovich 2010). A weeded collection will get more use and less crowded shelves are good for browsing. Do not worry about accidentally getting rid of gems that could be useful in the near or possibly distant future. Tight deadlines for weeding may be dictated by library initiatives or even university directives. The math liaison librarian should provide information about weeding projects early and often to faculty to make them feel involved and that their interests are considered.

When reducing the collection footprint, consider removing only what is absolutely necessary to lower the anxiety level of math library stakeholders. Clear communication with the department is vital. It will likely be more anxiety-inducing to remove monographs than journals. Educating faculty about the strategy for change and constraints on the space is also valuable. In order to be successful in the execution of a weeding plan or moving books into off-site storage, the communication around the project should be planned carefully. It may require delicate negotiations or compromises with both library stakeholders and math users. Generally, it is best

to do these projects out of view of a large number of people. Consider working after hours or even on weekends, when door counts are smaller or nonexistent. Be prepared for intense negotiations about whether materials can be donated, sold, or simply given away. Research charities that accept book donations, such as Better World Books. Consult with campus administrators about rules regarding the sale of campus-owned property and how the proceeds of these sales are allowed to be used.

It is also useful to set ground rules for weeding projects by asking the following questions: what are the limits, what is the rationale, what promises can be made about future access, and what contingencies can be expected? Rather than targeting certain subjects consider the number of shelves needed to make the collection workable. Math faculty and students are remarkably invested in the math library and its collection, so transparency is vital. It may be helpful to weed journals more heavily than monographs, especially if they are available electronically. Other criteria to take into account when weeding might include:

- whether multiple copies or editions of the resources exist
- whether the resources are in good physical condition
- whether recent circulation statistics show the resources are being used
- whether the resources focus on technology or software that is obsolete
- whether the material is frequently requested by interlibrary loan
- whether data about collection holdings are current and accurate
- whether electronic versions are available.

Criteria for deciding whether to permanently remove something from the collection or move it to offsite storage may vary, so let us begin with the less extreme solution of moving materials from the library to off-site storage. Many of the factors involved in annexing a math resource are the same as with other subjects, the primary being circulation information: how often the book or journal has circulated, when the most recent checkout occurred, and any additional information the library system can generate related to use. There may be guidelines within the library on how to apply these criteria, but remember to view the numbers through the lens of math users. They will continue to use older material, and usage may be sporadic. So give more weight to total usage than recent information. Next, check the number of copies in the library, since removing duplicates is generally a good idea. For recent editions of textbooks or other heavily circulated books continue to keep multiple copies on site.

As we emphasized earlier, textbooks in mathematics are important for any undergraduate taking a math class. They are important to graduate students for research as well. There are very few changes to newer editions of math textbooks with the exception of books relying on computer software. We have seen 30 year old textbooks with multiple copies completely checked out of the math library for entire semesters. Fundamental textbooks such as calculus can also be used by individuals learning the material on their own or as review texts for math preparatory exams.

When removing items from the collection permanently, take even more care than when choosing materials to move offsite. Even though we can now rely on access to e-books, mathematicians may still prefer to read a book in print. Duplicate copies are usually easy to

remove from the library unless they are currently in use or heavily used. Only one copy, even between multiple storage locations and library branches, should be sufficient. Compare electronic book collections, backfiles from publishers and also Google Books, against the print version to see if users can access a resource online. It is also important to check if the library is responsible for retaining the last print copy of a book due to a consortial agreement or mandate. In one author's consortium, there is an agreement and state financial support for three libraries to commit as repositories, which enables other libraries to weed more freely. Again, it is important to balance the strategic initiatives of the library, space allocation, and the interests of the Math department that we serve.

Weeding journals

If the library decides to reduce the size of the print journal collection, one of the first places to look for low-impact space savings is the bound journal collection. Older print issues may no longer be needed on-site thanks to projects like JSTOR and commercial publishers that provide long runs of journals in digital archives or sold as backfiles. The entire library may have purchased, or can plan to purchase, permanent access to these collections so users have electronic access to the entire history of a journal. As we have said, mathematicians use older materials more frequently than do faculty in other STEM fields, so these collections would be a priority for math libraries. Because users usually access older journals looking for a single article, rather than browsing, these collections work particularly well as a digital resource.

Once the library has persistent, digital access to journals there might still be a few reasons to keep some print copies. It could be a journal with a special relationship to a faculty member, the institution, or a subject of distinction within the department or university. Some digitized journals may also have problems with missing or poorly scanned content: advertisements or supplementary non-article sections may be omitted, or images may only be in black and white. Even in these cases, it may be enough for one library in a larger group, such as a state, regional or academic consortium, to keep a print copy of the journal that they agree to lend and rely on interlibrary loan for the rare cases when the digital copy is not enough. As a math librarian try to be an active participant in these conversations so you can help inform withdrawal decisions that affect preservation of the scholarly record of the discipline. JSTOR has a print archive in partnership with the Center for Research Libraries (CRL 2019), so it is possible to send older print volumes there to preserve an archival print copy. Some of the leading math specialty libraries have made use of excess print copies in the past, so it may be worth checking with the librarians at organizations like the Mathematical Sciences Research Institute (MSRI).

Unique Materials and Special Collections

Mathematics has a long history dating back to the ancient world, and many original notes, papers and rare materials still exist. Whether they are using a classic method from Pythagoras, attempting to prove a conjecture from the Renaissance, or simply exploring the history of a mathematical theorem or mathematician, students and faculty in math may need access to

original materials that are old, rare or unique. While the library may not have these types of collections, there are a few other places where these materials can be collected.

Special collections or archives are excellent resources for locating collections that math users might be interested in, including those in related subjects such as philosophy. Mathematicians and students in classes that deal with the history of mathematics may be the most interested in primary sources and other archival holdings. Some ways to show users how to explore these special collections include providing an instructional session for a class and demonstrating how to access digitized versions of the materials online.

Having a relationship with a special collections or archives can be useful when making decisions about what to do with a gift of math books to the library. When a retiring faculty member or public patron donates materials, there may be unique items that represent the institution's history or culture and could also be significant to the field of math. For example, a math professor may have collaborated or corresponded with other well known mathematicians or scientists. These famous mathematicians may not have considered how their papers and correspondence will be archived after they retire. Professional mathematical societies are another group that may not have plans for their archives. Some society publishers have discarded original manuscript collections due to lack of space. Libraries should reach out to acquire such rare materials to support research by future mathematicians and historians. There are already many unique national and international collections of primary materials in math. These could be letters between mathematicians like the University of Pittsburgh's "Archives of Scientific Philosophy" (https://pitt.libguides.com/asp), which has a few mathematicians among the many philosophers' letters. Historic collections in Germany and at large European universities like Oxford have folios and other rare books that are occasionally displayed and increasingly digitized.

Gifts from Faculty

At some point a mathematician may offer to donate their personal collection of books, journals or other items to the library. These gifts may also come from non-math faculty who have collections that may include foundational monographs. As we have stated before, because mathematics resources age well, these books can be a wonderful source for filling in gaps created by texts that have gone missing, are out of print, or have been ravaged by time and use. Additional copies of classics might even be in the gift. Because these collections can span a lifetime of intellectual activity, they are worth considering as they may help make a library collection more complete. Looking through a faculty member's collection is a good way to learn more about their areas of research. And while they are retiring, they are likely to have colleagues in the department interested in similar topics. Accepting books from a personal collection may not build the kind of goodwill towards the library that will eventually lead to more direct support in the form of monetary donations, but it is worth considering donations as part of building important relationships. Development and fundraising staff note that these "in-kind" gifts rarely lead to money, even when asking the donors for the funding to process the collection.

Most university library systems have clear rules about how to accept gifts. Some libraries must accept everything and can only provide an acknowledgment of receipt for the donor's records. Generally, librarians may not appraise gift books for the donor due to the potential for a conflict of interest, for example placing high value to book donation statistics. Potential donors should know that if they want a value of the books for tax purposes they will be required to figure that out themselves. There may be local private appraisers, but an internet search or consultation with archivists and special collections librarians may also help donors locate an appraiser.

Many gift collections are offered to others first before they are offered to the library. When space is at a premium, giving other faculty and graduate students first pick of the books that will go into building or filling in personal collections may result in greater use. While this may mean that what is left is not as useful for the library collection, in some library systems this means the books will be used more directly by the target audience. In a library with severe space constraints (and almost all have or will have space constraints) working consortially with other libraries in the region means adding books to a local collection is less vital. If gift books are an important part of the collection development strategy consider asking specifically for priority access to a potential donation when a faculty member is ready to donate it. Remember that communicating early and often with faculty will be an important aspect of making sure that the library is considered first.

Once a collection has been accepted through normal library procedures, it needs to be sorted. Duplicates can be valuable for adding a second or replacement copy to the existing collection, if the current library copy has high use or is in poor condition. It also may be valuable to a consortium or interlibrary loan program to add books that are not locally relevant, if there is space to do so. For books that are duplicates or not appropriate to the collection, donation programs or book sales can be used as a means of disposing of them. There may be policies to consider related to the disposal of gift materials, since they became university property after being accepted. It may be possible to modify university policies to include the possibility of donating those books rather than having them thrown away or recycled.

Keeping a list of issue or volume gaps in the journal collection is useful for determining if gifts can be used to fill in holes in a collection. Prior to our reliance on electronic access and backfiles, gifts of journal collections were an important way to provide complete access to a series title. While it is still appropriate to ask on the SLA PAM listserv if anyone wants runs of journals, space constraints as well as postage and shipping costs make these offers less attractive. Organizations that accept book donations are generally unable to handle journal donations at present. JSTOR still needs some older math journals to complete their archive, so check against their list before discarding issues. While there used to be a thriving trade for back issue vendors, electronic versions of material have largely replaced that demand.

References

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Ten Places to Donate or Sell Books:

1. Better World Books (http://www.betterworldbooks.com/go/donatebooks)
2. Thriftbooks (http://www.thriftbooks.com/library/)
3. Bridge to Asia (http://www.bridge.org/)
4. Zubal Books (http://www.zubalbooks.com/)
5. AbeBooks (http://www.abebooks.com/)
6. AMS Book Donation Program (http://www.ams.org/programs/donations/donations)
7. Powell's (http://www.powells.com/sell-books)
8. IMU Library Assistance Scheme (https://www.mathunion.org/cdc/scholarships/library-assistance-scheme)
9. International Book Project (http://www.intlbookproject.org)
10. Book Donation Programs listed by ALA (http://libguides.ala.org/book-donations)

This list is not in any particular order and we do not endorse these particular organizations. This list represents known options at the time of writing. Each place is different, but generally expect to pay for postage.

Conclusion

In this book we have introduced mathematics as a discipline with a long and diverse history. Mathematicians and math students have unique perspectives and needs at the university level, which librarians can discover through the outreach strategies mentioned and learning from other librarians through professional networks. Rest assured that one doesn't have to be good at math to be a good math librarian. However, taking the time to learn the language of mathematics and the culture of mathematicians is an important part of collection development and being a liaison. Even if the interactions are awkward at first, relationships are key to success. Regular communication with relevant constituents in the math department is vital. A strong working relationship with administrative staff in the mathematics department is important to create and sustain, as it will help in innumerable ways. Keeping users of the library up to date and aware of any changes will reduce anxiety and create a more user-centered library.

While this book exists to help the novice mathematics selector, professional development beyond these pages is important to success. Seek out networks and events, both online and in-person, through the Science and Technology Section (STS) of ACRL and the Physics-Astronomy-Math (PAM) Division of SLA. Current library research guides are a good source of updated information on databases and other key information sources covered in this book. General collection development skills and concepts are applicable to mathematics specifically, with a note that *both* a journal-focused science approach and a monograph-focused humanities approach are important to the math selector. There are some opportunities for librarians to learn from professional mathematics societies in certain conference programs of the American Mathematical Society (AMS) or mathematical literacy programs.

After you learn about the local library collection, ongoing assessment of user needs and usage should inform your collection development. Regular study of faculty research areas, graduate student theses, and undergraduate course requirements should be reflected in collection development decisions. By providing course reserves for math materials so that students do not need to purchase them, you can have a positive impact on student's ability to afford their education, so making the most current editions available is crucial to student success. This can also mean deciding between electronic or print formats, or providing both, in some cases. Collection management also includes reducing the collection at times. This may mean deciding which materials have low use and can be placed in storage or withdrawing duplicate copies. Remember that like their colleagues in the humanities, mathematicians utilize material that is decades or centuries old. Therefore access to some older works is more valuable for mathematicians than for faculty in other science disciplines.

While mathematicians still favor print books and journals more often than their fellow scientists, this trend is also changing. Where a logician may still want to read the current issue of Bulletin

of Symbolic Logic in print, they are happy to also have access to the older issues online. This impacts collection and retention decisions, and allows math libraries to use their space in new and innovative ways beyond book and bound periodical storage. Textbooks, popular works, and key research monographs may still be preferred in print, or print accompanied by an electronic version when possible. Again it is important to listen to the local users and to advocate for their current interests within the library organization, as far as budgets allow.

The scholarly publishing environment in mathematics is reaching a tipping point with regards to Open Access and information availability. Platforms that provide illegal (SciHub) and legal (arXiv) free access to research articles are changing the relationship between publishers and libraries just as we are reaching a breaking point in library collections spending. To justify the cost, indexing and abstracting services must provide a large amount of added value or be inexpensive. MathSciNet generally meets both these considerations, and remains valuable in the age of Google Scholar. Publishers, both commercial and academic, still have an important role in the dissemination of science. Librarians should engage them in critical and honest conversations on issues of cost and function to ensure value for our institutions.

Key values of math research and teaching align well with Open Access principles. Math faculty and students should be valuable allies and advocates for the library as a vital part of the university and the department. The librarian still has the significant task of keeping their users informed about changes in the publishing world and when possible, helping them to navigate this complex environment. There are many forces affecting the scholarly communication behavior of mathematics researchers including tenure requirements, funding agency mandates, and a desire to receive recognition for their work in the profession.

Traditionally math librarians were focused on collection development, as demand for bibliographic instruction or information literacy instruction was low. Due to the changing nature of librarianship and scholarly publishing, there is an increasing need for information literacy, research data management and measuring the impact of research. These are all intertwined with collection development and the scholarly publishing environment. The Framework for Information Literacy for Higher Education (http://www.ala.org/acrl/standards/ilframework) focuses on threshold concepts that rely on a more nuanced understanding of authorship, copyright, and scholarship that are especially applicable in mathematics. The metrics librarians already use for collection development are particularly useful for measuring the research impact of researchers and groups within the university. Research data management and institutional repositories fit in nicely with the culture of math, as they already rely heavily on preprint repositories like arXiv.org.

Departments of mathematics are unique among academic units on the university campus. It is fascinating work to get to know the department faculty, their motivations, their hopes, and their vision. Mathematicians can be extraordinarily talented in many ways (don't be surprised to find that some are either virtuoso musicians or magicians) and surprisingly interested in making you laugh. We have noticed that as a group they tend toward the driest of humor, and have found

ourselves struck by their insights for days afterward. The experience is both interesting and intellectually challenging, and it can be enriching both personally and professionally.

Librarians have moved beyond buying books, retrieving research articles, and answering reference desk questions and now have the opportunity to make an impact on the university as a whole. Mathematics is a pillar of robust general education, as understanding numbers is a vital part of modern society as well as all fields in the sciences, technology, engineering and more as well. The world needs more STEM graduates every year to solve the challenges we are facing this millennium. Math librarians have a unique opportunity to inspire students and make a difference in their lives.