

Mathematics on the Web: Information services of FIZ Karlsruhe/Zentralblatt MATH – a current status report

The Department of Mathematics and Computer Science (Berlin) of FIZ Karlsruhe, Germany produces four international databases and contributes to three portal sites in its scientific areas. In this article we will survey these services and provide an outlook on the future development of information services on the web.

Olaf Ninnemann

Historical survey

In 1977, FIZ Karlsruhe was founded as “Fachinformationszentrum Mathematik, Physik, Energie” integrating a number of German service institutes, among them the editorial offices of “Zentralblatt für Mathematik” in Berlin and “Zentralblatt für Didaktik der Mathematik” in Karlsruhe. FIZ Karlsruhe is a non-profit organization for scientific information services and a member of the Leibniz Association, with the aim to foster access to the worldwide published scientific-technical information. On the one hand FIZ Karlsruhe facilitates public access to these data, on the other hand it establishes and produces information services concerning these data. The institutes of the Leibniz Association are supported by the Federal Republic of Germany and the Federal States as individual research institutes or as institutes producing research services.

The central activities of FIZ Karlsruhe are the Online service STN International, the creation and production of databases and portal sites for its scientific fields, document delivery via FIZ AutoDoc and the development of e-Science solutions, such as the KnowEsis products.

With respect to databases, FIZ Karlsruhe has since its foundation been responsible for Zentralblatt MATH (ZMATH) and MathEduc (former Zentralblatt für Didaktik der Mathematik, ZDM), two worldwide renowned database services in mathematics research and education, respectively. In addition, as a result of the

ERAM project of the German Research Foundation, the database of the “Jahrbuch über die Fortschritte der Mathematik (1868-1942)” has been integrated into ZMATH in 2004 and is still offered independently according to the guidelines of the DFG (German Research Foundation). Finally, in 2006, a new database in statistics and applications of statistics was launched under the heading STMA-Z in collaboration with the Institute for Statistical Information (ISI) in Voorburg, The Netherlands as a successor of their CD/print information service STMA which ceased publication in 2005.

New Internet offers have been established in form of mathematics portal sites. One of these is the well-known EMIS server (a joint effort of EMS and FIZ Karlsruhe) mirrored at over 40 sites worldwide and offering a superb digital library ELIB-M giving open access to almost 100 mathematical journals, electronic books, and conference proceedings and new documents like Geometric Models and others. Moreover, EMIS offers a unique access point to the databases ZMATH, MathEduc, STMA-Z and many more. Another new mathematics portal site has been established at FIZ Karlsruhe, offering additional information on special topics from pure and applied mathematics for academic and non-academic users. The list of items covered includes the fields of Mathematical Finance, Statistics, Mathematical Education, and History of Mathematics. The addition of topics like Computational Fluid Dynamics, New Materials, and Control Theory is in preparation.

The stable production and constant development of these services in cooperation with national and international partners is one of the major aims of FIZ Karlsruhe.

Zentralblatt MATH was founded by the publisher Springer in 1931, aiming at an up-to-date review service for mathematical publications, since the existing “Jahrbuch” had accumulated a delay of approx. five years due to their policy of collecting the complete set of reviews for one particular year before final publication. Until the mid-70s of the last century ZMATH appeared only in printed form. In the late seventies first retrieval tests were carried out and at the time of integration of ZMATH into FIZ Karlsruhe, the first online version based on the metadata was made available to the public via the INKA host of FIZ Karlsruhe, which caused a sensation at the delayed 1983 ICM at Warsaw where online access to the database could be presented. A much more improved version allowing to search also within the review texts and with additional keywords, was made accessible worldwide two years later via STN International, the online service of FIZ Karlsruhe and Chemical Abstracts Service, Columbus, Ohio.

As early as 1993, ZMATH was offered via the internet as a result of a German project aiming at the improvement of database usage based on accessibility of information at the user’s desk. Another major improvement of the database offer was achieved by installing the specialized retrieval software of the French partner Cellule MathDoc from the University of Grenoble. Since then this software has been continuously enhanced and new user interfaces were designed. This was part of an EU project (2000 - 2004) on Large Infrastructures in Mathematics and Enhanced Services (LIMES) aiming at a stronger Europeanization of Zentralblatt MATH by supporting the creation of new access and input structures in certain European countries.

Also in 1993, responsibility for the editorial office shifted from Springer to FIZ Karlsruhe, allowing to establish a publisher-independent platform. Since 1996, when the EMS entered the editorial board, ZMATH has been edited by EMS, Heidelberg Academy and FIZ Karlsruhe, with Springer Verlag acting as publisher.

Today ZMATH represents the most complete (over 2.7 million items) and longest running database service (1868 to present) in mathematics offering numerous specialities such as linking to over a million online articles via DOI, library repositories, and national archives, and display formats xml, pdf, and MathML soon to come.

In mathematics education the database MathEduc (previously MATHDI) covering the worldwide publications (1975 to present) has been offered since 2002

via the EMIS/FIZ Karlsruhe mathematics server using the same French based software on the internet. The service is edited by the German Society for Education in Mathematics (GDM), EMS and FIZ Karlsruhe.

What kind of information is offered?

The databases ZMATH, MathEduc and STMA-Z cover peer-reviewed publications in their fields including applied areas. Publication is meant here in a rather broad sense, including articles from journals, collections and conferences, monographs and textbooks, theses and habilitations (if communicated), multimedia publications on CD, DVD and videos, as well as web documents (for example geometric models, special data collections like databases for codes, lattices, and others) from all over the world.

The database entries contain exact bibliographic information, reviews from independent experts and/or abstracts provided by authors /publishers, keywords assigned by reviewers/editors, links to online articles (via persistent identifiers such as DOI to publishers and via general html links to digital libraries), and finally links to document delivery services. Further extensions to authors’ affiliations and cited literature including links to ZMATH are in preparation.

ZMATH currently offers more than 2.7 million items (1868 – present) incorporating 220,000 items from the Jahrbuch JFM, MathEduc over 120,000 items, and STMA-Z approx. 350,000 data sets.

The portal sites EMIS, MATH, and io-port.net extend the coverage to preprints, non-refereed material, and topical sites hosting general information on institutions, societies, companies, database retrieval options, and many more. EMIS also hosts the Digital Math Library ELIB-M giving open access to approx. 100 math journals, and conferences and monographs and a number of special collections (Erdős publications). European projects can be also looked up here.

How to access this information

The online databases are offered via the internet and are subject to subscriptions (see the links at the end of the article for details). As a service for the public, the databases offer a limited answer set for free in order to allow teachers, students and other interested people to access the information provided. CD/DVD versions are published for remote or individual access

and the print versions can be found in most libraries (or alternatively online access is offered there). For special activities (bibliographies, demonstrations, etc.) one should contact the editorial office for special arrangements.

High quality metadata and unique search facilities

Highlight of the databases is of course the quality of the data contained. They have been selected, approved, standardized and evaluated by experts for more than 140 years. This is extremely helpful in finding author names, journal abbreviations and ISSN, monographs and ISBN, and publishers, but nowadays also DOI for full-text linking and any kind of web-links have been added. Classification codes, free keywords, and citations of relevant publications round off this service.

A very efficient tool recently introduced is the open source link that supports participating libraries with respect to document delivery.

Another unique feature with respect to information retrieval is session oriented retrieval, so that the user can select and change any of his/her previous searches, thus making ZMATH a worldwide unique service of excellence!

Hyperlinks – the best support for web searching

Internet technology today allows for effective searching and navigating within the databases. In ZMATH hyperlinks are offered for searching for authors, classification code, journals, reviewers, citations, and full text links. Easy to handle navigation tools are established for MSC classification and journals and recently for author search leading to the needed search queries. A number of help tools give additional assistance in case of basic problems.

Moreover, several interfaces mirroring different expertise at the user's side are available. Simple search is the familiar web-oriented access to the basic index where no specifications are necessary, whereas advanced search offers a more effective field-oriented search with additional Boolean logic combinations.

Specialties of ZMATH are Expert Search and Lookup Tool where the first stands for individual combina-

tions of search terms and the second for linking articles to their reviews (single or batch service) thus helping authors and publishers to link entire bibliographies with ZMATH.

Highlights – quality and completeness of our databases

One of the most important advantages of using ZMATH is the availability of carefully selected and approved metadata as described above, and its highly specialized content evaluation. The first is carried out by a well-trained technical staff of librarians and documentalists, the second is the responsibility of more than 30 editors in Berlin plus 12 editorial units in Europe and Asia, from Prague to Beijing, just to name a few. Among others they are responsible for a high standard math text editing, incl. classifying and proof-reading, relying on their high skills in mathematics.

Most of the editors act as advisors holding positions at one of the three Berlin universities or prominent research institutes.

Of equal importance is the panel of approx. 8,000 reviewers, selected/recommended experts that are assigned by the editors to review individual articles and books. Their knowledge and expertise reviews are another highlight of the ZMATH database.

The editorial unions contribute their own national publications and also a certain number of international ones assigned by the central unit in Berlin. Therefore completeness with respect to publications from countries like Russia, Ukraine and since 2007 also China is the best one can achieve today. In 2008, ZMATH will reach an annual input amounting to the magical number of 100,000 items.

Another highlight is the extensive inclusion of book literature which requires a close contact to the publishers worldwide. Requiring a much higher amount of editorial work than articles, ZMATH currently reviews approx. 3,000 books from introductory textbooks to highly specialized research monographs.

Above all an international Scientific User Committee installed under the auspices of the EMS gives recommendations for improving the service or comments on new developments. The members can be contacted by any user for proposals on improvements and/or additional services.

Applied Areas – mathematics is everywhere: from game theory to tomography

The importance of mathematics for the development of science, economy and technology has increased steadily during the last decades. As examples we just mention cryptographic methods for secure banking business (and any other system involving PIN numbers like mobile phones), optimization methods for transportation theory (goods or public transport), game-theoretic and probabilistic methods in economy (here mathematicians have received the Nobel prize, please remember that there is no Nobel prize for mathematics). A whole new branch of mathematics, called industrial mathematics, looks for solutions of real-world problems in production, business, engineering etc. New methods of image generation in medicine also require mathematical methods to recognize disease patterns.

To satisfy the needs of researchers and scientists for all these areas is a great challenge that ZMATH has successfully fulfilled during the last 75 years.

Special services for Statistics and Education

In two special areas, Statistics and Education, FIZ Karlsruhe's databases STMA-Z and MathEduc aim at the same goals as mentioned above and offer a high amount of expert knowledge.

In addition to the Statistics publications in "Zentralblatt", STMA-Z contains the material on general statistics from its predecessor STMA published by the ISI and contributions from journals on applications of statistics in medicine, agriculture, etc., thereby making it also attractive for people from these non-mathematical areas.

The MathEduc database (former MATHDI) is the only international database on mathematical education, evaluating the literature from all levels of education, from kindergarden to university teaching. National and international cooperations in Europe and the USA (ERIC database) play an important role in gaining all the material necessary for this database. The database also serves as an important entry point to popular and introductory material for laymen, pupils and others interested in mathematics.

What the future will bring

The growth in diversity of the original (web) sources, new areas of applications and more detailed information needs (data) but likewise the differences in notations used by engineers and researchers in companies and institutes will require an extension and a different structure of the services in the future. A first major step has been taken by establishing the two portal sites, EMIS and FIZ Karlsruhe Mathematics, offering specialized information for special topics of current interest like financial mathematics, statistics, history and education. Here, one can find additional factual information and predefined searches in the respective databases and, in case of EMIS, the digital library ELIB-M with almost 100 scientific journals for open access.

The current ViFaMath Project of the German Research Network with partners TIB Hannover, SUB Göttingen and FIZ Karlsruhe aims at establishing enhanced integrated search engines for different sources like OPACs, web and database information, as well as full-text search in the digital library ELIB-M. This is in a certain sense a follow-up of a former EU-project called EULER establishing an integrated search using Z3950 and database techniques. The introduction and assigning of additional keys for engineers and applied mathematicians should greatly enhance the value of this information for other disciplines. But this is only for the near future!

In the longer terms one might expect the development of new spatial navigation tools, however requiring a much deeper structured information source, but also improved tools for automatic multilingual indexing, formula extraction and many more. So there is still a lot of interesting work to do!

Web addresses

Leibniz Association: <http://www.bmbf.de/de/243.php>
 FIZ Karlsruhe: <http://www.fiz-karlsruhe.de/>
 Mathematics: <http://www.fiz-karlsruhe.de/mathematics.html>
 ZMATH: <http://www.zentralblatt-math.org/zmath/en/>
 MathEduc: http://www.fiz-karlsruhe.de/matheduc_products.html
 STMA-Z: <http://www.zentralblatt-math.org/STAT/>
 EMS: <http://www.emis.de/>
 io-port.net: <http://www.io-port.net/>
 Electronic Library: <http://www.emis.de/ELibM.html>
 JFM: <http://www.emis.de/MATH/JFM>

Olaf Ninnemann

FIZ Karlsruhe, Mathematics and Computer Science