The German Website Mathematik.de

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Abstract In this article we describe the German website Mathematik.de, and the ideas used to try to raise the public awareness of mathematics in Germany.

This website was originally created by Ehrhard Behrends. I joined the team in 2007, and since 2009 I have been the editor responsible for the site.

What Is Our Idea?

The idea behind Mathematik.de other than being the website of a professional association like the Deutsche Mathematiker-Vereinigung (DMV, the German Union of Mathematicians) is to give information and news about mathematics, about mathematics in the media, about mathematicians at work, about the history of mathematics, etc. to the general public. We therefore provide:

- A collection of news and current media stories about mathematics in Germany and elsewhere
- A collection of mathematical resources for students, engineers and otherwise interested people

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Fig. 1 Page header: the
polynomial for a sweet

$$(x^2+y^2+z^2-1)^2=9(x^4+y^4)$$
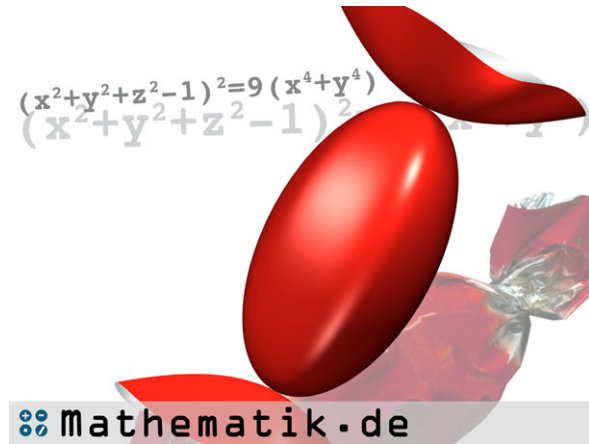
- A forum for people interested in mathematics to get an idea of the working life of a mathematician
- A list of web links to other interesting pages about mathematics

and much more.

Page Structure

Our web page:

- Has a daily graphical header
- Has a left-hand side with daily items
- Has a right-hand side with a menu with many interesting topics, see Fig. 2.

This structure was introduced in 2008 when we had the official Year of Mathematics in Germany and the site was given a facelift.

Our site is served by a database, which is invoked both to present the changing items automatically and to serve the menu.

The Page Headers

Each page header (see Fig. 1) combines a polynomial formula from pretty simple to rather complicated of a three-dimensional surface, a picture of this surface and a photo of a real-world item as an illustration of the model surface. (For more examples see Fig. 3). This type of header was largely influenced by the Imaginary exhibition (www.imaginary2008.de), which visited many German cities in 2008.

Fig. 2 The start page of Mathematik.de on 1 September 2010

News Messages

We add a news entry about every third day, so that each month we come up with about 10 news messages (Fig. 4). These are either news from electronic media in Germany, interesting press releases about mathematics, mathematicians, competitions or anything that we consider to be interesting for the public, for example:

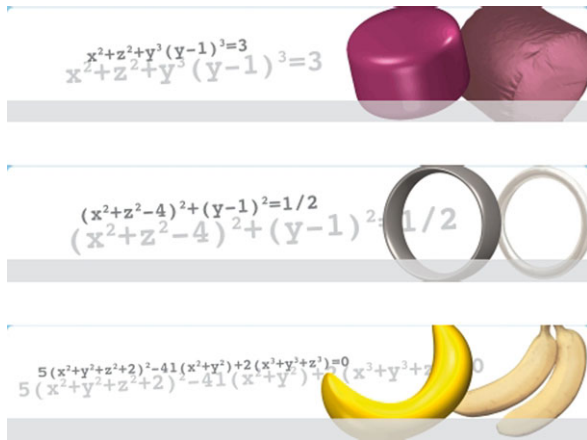**Fig. 3** Page headers: polynomials for a cushion, finger ring and banana

$$x^2+z^2+y^3(y-1)^3=3$$

$$(x^2+z^2-4)^2+(y-1)^2=1/2$$

$$5(x^2+y^2+z^2+2)^2-41(x^2+y^2)+2(x^3+y^3+z^3)=0$$

Fig. 4 News items

Neuigkeiten

Verleihung der Fields-Medaillen
26.08.2010 *In diesem Jahr findet der Internationale Mathematikerkongress (ICM) in Zentralindien statt. Im Kongresszentrum von Hyderabad hat die indische ...*
mehr ▶

6. Internationales Mathematik-Camp am Werbellinsee
24.08.2010 *Vom 20. bis zum 28. August 2010 findet in der Europäischen Jugenderholungs- und Begegnungsstätte am Werbellinsee nahe Berlin ein ...*
mehr ▶

Berlin wird Zentrum der Weltmathematik
16.08.2010 *Die Weltvereinigung der Mathematiker IMU (International Mathematical Union) wird ihren ständigen Hauptsitz ab 2011 in Berlin haben. Das ...* mehr ▶

- We announced Benoît Mandelbrot's recent death giving details about his life and presenting a nice movie of his fractals, see Mathematik.de/ger/diverses/aktuelles/benoit_mandelbrot_gestorben.html.
  Of course this was only possible because:
  – we asked for and received the authorization of the film director Nigel Lesmoir-Gordon [1]
  – we have somebody in our team who can prepare such a Flash animation
  – we were fast enough to get this page online without any substantial delay
- We released another news message about the DMV media award ceremony in 2010, presenting the relevant information about the awardees and publishing several pictures to visualize this event, see Mathematik.de/ger/diverses/aktuelles/medienpreis_2010/dmv_medienpreis_2010.html.
- A news message about Eugen Jost introduced and showed a dozen of his marvellous mathematical pictures, which were used to create nice calendars and for

Fig. 5 Citation of the day

Zitat des Tages

Die Mathematiker, die nur Mathematiker sind, denken also richtig, aber nur unter der Voraussetzung, daß man ihnen alle Dinge durch Definitionen und Prinzipien erklärt; sonst sind sie beschränkt und unerträglich, denn sie denken nur dann richtig, wenn es um sehr klare Prinzipien geht.
- *Blaise Pascal*

Fig. 6 Historic reminder

Heute vor 130 Jahren

Am 31.8.1880 wurde Heinrich Franz Friedrich Tietze in Schleinz (Österr.) geboren.
Er arbeitete in der Topologie und war wesentlich am Aufschwung dieser Disziplin beteiligt. Mit seinem Buch "Gelöste und ungelöste Probleme aus alter und neuer Zeit" machte er viele Laien mit schwierigen mathematischen Problemen bekannt.
Tietze verstarb am 17.2.1964 in München.
Mehr finden Sie hier ▶.

Fig. 7 Book of the day

Rezension des Tages

Alles Mathematik - Von Pythagoras zum CD-Player
- *Martin Aigner, Ehrhard Behrends* - mehr ▶

numerous exhibitions, see Mathematik.de/ger/diverses/aktuelles/mathemacher_november_2010/eugen_jost.html.

- In Mathematik.de/ger/diverses/aktuelles/energie_fuer_den_marathon.html we reported on a mathematical theory for marathon, which was published by Benjamin Rapoport from Harvard University.

Of course not all messages have a film or a slide show but every news message is illustrated by at least one picture to make the website as visually attractive as possible.

Daily Changing Items

Our daily changing items include one of 185 citations of the day (Fig. 5).

There is a large selection of historic reminders (which we obtain from http://www-history.mcs.st-and.ac.uk/history/Mathematicians, Fig. 6).

There are 80 books of the day (Fig. 7).

There are 136 items of Five-minute mathematics (Fig. 8).

The last category was started by Ehrhard Behrends as a weekly column in the German newspaper Die Welt and 100 of these stories were published as a book [2]. Some 36 more stories from different authors were added in 2008. As a result every day we can offer one of this large collection of very interesting short stories about mathematics to our readers.

Fig. 8 Five-minute
mathematics

5 Minuten Mathematik

Glückwunsch zum 32. Geburtstag!
Um ein Problem optimal erfassen zu können, sollte man es aus einem
geeigneten Blickwinkel betrachten. In der Mathematik ist es genau so:
Viel Mühe wird darauf verwendet, für die auftretenden Objekte eine
Vielzahl von Darstellungsmöglichkeiten bereit zu stellen, um dann für die
gerade anstehende Frage etwas Passendes zu finden.
mehr ▶

Our selection of book reviews is steadily growing. Currently we have about 250
book reviews accessible on our site, 80 of which are in the selection for the book
of the day. The books in the book of the day category were generally published less
than five years ago. New reviews are added into the selection for the book of the
day, and from time to time we delete the oldest ones.

Main Menu and Welcome

How do we communicate with our readers? Our main menu has the following op-
tions:

- Welcome
- First aid
- Exploring mathematics
- University and occupation
- Mathematics in the media
- Information
- School

with suitable subitems. For any of the following typical groups of readers:

- School pupils
- University students
- University lecturers
- School teachers
- Working mathematicians
- Journalists

we have a special welcome page linking to the most relevant submenus for the par-
ticular group.

First Aid

The most popular category on our web site is the First Aid. It addresses mainly
high-school and university students who have a specific mathematical problem, but
also offers mathematical knowledge for other interested people.

Since we don't want to answer daily emails of the type: "How do I solve a
quadratic equation?" or "I have a math test tomorrow, and need a lesson on power

laws", we offer everybody seeking mathematical help short descriptions, solution procedures and further links to the most frequently asked mathematical questions.

For this purpose we have written 60 detailed articles about topics from algebra, arithmetic, calculus, fractions, equations and systems of equations, geometry, percentage and interest calculation and probability theory, which are accessible on our site. One can easily find these pages from the menu, but also by using suitable keywords in Google.

Currently we are designing and integrating many multimedia-based components and incorporating them in our First Aid articles. Some examples are the following:

Figure 9 shows a JavaScript applet where the user can enter the numerator and denominator of a fraction. Then the applet executes the division calculating the remainder and showing all intermediate results and the complete computation, which gives the periodic decimal approximation of the fraction as shown in Fig. 10. There is a similar applet handling the reverse operation.

An interaction with Riemann sums uses the GeoGebra package [3], which we have incorporated several times after receiving authorization from the author Markus Hohenwarter. In the applet (Fig. 11) the user can change the function, the number of partition points (up to 100), can visualize the upper and lower sums and can compute the numeric value of the integral. This gives the user enough freedom to learn and understand the concept of integrals via an area computation.

In the section Mathematical Calendar Sheet we publish several times a year an article about an anniversary, which is important in the history of mathematics. With this we like to draw attention to mathematical breakthroughs, important publications and other milestones in the organizational and structural development of mathematics.

The recent article "1859: the ζ function, distribution of prime numbers and Riemann hypothesis" about Riemann's article *Ueber die Anzahl der Primzahlen unter einer gegebenen Grösse* [4] gave the historical developments around the ζ function. It contained the graph of $|\zeta(z)|$ from the book [5] (Fig. 12) as well as a *modern variant*, computed with *Mathematica* [6] (Fig. 13), which shows the care taken by the authors Jahnke and Emde.

Mathematics as a Profession

"What does a mathematician do at work?" "What are the working options for a math student?" "Do you want to become a math teacher or remain at the university?" These are typical questions that mathematics students are asked by other people.

In today's life mathematics plays an important although not always obvious role. The career options for mathematicians are excellent, unemployed mathematicians are virtually unknown in Germany and the salary prospects are great. We report these issues frequently. A very interesting story was *Doing the Math to Find the Good Jobs* [7] about a study giving the three best job opportunities in the US as (1) mathematician, (2) actuary and (3) statistician.

Bruch in Dezimalzahl umwandeln

Hier kann man sich einen Bruch in eine Dezimalzahl umwandeln lassen:

Man beachte:

- Bitte nur natürliche Zahlen eingeben.
- Es darf nicht durch 0 geteilt werden.
- Bei einem periodischen Bruch wird der Rest, der bei der Rechnung zweimal auftaucht, fett hervorgehoben.
- Wenn vor der Rechnung führende Nullen ergänzt wurden, so werden diese kursiv dargestellt.
- Bitte nur maximal 15-stellige Zahlen eingeben, da mit 16-stelliger Genauigkeit gerechnet wird.
- Schon bei Zahlen mit wenigen Stellen kann die Rechnung sehr lang werden, so dass die Zeit für die Darstellung der Rechnung übermäßig lange dauert. In diesem Fall wird die Rechnung spätestens nach 100 Schritten abgebrochen und es werden entsprechend nur die ersten 100 Rechenschritte angezeigt.
- Beim Klick auf nur Ergebnis anzeigen wird maximal mit 1000 Schritten gerechnet und nur das Ergebnis ohne Rechnung ausgegeben.

| 5 | : | 13 | | = |

| zurücksetzen | zufällige Ausgabe | nur Ergebnis anzeigen |

Fig. 9 Applet for converting a fraction to a decimal

Fig. 10 The fraction 5/13 as a decimal

$$5 : 13 = 0,3\overline{846153}$$

```
 5                    : 13  =  0, 3 846153
-3 9
 ───
 1 1 0
-1 0 4
 ───
    6 0
   - 5 2
    ───
      8 0
     - 7 8
      ───
        2 0
       - 1 3
        ───
          7 0
         - 6 5
          ───
            5 0
           - 3 9
            ───
             1 1 0
```

In the exciting category on Mathematics as a profession, which we started recently, we show various career opportunities by interviewing many mathematicians. Our interviewees work in different professions and give a broad picture and personal points of view about the professional work of a mathematician.
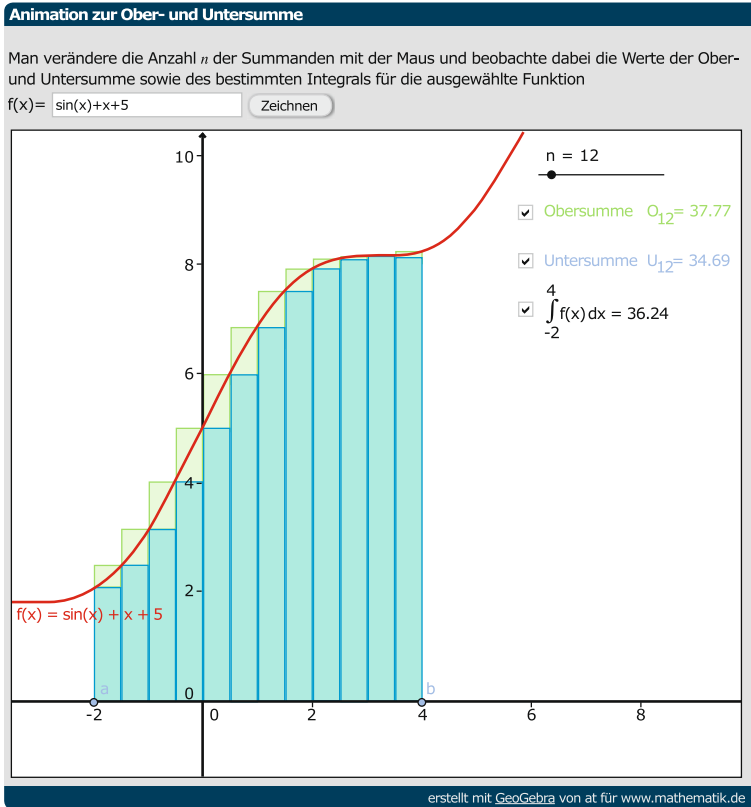
Animation zur Ober- und Untersumme

Man verändere die Anzahl n der Summanden mit der Maus und beobachte dabei die Werte der Ober-
und Untersumme sowie des bestimmten Integrals für die ausgewählte Funktion

f(x)= sin(x)+x+5   Zeichnen

n = 12

Obersumme O_{12}= 37.77

Untersumme U_{12}= 34.69

$\int_{-2}^{4} f(x)\,dx$ = 36.24

f(x) = sin(x) + x + 5

erstellt mit GeoGebra von at für www.mathematik.de

Fig. 11 Riemann sum for $\sin x + x + 5$

Supporting Giftes Students

There are international competitions such as the International Mathematical Olym-
piad (http://www.imo-official.org), similar national contests, and many institutions
cater for them. The section Supporting gifted students features these institutions
(Fig. 15). Our site gives these activities a common platform. Institutions that are not
yet included in our list can use a web form to submit their details.

Statistics

We are very happy that Mathematik.de is used by many people. Our site has more
than 2,000 daily hits showing that the type of information we provide is useful to
the public (Fig. 16).

One should realize that most of our readers visit our site via search engines like
Google. Note that the search term Mathematik in Google gives Mathematik.de a
high ranking.

Fig. 12 $|\zeta(z)|$ function [5]
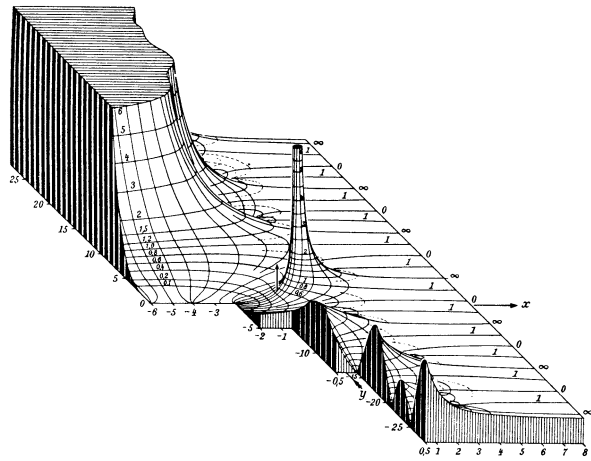
Fig. 13 $|\zeta(z)|$ function computed by *Mathematica*
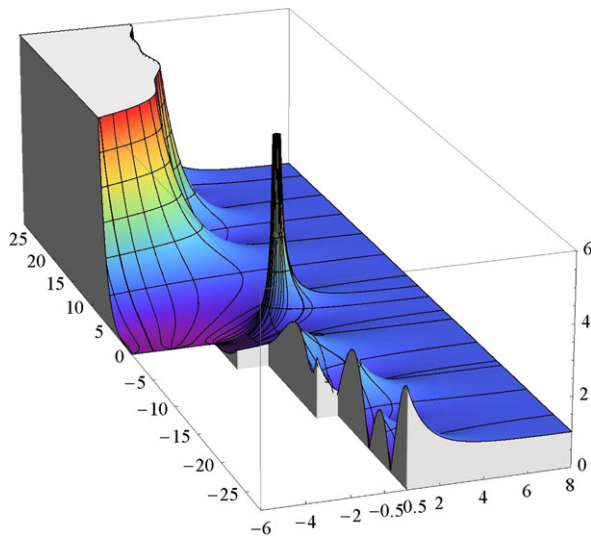
Our website now has been online for ten years and can clearly be called a success story.

Administering the Site

In this section we would like to answer some questions that might be of general interest for those who run a popular website like ours.

- Where do we get our news from? One student in our team is continually searching the Internet for news about mathematics. Important resources are especially the online pages of large magazines and newspapers. Our search finds an interesting

Fig. 14 The polynomial of a
street light

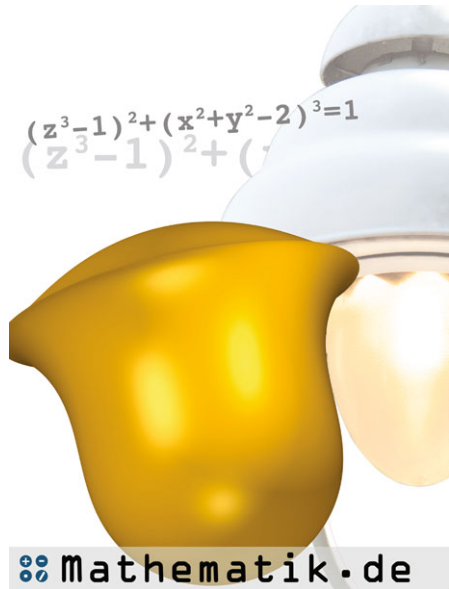$$(z^3-1)^2+(x^2+y^2-2)^3=1$$

Fig. 15 Locations of
institutions supporting gifted
students

news article about every third day. Furthermore, the DMV has press releases that
we use. We publish only news that seems to be of importance for a wide audience.
We link only to sites that seem to be permanent.

- How do we handle copyright questions? For the text of press releases copyright
  is not an issue, and if we use other sources, we cite them or link to those sites.
  However, the copyright of pictures is an important legal issue. If we want to use
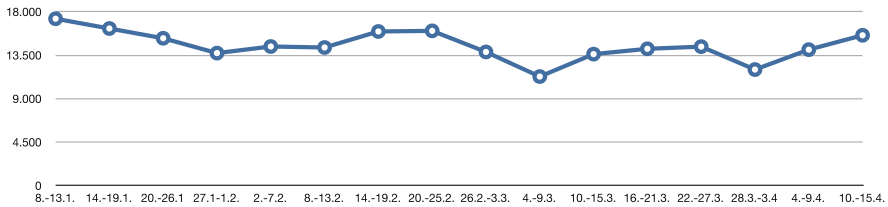
Fig. 16 Number of visitors to Mathematik.de per week

an image from a website or a press release, we ask the owner by email to give us the right to use it. If we get permission, that's fine, and we cite the copyright owner's permission. If this is not successful and in other cases of doubt we do not use such pictures. One other important source for images is Wikipedia [8] since the copyright status of the pictures given there, including many photos of mathematicians, is clearly stated.

- How do we handle book reviews? One student in our team checks new publications, selecting those books about mathematics mainly in German language that would be of interest for the public and ask the relevant publishers to send us reviewer's copies. Some publishers send us their books without asking. The selected books are then distributed to our reviewers. When a review appears, we send the link to the publisher. New reviews are used for the "Book of the Day".
- How do we get interviews with Mathematicians? Some time ago, we sent a letter to the mathematics departments of every German university. We attached questions of the interview, and asked them to be distributed to their alumni. We also sent the questions to business organizations. The complete correspondence for this section uses its own email address.
- How do we guarantee quality? Any of the above processes will create a new or changed article for distribution generated by the responsible student or by our web master. However, before a new article is put online, every new or changed page must get my approval. Although this is a lot of work I find this step necessary for quality control.

Our Team

Currently, our team has nine members, see Mathematik.de/ger/impressum/impressum.html. For each of the following activities one or two student members are responsible:

- Selecting news messages
- Handling the reviewing of new books
- Collecting interviews for "Mathematics as a Profession"
- Producing multimedia resources for the "First Aid".

Fig. 17 Torsten Sprenger (*left*) and Wolfram Koepf (*right*)

My assistant Torsten Sprenger (Fig. 17) is responsible for technical questions and for the management of the database, and Margarete Eisele is our technical assistant and web master. If we have a problem that is outside our technical scope, then we ask for external help.

Our sincere thanks go to our sponsor **ERGO** (Ergo.com). Without the financial support of the ERGO Group we could not run our website.

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