MathEduc – information for teaching and learning mathematics

Are students incapable of understanding mathematics, or do the teachers lack the fantasy required for giving learners an idea of how beautiful mathematics can be? Students are as good as the lessons they receive, and all teachers in preservice and inservice teacher education should have access to examples of good and dedicated teaching. MathEduc provides this information.

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1. Mathematics and society

People claiming to be educated often are ashamed if they are unable to discuss politics, society, literature, music, or the arts. They have, however, no problem admitting: "I have always had bad marks in maths." On a simple educational level, this is reduced to the comparison between writing and reading abilities, which, of course, should have top priority in school, and acquiring basic mathematical skills. Neglecting the latter, after graduating from school, is more likely to be excused, despite the fact that mathematical skills are an integral part of our everyday life. They are required when checking a restaurant bill, estimating the price of goods in the shopping basket, comparing the conditions offered by insurance agents or creditors, or when making strategic decisions in games like Poker or Bridge. Although many people are not aware of it, mathematics involves much more than just mathematical skills and numbers. Below are some examples of the many obvious or hidden applications of mathematics we have to deal with in everyday life: assessing the risk of loss in gambling (which always is inevitable in the long run); diagrams showing the development of stock market prices in the business section of a newspaper; satellite navigation systems; optimization of time schedules; correct image transmission; ballot-rigging through adequate voting rules, etc.

Fig. 7: Roulette winning chances are subject to probability laws.

There are also many ways of applying mathematics in science and technology. In most cases, only specialists or people interested in science are able to understand them. Thus, understanding mathematical relations is an indispensable part of general education. Last but not least, improving general mathematical knowledge and training problem-solving methods using logics, could help to reduce the wrong perception that mathematics deals with numbers only (with the consequence that everything is known already) and to undermine the authority of those who hide drawbacks in their considerations by pretending that everything had been checked mathematically, whatever that means.

Everyone has the ability to reason mathematically, though admittedly some people are more capable to apply this in daily life than others. In particular, it is

not true that women are less gifted in mathematics than men. However, as a result of a prejudiced education and of teachers with a very limited understanding of mathematics, individuals may develop reservations against mathematics, consider themselves untalented and settle for this alleged inability, as described above.

2. Why MathEduc?

The problems described above can only be solved by improving mathematical education, publishing materials motivating and enabling people to study maths on their own, and offering teacher training in maths that meets today's requirements. Future maths teachers not only need to be taught elementary mathematics on a higher level, but they also have to be given the necessary skills to understand teaching and learning processes and to apply their expertise in a modern teaching environment.

Many surveys and publications are dedicated to these problems. Long before TIMSS and the PISA study became an issue, schools and universities recognized the need to reform the way of teaching mathematics. One example that comes to mind is the highly controversial discussion about "New Maths". This discussion was held at a time when mathematical education was a hot topic of interest at teacher training institutions.
At the same time, the end of the 1960's, "Zentralblatt für Didaktik der Mathematik" was founded. It contained a section devoted to articles on mathematical education and a section dedicated to documentation with reviews of relevant literature in the field.
Using modern information technologies, this documentary section evolved into the searchabe online reference database MathEduc which is available on the web.

Its task is to evaluate the existing literature on mathematical education as well as publications dedicated to conveying mathematical skills at schools, universities and to the interested public. Additional information is also provided, so that an information system on mathematical teaching and learning which is as comprehensible as possible is available to a wide audience. The features of this database are similar to that of the database ZMATH (Zentralblatt für Mathematik) which is described in another article in this brochure and mainly contains information on mathematical research publications.

Subjects covered by MathEduc are ranging from education at all school levels and school types, vocational training, teacher training and tertiary education to presentations making mathematical considerations comprehensible for the general public. MathEduc provides bibliographic references to relevant topics such as learning theory, educational psychology, teaching methods and lesson planning, interdisciplinary and application-orientated approaches, etc. In addition to subject-specific literature, publications from educational science, psychology, sociology, and other basic sciences dealing with teaching and learning are reviewed. A convenient search mask helps in locating information on all these topics and allows one to limit the search to individual school levels.

The following should serve as an example for information in MathEduc which is relevant to school education in mathematics: In pre-school education children should be guided playfully towards basic concepts of numbers and simple geometric shapes. In primary school, students are to be taught basic arithmetic operations, elementary geometry and word problems as well as simple ways of arguing and logical thinking. In secondary school, students should not experience mathematics by working through a set of traditional topics, but rather learn by means of applications, interdisciplinarity, and building mathematical models, i.e. that mathematics is part of everyday life. At present we have 2,750 hits for "interdisciplinarity" and about 4,400 hits for "mathematical models" in MathEduc.

Fig. 8: MathEduc: 1,425 hits on pre-school education

Today, students are confronted with information technology already at an early age. Computers, the Internet, and educational software are part of their everyday lives. Teachers should use this familiarity with and positive attitude towards computers as a motivating factor in class. They need, however, assistance to be able to decide in which situations it makes sense to use computers. For example, using new technologies can relieve students from complicated, routine calculations and allows them to focus on the actual mathematical problem and how to solve it, or graphical representations can shed new light on a problem.
At the university level, the situation is basically the same as at school. Besides basic studies of mathematics, special mathematical lectures are offered to students of science, engineering, and economics, and even in some disciplines of the humanities.
Information on textbooks presenting mathematics in a way appropriate to a student's actual field of study is of fundamental interest.

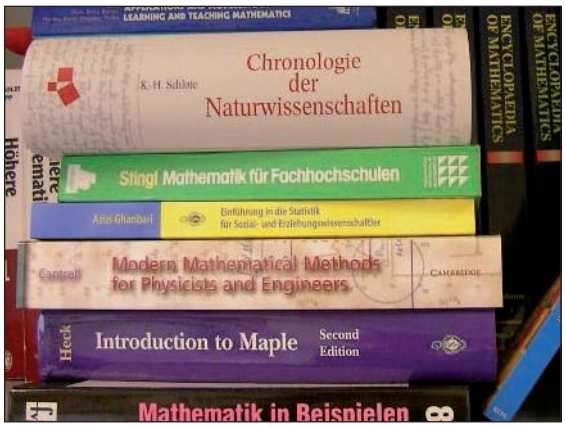
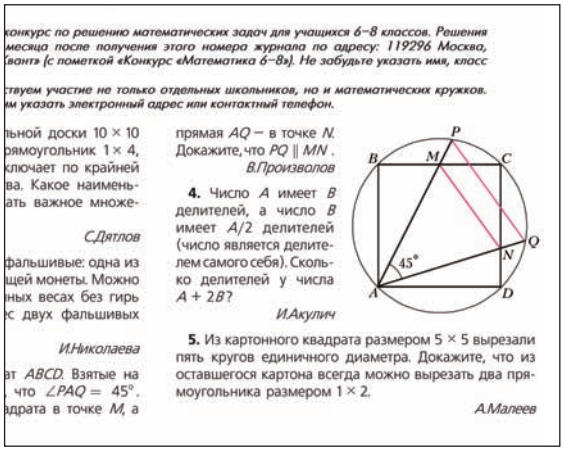


Fig. 9: MathEduc: References to about 3,700 textbooks for academic studies

3. MathEduc – an outlook into the future

In the initial stage (the former "Zentralblatt für Didaktik der Mathematik") the documentary section was very much focused on Germany. Just as in mathematical research, some journals on mathematical education were targeted towards an international audience. But the different school systems in different countries and the large variety of occupational fields in mathematics inevitably resulted in publications that were mainly of local or regional interest. Since approaches towards overcoming problems in mathematical education may be of global interest, even if


конкурс по решению математических задач для учащихся 6–8 классов. Решения
месяца после получения этого номера журнала по адресу: 119296 Москва,
вант» (с пометкой «Конкурс «Математика 6–8»). Не забудьте указать имя, класс

ствуем участие не только отдельных школьников, но и математических кружков.
м указать электронный адрес или контактный телефон.

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С.Дятлов

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с двух фальшивых

И.Николаева

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, что ∠PAQ = 45°.
адрата в точке M, а
прямая AQ – в точке N.
Докажите, что PQ ∥ MN.

В.Произволов

4. Число A имеет B делителей, а число B имеет A/2 делителей (число является делителем самого себя). Сколько делителей у числа A + 2B?

И.Акулич

5. Из картонного квадрата размером 5 × 5 вырезали пять кругов единичного диаметра. Докажите, что из оставшегося картона всегда можно вырезать два прямоугольника размером 1 × 2.

А.Малеев

Fig. 10: MathEduc: Co-operation with Moscow; copy of a title page from Kvant

the systems may vary from country to country, the decision was made to broaden the scope of references accordingly.

For MathEduc, this meant that descriptive texts written in several languages were included and that metadata were offered in English as the international standard language. Thus, even local publications mainly targeted at a narrow audience may provide users of MathEduc with interesting additional information.
This internationalization of MathEduc is an ongoing process. In the meantime, much progress has been made, but the database still has a long way to go in order to achieve global coverage. Thanks to a long-term partnership with the American information service ERIC and additional in-house editorial work, relevant publications form North America are well represented in MathEduc. In other countries, groups of experts have formed who have the necessary expertise to decide whether or not a regional publication is to be included in MathEduc and who then also provide the required input. Thanks to this co-operation, the database has a broad coverage of literature from France, Italy, Spain, Portugal, Serbia, and the Czech Republic. Similar cooperations with Argentina, Greece, Romania and Scandinavia will start in the near future. As a first step for Russia, GPNTB in Moscow is handling two Russian journals for MathEduc.

Not to be underestimated is the interest people in developing countries may have in MathEduc. It is true that apart from a few mathematicians who return to their home country after having received their training and graduation in industrialized countries (mainly the USA), not many people in these countries require cur-

rent information on mathematical research results. The relevant issues for these countries primarily are to know about methods of mathematical training, to obtain good textbooks and to have qualified teachers available. Here, information like that provided in MathEduc finds grateful, but mostly penniless recipients. In this field MathEduc could, in the future, turn publicly funded editorial work into development assistance.

Another parameter which will require a further enhancement of the input activities for MathEduc are the numerous online offers on mathematical education. These are important trends with respect to promoting mathematics and improving the dissemination of mathematical information. The growth of these offers must not be underestimated. At the same time, they create new problems: They are the result of more or less spontaneous initiatives. They are hard to find and it is not clear, whether they will be available on a permanent basis. Not all of them have been checked for quality, and if they have, the applied criteria are not clear. In most cases, they are not intended for public use, although they are of sound quality and could be of interest to a wide audience. Web crawlers may help to find and pinpoint such offers. Unlike traditional documentary work, the information that can be automatically generated for MathEduc by means of web crawlers will be rudimentary only. It has to be decided on a case by case basis, for which offers this information is to be enhanced by means of further editorial work. Two important criteria are that the offer has to be developed on a sound basis and that its availability during a reasonable period is ensured. Examples for such offers are WebALT (Web Advanced Learning Technologies; www.webalt.com/) from Helsinki or ActiveMath (www.activemath.org/) from the DFKI in Saarbrücken. In such cases there should be a more detailed entry in MathEduc. Electronic lecture transcripts provided on the web pages of university departments are less suited for this purpose.

For web offers to be systematically edited, MathEduc has to revise the input procedure, implement alternative procedures, and modify the metadata structure used. In addition, an external reference system of virtual archives has to be developed that can provide and administrate the web offers referenced in MathEduc. Such a network can only be established within the scope of an international project with several partners.

Fig. 11: Website ActiveMath

With the growing internationalization, MathEduc has reached a level of completeness which makes this database a worldwide unique information system for learning and teaching mathematics. The support of FIZ Karlsruhe has made it possible to create and further develop this database. The internationally distributed input work will continuously enlarge the collection of relevant literature from all over the world.

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