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FINAL REPORT OF THE PROJECT "DEVELOPMENT OF UNIVERSITY EDUCATION IN MATHEMATICS AND EXACT SCIENCES VIA TRILATERAL CO-OPERATION, FINLAND – HUNGARY – SWEDEN"

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Abstract

In the project one compares university education of mathematics in the participating Finnish, Hungarian and Swedish departments of mathematics, with a view that the departments may learn from each other and develop their own modes of action. Special attention is paid on the education of teachers of mathematics.

Key words
Mathematics education, university education, teacher education

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Preface

As a part of a joint national action programme for developing Finnish knowledge in mathematics and natural sciences (LUMA programme), the Finnish Ministry of Education has agreed with its Hungarian and Swedish counterparts to launch a project in which some university departments from the three countries analyse and compare the ways in which education is organized. The purpose is to gain an understanding of the structure and processes with a view to improve the quality and efficiency of university education in exact sciences. ”LUMA” is an acronym of the Finnish words LUonnontieteet (natural sciences) and MAtematiikka (mathematics).

Initially, the project concentrates on mathematics and chemistry. Later the co-operation may be extended to physics and computer science, possibly even to biology and geography.

This is the final report of the LUMA evaluation project concerning mathematics. Seven departments of mathematics from the three countries have participated: In Finland the departments at Helsinki University and at the University of Oulu, in Hungary the Institutes of Mathematics at the Budapest University of Technology and Economics, at Eötvös-Loránd University of Budapest and at the University of Szeged and in Sweden the departments at Göteborg University / Chalmers University of Technology and at Lund University. Each of these departments has produced a self-assessment, and from each of the departments, a delegation has paid a site visit to a department in of each of the two other countries. The site visits have been important for completing, clarifying and confirming the information given in the self-assessments. The self-assessments and the reports from the site visits are attached as appendices to this report. The project has been going on during the academic year 2001-2002.

The members of the joint benchmarking group for mathematics are senior lecturer Per-Anders Ivert (Lund university), who has edited this report, senior lecturer Lennart Frennemo (Göteborg university), professor István Hortobágyi (Eötvös-Loránd University of Budapest), professor Olli Martio (Helsinki university), professor Peter Moson (Budapest University of Technology and Economics), professor Lassi Päivärinta (Oulu university), and professor Tamás Szabó together with assistant teacher Zoltán Kovács from Szeged university. In addition, special government adviser Mirja Arajärvi (Ministry of Education, Finland), project officer Lars Brandell (National Agency for Higher Education, Sweden), project coordinator Antero Hietamäki (National Board of Education, Finland), professor Kjell-Ove Widman (Mittag-Leffler Institute), and senior adviser Anna-Maija Liuhanen (Finnish Higher Education Evaluation Council) have contributed as members of the international steering group of the project.

Contents

Summary and recommendations

All the participating institutes belong to well-established universities, the youngest one being 44 years old. They all have solid traditions in education and research, and the infrastructure is reasonably good at all sites.

We can also note that the academic teachers (professors, lecturers etc.) involved in mathematics teaching are in general committed to their task and pay great interest in developing their teaching methods.

One of the most serious problems, known also from other European countries, is the decline of the level of mathematical skill and knowledge of beginning students. Mathematics teaching, and science teaching in general, has become more descriptive than before and does not provide enough of the "basic core" of mathematics. This fact implies problems that seem to be particularly noticeable in Hungary (although not so much at the BUTE) and in Sweden, but the process has seemingly a longer history in Sweden. It is important that as well students with good as those with less good prerequisites are given sufficient possibilities for

development, and that the beginners are subject to relevant demands and challenges.

A necessary condition for good recruitment to higher mathematical education is a supply of capable secondary school teachers. In mathematical circles, the flourishing of mathematical and scientific education in Hungary on high school level after the political "compromise" of 1867, when Hungary at least formally became an equal part of the Austro-Hungarian monarchy, is well known. This flourishing depended on foreseeing legislation of politicians and on the dedicated work of competent, skilful and enthusiastic teachers, and it led to a corresponding flourishing of Hungarian mathematics on the scientific level. Also in the Nordic countries, mathematics enjoyed a better reputation in the first half of the previous century. Today society is more complex, and it has become more difficult to attract the interest of gifted young people. Nevertheless, mathematics maintains its importance for the development of society, and it should be a major concern for education planners and decision-makers. During the last three decades, mathematics has played a major rôle in the development of new areas like cryptology, fluid dynamics, biological informatics, data analysis economical prediction, robotics, etc.

"The good students can become mathematicians, and the less gifted will at least be good enough for teaching in school". This attitude has been prevailing in academic life for quite some time. However, this attitude does not exist any more in the mathematical departments responsible for teacher education. Very little has been done by decision-makers to change the public image in this respect. The departments of mathematics have had no financial means to influence public opinion.

Technical education has suffered a similar failure, but this has to a great extent been rectified using resources from industry. Teacher education has had no such outside resources. This has created a vicious circle for mathematics education, the constituents of which are less capable school teachers, low prestige of the teacher's profession, diminishing interest for mathematics among young people and a negative selection of students to teacher training. It creates damage that is very difficult to repair.

One observation in the evaluation is that the competence provided by the teacher education is higher in Finland and even more in Hungary than in Sweden. It is clear that the education of mathematics teachers, especially in Sweden, is threatened by a serious decline in quality. We strongly recommend that the subject theoretical training will be strengthened and that the mathematical departments at the universities will be responsible thereof.

Also in Hungary, with its very proud tradition of mathematical education on the high school level, the teacher education seems to be in danger, due to the recruitment difficulties. These are connected with the conditions (e.g. salaries) for teachers in the country, and it is our hope that essential improvements in this respect will be possible in the future. The decision of the new Hungarian government (June 2002) about the 50% increase of the salary of teachers can be considered as a step in this direction.

The problems concerning the students' prerequisites, commented on above, have changed the working conditions for academic teachers, especially on the intermediate level. It is now a much more cumbersome and demanding task to organize the teaching of a course and go through with the examination procedures than it was a couple of decades ago, and much more time and attention has to be spent. This has lead to an increase in the teacher's working load, leaving little or no time for own research or development. It is of vital importance that all academic teachers are granted reasonable conditions, with time to reflect over the subject and the teaching and to remain updated with the development in the field.

Three countries – three systems

The evaluation comprises seven institutions for higher mathematical education in three different countries. One has of course to be aware of the different historical and cultural conditions and the different traditions in different countries when making comparisons of the outcome. We here give a brief description of the educational systems in the three countries with an emphasis on the upper secondary school level and the eligibility criteria for entering university.

Finland

The Finnish educational system consists of comprehensive school, post-compulsory general and vocational education, and higher education and adult education. Comprehensive school provides a nine-year general education for all children in ages between seven and sixteen. Post-compulsory education is given by upper secondary schools and by vocational institutions. Higher education is given by 20 universities and by 30 polytechnics (vocational university colleges).

Comprehensive school is free of charge. Its curriculum is common for all children. It has no final examination, but it gives eligibility for all education on the second level.

The second level consists of general upper secondary school and vocational education. Its tenure is three (for some vocational education two) years, which means that its pupils are normally of age between sixteen and nineteen. The vocational education is provided by vocational institutions and leads to basic vocational qualifications. The upper secondary school, attended by more than half of the age group, gives a general education and leads to a matriculation examination, giving eligibility for all education at the university level. To enter the studies in mathematics at a university level, the most important part of the matriculation examination is mathematics. The examination has two levels,

advanced and basic; neither one is compulsory for passing the matriculation examination.

Higher vocational education is given at the polytechnics and leads to post-secondary and higher vocational qualifications, which take from 3.5 to 4 years to attain. Students who have passed the matriculation examination or have a basic vocational qualification are eligible for admission.

All universities engage in both education and research and have the right to award doctorates. The first university degree, which roughly corresponds to a Bachelor's degree, can generally be attained in three years of full-time study and the higher, Master's degree in five years, i.e. two additional years after the Bachelor's degree. These degrees correspond to 180 and 240 ECTS, respectively. There is also an optional pre-doctoral postgraduate degree of licentiate, which can be completed in two years of full-time study after the Master's degree. Full-time studies for a doctorate take approximately four years following the Master's degree.

Adult education, which is designed for the entire working-age population, has expanded rapidly in the past few years. General adult education is given by independent sponsoring organisations and by evening schools. Vocational adult education is given by all vocational institutions and in particular by vocational adult education centres. Adult education at universities comprises further education and Open University courses. Each university has a centre for continuing education.

Hungary

The basic level of the Hungarian educational system is the comprehensive eight-year general school, divided into two four-year stages. In 2001/2002 it had 943 thousand pupils, of which almost 3000 were adults.

The second level has three four-year branches: the upper secondary school (gimnázium, 33% of the pupils in 2001/02)), the intermediate vocational school (szakközépiskola, 43%) and vocational school (szakiskola, 24%). The upper secondary school gives a general education and leads to a maturity examination, giving eligibility to university education. This examination, and thus also entrance to universities, is reachable also from the intermediate vocational school. From the second year of vocational school it is possible to get transferred to upper secondary school or intermediate vocational school.

The Hungarian higher education has a dual system, there are colleges and universities. Some colleges are associated with universities as college faculties of the universities. A university can offer college level courses, too. The tenure of the college level training (corresponding to B.Sc. level) is 3 - 4 years; the tenure of education at university level (corresponding to M. Sc. level) is minimum 4 years, maximum 5 years (with the exception of medical universities where the tenure of education is 6 years).

The Law on Higher Education from 1993 regulates the admission to higher education institutions. Applications for admission can be submitted by anyone meeting the eligibility requirements. The admission procedures and requirements are strongly influenced by individual requirements of the higher education institutions themselves. There are multiple methods for ranking the applicants, and the rather complex admission system is (or can be) based both on high school achievements and the result of an entrance examinations. In addition, higher education institutions can award partial or full exemption from these. The Ministry of Education is currently developing a long-term plan for the reform of the admission process in order to obtain a more standardised system, to be introduced this year.

The 1996 Amendment of the Law on Higher Education initiated an integration of the universities of the country. It allowed the formation of higher education federations to become fully merged within two years. Until recently the number of higher education institutions was 89 (55 state, 28 church and 6 foundation institutions). The government taking office in summer 1998 decided to establish a new network of integrated higher education institutions from 1 January 2000. The target institutions of the integration process were the state universities and colleges. Now there are 17 state universities, 13 state colleges (the number of state institutions was reduced from 55 to 30), 26 church-owned institutions and 6 foundation colleges.

The academic year consists of two semesters. The fall semester starts at the beginning of September and consists of 14-15 weeks for lectures, seminars, practical work and 6 weeks for exams. The spring semester lasts from the beginning of February until the end of May (14-15 weeks) and ends with a period for examinations (generally 6 weeks).

There is also an extensive system for adult education, consisting of three stages of four years each.

Sweden

In Sweden, the compulsory primary and lower secondary school consists of totally nine years of education for children between seven and sixteen years old. It provides tuition in mathematics in all years. Almost all pupils (98% in 1999) attending compulsory school continue directly to the upper secondary school (gymnasieskolan). Unlike in Finland or in Hungary, there is thus only one school form at the upper-secondary level. Gymnasieskolan contains 17 different three-year programmes. Fourteen programmes include vocational subjects, whereas the Natural Science programme and the Social Science programme focus more on university entrance. In 1999/2000 these two programmes were attended by 45% of the pupils (Natural science 20%). There is no maturity examination.

Subjects in upper secondary school are divided into courses. Grades are awarded at the end of each course. There are four grade levels: Fail, Pass, Pass with Distinction and Distinction.

The mathematics curriculum in upper-secondary school consists of different courses. There are five "standard" courses: Ma A – Ma E, (where Ma B is based on the contents of Ma A etc). The first course, Ma A, is compulsory in all Upper Secondary School national programmes. The course Ma B is compulsory in the Social Science programme and in the Natural Science programme. The courses Ma C and Ma D are compulsory in the Natural Science Programme, whereas Ma E is optional. There is also a new course in discrete mathematics that is optional for most students. In some upper secondary schools there are also more advanced optional courses called Ma F, Ma G etc.

There are at present 15 universities and 26 university colleges in Sweden. Studies are organized either in the form of study programmes or single-subject courses, in both cases leading to a degree. There is a system of credit points, where roughly one week of successful full-time studies is equivalent to one credit point. One year of studies yields 40 points. (One Swedish credit point corresponds roughly to 1,5 ECTS-points.)

There are two general degrees at basic education level, which could be translated to B.Sc. (fil. kand.) and M.Sc. (fil. mag.). The B.Sc.-degree requires a minimum of 120 credit points with courses of at least 60 points in a major subject (including a thesis of 10 points). The M.Sc.-degree requires 160 points with courses of at least 80 points in a major subject (including one thesis of 20 points or two theses of 10 points).

The degrees of B.Sc and M.Sc with mathematics as the major subject can be taken at approximately 20 universities or university colleges in Sweden.

In addition to the two general degrees there are also a number of professional degrees, e.g. different teacher's degrees and the degree of civilingingenjör (Master of Engineering).

Like in Finland, there are two levels of graduate degrees: licentiate and doctor. The tenure of the doctoral education is normally four years of full time studies. The licentiate degree, which can be part of the examination for the doctor's degree requires two years of full time study.

The education for Upper Secondary School teachers contains courses in two or three school subjects with at least 60 credit points (= 90 ECTS) in each subject, combined with courses of a total of 60 credit points (=90 ECTS) in *theory and practice of teaching.*

The education for primary and lower secondary school teachers is oriented either for work in school years 1-7 (with specialization either in *Swedish and social sciences* or in *mathematics and natural sciences*) or for work in school years 4-9 with specialization in for example mathematics and natural sciences.

In the current teacher education, some parts, 60 Swedish credit points (=90 ECTS), are common for all future teachers.

Tables

The following table gives the approximate number of regular staff members at the participating institutions. This includes professors, associate professors, lecturers and other permanently employed teachers. Not counted are graduate students and other non-permanent teachers, paid on an hourly basis.

In some cases it also indicates the allocation of financial means related to the number of full time students per year (full-time equivalents, FTE). The abbreviations used are:

Helsinki - Department of Mathematics, University of Helsinki

Oulu - Department of Mathematical Sciences, University of Oulu

BUTE - Institute of Mathematics, Budapest University of Technology and Economics

ELTE - Institute of Mathematics (I & II), Eötvös Loránd University of Budapest

Szeged - Bolyai Institute, University of Szeged

CTH/GU - Divisions of Mathematics and Mathematical statistics, Department of Mathematics and Computer Sciences, Göteborg University/Chalmers University of Technology

Lund - Centre for Mathematical Sciences, Lund University

Institution	Permanent teaching staff	Allocation for each FTE	Total budget
Helsinki	34		€ 1 950 000
Oulu	31		€2 200 000
BUTE	57	HUF 600 000 (€ 2450)	HUF 171 500 000 (€ 700 000)
ELTE	81		
Szeged	50	HUF 489000 (€ 1996)	HUF 157 113 000 (€ 641 278)
CTH/GU	93	SEK 26000 (€ 2808)	
Lund	62	SEK 30000 (€ 3240)	SEK 88 818 000 (€ 9 592 344)

One has to be very careful when comparing the data in the table above. The conditions are very different in different countries. In Sweden, for example, the rental costs for the localities are included. In the Finnish data, taxes amounting to 35% are included.

The table on the following page contains some statistical data for the most important study programmes considered. When comparing data from different institutions, one should bear in mind that the programmes do not have the same relevance at all sites. In Sweden for example a large part of the students of mathematics are not enrolled in a programme, but are taking single courses, thus composing a programme of themselves. This makes it difficult to analyse the admission statistics and compare it with the examination statistics. Finland and Sweden have their own credit systems. The number of credits is here transformed to the ECTS system. This system is not fully implemented in Hungary, and this fact presents another difficulty when comparing data.

Overview over the education of mathematics majors and upper secondary school teachers

Programme	Site	Number of students enrolled each year	Extension of the programme (ECTS)	Minimum number of credits in mathematics (ECTS)	Yearly number of Masters' theses	Relative frequency of interrrup-tion
Mathematics	Helsinki	180	240	135	24	20-30%
Teachers' education	Helsinki			115	23	20-30%
Mathematics	Oulu	100	240	120	18	30-40%
Teachers' education	Oulu			95	31	
Mathematics	BUTE, Budapest	35	300	265		30%
Mathematics	ELTE, Budapest	50	300	300	31	15-20%
Teachers' education	ELTE, Budapest	135	300	160	74	
Mathematics	Szeged	48	300	205	6	57%
Teachers' education	Szeged	77	300	170	81	44%
Mathematics	Göteborg	50	240	120	27	60%
Teachers' education	Göteborg	35	270	90	0-1	30%
Mathematics and Math.stat.	Lund	54	240	120	26	
Teachers' education	Lund	30	270	90	0-1	
Engineering physics	BUTE, Budapest	55	300	51		10-20%
Engineering physics	Göteborg	130	270	45	10	30%
Engineering physics	Lund	130	270	45	15	

Education of Mathematics majors

The nominal study time for the main programme for mathematicians is 5 years in Hungary and Finland and 4 years in Sweden. The most striking differences between the education in Hungary on one hand and in Finland and Sweden on the other, is that the education of mathematicians in Hungary requires much more mathematics and less of secondary subjects. Also more scheduled teaching (about 20 hours weekly or more) is given to the Hungarian students. It is clear that a Swedish student majoring in mathematics, but taking the minimum necessary amount of mathematical courses, can get his/her diploma with a relatively weak knowledge of mathematics.

The throughput (relative examination frequency) is very good at the universities in Budapest, 80 – 85%. In Szeged it is about 60%, and at the Finnish and Swedish universities it is in general 40 - 60%. It is difficult to compare the data because of the different systems and due to the fact that the programmes are of different relevance at different sites. For example, at the Swedish universities the throughput at single courses amounts to almost 80%. In Finland it varies from 60% to 90%. There most of the first and second year courses do not include a final examination, and a course can be passed by obtaining a sufficient number of credit points in 2-3 examinations during the course. However, there is a possibility to take the final examination only and the aforementioned figures do not contain those who have chosen this option.

The basic principles governing the education of mathematicians are essentially the same at all sites. The predominant methods of teaching are lectures and exercises in problem solving in smaller groups. The most far-reaching experiments with complementary forms of teaching seem to have been made at the Finnish universities, with tutoring and instruction groups. In Göteborg and in Lund special efforts are taken to train the oral communication skills of the students. Also in the teacher education at the University of Helsinki such efforts have been undertaken.

The prerequisites, i.e. the expected (wished for) level of beginning students' knowledge and mathematical skills are very similar at all sites, as are the level of introductory courses. A major problem in all three countries is the deteriorating conditions for the education, namely the decrease in the real level of the beginners' knowledge and skills. An exception is BUTE, an institution that is lately relatively competitive in the recruitment of talented students. In Szeged and at the Swedish institutions this problem, together with the problem of decreasing student influx, is considered to be very serious. Also at ELTE the problem of recruiting gifted and interested students has been noticed. The problem with the deteriorating qualifications of beginning students is of course connected to the recruitment problem.

In the University of Helsinki the admission system in mathematics has been changed rather lately and now almost all the Finnish universities (except technical universities) follow the same system for students of mathematics. The system is based on the results of the matriculation examination. In general, the students having obtained one of the three highest grades in the advanced level matriculation

examination in mathematics can enter mathematics studies without any other entrance examination. About 25-30% of the students taking part in the aforementioned examiation reach this level. The universities still organize entrance examinations but these have little effect; they are used for exceptional cases only.

Education of engineers

Three of the participating institutes provide education of engineers, Chalmers Institute of Technology in Gothenburg (CTH), Lund Institute of Technology (LTH) and Budapest University of Technology and Economics (BUTE). In Oulu this activity is limited to service teaching for some students from the Faculty of Technology. The technical education is quite similar in the mentioned institutes, and the level of mathematical training is comparable. The mathematical training of engineers and the service teaching involve several thousands of students.

The yearly intake of students is equally large at CTH and LTH, and roughly twice as large at BUTE. The methods of teaching are the same at all the three institutions, dominated by lectures and lessons in smaller groups. Unlike CTH and LTH, BUTE is dominating in the technical education in the country, and thus it has a more favourable situation when it comes to recruiting students. The problem with the level of knowledge is consequently less noticeable at BUTE, and it also shows somewhat better performance in producing graduate engineers.

Teacher training

In the education of upper secondary school teachers there are differences between the sites considered in this evaluation. At the Hungarian institutions (Szeged and ELTE), the education of teachers in mathematics is the responsibility of the department of mathematics. In Göteborg, Oulu and Helsinki it is a joint venture of the departments of Mathematics and the departments of Pedagogy. The Finnish system educates subject teachers in two subjects. The main subject, in this case, is mathematics (approx. 95-115 ECTS) and the secondary subject (52 ECTS) can be physics, computer science, chemistry etc. Pedagogical and didactic studies and practice at school are organized by the Faculty of Pedagogy and are composed of 52 ECTS altogether.

In Lund this responsibility belongs to the Teachers Education College in Malmö, which acquires some mathematical education from Lund University. According to their new curriculum, the required amount of mathematics for being an upper

secondary school teacher amounts to 90 ECTS, didactical training included. This minimum amount is 90 in Göteborg, 95 in Oulu, 115 in Helsinki, 160 at ELTE and 170 in Szeged. There seem to be no remarkable differences in the examination frequency (throughput) at different sites.

There is no teacher training at BUTE, but there are Ph.D.-students and a doctoral programme in the methodology of vocational education. The Faculty of Natural Sciences has been running a PhD programme in Mathematics since 1998. There are over 20 graduate students involved in this program.

Another difference is that in Sweden and in Hungary, students majoring in mathematics and teacher students normally are admitted into two separate programmes from the beginning, whereas in Finland the students all start in the same programmes and can postpone their decision about what career to follow. Also it is easy to change from other mathematics programmes to the teacher education. During the last four – five years the University of Helsinki has admitted students also directly to the mathematics teacher training programme.

The prerequisites are the same as those for mathematics majors, but the difficulties in recruiting students meeting these requirements sufficiently well is even larger than in the case of mathematics majors. In Helsinki for example, there is a numerus clausus of 35 students yearly that can be admitted to the teacher training programme from the students of mathematics. In the years 1999-2001 there were in the average only 11 students yearly taking part in the corresponding entrance examination and all of them were admitted. However, this figure does not include all the students who complete the teachers' training programme. In Szeged there are yearly vacancies of 20-25% in the Mathematics teachers' programme.

Service teaching

For many mathematical departments a large part of the working load is connected with service teaching, i.e. teaching of mathematics to students majoring in other subjects, like physics, chemistry, computer science, biology or economy. At BUTE, which is a technical university, this type of teaching is of course dominant (90% of the teaching), and it is directed to engineering students of the various programmes. Also at the departments of the universities of traditional type, the servicing teaching is a large part of the teaching activity, and in Helsinki, for example, 50-55% or slightly more of the credit points are attributed to students minoring in mathematics.

There are no reports on particular problems with service teaching, apart from the general observations already mentioned, or on special methods in this teaching.

The service teaching can be organised in various ways, and which one to choose depends for example on the resources available. At the Finnish institutions, there

are a couple of courses intended for students of physics, but otherwise the mathematics minors choose courses from the regular supply, common with the mathematics majors. In Budapest and in Szeged, special courses for mathematics minors are designed for the various programmes. This is the case also in Göteborg. In Lund, a course “Mathematics for Scientists”, (2x15 pts ECTS) which was abolished a few years ago, will be reintroduced this year.

In Sweden the finances of the departments of mathematics very much depend on the amount of teaching. In Finland, the annual number of M.Sc:s is the most decisive factor and the Finnish departments of mathematics receive a negligible amount of financial support for service teaching. The Swedish system offers better possibilities to develop the mathematics curriculum to the changing needs of other subjects.

Conclusions

The theoretical level of the mathematical education is high in all the three countries considered, and all the participating institutions are equipped with highly qualified staff, scientifically and didactically. Departmental infrastructure, recruitment and level of students’ pre-university knowledge are quite similar in almost all institutions. Financing of the departments is based on different principles in different countries. These principles very much influence the teaching of mathematics as well as the mathematical curriculum and the staff structure.

The decreasing level of students’ pre-university knowledge is a problem in all countries. The problem seems to be particularly large at the Swedish institutions and in Szeged.

The financing is in general insufficient for actions to meet these more difficult preconditions. This goes particularly for the Hungarian institutions. Oulu sets a good example in the way of receiving newcomers.

The recruitment of students to the mathematics teacher programmes is a serious problem in all countries. In the long run, this will have a negative effect on science education at all levels.

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A self-evaluation of the Mathematical Sciences at Budapest University of Technology and Economics.

(1st variant. January 31, 2002)

Part A: Undergraduate studies

A1. Structure and Resources

(Structure is about " what you have ", in form of economy, regulations and syllabi, employees, infrastructure etc.)

Contents

1. *Give a short description of the department and the study programs offered or in which you participate.*

Hungary. The Hungarian higher education after the democratic changes of 1990 can be characterized by the following main elements:

- Autonomy of higher educational institutions (guaranteed by the law). Coordination of activities by "Hungarian Rector's Conference". Practically all institutions are under the supervision of the Ministry of Education. Existence of intermediary institutions ("Hungarian Accreditation Committee" and "Higher Education and Scientific Council") for development, control.
- Norm based budgeting (4 headings: student support, training and maintenance, development, research).
- Diversification of training (4 levels: bac+2 /AHVT- accredited higher level vocational training/; bac+3 /college/; bac+5 /university/; bac+8 /Ph.D./).
- Increase of the number of students (it was doubled in the past decade, the higher education population exceeds 30% of the corresponding generation).
- Following of the international development (introduction of the ECTS system, signature by the Hungarian Ministry of Education of the "Bologna declaration" etc.).
- Joining European programs (e.g. Hungary is an eligible participant of Socrates, Leonardo programs).
- Integration of the higher education (On January 1, 2000 the earlier about 100 higher educational institutions entered into new integrated units. At this moment there is 17 state universities, 13 state colleges, 32 church, foundation owned institutions).
- There is a political wish to increase the financial support provided to the higher education, but in reality it is permanently underfinanced.

(A more detailed description of Hungarian higher education and the recent statistics can be found on the home page of the Ministry of Education: www.om.hu.)

BUTE (Budapest University of Technology and Economics - BME, Budapesti Műszaki és Gazdaságtudományi Egyetem, founded in 1782) is the largest and most reputed technical higher educational and research institution in Hungary. BUTE provides different educational forms (from 2 years short cycle engineer-assistant training to 8 years doctoral programs) for a total number of about 15.000 students. The academic staff is approx. 1000.
BUTE has 6 engineering type faculties (architecture, chemical, civil, electrical & informatics, mechanical, transport), so it covers all main fields of engineering science.

10-15 years ago related to the general worldwide globalization procedure, and especially to the political and economic changes in Central-Eastern Europe BUTE created education in 4 foreign languages (English, French, German, Russian). At this moment about 1.000 students are involved into the foreign language training forms from all over the world.
More information about the university: www.bme.hu .

Faculty of Natural Sciences. In the last decade BUTE widened its activity, new training forms (mathematician, physicist, manager, economist etc.) were introduced. 2 "general" faculties (natural sciences, social and economic sciences) have been created. The Faculty of Natural Sciences contains 3 units: institutes of mathematics and physics, an educational nuclear reactor.

Institute of Mathematics. However education and research in mathematics has a long tradition (with some worldwide famous scientists) at BUTE, the Institute of Mathematics was created only 6 years ago from 7 departments belonging to different engineering faculties. The head of the institute is the director (academician Domokos SZÁSZ). The institute contains 5 chairs (departments): Algebra, Analysis, Differential Equations, Geometry, Stochastics. The total staff (from academicians to graduate students) involved in the education and research is about 100. See as well www.math.bme.hu .

Study programs. The main task of the Institute of Mathematics is research and education (on all levels) in mathematics. Here a short summary is given only, for more precise information see further.)
Most of the teaching activities is service type for the other 7 faculties of BUTE. In average the total number of credits / student is 20. There is a 3 level (A - college, B - university, C - advanced) more or less common program delivered in the first 2 (A), 4 (B,C) semesters. The number of students involved is 3000-5000 (depending on semesters, years). The institute offers special training requested by the faculties (for 1000-2000 students) as well.
The Faculty of Natural Sciences has 2 own training forms: mathematician, engineer- physicist with contain much more training in mathematics.

2. *How much time, measured e.g. in credit units like ECTS, is spent on studying mathematics within the different programs, in particular within programs for future teachers?*

The following table summarizes the compulsory subjects in mathematics for the different training forms of BUTE. The 1st column is the name of the training, the 2nd contains the number of students entering per year (x+y, x = state financed, y - tuition fee), the 3rd the total number of credits in mathematics (compulsory) during the full program. There is no precise data about the optional subjects, but it can be estimated approx. 10 credits / training form, except mathematician, where it is about 100-150.

FACULTY / SPECIALITY	*Student / year*	*Credits*
Architecture		
Architect	243+30	8
Civil Engineering		
Civil engineer	269+40	29
Surveying and space informatics	50+10	29
Economic and Social Sciences		
economist	100+60	18
engineer - manager	130+30	22
Mechanical		
mechanical engineer	305+80	29
design	60+30	17
energetics (college)	40+30	14
mechanical (college)	160+60	14
Transportation engineering		
Transportation engineer	285+60	24
Natural Sciences		
mathematician	25+10	140
engineer-physicist	45+10	51
Chemical Engineering		
biological engineer	98+20	17
chemical engineer	100+20	20
environmental engineer	50+40	24
Electrical Engineering and Informatics		
technical informatician	460+50	19
electrical engineer	413+50	23

Table 1.

3. *Give an account for the teacher training with special emphasis on upper secondary school, but also basic facts (statistics) about the primary school teacher training*

BUTE has no teacher training in mathematics at the moment.

REMARKS:

1. BUTE has pedagogical departments. Teachers are trained (mainly for vocational education by postgraduate (and parallel) training forms.
2. BUTE has a doctoral program in the methodology of vocational education. An important number of teachers (in mathematics as well) participates in this program. They prepare their Ph.D. in subjects related to distance education, evaluation of computer aided learning of mathematics, computer aided assessment etc.
3. BUTE has an International Secondary Grammar School (the language of instruction is English).

Service teaching in mathematics and mathematics as a minor subject

1. *Describe the scope of service teaching, e.g. for students in other programs such as physicists, chemists, biologists, economists, etc.*

As it was mentioned before most (approx. 90%) of the educational activities is service teaching. Please see Contents 1. Study programs, 2. Table.

2. *Are physicists, chemists, biologists, computer scientists, and economists taught differently from mathematics majors?*

There are only a few courses in common (e.g. with physicists).

Teacher education

1. *Describe the syllabus for teacher education in mathematics, taking into consideration also teachers who have mathematics as a second or third subject.*
2. *How much mathematics is required to qualify as a teacher for respectively primary, secondary and upper secondary school?*

These questions are not relevant to BUTE.

Diploma in mathematics

1. *Describe the contents and the general level of the master's degree.* The mathematical program at BUTE leads to a university diploma (considered equivalent to a Master's degree) and requires at least five years (ten semesters) of full studies (at least 300 credit points) and contains a thesis worth 30 credit points.
2. *To what extent does the basic education consist of compulsory and optional courses, respectively?* The first five semesters of studies consist of compulsory courses in different fields of mathematics, such as calculus in one and several variables, differential equations, elementary algebra, linear algebra, scientific programming, numerical analysis, probability and statistics, algebraic structures and advanced calculus.
3. *What possibilities do the students have to specialize in different areas?* After the fifth semester one can specialize choosing one or two of four major directions: Algebra and its applications, Mathematical analysis and its applications, Operations research, Stochastics. We also offer Geometry as a minor. After this fifth semester one can specialize choosing one or two of four major directions: Algebra and its applications, Mathematical analysis and its applications, Operations research, Stochastics. We also offer Geometry as a minor.
4. *What are the syllabi (what fields are covered in pure and applied mathematics)?* The mathematical program at BUTE is given in Appendix 1.

Economy

1. *What financial means do you have at your disposal (for example in man-years)? How are the disposable assets distributed and used?*

The university is financed by a normative base (depending on the number of students and their training form). Part of the resources is transferred to the Faculty of Natural Sciences, and part of it afterwards to the Institute of Mathematics. The number of staff is determined (the salary is fixed by the state). This system covers the salary of teachers. There is only a limited sum for other costs. Research, exchange of professors and students, equipment etc. are financed typically by other sources (national, international projects, grants). The own income of the institute is not important. The national situation (shortage of financial resources) is valid in our case as well.

Admission and recruitment of students

1. *How are students admitted to mathematical studies? Is there a numerus clausus? Give an account for the student selection system and criteria.*

There is a common entrance exam system in Hungary for all higher educational institutions. The students can candidate for an arbitrary number of studies, but they must indicate their priority. Based on secondary school and/or entrance exam results each student obtains some points (in most of training forms on a 120 point scale). The maximal possible recruitment for each training is determined by the ministry. The minimal number of points for admittance of a training is determined at the ministry (by an iterative way) with the participation of the representatives of higher educational institutions.

2. *What means of recruiting new students are at your disposal?*

The students are informed (mainly by a book) about all possible higher educational studies. They determine their priority based on different factors. That is why BUTE Institute of Mathematics carries out publicity in general for the profession of mathematician, and especially underlines the advantages of its own training. Nowadays mathematics (either research and teaching) is not very popular for the young generation. The methods of motivation used by us are: special courses offered (free) for the secondary school students during the academic period, summer camp with motivating mathematical exercises, publicity in the journal KÖMAL (This journal organizes yearly a competition in mathematics, physics. Students send monthly the solutions of problems published in it.) etc. Last year the BUTE training was the "most popular" in mathematics in Hungary (in that sense, that the minimal number of points necessary for the admission here was the highest).

The students

1. *How many students have been accepted each semester/academic year in the last 3 years? How many did really enroll/start their studies? What are the gender distributions?*

The number of students that have been admitted each academic year is as follows:
1st year: 28
2nd year: 21
3rd year: 12
4th year: 12
5th year: 23.
There are 61 male and 35 female students.

2. *What qualifications do the students have? How is their previous knowledge in general, in relation to what is demanded or desirable? How do these prerequisites influence the putting up of the studies and the teaching?*
2. *Has the level of the students' previous knowledge changed in the last years? Are there time series information from diagnostic tests, done by the beginning students?*

Recently we do not have information about any changes in the level of student's knowledge, because this is a new module in our University. We started the mathematical program only 5 years ago.

REMARK. Related to the service teaching (non mathematicians) there is a slow but continuous decrease in both of students knowledge and hours (credits) devoted to mathematical education.

Academic teachers

1. What categories (professors, lecturers etc.) of teachers are there? Are their responsibilities well-defined?

Categories of teachers:

1) Full professor
2) Associate professor
3) Assistant professor
4) Junior lecturer.

The number of current positions at the different departments is given in the table below.

Department	Professors		Associate Professors		Assistant Professors		Junior Lecturers	
	Full time	Part time	Full time	Part time	Full time	Part time	Full time	Part time
Algebra	1	1	8	0	3	0	0	0
Analysis	2	1	5	0	4	0	1	0
Differential Equations	3	1	5	0	4	0	2	0
Geometry	1	0	2	0	3	0	1	0
Stochastics	1	1	5	0	3	0	1	0
Total	**8**	**4**	**25**	**0**	**17**	**0**	**5**	**0**

Table 2.

The recruitment procedure, the salary of teachers is regulated in detail by different (national, university level) rules. The responsibilities of teachers are less defined, they are based mainly on local traditions.

In addition to courses offered for the students majoring in mathematics the Institute of Mathematics is responsible for the mathematics courses of many engineering students of the university. Most faculty members have both kinds of courses. According to an estimation the undergraduate and graduate teaching of mathematics students is carried out by one third (about 16) of the full time teachers (estimation in man-years). The relatively small mathematics student to professor ratio ensures that students will have adequate opportunity to interact with faculty.

2. Give an account of the supply of teachers and other staff. Is the constitution optimal in the current semester?

The average age of our professors is much over 40. We do need some new supply. Being a junior lecturer or an assistant professor is not very popular among talented young mathematicians and researchers. It is not easy to find proper persons for these positions. Luckily the ones we have are excellent teachers.

The Faculty of Natural Sciences has been running a PhD program in Mathematics since 1998. In this program we have over 20 graduate students. Some of the students participating our doctoral program are supposed to become lecturers and later professors at one of our departments. Hopefully, this way we can educate our teacher supply.

3. How large a part of undergraduate teaching is carried out by permanent teachers and how large a part by non-permanent teachers, paid on an hourly basis? (Current semester.)

Undergraduate teaching is carried out by permanent teachers, non-permanent teachers paid on hourly basis, and PhD students. Table 3. below gives some details of teaching.

	Rate of classes (average rate, changes with semesters) (%)
Permanent teachers	80 – 90
Non-permanent teachers	5 – 10
PhD students	5 – 10

Table 3.

4. What possibilities do teachers, other than professors, have for their own research?

Faculty members have research specialties spanning most areas of mathematics, applied mathematics and statistics. They regularly participate in annual and other conferences of these fields. The BUTE provides an excellent environment for researchers in applied mathematics. For a mathematician it is very easy here to meet representatives of different technical fields such as electrical engineering, mechanical engineering, civil engineering, economic fields, etc. Being inspired by the highly qualified researchers of engineering and economics our professors develop the atmosphere which helps our students to incorporate new methods and technologies.

The Institute hosts four types of regularly scheduled seminars: seminar on mathematical analysis, seminar on stochastics, seminar on stability (differential equations) and a seminar of the Institute on different topics of general interest. Distinguished mathematical scientists are invited to deliver lectures. Students are strongly encouraged to participate in these activities.

5. How large a portion of the professors' duties consists of undergraduate teaching?

Undergraduate teaching is one of the duties of professors. Its rate among their other duties varies with many factors like the number of their PhD students, etc. Its average rate is between 40-60%.

6. Possibilities for the teachers to develop their teaching skills

The youngest, our teaching assistants and PhD students get help in their teaching from the professor who is in charge of the particular course. Becoming more and more experienced they get more and more responsibility.

Our faculty members teach courses in different languages. The TUB maintains programs for international students coming from abroad. The courses are in English. The mathematical courses of different levels of these programs (B.Sc., M. Sc., and PhD) are carried out by the faculty members of the our Institute. The university also provides French and German version of the undergraduate engineering programs. Teaching in these programs is an exceptional

opportunity and also a challenge for our teachers to develop their teaching skills in languages other than Hungarian.
A great number of our professors spent semesters at different European, American or Japanese universities as invited lecturers or visiting professors.
The staff is active participant of seminars, conferences on education (organized by SEFI, ICEE etc.). It should be mentioned here that the 6th International Congress on Mathematical Education (an event held in each 4th year) was at the buildings of BUTE with important contribution of our mathematicians in the organization.

Infrastructure

1. *What equipment and what premises are available for the education? Are the premises well adapted to their purpose?*
2. *Give an account of the supply of computers, space for studying and library resources.*

The Institute of Mathematics of BUTE occupies 4 levels of the same building. Apart from the rooms belonging to the departments, there are two small class rooms, two computer laboratories, and a library. There is at least one PC or workstation in each office room, there are 25 LINUX PCs in the labs, all machines are connected by a high speed network system, and all these machines are supervised by our own servers. The system is managed mainly by students.
Above all the software packages Maple and Mathematica are used in education and research. There is a university license for the first for 16 persons, for the second 16network and 16 teachers' license.
The University offers 20 more labs and free access to 100 more PCs, which are also used extensively since most of the administrative, financial work related to the educational process are managed by a computer system.

The area of the library of the institute is approximately $100m^2$, there are 26300 books and 3570 copies of periodicals in it. The staff has access to the University's big, central library, which plays an important role among the Hungarian main libraries, and it maintains an extensive collection of books and journals to the mathematicians, statistician scientists as well and participates in the inter-library loan system.

Summary

Summarize the structure and the prerequisites for the education and indicate strengths and weaknesses.
In general: There are important changes in the conditions of education (nationwide and worldwide). The Institute of Mathematics at BUTE is a relatively new unit, so we have to stabilize and develop at the same time our structure, education etc. under not really favorable (mainly from a financial viewpoint) conditions.
Related to the education of mathematicians:
The most essential strengths of our education are the well-qualified teachers.
The weaknesses: a certain lack of rooms suitable for self-activities and the small number of students in the mathematical programs to offer more variety of courses to choose.

A2. Educational process

(The process is about "what you do", that is how the work and the education is organized within the given structure)

Didactics, types of teaching, examination forms.

1. *What types of teaching and learning are there? How much, in hours per week, teacher-led instruction is given, and in what forms? Lectures? Exercises? Tutorials? Which is the predominant form of teaching? Is there a change of predominant form of instruction during the time of study? What is the role of computers in learning?*

As it was mentioned before the Institute of Mathematics was formed from 7 different departments only a few years ago. This fact and the autonomy of teachers explains the large diversity of educational methods applied. In general the typical educational form is face to face by use of blackboard, it contains lectures and seminars. However there are many educational experiments (based on the use of ICT) mainly initiated by the professors and encouraged by the direction of the institute. Some of these are introduced into the regular work (e.g. Computer implementations for mathematicians giving an introduction into the application of software packages). In case of interest a more detailed description of these activities can be given.

2. *How is student activity encouraged in the teaching?*

The main methods are: a system of homework, regular checking of knowledge (tests), motivation by grading system etc.

3. *To what extent are oral and writing skills trained in the education?*

There is a difference between the service training (mainly of engineers) and the education of mathematicians.

Service training. As the number of students is large (100-400/lecture), (20-150/seminars) the written form is predominant.

Mathematician training. The mission statement is the following:

The professors of the Institute of Mathematics strives to prepare students with the knowledge and critical skills they need to adapt challenge in life, employment and scientific work. To this end, we help them develop their following abilities: to learn throughout their lives; to change and grow; to develop a depth of knowledge in an area of specialization; to learn the basic techniques of scientific research; to communicate effectively; to collaborate on the job; to adapt to technological change; to be creative in problem-solving, risk-taking. Our mathematics program leads to a broad spectrum of the wide range of careers open to mathematics students: industry, finance, government, education, as well as advanced degrees in mathematical sciences. Our programs are flexible and close professor-student interaction is the norm. This, in turn, helps students truly grasp that mathematics is a human activity and eases their transition to being active participants.

The maintainer of the mathematics programs challenges itself to uphold high standards and improve academic quality.

As the number of students is limited and the professors are devoted the oral form can play an important role in this training.

4. *Describe the guidance system used to help the students.*
5. *Describe the follow up and feed-back systems in teaching at your department.*

The corresponding common systems of university are used for these purposes, i.e. there is an electronic (information, archives etc.) system, called NEPTUN, or at the end of each semester the students fill up a questionnaire evaluating the teaching process.

Summary

Summarize the educational process and indicate strengths and weaknesses. Consider especially teacher education in mathematics.

The educational process at BUTE is based on the tradition combined with the introduction of new methods related mainly to the use of computers, ICT.
The radical increase of students (while the number of teachers does not change practically) requires new methods of education, which have been found only partly.

A3. Outcome

(Outcome is about " what you get " as a consequence of the given structure and process in the form of how many students that pass.)

Through-put

1. *How many students manage to take their master's degree each year? How many get the competence of teacher in mathematics? How large is the proportion that interrupts studies?*
2. *What is the median time of study, related to the expected time of study?*

Follow-up

1. *Where do the students go after graduating? Do they get jobs that correspond to their qualifications?*

Summary

Summarize the outcome in strengths and weaknesses.

The first mathematicians at BUTE will finish their studies this year. So these questions are not relevant.

REMARK. BUTE has a common university level follow up system. Once a year the previous graduates are asked to fill in a questionnaire (approximately 30% is returned), the results are published. The general conclusion is that lately the popularity, the need in specialists in natural and technical sciences increases.

A4. Comprehensive assessment

1. *Describe the strengths and weaknesses identified by the self-assessment. Which ones are the most important?*
2. *What other things do you consider especially worth mentioning?*

We consider that it is better to formulate the assessment after the study and discussion of the evaluation of other institutions, site visits.

Part B: Graduate studies.

B1. Structure

Contents

1. What disciples of mathematics, applied mathematics, numerical analysis or mathematical statistics does the department manage?

The aim of the doctoral program "Mathematics and computer sciences" is to give a general view of the subject and a knowledge of the most important methods used in the various branches of mathematics. Using the speciality of our university, the applications are in the focus.

The doctoral program contains the following six subprograms: Algebra and mathematical logic, Analysis and applications, Differential equations, Geometry, Stochastics, Computer science, combinatorics and optimization.

2. Give a short description of the formalities concerning graduate studies, admission, nominal study time for PhD, requirements on the thesis and so on.

There are 3 ways to prepare a Ph.D.: participation in a 3 year graduate program (financed by the state), correspondence and individual variants. The number of state financed students is limited. There is an entrance exam. The Ph.D students have different duties (participation in special courses, undergraduate education, sitting at exams etc.), they have to satisfy some obligatory conditions (2 language exams, thesis) as well.

Organization

1. Give a short description of how the management of the department is organized.

2. Describe the organization of the supervision of the graduate students.

Our doctoral school is based on six departments in mathematics belonging to two different faculties of the Budapest Univesity of Technology and Economics. Five of them (Department of Algebra, Department of Analysis, Department of Differential equations, Department of Geometry, Department of Stochastics) belong to the Mathematical Institute of the Faculty of Natural Sciences, one of them (Department of Computer Science and Information Theory) belongs to the Faculty of Electrical Engineering and Informatics.

The doctoral school is controled by the Doctoral Committee of the Faculty of Natural Sciences.

The students

1. How many students have been enrolled each year in graduate studies the last years?

During the entrance examination the students can take 100 points. The upper limit is 80 points. The following table shows the number of doctoral students admitted during the last years (only the departments of the Institute of Mathematics are listed).

	2001	2000	1999	1998	1997
Algebra and mathematical logic	1		1	1	1
Analysis	2	1	1	2	2
Differential equations		2	2	1	1
Geometry			1	1	1
Stochastics	1	4	3		
Computer science, combinatorics and optimization	1	1	1	1	1

Table 4.

During these years 30 men and 5 women were admitted in the different subprograms.

The teachers

1. Describe the resources in form of teachers, supervisors and their academic status. Does your department have assistant supervisors?

The school of Mathematics consists of six departments in mathematics belonging to two different faculties of the Budapest University of Technology and Economics. Among the members of these departments there are 3 members of the Hungarian Academy of Sciences, 13 members hold the degree of a doctor of mathematical sciences, 36 of them have the degree of PhD (among them 4 members are habilited).
Among the teachers there are 9 women, all of then associated professors.

The infrastructure

1. *What type of help do you have at your disposal, for example personnel for copy-service and so on?*
2. *Describe the support in form of computer equipment, scientific information and mathematical library.*

The PhD students has a room of their own. They can use all facilities listed in the infrastructure of Part 1. Undergraduate studies.

B2. Process

Courses

1. *What is the relation between the time for courses and the time for working with the thesis within the PhD programs?*
2. *Describe the character of the courses, how much is compulsory, how much is directly connected with the work on the thesis ?*

Our doctoral program takes three years. By the end of the studies the students have to obtain 180 credit points, according to the following distribution: 30-40 points for courses, 105-125 points for research work, 25-35 points for teaching.

The thesis

1. *Does there exist any form of licentiate examination prior to the PhD?*

There is a final examination at the of Ph. D. studies (3 subjects, 2 of them are connected to the topic of the thesis). The licentiate as a legal concept is not used in Hungary in mathematics.

2. *Is it possible to make parts of the thesis in cooperation within a research group?*

The major part of any Ph.D. Thesis in Hungary should be based on the independent and individual work of the student.

3. Can a thesis be in form of different essays with a common summary or must it be in form of a monography?

No, this practice is not applied to mathematical sciences.

Interruption

1. *To what extent do the students leave their doctoral studies without a PhD-degree?*

The Ph.D. scholarships granted by the state for a period of 3 years. Typically the preparation of a Ph.D Thesis in mathematics takes 3 years and is defended in the 4^{th} or 5^{th} year. Promising students usually obtain for the 4^{th} year some kind of extra scholarship.

B3. Outcome

Graduation

1. What are the number of PhD's and licentiates (if appropriate) in each of the last 3 years?

Altogether 7 men and 2 women were awarded a PhD degree in mathematics during these years. The details are presented as follows.

	2001	2000	1999	1998	1997
Algebra and mathematical logic	1	1	1		
Analysis			1		
Differential equations	1				
Geometry	1			1	
Stochastics					
Computer science, combinatorics and optimization	1			1	

Table 5.

2. Describe the median time for doctoral studies and the median age when the students are awarded their Ph.D.

The median time for doctoral studies 3-4 years in mathematics, and the median age when the students are awarded is 28.

3. How many of the students are female?

About 20%.

4. What happens with the PhD's after their graduation? Do they get jobs that correspond to their qualifications?

For the time being, only 9 Ph.D. students have finished their studies. According to our knowledge, all of them are working either at international enterprises, or in academic institutions. The best of them have post-doc positions abroad.

B4. Summary

1. Which are the strong and the weak sides in graduate studies at your department?
3. Are there other things do you consider especially worth mentioning?

Our Ph.D. program is a relatively new one, with the usual enthusiasm and organizational weaknesses.

REMARK.
We repeat our remark from Part 1. that BUTE has a doctoral program in the methodology of vocational education. An important number of teachers (in mathematics as well) participates in this program. They prepare their Ph.D. in subjects related to distance education, evaluation of computer aided learning of mathematics, computer aided assessment etc. In case of interest a similar presentation of this program can be presented.

Appendix 1.

Syllabus for the Mathematical program - BUTE, Budapest												
courses		Semesters										hours/ credits
		1	2	3	4	5	6	7	8	9	10	
Non-natural sciensis												
free to choose				4/0/0/v/4			2/0/0/v/2	2/0/0/v/2	4/0/0/v/4	4/0/0/v/4		**16/16**
Compulsory mathematical subjects												
Calculus lecture 1,2,3		4/0/0/v/5	4/0/0/v/5	4/0/0/v/5								12/15
Calculus seminar 1,2,3		0/4/0/f/4	0/2/0/f/2	0/2/0/f/2								8/8
Complex functions lecture				2/0/0/v/3								2/3
Complex functions seminar				0/2/0/f/2								2/2
Funkcional analysis lecture					4/0/0/v/5							4/5
Funkcional analysis seminar					0/2/0/f/2							2/2
Ordin. differential equations lecture					3/0/0/v/4							3/4
Ordin. differential equations seminar					0/2/0/f/2							2/2
Linear algebra lecture		4/0/0/v/5										4/5
Linear algebra seminar		0/2/0/f/2										2/2
Number theory		2/1/0/v/4										3/4
Algebra lecture 1,2			2/0/0/v/3	2/0/0/v/3								4/6
Algebra seminar 1,2			0/2/0/f/2	0/2/0/f/2								4/4
Total hours/credits		17/20	10/11	14/18	11/11							52/61
Further mathematics and natural sciences												
Problem solving seminar 1,2		0/2/0/f/2	0/2/0/f/2									4/4
Physics 1,2					2/0/0/f3	2/0/0/v/3						4/6
Applied mathematics 1,2,3,4							0/4/0/f/5	0/4/0/f/5	0/4/0/f/5	0/4/0/f/5		16/20
Compulsory by choise (seminar)								0/2/0/f/2	0/2/0/f/2			4/4
Compulsory by choise							2/0/0/v/3	2/0/0/v/3	2/0/0/v/3	2/0/0/v/3		8/12
Compulsory by choise								2/0/0/v/3				2/3
Major subjects							6/0/0/v/9	6/0/0/v/9	6/0/0/v/9	6/0/0/v/9		24/36
Minor subjects							4/0/0/v/6	4/0/0/v/6	4/0/0/v/6	4/0/0/v/6		16/24
Differencial geometry 1. lecture.					2/0/0/v/3							2/3
Differencial geometry 1. seminar					0/2/0/f/2							2/2
Differencial geometry 2.						2/0/0/v/2						2/2
Stochastic processes lecture						2/0/0/v/3						2/3
Stochastic processes seminar						0/2/0/f/2						2/2
Parcial differencial equations lecture							3/0/0/v/4					3/4
Parcial differencial equations seminar							0/2/0/f/2					2/2
Preparatory for thesis										0/2/0/f/2		2/2
Thesis											0/24/0/f/30	24/30
Total credits		2/2	2/2		6/10	8/10	21/29	20/28	18/25	18/25	24/30	119/ 159
Other sciences												
Geometry lecture			4/0/0/v/5									4/5
Geometry seminar			0/2/0/f/2									2/2
Probability theory 1. lecture				2/0/0/v/3								2/3
Probability theory 1. seminar				0/2/0/f/2								2/2
Probability theory 2. lecture					2/0/0/v/3							2/3
Probability theory 2. seminar					0/2/0/f/2							2/2
Mathematical statistics lecture						2/0/0/f3						2/3
Mathematical statistics seminar						0/2/0/f/2						2/2
Numerical methods lecture						4/0/0/v/5						4/5
Numerical methods seminar						0/2/0/f/2						2/2
Intoduction to operation research						0/2/0/f/3						2/3
Set theory and mathematical logic						3/1/0/v/5						4/5
Combinatorics and graph theory 1.		2/1/0/v/4										3/4
Combinatorics and graph theory 2. lec			2/0/0/v/3									2/3
Combinatorics and graph theory 2. se			0/2/0/f/2									2/2
Theory of algorithms					4/0/0/v/5							4/5
Computer implementations 1,2,3		0/0/4/f/4	0/0/4/f/4	0/0/4/f/4								12/12
Total credits		**7/8**	**14/16**	**8/9**	**8/10**	**16/20**						**53/63**
Sum												
Hours/weeks		26	26	26	25	24	23	22	22	22	24	240
total credits		30	30	30	31	30	31	30	29	29	30	300
number of exams		4	4	4/2	5	5	5/1	5/1	4/2	4/2		42/8
Requirements												
Physical education		0/2/0/a/0	0/2/0/a/0	0/2/0/a/0	0/2/0/a/0							8/0
compulsory seminars										2/0/0/a/0		2/0
Foreign language												
Comprehensive exam in algebra and calculus					0/0/0/s/0	0/0/0/s/0						

Self -evaluation within the trilateral LUMA - project
Eötvös Lóránd University of Budapest
Institute of Mathematics

Part A: Undergraduate studies

A1. Structure and Resources

Contents

1. The institute of Mathematics at Eötvös Lóránd University has two groups of mathematical departments. The departments are : Analysis, Applied Analysis, Algebra and Number Theory, Geometry, Probability Theory and Statistics, Computer Science, Group of Didactics of Mathematics, Operational Research

The Institute offers study programmes for mathematics teacher students (secondary school level), mathematician's students, and applied mathematicians students. Each training program 5 years long.

It is possible to study only one teacher subject. There is no difference between the subjects, there are not first, second etc. subjects in the teacher training.

The mathematics teacher training and the mathematician training are quite separated. There is no common lecture!

Time

Mathematics Teacher training

Whole time 164 hours / week / semester (1 hour means through a semester each week one hour)
Compulsory 94 hours (81 mathematics)
Compulsory optional 22 hours (16 math)
Optional 36 hours
Teaching practice 12 hours
Lectures about 61 Exercises - seminars: about 65

Mathematician training

Whole time 254 hours
Compulsory 152 hours
Compulsory optional 50 hours
Optional 52 hours
Lectures 165 Exercises- seminars 89

Applied mathematician training

Whole time 235 hours
Compulsory 160 hours
Compulsory optional 59 hours
Optional 16 hours
Lectures 115 Exercises- seminars 120

Credit system

From September 2001 we use the credit system. Comparing it with old system, we may say there is some hierarchy, a rank order between mathematical subjects. The basic courses must be absolved first.

About the credit points:

2 hours lecture weekly one semester long means 2 credit points (the number of the hours equal to the number of cerdit points)

2 hours exercise weekly one semester long means 3 credit points
The number of necessary credit-points is in all three directions about 300
We have only a half year experience in using of credit-system. Modifications will be made in the future.

Service teaching in mathematics

Mathematics department offers service teaching for physicists, chemists, biologists, geologists, geographer students. Altogether 8 lessons (week, semester) in each subject.
These courses are separated from mathematician, mathematics teacher training.

Teacher education syllabus

Algebra and Number Theory 8 lectures + 7 exercises
Analysis 10 + 10 Geometry 8 + 8 Elementary mathematics 0 + 8
Foundation of mathematics 4 + 0 Didactics of mathematics 0 + 4
Numerical analysis 0 + 4 Informatics 0 + 4 Probability 2 + 2
Finite mathematics 0 + 2 Facultative block 8
Facultative special courses 8 Pedagogical, psychological courses 13

Master's degrees in mathematics

Mathematician syllabus

I. Phase (1 - 6 semesters)
Analysis 16 lectures + 12 exercises Algebra 10 + 9
Number Theory 4 + 1 Geometry 8 + 6 Finite math 4 + 4
Informatics 2 + 5 Numerical analysis 4 + 3 Operational research 2 + 2
Algebraically topology 2 + 2 Introduction into the topology 2 + 0
Probability 5 + 4 Statistics 3 + 2 Set theory 2 + 0
Mathematical logic 2 + 1 Differential equations 3 + 2
Complex function theory 4 + 4 Differential geometry 4 + 2
Functional analysis 3 + 4 Function-series 2 + 0
Partial differential equations 3 + 2 Elementary physics 2 + 0
II. Phase (7 - 10 semesters)
Special directions
Optional courses
The underlined courses are 4 semesters long 4 lessons weekly, the other courses are 4 semesters long 2 lessons weekly. Minimum condition 3 + 1 whole courses.
Algebra, Group theory, Universal algebra, Number theory
Topological analysis, Real function theory, General and set theoretical topology
Complex analysis, Algebraical topology, Topology
Discrete geometry, Differential geometry, Convexity
Physical mathematics /stochastic direction) Mathematical methods in elementary physics
Functional analysis, Differential equations, Mathematical physics, Discrete mathematics, Complexity theory, Set theory and mathematical logic
Operational research, Linear programming, Non-linear programming
Combinatorial optimalization, Discrete programming, Stochastic modelling
Probability theory, Mathematical statistics, Numerical and computer based methods in statistics, Stochastical analysis, Insurance mathematics, Information theory ,
Mathematical system theory
Applied mathematics
1 - 6 semesters
Analysis 16 lectures + 12 exercises Algebra 8 + 6 Number Theory 2 + 0
Geometry 3 + 2 Finite mathematics 4 + 4 Informatics 0 + 4
Algorithm theory 4 + 4 Linear algebra 2 + 2 Numerical analysis 4 + 3

Operational research 2 + 2 Probability 3 + 2 Statistics 3 + 2
Stochastical processes 2 + 2 Mathematical logic 3 + 2
Differential equations 3 + 2 Complex function theory 3 + 2
Differential geometry 2 + 0 Functional analysis 2 + 2
Partial differential equations 3 + 2
7 - 10 semesters
There are 3 main directions typical for Eötvös University
1. Determined mathematical models in techniques and in natural sciences
2. Stochastical mathematical models in technical and naturalscientistical processes.
3. Operational research
There is a seminar Mathematical *modelling of industrial and economical processes* with the supplement of European Consortium in Industry Society.
There is a one year long practice, mostly realised at big Hungarian companies like MOL, TUNGSRAM, CHINOIN etc.

Organisation
Decision making process within the department:
Lowest level: department, (first suggestions)
Middle level: Group of departments
Final decision: Council of Faculty of Natural Sciences

Economy
The Ministry of Education of Hungary finances the studies according to the number of students. The money obtained by the departments is enough only for the most important basic things (mailing costs, phone)

Admission and Recruitment of students
There is a written entrance exam for the university mathematics studies. It is a common maturity and entrance exam from mathematics. The exam problems are centrally chosen, made by an exam committee. Time for the exam: 180 minutes. University teachers evaluate the written works.
Marks from schools are accounted (50 %, mathematics is between 6 subjects if somebody want to study math)
There are two modes of calculation: secondary school points + entrance exam points
Entrance exam points alone (if the candidate took the maturity exam 2 years earlier)
If both calculations are permitted, the more positive result will be accepted.
It is possible to join the mathematics studies in higher years, but there are some preconditions prescribed. (To make an exam from basic subjects)

The students
Number of students (I. year)

	1999		2000		2001	
	Male / female		male/female		male /female	
Mathematics teacher	49	83	45	82	55	83
Mathematician	45	14	32	13	33	15
Applied mathematician	44	28	41	21	24	33

The qualification of students weakened in the last years.
The reasons are:

1. There is a tendency between students to study first of all Economy, Management, Informatics. The teacher job is not popular, the better students do not choose it. Unfortunately there is a similar tendency at mathematician training.
2. The average level of secondary school students is going down.

Diagnosis test was realised in 1999 for the entered students. Especially at the application problems of mathematics showed the students very low achievement.

Academic teachers

Teacher categories: professor
associate professor
lecturer
teacher assistant

The conditions and responsibilities are well defined (scientific degree, teaching time)

Teacher training

Permanent teachers 34
Non permanent teachers 4

Mathematician, Applied mathematician training

Permanent teachers 47
Non permanent teachers 18
Guest teachers (form abroad) 20

Permanent teachers carry out the largest part of undergraduate teaching. (Teacher training 98%, mathematician training about 80 %)

Because of financial difficulties, it is very hard to convince somebody from industry, trade, business, banks to teach at the university some lessons, although it would be very important first of all for the applied mathematicians training.

It is problematic that we have only very few young colleagues. The reason is the same.

Teachers other than professors have possibilities for research, but they must apply for grant at different organisations, foundations, because the university has no money for such aims.

Undergraduate teaching is half part of duties of a professor.

Infrastructure

Our institute is now in a quite new building. The lecture and seminar rooms are well equipped. There is a mathematical library, which offers good possibilities for students and teachers. (Periodicals, books) With supplement of the Ministry of Education of Hungary it is possible to reach numerous international journals by Internet.

There are computer laboratories, one of them free to use for students. (Internet, email)

Because of lack of money, orders the library only 2 mathematics didactical journals, and there is no money to by new mathematics didactical books.

Summary

The undergraduate teaching at Eötvös Lóránd University has a high level in mathematics due to the traditionally world-famous Hungarian mathematics.

The applied mathematics training - exists only since 6 years - try to balance the relation between theoretical and applied aspects of mathematics.

The application aspects of mathematics should be emphasised in the teacher training too.

We hope in a better future (higher salaries, more money for research projects, for scientific literature, for conferences etc)

A.2 Educational process

Didactics, types of teaching, examination forms

The traditional forms of teaching are lectures, exercises, seminars, and tutorials. The teacher students have about 15 lessons from one subject in a week. The mathematician students have about 20 lessons in a week.

The tutorial form is used at the undergraduate education for leading the diploma works in the last year.

The dominant teaching forms are lectures and exercises. The student activity is encouraged first of all on exercises and seminars. (individual problem solving, students lectures, discussions) An important idea in Hungary is: it is not enough to know mathematics, but to apply it at solving mathematical problems.

The computers are used at Informatics courses and at some applied mathematics courses.

There is no extra tendency to train the oral and writing skills of students. The teachers try to give a positive model how to communicate mathematics (orally, written)

Teacher education

The above listed characteristics are typical for mathematics teacher training too. More emphasis given to mathematical communication (oral, written) because of its role in the teacher's work.

Responsibilities

Mathematical departments 97 fix lessons (compulsory)

Department of Pedagogy 13 fix lessons (compulsory)

Practice schools 12 fix lessons (compulsory)

Summary

Due to Hungarian mathematical traditions great emphasis given for the development of the problem-solving abilities of students.

Important task is for the future to use the Internet possibilities at the mathematics and mathematics-didactics courses.

A.3 Outcome

Throughput

Master degree

	1999	2000	2001
Mathematics teacher	39 fem./ 30 male	42 f / 56 m	40 f / 25 m
Mathematicians	2 female/ 10 m.	3 f / 15 m	3 f / 9 m
Applied mathematicians	----	--------	3 f / 16 m

Interruption

The average rate of interrupted students is about 15 - 20 %.

It is possible to move the final state exam 3 years long after the last semester. Some students start to study other subjects or visit other colleges. For this reason they move the finish their studies.

A new problem is: necessary condition for the diploma is to have a state exam from a foreign language. Yearly 5 % - 10 % of students can not finish in time for this reason.

Median time
Most of the students finish their studies in 5 years.

Follow-up
The university has no official data where the students go after their studies. Most of the teacher students go to the schools to teach their subject. A negative tendency that more and more qualified teacher goes to the industry, trade and so one.
A strong tendency between qualified mathematicians to continue their study. The high-qualified mathematicians have good chances to get a PhD scholarship in USA. Yearly 10 young mathematicians can start their mathematics PhD studies at our university .

Economy
The education is satisfactory in relation to its costs.

Summary
There is a tendency between teacher students to study beside mathematics economy, trade etc. too, in the hope to get a better job. We lose yearly a lot of high-qualified teachers.

Comprehensive assessment
Strengths
High level of the mathematics training.
Fostering of the talented students.
Developing the problem-solving abilities of students.
Weakness
The financial conditions are not appropriate.
Neglecting of the application aspects of mathematics in teacher training and mathematician training.

Part B: Graduate studies

B1 Structure

Contents

The Mathematical Doctorate Program started in 1993 as a subprogram of the Doctorate School
of the Faculty of Natural Sciences at Eötvös Lóránd University. From 2001 there is a Mathematics Doctorate School with two programs.
I. Theoretical Mathematics Program
II. Applied Mathematics Program
There is an entrance exam for PhD studies.
The Ministry of Education finances some students with scholarship 3 years long. (The scholarship is equivalent with the minimum-salary in Hungary) The mathematics domain get usually 6 places yearly. In the last years the theoretical direction got 2, the applied direction 4 places. Some students are sponsored by research institutes or companies. Some students with Hungarian origin in neighbouring countries also can get a scholarship from the Ministry of Education of Hungary.
Nominal study time are 3 years, this period ends with a closing exam.
In other 3 years need the students to write and to defence the thesis.
Requirements: the PhD students need to visit compulsory and optional courses, research seminars. They need to publish two articles about their research-results in foreign languages in international journals.
After the 3-years course the students have 2 years to write the thesis and to defence the thesis.

Objectives

Main aim of the graduate program is the supplement the new research and teacher-generation in mathematics.

Organisations

The mathematical PhD courses are organised by our Mathematics Departments. To realise of PhD courses belong to the normal work of university teachers, it is not extra paid.
Each PhD student has a supervisor, who is mainly a university teacher, but it may happen that a student has a supervisor from other universities, institutions, sometimes from abroad. The supervisor directs the PhD studies and the research work and the writing of the thesis of his student.

Economy

The Ministry of Education of Hungary finances the PhD program based on the number of

participating students.
The Mathematical Doctorate School has a Committee of Doctorate School consists teacher and some student member. This committee decides about the resources, and about the syllabus.

The students
The number of immatriculated students in the last years.

	Theoretical Mathematics	Applied Mathematics
1998/99	21	23
1999/00	21	18
2000/01	19	22

The Committee of Doctorate School decides about the structure and the content of mathematics PhD studies.
The individual students have some freedom to choose from optional courses.
Officially has each student to teach two lessons in a week during 3 years at undergraduate level.
A part of the money is reserved for the students to visit conferences.

The teachers
42 university teachers from our departments (academicians, professors, associate professors) and 53 teachers, researchers from other universities, institutions work in the Mathematics PhD program.
Supervisors
7 members of Hungarian Science Academy (Mathematics)
15 university mathematics professors
24 university associate professors

The infrastructure
The PhD studies are organised realised by our mathematical departments. PhD students may use everything, which belongs to the departments. There are computer-laboratories free for students (Internet, email)
The mathematical library is well equipped with mathematical books and international journals. A lot of Hungarian mathematics professors are working in abroad and they use the possibility to support our mathematical library. (Change of mathematical journals etc.)
From 2002 more than 1000 international scientific journals are available - through help of Ministry of Education - by Internet.

Summary
Because of limited places newly and newly more and more talented students can be not accepted for PhD studies.
The high qualified, internationally accepted mathematics professors are involved in the program without any financial support. They need more help to visit international conferences, to by the most important books, to make researches etc.
Thank to the good connections with other universities in abroad (France, USA, England, Germany) the PhD students have good possibilities to make their studies for more months at these universities.

B2 Process

Courses
The students - with help of their supervisor - make a plan at the beginning of each semester. The Committee of Doctorate School evaluates it. At the end of the semester the students must make a report about their work. The acceptance of this report is a necessary condition to continue the study in the next semester.
In 3 years it is compulsory to achieve 8 courses - each 2 lessons per week in a semester.
The students may choose the courses from the optional courses.
The main forms of courses are lectures.
Seminars and conferences
The PhD student can visit higher research seminars also. Usually the students attend the research seminar, which is close to their research topic. The Mathematics Research Institute Budapest organises a lot of research seminars, some students visit these also.

The thesis
There are two main exams. The first one is a basic exam, one part of it close to the topics of the thesis.
The second exam is the defence of the thesis.
It is possible to make some parts of the thesis in co-operation within a research group. But the PhD student needs to declare that some results obtained by common research work.
It is not rigorously prescribed the form of the thesis: essays with a common summary or monography.

Examination and teaching
Forms of education during the doctorate program: lectures.
Forms of examinations:
At the end of each chosen course there is an oral exam. At the end of the 3 years the students must have 8 positive exam results, if yes they get the so-called *Absolutorium*
In the next 3 years there is the main exam, which consists from 1 main subject and 2 secondary subjects. There is some restriction to combine the subjects.
The successful exam result is a necessary condition to defence the thesis.
Co-operation partners
Technical University of Budapest, Economical University of Budapest, Mathematics Research Institute Budapest, Ruttgers University New Jersey, Brunel University London.
A lot of Hungarian mathematicians are working in abroad, they help to the PhD students to get scholarships at their university
Co-operation with ERICSSON company is a very effective connection.

Interruption
Theoretical mathematics
1993 - 2001 Immatriculated 54 students, Absolutorium 35 students PhD title 15 students
Applied mathematics
Immatriculated 52 students, Absolutorium 28 students, PhD degree 6 students

Quality aspects
There is a continuous discussion between the teachers, supervisors and the doctorate students about the experiences.
Male - female portion
From 15 students, who received the PhD degree are two women in theoretical mathematics domain.

From 5 students with PhD degree in applied mathematics there is only one woman.
The number of female students at graduate level is to low.
Women are strongly underrepresented among the teacher and supervisors also.

B3 Outcome

Graduation

	1996	1997	1998	1999	2000	2001
Theoretical math.		3		7	5	
Applied math.	1		1	3		1

Median time for doctorate studies awarded by PhD title 5 - 6 years
Median age: there are two groups. 28 years and 35 years
The main part of the students with PhD degree is working in higher education.

Summary

Strong side in graduate studies

High theoretical level in mathematics courses. Fostering the originality, flexibility in mathematical research.

The importance of the right mathematical communication: between 1993-2000 about 100 articles were published in accepted international mathematical journals.

Weak side

Very low financial support.

The teachers and supervisors make this work as their additional, plus work.

We are waiting for the Hungarian membership of EU in the hope, that the European laws for teaching and research will guarantee officially more money.

We may consider the lack of Mathematics- Didactics Doctorate Program as a problem also.

The theoretical mathematics has a long historical tradition in Hungary. It is characteristics for recent mathematics research also. The most talented students want to study theoretical mathematics. It is desirable to change this situation.

A self-evaluation of the Mathematical Sciences at Göteborg University and Chalmers University of Technology.

Part A: Undergraduate studies

A1. Structure and Resources

Contents

Mathematical Sciences is a department common to Göteborg University (GU) and Chalmers University of Technology , and it is organized in three units: Mathematics, Mathematical Statistics and Computational Mathematics.

The department is led by a Dean and a Vice-Dean and is subordinated to the Faculty of Natural Sciences at GU and the Faculty of Engineering at Chalmers.

At the department level, programs are decided upon and financial resources are divided amongst the different units. For more information you can look on the web under the adress www.md.chalmers.se or within some months, due to a change of the organization, on www.math.chalmers.se.

At unit levels there are also directors of study, who among other things coordinate courses after discussions with the different teachers.

For students at GU the department offers two four-year study programmes for which the department is independently responsible:

Mathematical program (40 students)
Program for Industrial Mathematics (10 students)

The department also gives courses in other programs within the Faculty of Natural Sciences:

Program for Computer Science (50 students and about 30 pts (ECTS) in mathematics)
Program for Physics (50 students and about 60 pts (ECTS) in mathematics)
Program for Chemistry (75 students and about 30 pts (ECTS) in mathematics)
Program for Problem-solving in the Natural Sciences (40 students and about 40 pts (ECTS) in mathematics)

Furthermore the department gives courses within three teachers training programs:

Program for primary school teachers (100 students each year that have mathematics as a part of their studies)
Program for secondary school teachers (Nominally 65 students but about 15 vacancies)
Program for upper secondary school teachers (Nominally 65 students but about 30 vacancies)

The larger part of the offer of courses for students at GU, in fact about 90 different courses in mathematics and mathematical statistics, could be studied independently of the programs above. Altogether there have been about 550 students each year, if they are evaluated as full time students. In numbers they have been considerably more.

For students at Chalmers the department takes part in mathematical education in twelve different programs:

Programs	Number of students admitted each year	Compulsary pts (ECTS) in mathematics	Optional pts (ECTS) in mathematics
Computer science and Engineering (D)	160	30	20
Electrical Engineering (E)	200	45	20
Engineering Physics (F)	130	45	20
Industrial Engineering and Management (I)	90	27	12
Information Engineering (IT)	60	30	12
Chemical Engineering (K)	90	30	12
Bioengineering (Kb)	60	30	12
Chemical Engineering and Engineering Physics (Kf)	30	36	12
Mechanical Engineering (M)	150	36	8
Industrial Design Engineering (TD)	30	27	8
Civil Engineering (V)	120	30	8
Automation Engineering (Z)	90	32	8

Beside these programs there also is an additional program, Technical Mathematics (TM), which can be taken by students from most programs above after the first two years of study. About 40-45 students choose this program each year. The education consists of at least 45 pts (ECTS) of studies in mathematics, mathematical statistics and computer science.

Service teaching in mathematics and mathematics as a minor subject
From what is described under contents above most of the courses given at the department is in fact service teaching for different programs.
Even if students from the same program study in groups of their own, most of the mathematics is the same in the different programs. The applications though are generally choosen especially for the specific programs.

Teacher education
The syllabus for the teacher education is as follows: (Here 1 pt should be multiplied by 1,5 to be compared with pts measured in ECTS)

School years 1-7 (primary school):
15 pts Didactical mathematics (Dept. of Education), 5 pts Elementary number theory, combinatorics, synthetic geometry.
Optional: 5 pts Further number theory and combinatorics, polynomials, complex numbers, 5 pts Linear algebra and analytic geometry

School years 4-9 (secondary school):
15 pts Didactical mathematics (Dept. of Education), 10 pts Elementary algebra and synthetic geometry, 5 pts Single variable calculus, 5 pts Linear algebra, 5 pts Probability and statistics
Optional: 5 pts Algebraic structures (groups, rings, fields), 5 pts Number theory, 5 pts Multivariable calculus, 5 pts Project course (often with a theme of mathematics in history, in science, in society, in art, ...)

Upper secondary school (years 10-12):
15 pts Didactical mathematics (Dept. of Education), 10 pts Elementary algebra and synthetic geometry, 10 pts Single variable calculus, 5 pts Linear algebra, 5 pts Probability and statistics, 5 pts Algebraic structures (groups, rings, fields), 5 pts Multivariable calculus, 5 pts Project course (often with a theme of mathematics in history, in science, in society, in art, ...)
Optional (Required if mathematics is your main teaching subject): 5 pts Foundations of analysis, 5 pts Complex analysis, 10 pts chosen among higher level courses given by the dept. of mathematics or a Bachelor's thesis.

Diploma in mathematics
The Mathematical program at GU leads to a Master's degree and requires at least four years of full studies and contains a thesis worth about 30 pts (ECTS).

The first two years of studies consist of cumpulsory courses in different fields of mathematics, such as calculus in one and several variables, elementary algebra, linear algebra, scientific programming, numerical analysis, probability and statistics, algebraic structures and advanced caclulus.
After this two years one can specialize in three directions: mathematics, mathematical statistics or financial mathematics. Here one can chose among a large number of courses, most of them after the students own preferences.

The program for Industrial mathematics also leads to a Master's degree and have about the same amount of mathematical stuff, but is more oriented against technical mathematics.

Syllabuses for the Mathematical Programs at GU are given in appendix 1.

At GU it is also possible to take a Bachelor's degree in mathematics by a quite freely chosen combination of courses. This will take at least three years of studies and contains a thesis worth about 15 pts (ECTS).

Most of the different programs at Chalmers leads to a Masters degree in engineering and requires at least four and a half years of study. The additional program TM contains enough mathematics to qualify for graduate studies in the different branches of mathematics or in mathematical statistics. For the syllabus see www.math.chalmers.se/TM/TM01e.html. At Chalmers there also exists an international master program in Engineering Mathematics see www.math.chalmers.se/EM-Masters/.

Economy
At an average the department gets about 26 000 Swedish kronor per annum for each full-time student, and it is about the same for the different programs. About 75 percent of this is used for payment of teachers and 25 percent for overhead-costs. A further analysis of the costs for teachers shows that in reality about 85 percent is used for teaching. The rest is used for teacherdevelopment, costs for directors of study and students guidance etc. From the description above, and for an international comparison, it can be noted that about 30 to 35 full-time students is needed to afford one senior lecturer.

Admission and recruitment of students
There is a numerus clausus for admission to studies in the programs described above. The students are admitted according to a very complicated selection system, which is described in appendix 2.

There are several methods that are used to recruit new students, besides advertising in the newspapers. There are planned visits to all upper secondary schools in the region and also invitations to pupils and their teachers to visit the department and listen to some interesting talks about various parts of mathematics. Some hundreds of pupils come and listen to this type of information each year. The department also arranges one or two contact days each year between teachers from upper secondary school and the mathematics department.

The students
The number of students that have been admitted each academic year is clear from the description above of the different programs.

At GU the proportion of female students is somewhere between 30 and 40 per cent, except for the teacher educations where the percentage is about 60.

At Chalmers the proportion of female students varies from 10 per cent in the program for Computer science and Engineering up to over 60 per cent in the program for Chemical Engineering. At an average about 30 per cent of the students in mathematical courses are female.

It is clear that the level of the students' previous knowledge has changed in the last years. There are long-time series of information (28 years) from diagnostic tests, done by the beginning students, that clearly indicates a change for the worse. The general experience from the teachers also points in the same direction.
To meet this, there has been established some introductory courses and there has also been a slower start in the studies. The requirements of passing an examination has also been reduced and generally the students need somewhat longer study periods before leaving their studies.

Academic teachers
Here comes a table whichs shows the different categories of academic teachers and the number of each category.

	Mathematics etc	Mathematical statistics
Professors	13	10
Senior lecturers (Associate professors, docent in Swedish)	22	5
Lecturers	25	5
Assistant professors	11	2
Doctoral students with teaching duties	35	21
Others	5	3

At an average a professor fulfils about 60 percent of his duties working with his own research and his graduate supervision, and aproximately 20 per cent for courses in undergraduate education. Senior lecturers have about 30 percent of their duties in form of their own research and the corresponding amount of own research is about 25 percent for the lecturers.
The undergraduate teaching is to more than 90 per cent carried out by permanent teachers at GU and about 70 per cent at Chalmers.
There are seminar series for the teachers to develop their teaching skills organized within the department and also those organized on a central level for teachers from different subjects.

Infrastructure
It is favourable to be a department common to two universities since the basic resources are better and it gives a lively environment. The teachers indeed have a very good computer environment. They all have workstations of their own in their offices, and the department has employes to manage the data systems.
One of the main advantages is that we have one of the best mathematical librarys in Sweden. The support in form of scientific information is very good.

There are very good localities for all types of courses, but the demand is somewhat bigger than the supply. There would perhaps be more education in form of self-activities if there were a better access to localities suitable for this.

For both mathematics and mathematical statistics there are offices that administrate the localities, the students' registration, materials for the different courses etc.

There are also porters that serve the teachers with copying, printing and selling compendiums etc.

Summary
The most essential strengths are the well-qualified teachers, a good infrastructure and a stimulating and lively environment.

The weaknesses consists of a change to the worse of the students' previous knowledge, a certain lack of rooms suitable for self-activities and a too small number of students in the mathematical programs at GU to get the necessary stability.

A.2 Educational process

Didactics, types of teaching, examination forms.
The education is generally given in the classical forms of lectures in larger groups (often for a whole program), followed by lessons for groups less than 30 pupils. There are also laboratory works, home-works and group-works that sometimes are part of the examination. There is classical as well as explorative education.

The number of scheduled hours for a full-time student in the mathematical subjects during the first two years is about 15 to 17 per week, during the semester time. About half the scheduled time is in form of lectures. At the end of their studies the students have to work more on their own, and are then only given about 12 hours scheduled per week.

The laboratory work mostly consists of computer explorations using programmes like MATLAB, sometimes also Maple or Mathematica.

The education requires a considerable amount of self-activity from the students. Oral and writing skills are essentially trained in form of group-works, with oral and written reports.
The examination in most courses take place in a traditional written form with problem solving and also some proofs of mathematical theorems. Group works and home-works with written or oral reports could be part of the examination.

To guide the students in their mathematical studies there are student advisors placed at the department. For more general guidance there are advisors in the central administration of GU and Chalmers as well.

For most programs there are steering-groups consisting of students and teachers responsible for the program, who together have a responsibility to follow up the education in the programs. To follow up and get feedback concerning the different courses, there usually are inquiries after most courses. Mostly, and at Chalmers always, these inquiries are followed by discussions with the students. At Chalmers the students' association has formalized this evaluation.

The teacher training programs for secondary and upper secondary school start the first semester with the following schedule: The day starts with two hours of self-studies followed by two hours of teacher-led instructions and then in the afternoon there follows two hours of lectures covering questions raised during the morning. Partly they also use a self-instructive material. The rest of their studies is more traditional and resembles the other programs described above.

Summary
The education is quite traditional with a good contact between undergraduate education and research, mainly depending on the fact that most of the teachers are active in their own research.
For the teacher training programs there is a starting period with more intensive studies adapted to the students weak previous knowledge.

A.3 Outcome

Through-put
Since the present Mathematical program and the program for Industrial Mathematics at GU just started some years ago, the data of through-put comes from their predecessors. In those programs most of the students ended up with a masters degree in Computer Science. Hence there are quite few pupils that have taken a master's degree in mathematics. At an avarage it has only been about 5 students each year in mathematics and about the same number in mathematical staristics the last three years. There has been a change the last years, and there are probably a larger part of the students that will end up with a master's degree in mathematics in the coming years.

The proportion of students that interrupt their studies is very large. Only 40 percent of the students admitted to programs at GU complete their studies with a degree.

In the engineering programs at Chalmers about 70 per cent complete their studies with a degree; this includes the additional program of Technical Mathematics. For the individual mathematical courses the through-put is about 80 percent.

The median time of study in the different programs is about 10 to 20 per cent longer then the expected time.

In the Teacher training programs at an averadge 70 per cent complete their studies. The percentage is somewhat higher for primary school teachers than for upper secondary school teachers.

Follow-up
The department has a very good knowledge of what happens with the students after finishing their studies. There has been established a group with a resposibility to get a better contact with the world outside the department. They have sent enquiries to most former students at GU to follow-up what has happend to them after their graduation. It is clear that they really have got jobs adequate to their qualifications.

The same type of follow-up exists at Chalmers, but is administed by the central administration, and points in the same direction. The students really get jobs that correspond to their qualifications.

Summary
The essential strength of the education in general is that it seems well-adapted to the demand from the labour market. The students from all programs really get adequate jobs after finishing their studies.

The through-put for students in the mathematical programs at GU is quite bad, except for the teacher training programs. At Chalmers the through-put is better, probably depending on the more determined students with better previous qualifications. It is in general more difficult to be admitted as student at Chalmers than at GU.

A4. Comprehensive assessment

The strengths of the department are a very good access to well-educated and interested teachers with a great commitment to renewal of the education, a lively environment with courses and programs for all types of mathematical interests, a very good infrastructure and educational programs that seem well-adapted to the labour market.

The weaknesses are a change for the worse of the students previous knowledge, a bad through-put in the mathematical programs at GU and too small a number of students in the programs at GU to obtain a reasonable stability.

Part B: Graduate studies.

B1. Structure

Contents
At the department for Mathematical Sciences, postgraduate studies are given in the following programs: Mathematics, Applied mathematics/Computer analysis, Industrial mathematics, Computational mathematical modelling, Mathematics with didactics and Mathematical statistics.

In all these programs one can study for a Licentiate examination (nominaly two years of full time studies) and also be awarded a PhD (nominally four years of full time studies including time for writing a thesis).

These graduate studies consist of a quite comprehensive part of courses, common for all students, the aim of which is to give a general view of the subject and a knowledge of the most important methods used in the various branches of mathematics.
Moreover the students have to take an inividual set of courses specially adapted to their thesis work.

A licentiate thesis should prove that the author has skill enough to understand a new problem in a modern reasearch area and also to put together results from different sources and use standard methods on new problems. There is a special licentiate education in Industrial mathematics on a European level, the so called ECMI-program (See www.math.chalmers.se/Math/Foutb/ECMI) with part of the studies abroad and with industrial projects as a part of the studies.

To be awarded a Ph.D the student must show that he can manage the common techniques used in some area of mathematics and also that he has penetrated some problem areas thoroughly. He must also show that he has the ability to make his own contributions of a non-routine character.

It may be remarked that the doctoral students usually have an appointment at the department with 80 percent of full time for their own research and 20 percent for teaching at the undergraduate level. The doctoral studies therefore in practise take more than five years after finishing undergraduate studies.

More information is awailable on the web under the address www.md.chalmers.se or within some month, due to a change of the organixzation, on www.math.chalmers.se. Also look for the annual reports from the department.

Organization
Mathematical Sciences is a department common to Göteborg University (GU) and Chalmers University of Technology, and it is organized in three units: Mathematics, Mathematical Statistics and Computational Mathematics.
The department is led by a Dean and a Vice-Dean and is subordinated to the Faculty of Natural Sciences at GU and the Faculty of Engineering at Chalmers.
At the department level programs are decided upon and financial resources are divided amongst the different units. Also the examinators, the supervisors and the number of doctoral students possible to admit are decided upon at this level.
There are also directors of studies in matematics and mathematical statistics respectively, whio coordinate courses after discussions with the different teachers, and also take part in the annual conferences for the supervisors.

The students
This table shows the number of doctoral students admitted during the last years.

	2000/2001	1999/2000	1998/1999	1997/1998
Math, Industrial math and Applied math	11	12	12	10
Mathematical statistics	1	3	3	7

During these years 39 men and 6 women were admitted in the different mathematical programs, whereas 10 men and 4 women were admitted in mathematical statistics.

The total number of graduate students in the doctoral programs in the mathematical subjects has been somewhere between 50 and 60 during the last years. This year only six of them are women, which in fact is quite normal. Unfortunately the drop-out rate amongst the female students is higher than amongst the males.

The internal distribution this year is that 27 are registered in pure mathematics, 12 in industrial mathematics and 13 in applied mathematics.
In mathematical statistics the number of persons in the doctoral program has ranged from 20 to 30 during the last years. This year only 8 of the students are female.

The teachers
In mathematics there are 13 full professors and 23 senior lecturers (associate professors, docent in Swedish), all active in research.
In mathematical statistics there are 9 full professors and 7 senior lecturers.
Sometimes also lecturers and other teachers may give doctoral courses.

Among the supervisors in mathematics/mathematical statistics there are no women, but there are women responsible for som of the courses.

Seminars are often given by teachers from other departments. It also happens that guests at the department staying for a longer period could be responsible for some courses.
It also happens, but it is not common, that there is an assistant supervisor from another department.

The infrastucture
It is favourable to be a department common to two universities since the basic resources are better and it gives a lively environment.
The teachers indeed have a very good computer environment. They all have workstations of their own in their offices, and the department has employees to manage the data systems.
One of the main advantages is that we have one of the best mathematical librarys in the country. The support in form of scientific information is very good.

Summary
There is a very good supply of competent teachers and supervisors. In fact they could manage to take care of many more doctoral students than today. It is a waste of resources that there are competent potential doctoral students who could not be admitted. This depends on the Swedish system, where the doctoral students in principle must be employed at the department during their doctoral studies. The economic resources to admit more students are too small.

B2. Process

Courses
For passing a Licentiate examination the student needs 120 pts (ECTS), which nominally takes two years of study; 90 of these points constitute courses.
For the PhD, the demand is 240 pts (ECTS), where about 120 points constitute courses. About half of the amount of courses is in general basic courses while the rest is related to work for the thesis.
Usually the students follow a number of the 12 - 15 regular courses given each year.
Four of these courses are in practice compulsary and are naturally given each year. For the students within the ECMI-program there are compulsory basic courses of together 45 points.
Formally most of the courses are voluntary but in practise some of the basic courses are compulsory.
The directors of study and the supervisors regards the study programs as realistic.

The thesis
Licantiate examination is not compulsory as a part of the doctoral studies, but lately it has been common to take the licentiate examination on the way to a Ph.D. There is no experience that this will be of any hindrance in their studies, instead it is a way to gradually reach greater independence.

In both mathematics and mathematical statistics it is usually the department/supervisor that proposes the thesis subject.

Work on the thesis is seldom done in research groups. By tradition this is done individually with support from the supervisor. In applied mathematics and in the ECMI-program the thesis may be a separate part of a greater research projekt.

The thesis may be published either as a monography or as a number of essays with a summing up. The latter is most common nowadays.

Interruption
There are very few, less then 10 per cent, graduate students who leave their studies without a degree. Some more may have had the ambiton to get a PhD degree but leave with a Licentiate examination.

B3. Outcome

Graduation
We give some tables showing the number of licentiate examinations and PhD's the last years.

Number of licentiate examinees

	2000/2001		1999/2000		1998/1999		1997/1998	
	GU	CTH	GU	CTH	GU	CTH	GU	CTH
Math, Industrial math and Appl. math.	1	5	1	8	5	4	1	7
Math statistics	2	5	1	3	0	7	2	2

In all 28 men and 4 women completed the licentiate programs in mathematics, and 16 men and 6 women in mathematical statistics, during these years.

Number of persons awarded a PhD

	2000/2001		1999/2000		1998/1999		1997/1998	
	GU	CTH	GU	CTH	GU	CTH	GU	CTH
Math, Indutrial math and Appl. math	3	4	2	1	1	2	2	2
Math statistics	0	1	3	0	1	1	1	0

Altogether 15 men and 2 women were awarded a PhD degree in mathematics and 4 men and 3 women in mathematical statistics during these years.

The average time before they finished their doctoral studies was just less than 7 years, whereas the median time was just over 6 years. The average age when they were awarded their doctoral degree was 34,5 years, while the median age was about 30.

B4. Summary

Mathematics and mathematical statistics in Göteborg is the largest connected unit for research and graduate education in these subjects in Sweden. The number of students that are awarded a PhD or pass a licentiate examination is quite good, but the department has teachers and supervisors for a much larger output. The conditions for students, who are admitted to doctoral studies, to complete their studies are quite good.
The graduate education is thus well-organized with a regularly offered number of basic courses and a large number of specialized courses and seminars.

During the last six years there has been an output of 21 PhD's in mathematics, where 3 of them are women. In mathematical statistics the corresponding numbers are16 and 8, respectively.
An obvious problem for the department is that the recruitment of female students for graduate studies in mathematics is quite bad, whereas the situation is better in mathematical statistics.

The median value of the the study time for a PhD is still over 6 years in contrast to the financing which only covers 5 years.

Appendix 1

Syllabus for the *Mathematical Program*

The program begins with a two-year block of basic courses, which are compulsory.
To be compared with pts measured in ECTS in this program, muliply the pts below with 1.5.

1:st year

5pts	Basic Course in Mathematics
5pts	Linear Algebra
10pts	Single Variable Calculus
10pts	Multivariable Calculus
10pts	Computer Programming

2:nd year

5pts	Linear Algebra II
5pts	Numerical Analysis
10pts	Probability Theory
5pts	Algebraic Structures
5pts	Advanced Calculus
10pts	Statistics Theory

After the first two years the students can choose among three different directions: Mathematics, Mathematical Statistics and Financial mathematics (Last direction in cooperation with Department of Economy).
Here comes the syllabus for the Mathematics direction, where the students to some extent may choose courses quite freely. The courses below can thus be modified.

3:rd year

Theoretical profile		Applied profile	
5pts	Analytic Functions	5pts	Fourier Analysis
5pts	Fourier Analysis	5pts	Numerical Linear Algebra
5pts	Linear Algebra III	5pts	Partial Differential Equations
5pts	Galois Theory	5pts	Some course from Th. Profile
5pts	Differential Geometry	5pts	Applied Optimization
5pts	Logic and Geometry	5pts	Discrete Mathematics
5pts	Ordinary Diff. Equations	5pts	Comp. Science and Data Structures
5pts	General Topology	5pts	Some course from Th. Profile

4:th year

Theoretical profile		Applied profile	
5pts	Integration Theory	5pts	Partial Diff. Equations II
5pts	Functional Analysis	5pts	Fourier and Wavelet Analysis
5pts	Mathematical Logic	5pts	Big Matrix Problems
5pts	Algebraic Number Theory	5pts	Applied Functional Analysis
20pts	Thesis	20pts	Thesis

Syllabus for the *Program for Industrial Mathematics*.

The first two years of study are in principle compulsory, but after that the students have some possibilities to choose courses after their own preferences. To be compared with pts measured in ECTS in this program, muliply the pts below with 1.5.

1:st year

10pts	Single Variable calculus
10 pts	Linear Algebra
10 pts	Multivariable Calculus
10 pts	Physics

2:nd year

5pts	Fourier Analysis
5pts	Numerical Methods
10pts	Computer Programming
5pts	Differential Geometry
5pts	Computer Algoritms
5pts	Mathematical Statistics
5pts	Mathematical Modelling

3:rd year

5pts	Visualization
5pts	Applied Mathematics
5pts	Geometry for Computations
5pts	Partial Diff. Equations
5pts	Applied Optimization
5pts	Computer Aided Geometrical Design
5pts	Applied Funcional Analysis
5pts	Ordinary Diff. Equations

4:th year

5pts	Partial Diff. Equations II
5pts	Technical computations
10pts	Physics

20pts Thesis

Appendix 2

Admissions to undergraduate education in Sweden.

To be admitted to undergraduate education the applicant must satisfy some basic eligibility requirements, which are the same for all courses and programmes of education.

Basic eligibility is attained by completing an upper secondary school programme and obtaining a pass grade or better in courses covering at least 90 per cent of the upper secondary credits required in the programme, or by providing proof of an equivalent level of knowledge. People who are at least 25 years old, who have been in work for four years and who have command of English and Swedish corresponding to that obtained by completing a national upper secondary programme are also considered to have basic eligibility.

Most courses and programmes of education also have course eligibility requirements that vary depending on the subject area and the type of course.

If the number of qualified applicants for a course or a programme exceeds the number of places allotted for new students, a selection process is necessary.

At least a third of the places must be allocated on the basis of upper secondary grades*, and at least a third on the basis of the Swedish Scholastic Aptitude Test.

The Swedish Scholastic Aptitude Test measures knowledge and skills of importance for successful studies in higher education. It is taken by more than 100 000 prospective students every year. The test is voluntary, but it may well increase an applicant's chances of being admitted to higher education.

* A medium value of nearly all subjects is taken account to, with no specific regards to grades in mathematics even if the applicant tries to be admitted to a mathematical program. It is enough to have been passed in all courses in mathematics.
To day in fact about 60 per cent of the students are admitted this way,

More information is available on the web under the address:
http://www.si.se/docs/e_studiersverig/changingface.pdf
Look for pages 18 and 19.

Self-evaluation of the Department of Mathematics of the University of Helsinki within the trilateral LUMA-project.

Part A: Undergraduate studies

A1. Structure and Resources

Contents

The Department of Mathematics is part of the Faculty of Science of the University of Helsinki. The department is the largest mathematical institution in Finland and offers the most versatile opportunities for high-calibre research. Teaching is given in both pure and applied mathematics. Basic courses are very much the same in both fields and graduate courses are closely linked to each others.

The department educates prospective teachers of mathematics. Special courses are also offered to teachers of mathematics who wish to upgrade their professional skills. Teaching in applied mathematics is carried out in cooperation with Rolf Nevanlinna Institute as well as industrial, insurance and information technology companies. The department welcomes researchers from different countries and has good connections and cooperation agreements with many distinguished universities. The development of teaching is a high priority and the department has recently adopted a versatile system of tutoring and academic advising.

More general information of the department is available on the web site http://www.math.helsinki.fi/.

Programmes of study. Students may plan their studies according to their interests and aptitudes. Students of mathematics have a choice among four programmes of study: mathematics curriculum, applied mathematics curriculum, mathematics teacher curriculum and computer mathematics curriculum. In the mathematics curriculum, students choose a specialisation option from among the numerous sub-areas of the discipline, i.e. algebra, topology, analysis, mathematical physics and mathematical logic. In the applied mathematics curriculum, the specialisation options are applied mathematics (including numerical methods and industrial mathematics), stochastic modelling and data analysis, computer-aided mathematics, and insurance and financial mathematics. Students wishing to become teachers of mathematics can obtain teacher's qualifications via the mathematics teacher curriculum. Teacher's curriculum includes some didactic studies which are carried out at the Department of Teacher Education within the Faculty of Education of the University of Helsinki. The computer mathematics curriculum was added in 2000 to the programmes available at the department. It is a joint programme with the Department of Computer Science, and the aim is to acquaint the student thoroughly with both disciplines.

In order to obtain M.Sc. (Master of Science) degree, a student must earn at least 160 units of academic credit; the minimum requirement for B.Sc. (Bachelor of science) degree is 120 credit units. One credit unit normally corresponds to roughly one week (40 hours) of study, which may consists of attending lectures, participating in problem solving classes, and independent study. Note that ECTS is not quite the Finnish credit point system: 1 Finnish credit unit (cu for short) is approximately equal to 2 ECTS credit units.

The M.Sc. degree in mathematics or in applied mathematics requires 93 cu (minimum) studies on mathematics, but the mathematics teacher and computer mathematics curricula require only 75 cu. The required courses depend on the curriculum the student is following. The minimum requirement of mathematics studies for B.Sc. degree is 55 cu. The B.Sc. degree is offered in each curriculum.

Primary school teachers (so called class teachers) are educated by the Department of Teacher Education of the university. Their major subject is pedagogic, and all the mathematics studies for their purposes are given by the Department of Teacher Education as well. Secondary studies of primary school teacher students include the course Didactic of mathematics (4 cu), which is the only compulsory course connected to mathematics for them. One objective of this course is that students are aware of mathematics as a science area and as a school subject. Moreover, students are required to understand didactic of mathematics so widely that they are capable to teach mathematics to primary school pupils (ages 7-12). Students can take a non-compulsory course of mathematics (15 cu), but very few take this opportunity.

Lower and upper secondary school mathematics teachers (so called subject teachers) are educated by the Department of Mathematics in cooperation with the Department of Teacher Education. Teacher mathematics students are admitted in the degree programme of mathematics as the other majors, and the students who follow the mathematics teacher curriculum are selected during the second or third year of their studies. In recent years some mathematics majors have been admitted particularly to follow the mathematics teacher curriculum from the beginning of their studies at the departmet. The teacher mathematics curriculum is considered later.

Service teaching in mathematics and mathematics as a minor subject

The departement gives service courses in mathematics for students of physics, chemistry, and computer science. Students in many other degree programmes, in all the faculties of the university, take mathematics courses as well. This strong methodological and service character of the department is reflected in the fact that approximately 45-50 per cent of the yearly credit points are attributed to students minoring in mathematics.

During the recent years the computer science majors have formed the most significant group of minor students of the department. This phenomenom has caused important changes in the mathematics service teaching. Approbatur I and Approbatur II were the basic mathematics courses indended for mathematics minors, and in particular they were focused for the needs of physics students. These courses were stopped in 2001, and minor students collect the required amount of credit points among the same courses as mathematics majors. The basic level course Calculus was launched in 2001 for the purposes of mathematics minors, but it can be taken by the mathematics majors in some mathematics major programmes as well.

The minimum requirement for the lowest level total study programme available in mathematics called *approbatur* is 15 cu. Mathematics minors can take it by choosing courses freely from the following basic level courses:

- Approbatur I (7 cu): Basic properties of vectors, analytic geometry of lines and planes, and differential and integral calculus of one real variable.
- Approbatur II (8 cu): Elements of matrices and linear algebra, series, and multivariate differential and integral calculus.
- Calculus (5 cu): Single variable calculus in forms of curves and functions, derivation and integration, series, and differential equations. These topics are taught in connection to mathematical computer software (e.g. Maple and Mathematica).
- Differential and integral calculus I.1 (5 cu).
- Differential and integral calculus I.2 (6 cu).
- Written assignment on Differential and integral calculus I (1 cu).
- Linear algebra I (5 cu)
- Discrete mathematics I (5 cu).
- Algebra I (5 cu).
- Logic I (5 cu).
- Differential and integral calculus II (5 cu).
- Differential equations (5 cu).
- Mathematical methods for scientists (5 cu).
- Optimization I (5 cu).
- Probability theory I (5 cu).
- Topology I (5 cu).

If the programme contains Approbatur I, then it can not contain Differential and integral calculus I. Only the first three courses mentioned above are mainly for the purposes of the mathematics minors taking only the approbatur programme in mathematics. The other courses are planned for the purposes of mathematics majors (and minors too) taking the cum laude approbatur or laudatur programme in mathematics, and the contents of these courses are explained later in the section Master's degrees in mathematics. These courses are not taught differently to mathematics minors (such as physicists, chemists, biologists, computer scientists and economists) from mathematics majors, but some special courses (e.g. in industrial and financial mathematics) are planned so that they serve the needs of mathematics minors as well as mathematics majors.

The minimum requirement of the *cum laude approbatur* study programme for mathematics minors is 35 cu. It must contain Differential and integral calculus I or optionally Approbatur I and II. The first mentioned is compulsory for the prospective teachers who have mathematics as the second subject of teaching. The programme has to contain at least one of the courses Algebra I, Discrete mathematics I, and Linear algebra I. Other basic and

advanced level courses (minimum 20 cu) can be chosen freely for example from the optional courses listed before and from the advanced level courses offered by the department.

The minimum requirement of the *laudatur* study programme for mathematics minors is 70 cu. It consists of the cum laude approbatur programme, laudatur assignment for minor students (8 cu), and at least one of the following options:

- Measure and integral (3 cu) and Real analysis I (3 cu).
- Advanced course for mathematics teachers (6 cu). Compulsory course for the prospective mathematics teachers.
- Measure and integral (3 cu) and Advanced course in applied analysis (3 cu).
- Probability theory II (4 cu) and Stochastic processes (2 cu).
- With some limitations, 6 cu collected from the basic courses.

The rest of the courses (minimum 20 cu) adding to 70 cu can be chosen freely from the advanced level courses.

Teacher education

The *teacher mathematics curriculum* consists of at least one secondary subject (so called second subject of teaching); typical choises are computer science, physics, and chemistry. In addition, curriculum includes didactic studies (35 cu) which are carried out at the Department of Teacher Education of the university.

The minimum requirement of mathematics major studies in teacher mathematics curriculum is 75 cu. The basic level programme (cum laude approbatur) consists of the following compulsory courses, altogether 27 cu:

- Differential and integral calculus I (11 cu).
- Written assignment on Differential and integral calculus I (1 cu).
- Linear algebra I (5 cu).
- Topology I (5 cu).
- Differential and integral calculus II (5 cu).

Moreover, the cum laude approbatur programme is required to include at least two of the following optional courses (minimum 10 cu):

- Algebra I (5 cu).
- Differential equations (5 cu).
- Discrete mathematics I (5 cu).
- Logic I (5 cu).
- Probability theory I (5 cu).

The advanced level programme (laudatur) consists of the cum laude approbatur programme (37 cu), M.Sc. thesis (13 cu), and the following compulsory courses:

- Advanced course for mathematics teachers (6 cu): Course organized in a seminar style.
- Geometry (5 cu).

Recommended optional courses for prospective mathematics teachers (minimum 14 cu) are, for example, Probability theory I (5 cu), Function theory I (5 cu), Function theory II (5 cu), Algebra II (5 cu), Topology II (5 cu), Linear algebra II (5 cu), Introduction to elementary number theory (5 cu), Elements of set theory (5 cu), Logic I (5 cu), Mathematical logic (5 cu), Discrete mathematics II (5 cu), Optimization I (5 cu), Differential equations (5 cu), History of mathematics (I-II), and Pro gradu seminar. If Probability theory I is not included in the cum laude approbatur programme, then it is required to be taken to the laudatur programme.

The mathematics programme for the prospective teachers who have mathematics as the second subject of teaching was taken into consideration in the previous section.

Master's degrees in mathematics

The 160 cu needed for the M.Sc. degree in mathematics are subdivided as follows (in each case the indicated number is the minimum requirement):

- Mathematics 93 cu
- Minor subjects 45 cu
- General studies 15 cu;

the total must be at least 160 cu. The student must have at least two secondary subjects; typical choices are computer science, the physical sciences, chemistry, statistics, and theoretical philosophy. The mathematics studies for the M.Sc. degree can be subdivided as follows:

- Basic courses (cum laude approbatur) 42 cu
- Advanced courses (laudatur) 35 cu
- M.Sc. thesis (Pro gradu) 16 cu,

adding to 93 cu, however, teacher's and computer mathematics programmes require only 75 cu. The required courses depend on the curriculum the student is following. The contents of the curricula and specialisation areas are described later in this section. Some courses are taught also in Swedish or English.

In the mathematics, applied mathematics, and computer mathematics curricula every student writes a M.Sc. thesis (16 cu), so called pro gradu. In the teacher mathematics curriculum considered in the previous section the M.Sc. thesis is worth 13 cu. A student can not begin to write it before the cum laude approbatur programme and at least 6 cu of advanced level studies are taken. All the mathematics studies must add to 93 cu (minimum) in the mathematics and applied mathematics curricula, and 75 cu (minimum) in the computer mathematics curriculum.

The *mathematics curriculum* consists of the following compulsory basic courses (cum laude approbatur), altogether 22 cu.

- Differential and integral calculus I (11 cu): Analysis in one real variable.
- Written assignment on Differential and integral calculus I (1 cu).
- Linear algebra I (5 cu): Analytic geometry. Theory of real vector spaces, linear mappings, and matrices.
- Differential and integral calculus II (5 cu): Elementary analysis in several variables.

In addition, students choose four optional courses from the following basic level mathematics courses, altogether 20 cu.

- Algebra I (5 cu): Elements of set theory. Introduction to some algebraic structures such as groups, rings, fields, and polynomial rings.
- Differential equations (5 cu): Theory of ordinary differential equations.
- Discrete mathematics I (5 cu): Logic and set theory (language of mathematics).
- Linear algebra II (5 cu).
- Logic I (5 cu): Introduction to propositional and predicate logic.
- Mathematical methods for scientists (5 cu): Basic numerical methods, Fourier analysis, numerical solutions of differential equations, using Matlab and Mathematica software packages.
- Probability theory I (5 cu): Introduction to probability theory and mathematical statistics.
- Topology I (5 cu): Point set topology with emphasis on Euclidean and metric spaces.

Students of *algebra and topology specialisation area* have to take Algebra I and Topology I from the previous basic level courses. They have two compulsory advanced level mathematics courses (laudatur): Measure and integral (3 cu) and Real analysis I (3 cu). Moreover, they choose at least two courses from the following three courses: Algebra II (5 cu), Linear algebra II (5 cu), and Topology II (5 cu). Recommended optional advanced level courses are, for example, Algebraic topology (5 cu), Manifolds and Lie groups (5 cu), Transformation groups (5cu), Topological groups (5 cu), Introduction to elementary number theory (5 cu), Function theory I (5 cu), Riemannian surfaces (5 cu), and Discrete mathematics II (5cu).

Students of *analysis specialisation area* have two compulsory advanced level mathematics courses: Measure and integral (3 cu), and Real analysis I (3 cu). Moreover, they collect minimum 29 cu from the optional advanced level courses, for example, Introduction to functional analysis (5 cu), Function theory I (5 cu), Function theory II (5 cu), Partial differential equations (5 cu), Real analysis II (5 cu), Probability theory II (4 cu), and Variational calculus (5 cu).

Students of *mathematical physics specialisation area* have two compulsory advanced level mathematics courses: Measure and integral (3 cu), and Real analysis I (3 cu). Moreover, they collect minimum 29 cu from the optional advanced level courses, for example, Introduction to mathematical physics (5 cu), Introduction to functional analysis (5 cu), Function theory I (5 cu), Partial differential equations (5 cu), Differential geometry (5 cu), Real analysis II (5 cu), Probability theory II (4 cu), Stochastic processes (2 cu), Algebraic topology (5 cu), Topology II (5 cu), Algebra II (5 cu), and Function theory II (5 cu).

The cum laude approbatur programme of *mathematical logic specialisation area* must include Logic I (5 cu). Students of this area are required to take the advanced level course Mathematical logic (5 cu). Moreover, they

have to collect at least 10 cu chosen from the following courses: Algebra II (5 cu), Discrete mathematics II (5 cu), Measure and integral (3 cu), Real analysis I (3 cu), and Topology II (5 cu). In addition to these, they have to take at least two of the courses Elements of set theory (5 cu), Model theory (5 cu), Theory of computability (5 cu), Theory of finite models (5 cu), Nonstandard analysis (5 cu), and Axiomatic set theory (5 cu). Other optional studies can be chosen freely adding to 93 cu (minimum) studies in mathematics.

The *applied mathematics curriculum* consists of the following compulsory basic level courses (cum laude approbatur), altogether 42 cu.

- Differential and integral calculus I (11 cu).
- Written assignment on Differential and integral calculus I (1 cu).
- Linear algebra I (5 cu).
- Differential and integral calculus II (5 cu).
- Differential equations (5 cu).
- Optimization I (5 cu).

In addition, students choose four optional courses from the following basic level mathematics courses, altogether 10 cu.

- Discrete mathematics I (5 cu).
- Probability theory I (5 cu).
- Mathematical methods for scientists (5 cu).
- Topology I (5 cu).
- Logic I (5 cu).
- Algebra I (5 cu).

Students of *applied mathematics specialisation area* have to include Probability theory I (5 cu) to the cum laude approbatur programme. Their laudatur programme must consist of either

- Measure and integral (3 cu) and Real analysis I (3 cu), or
- Probability theory II (4 cu) and Stochastic processes (2 cu).

Students of applied mathematics specialisation area are required to take at least two of the following optional advanced level courses:

- Partial differential equations (5 cu).
- Numerical analysis (5 cu).
- Statistics (5 cu).
- Measure and integral (3 cu).

Moreover, they have to take more optional advanced level courses so that the total points in mathematics are minimum 93 cu (including pro gradu, 16 cu). The courses introducing applications in industry are the following:

- Introduction to mathematical projects for industry (3 cu).
- Mathematical projects for industry (7 cu).

Other advanced level courses can be chosen freely, the recommended ones are the following:

- Approximation with splines (5 cu).
- Bayesian statistical methods (5 cu).
- Solving partial differential equations numerically (3 cu).
- Discrete mathematics II (5 cu).
- Stochastic processes (2 cu).
- Statistical pattern recognition (5 cu).
- Testing of statistical hypotheses (5 cu).
- Probability theory II (4 cu).
- Advanced course in risk theory (5 cu).

Students of *stochastic modelling and data analysis specialisation area* have to include Probability theory I (5 cu) to the cum laude approbatur programme. They may substitute it with the course Introduction to probability calculus (5 cu) offered by the Department of Statistics within the Faculty of Social Sciences of the university. The compulsory advanced level courses are as follows:

- Probability theory II (4 cu).
- Stochastic processes (2 cu).

Moreover, students have to make written assignments (minimum 2 cu) and choose one of the following aoptions:
- Statistics (5 cu).
- Statistical decision making (by the Department of Statistics) and Bayesian statistical methods, altogether 11 cu.
- Statistical decision making and Advanced course in statistical decision making (both courses by the Department of Statistics), altogether 11 cu.

Other optional advanced level mathematics courses can be taken freely so that the total points in mathematics are minimum 93 cu (including pro gradu, 16 cu). It is possible to specialise in biometry or in mathematical methods on information technology offered by the Rolf Nevanlinna Institute.

Students of *computer-aided mathematics specialisation area* have to include Mathematical methods for scientist (5 cu) to the cum laude approbatur programme. The compulsory advanced level courses are the following:
- Measure and integral (3 cu).
- Advanced course in applied analysis (3 cu).
- Numerical methods and C programming language (5 cu).

Students of computer-aided applied mathematics can freely choose minimum 24 cu from the advanced level courses, the recommended ones are Symbolic calculus (5 cu), Introduction to mathematical projects for industry (3 cu), Mathematical projects for industry (7 cu), Partial differential equations (5 cu), Real analysis I (3 cu), Real analysis II (5 cu), Stochastic processes (2 cu), and some particularly agreed courses in computer science, for example, Graphical and mathematical data processing and Digital signal processing, both offered by the Department of Computer Science of the university.

Students of *insurance and financial mathematics specialisation area* have to include Probability theory I (5 cu) to the cum laude approbatur programme. The compulsory advanced level courses are the following:
- Probability theory II (4 cu).
- Stochastic processes (2 cu).

They have to take advanced level courses of statistics minimum 5 cu (see the stochastic modellind and data analysis specialisation area mentioned before) and courses of insurance and financial mathematics, for example, Life insurance mathematics (5 cu), Advanced course in risk theory (5 cu), and Theory of financing (5 cu). Moreover, they choose other optional advanced level courses so that the total points in mathematics are minimum 93 cu (including pro gradu, 16 cu).

In every specialisation area of applied mathematics students choose two minor subjects, and another of these is required to be computer science or statistics. The cum laude approbatur programme of computer science is compulsory in the computer-aided mathematics specialisation area.

The *computer mathematics curriculum* include minimum 30 cu studies collected from the following optional basic level courses (cum laude approbatur):
- Calculus (5 cu).
- Differential and integral calculus I (11 cu).
- Written assignment on Differential and integral calculus I (1 cu).
- Linear algebra I (5 cu).
- Discrete mathematics I (5 cu).
- Logic I (5 cu).
- Probability theory I (5 cu).
- Mathematical methods for scientists (5 cu).
- Differential and integral calculus II (5 cu).
- Differential equations (5 cu).
- Topology I (5 cu).

Students of this specialisation area have to take advanced level mathematics courses minimum 30 cu. Particularly recommended courses are Probability theory II (4 cu), Numerical methods and C programming language (5 cu), Numerical analysis (5 cu), Queueing theory (5 cu), Advanced course in applied analysis (3 cu), Stochastic processes (2 cu), Mathematical logic (5 cu), Theory of computability (5 cu), and Discrete mathematics II (5 cu). Moreover, students must take at least cum laude approbatur programme in computer science (minimum 60 cu).

Other studies of curricula in mathematics contain compulsory courses in Swedish or in Finnish for those students whose mother language is Swedish (2 cu), in English or some other foreign language (1-2 cu), and introductory studies of data processing (2 cu) in case of computer science is not a minor subject. Also a tutorial course of studying at the university is given (1 cu). Other optional courses may include, for instance, History and philosophy of science (1 cu), and History of mathematics (2 cu). Moreover, working life experience sensibly connected to the studies in mathematics may give some extra credit points.

Organisation

The Finnish Constitution secures the freedom of the sciences and the highest level education. To implement these principles, the new Universities Act (1998) ensures the autonomy of the universities and prescribes their functions, operation and objectives in general terms only. Within these limits, each university decides on the detailed organisation of its administration and the decision-making power of its administrative bodies.

The Department of Mathematics has administrative posts on the following university and faculty level bodies: Faculty Council, Faculty Entrance Board, Faculty Planning Board, Subject-teacher student entrance board in the Faculty of Education, Teaching development board in the faculty, and Faculty library board. The department is headed by chairman elected every third year among the professors of the department. The Department board is chaired by the chairman of the department, and in addition to the chairman it consists of 3 members with vice members from the staff of the department and 2 student members also with vice members. Other department level bodies are Subject-teacher student evaluation board in mathematics and Department development board.

Economy

All Finnish universities are state institutions whose operations are primarily financed from public funds. In 1999 some 65 per cent of the universities' budget came from the state budget through the Ministry of Education. In addition to the university budget set by the state, the universities are increasingly procuring external funding and expanding their chargeable services. The Academy of Finland and National Technology Agency (Tekes) are among the main sources of external funding. This funding is mainly for research.

The state university budget is allocated according to a formula. This formula-based funding system has been gradually implemented since 1997 and it will be fully operational in 2003. The formula allocates basic funds to universities primarily according to their target numbers for Master's degrees and doctorates weighted by field of study. Lagging behind the targets is also taken into account in the formula.

The expenses covered directly by the department can be divided into the following seven parts:
1. The salaries of the regular staff (from 1998 on they are paid from the budget of the department).
2. Teaching fee allocation (the salaries of the instructors and the teaching assistants).
3. The acquisitions of the library: books, periodicals, and CD-ROMs.
4. Research: reports, salaries.
5. Travels and scholarships.
6. Computers: microcomputers, printers, computer software etc.
7. Mixed expenditure (this includes, e.g., mailing, telephone, telefax, photocopy paper).

The following table gives these costs in thousands of marks (FIM) in the years 1998-2000.

Year	1998	1999	2000
Salaries	9916	9270	9176
Teaching	1720	2210	1916
Library	514	816	909
Research	28	22	18
Travels	78	12	57
Computers	95	228	162
Mixed	134	142	362
Total	12485	12700	12600

In 1998 the external research funding amounted to approximately 4.36 million FIM, of which 0.96 million FIM were due to the Graduate School. In 1999 these sums were 7.63 million FIM and 0.97 million FIM, respectively, and in 2000 there were 8.54 million FIM and 1.01 million FIM, respectively.

Admission and Recruitment of students

The universities select their own students, and the competition for university places is rather fierce. An applicant may apply and become accepted for a number of places at the same time. However, as for the selection procedure for the academic year 1999-2000 onwards, a student has been able to accept only one place leading to a degree, in any one academic year.

In general, there is no national entrance examination common to all universities; the existing tests serve the various selection purposes of autonomous universities and their independent departments. However, the Department of Mathematics of the University of Helsinki use the same entrance exam for the applicants as the mathematics departments of the universities of Joensuu, Jyväskylä, Oulu, and Turku. This is possible because the examinations are organised simultaneously. The admission limit points may vary between the departments depending, for example, on the different numerus clausa and the numbers and the qualifications of the applicants.

Students majoring in mathematics are admitted in the degree programme of mathematics in two ways, firstly on the basis of matriculation certificate and secondly via entrance examination. The maximum points of the entrance examination are 20 (max. of the exam is 60 points but the points are divided by 3); these points are called as *subject points* and they can be replaced by the points coming from the matriculation certificate mark in mathematics (see the table below). If a candidate participates in the entrance examination, then the lower subject points are disregarded in selection. Note that there are two levels of matriculation examinations (advanced and basic level)

Matriculation certificate mark in mathematics	Points
Advanced level mathematics programme	
Laudatur	20
Eximia cum laude approbatur	17
Magna cum laude approbatur	14
Cum laude approbatur	11
Lubenter approbatur	0
Approbatur	0
Basic level mathematics programme	
Laudatur	14
Eximia cum laude approbatur	11
Magna cum laude approbatur	9
Cum laude approbatur	7
Lubenter approbatur	0
Approbatur	0

So called *general points* and *course points* for the selection procedure are given only for the candidates matriculated during the latest three years. The general points are indicated in the following table.

Matriculation certificate mark	Lang 1	Lang 2	Lang 3	Math	Real
Advanced level programme					
Laudatur	3	3	3	3	3
Eximia cum laude approbatur	2.5	2.5	2.5	2.5	2.5
Magna cum laude approbatur	2	2	2	2	2
Cum laude approbatur	1.5	1.5	1.5	1.5	1.5
Lubenter approbatur	0	0	0	0	0
Approbatur	0	0	0	0	0
Mid or basic level programme					
Laudatur		2.5	2.5	2.5	
Eximia cum laude approbatur		2	2	2	
Magna cum laude approbatur		1.5	1.5	1.5	
Cum laude approbatur		1	1	1	
Lubenter approbatur		0	0	0	
Approbatur		0	0	0	

The subjects are abbreviated in the previous table as follows:

- Lang 1: mother language (Finnish or Swedish).
- Lang 2: another domestic language (Swedish or Finnish).
- Lang 3: foreign language (usually English).
- Math: mathematics.
- Real: so called real subjects, including e.g. physics, chemistry, geography, biology, history, and religion.

The following table indicates the system of course points given based on the number of taken courses in mathematics (in the upper secondary school) and the level of these courses:

Number of taken courses	Course points
Advanced level mathematics programme	
10	0
11	2
12	4
13 or more	5
Basic level mathematics programme	
6	0
7	2
8	4
9 or more	5

The *comparison number* of an applicant is set to be the greater one of the sum of subject, general, and course points (max. 20 + 15 + 5 = 40) and 2 times subject points (max. 2 x 20 = 40). The selection is made based on the order of these comparison numbers provided that all of the admitted applicants achieve the minimum points set by the selection board.

The following table contains the numbers of inscribed mathematics majors during the years 1998-2000.

Year	1998	1999	2000
New majors	201	180	201

In addition to majors, every year on the average 380 minors start their studies in mathematics mainly on the introductory courses Calculus (Approbatur I), Differential and integral calculus I and Linear algebra I.

The students who follow the mathematics teacher curriculum are selected among the mathematics majors during the second or third year of their studies (max. 35 students yearly), see the detailed statistics below. The selection is based on examination according to qualifications in mathematics and an interview. In recent years some mathematics majors (max. 35 new majors yearly) have been admitted particularly to follow the mathematics teacher curriculum from the beginning of their studies at the department. In 1999 the number of admitted mathematics students with this procedure was 32; the number of applicants was 37.

The following table indicates statistics concerning the students majoring mathematics who were admitted to follow the teacher mathematics curriculum in 1999-2001.

Year	1999	2000	2001
Numerus clausus	35	35	35
Number of applications	8	14	12
Entrance exam participants	8	14	11
Admitted students	8	14	11

The following table indicates statistics concerning the students who had graduated in mathematics before and were admitted to extend their degree with pedagocical studies (35 cu) in 2000-2001.

Year	2000	2001
Numerus clausus	5	5
Number of applications	0	3
Entrance exam participants	0	3
Admitted students	0	3

No special methods are used to recruit new students to the department. There are yearly announcements by the faculty published in all widely distributed Finnish newspapers. The faculty provides information of admission and application forms on its web site http://www.helsinki.fi/ml/tdk/. Moreover, some upper secondary school classes, in particular natural science oriented ones, may visit in the department before the entrance examinations of the universities, and a staff member introduces the department to them.

The students

The following table contains the total numbers of students who were majoring in mathematics and the numbers of foreign students who were studying at the department having mathematics as their major subject.

Year	1998	1999	2000
Students majoring in mathematics	1135	1153	1143
Foreign students majoring in mathematics	17	20	18

In 1998 of foreign students 14 had the M.Sc. degree as the goal, one had a postgraduate degree as the goal, and two were taking some courses without aiming any degree. In 1999 these numbers were 11, 3 and 6, respectively, and in 2000 they were 12, 1 and 5, respectively.

In 1999 the proportion of female students of all students majoring mathematics was 363 (31.5 %). In the case of the students following teacher mathematics curriculum this percentage of female students is usually more than 50 %.

The level of the students' previous knowledge in mathematics is unfortunately rather getting worse than remaining the same as before. There is no time series information on diagnostic tests concerning the beginning students, but the tendency seems to be clear based on the lecturers experiences within the basic level courses. In principle, the Advanced level upper secondary school mathematics programme is regarded as a splendid base to begin the mathematics studies at the university. However, some beginning students have adopted this programme incompletely, even if they have passed the matriculation examination in mathematics rather well.

Academic teachers

There are five different categories of teachers working at the department: professors, lecturers, senior assistants, assistants, and instructors (the numbers of teachers at the department are indicated in the table below). Previously the professorships were divided into two categories, professorships and associate professorships; this terminology was changed in 1998. Also the lower level categories are now under the change; both assistant categories and the lecturer category will disappear and they will be replaced with some new categories such as university lecturers.

Year	1998	1999	2000
Professors	15	15	14
Lecturers	3	3	3
Senior assistants	2	2	2
Assistants	12	12	12
Instructors	2	3	3
Total	34	35	34

There were about 15-20 teachers on a part-time basis in 1998. This number was about 10-15 both in 1999 and in 2000. In 1998 the department had 56 docents, in 1999 this number was 61 and in 2000 it was 63. The department accommodates also foreign visiting scholars funded by the Academy of Finland and other external sources.

Compared to the number of the graduates, the number of the teachers at the department should be sufficient. However, the service teaching is a demanding challenge for the department, and it is not possible to offer all the required courses and instruction groups every year. This is influenced mainly by the insufficient state university budget necessary to hire more instructors.

Principally teachers' (lecturers, senior assistants, and assistants; professors are not considered here) work schedule consists of time for their own research too. Increasing stress on teaching and paper work has caused that the

time left for research may be insufficient. After all the main part of the teachers also publish research articles every year.

The professors' duties consist of teaching about one lecture course both in the spring term and in the fall term (a term lasts about 15 weeks). One lecture course usually consists of 4 lecture hours and an exercise session weekly, but the preparation of course material, instruction problems, and examinations takes, of course, even more time than the actual lecturing.

The feed back system in teaching has been developed recently at the department. Previously the feed back was collected from each course separately by the filled paper forms. Usually the mathematics student organisation Matrix prepared a summary of the returned forms. The feed back system was reorganised during the spring term 2001, and since then the feed back is received electronically via internet based on filled web forms. The feed back offers to teachers an opportunity to learn students' opinions and to develop teaching methods.

Infrastructure

The premises of the department are located in four floors (4.-7.) of the office building Heimola (Yliopistonkatu 5) in the centre of Helsinki. There are 52 offices, 5 seminar rooms, a departmental library, and 2 microcomputer rooms, altogether 1556 m^2. In addition, in the office building Vuorikatu 20 there are 4 seminar rooms, altogether 156 m^2. A large part of the lectures and all exams are held in big lecture halls of the university outside Heimola.

The department has about 100 PC computers and 8 Macintosh computers, which are all connected to the university network. For output there are 18 laser printers. The computers are mainly used for word processing, typesetting, and communication by electronic mail, but some mathematical and statistical programs are used as well. The laboratory engineer of the department supports the equipment and consults the staff in automatic data processing. Students can use two microcomputer classrooms, which have altogether 19 PC computers and one laser printer. The students and the staff of the department have about 1000 accounts on the UNIX machines of the university.

The department has the largest and most comprehensive mathematical library in Finland. The collection is the only one containing advanced mathematical literature at the University of Helsinki. The collection covers a wide range in the field of mathematics. It is considered to be of a very high international standard (especially the journals). The library is exclusively funded by the department.

The collection of the library consists of about 45000 bindings on almost 2000 shelfmeters. During the latest years the accumulation of new books has been 350-400 titles annually. In 2000 the library received 435 titles in periodicals and reports. Most of them are received only in printed form, about 100 both in printed and digital form and one title as CD-ROM. Some titles are received through internet only. On the printed titles 55 are also available through FinELib which is an electronic database. The most important reference databases are MathSciNet and the STN International Math, which can be used as on-line versions on each PC computer at the department. Also the book- and journalcatalogies have been transformed into a part of the electronic HELKA- and LINDA-databases. LINDA is aimed to comprehense all scientific libraries at Finnish universities. The library produces material to the ARTO/JULKI database, which gives information on articles either published by Finnish authors or published in Finnish journals. The Faculty of Science has its own database SIEPPO, which includes in particular the theses of various degrees.

The core clientele consists of teachers and researchers at the department, as well as of graduate students and advanced undergraduate students, and of the mathematics departments of other Finnish universities. During the semesters the opening hours are 8.30-19.30 Monday through Thursday, and 8.30-17.30 on Friday. Off semesters the library is open 8.30-15.30 daily (not on Saturdays, though). In the autumn of 1999 the library joined the computerised lending system provided by the HELKA database. Information services – such as scrutinising the contents of journals – has been offered to several customers.

The administrative, library, and technical staff consists of 7 persons.

Summary

Indicated strengths of the structure and the prerequisites of the education:

- Versatile range of mathematics courses.
- Competent teachers as well as other staff.

- Internationally high-level research in various sub-areas of mathematics.
- The library is of a very high international standard (especially journals).
- Flexible mathematics programmes for students.
- The department is capable to compete project funds.

Indicated weaknesses and threats of the structure and the prerequisites of the education:
- Insufficient space for computer rooms.
- Insufficient amount of the automatic data processing equipment.
- Crowded staff office rooms.
- Over 150 students in the same lecture hall in the basic courses.
- Crowded classrooms.
- Service teaching is not appreciated by the faculty.
- On the average, previous mathematics knowledge of new students is getting worse.
- Studying is secondary for the students; a priority is to work and earn better standard of living.
- Insufficient state university budget.
- Mathematics and studying mathematics are not esteemed highly enough in our society.

Positive challenges in the future:
- Effective and versatile mathematics teacher training.
- Fresh ideas on teaching methods.
- Concentrating on new areas in applied mathematics (e.g. mathematical finance and risk theory).
- Cooperation with information technology companies.
- Increasing number of students interested in mathematics.
- Ever-increasing need for mathematics in our society.
- In 2004 the department will move to the Kumpula campus area where all the natural science departments will be located then. The new campus offers better facilities.
- Plans to combine the Department of Mathematics and the Department of Statistics.

A.2 Educational process

Didactics, types of teaching, examination forms.

In mathematics, independent study plays a greater role than in many other subjects. The most important methods of teaching are lectures, problem solving classes, various kinds of written assignments and projects, and (principally in postgraduate studies) seminars. Workshop teaching is also used to complement the more traditional forms of teaching. In every year 1998-2000 there were around 90 small problem solving groups per term convening once a week. In addition to this traditional line, several pilot programmes have been run in recent years to advance teaching and collaboration between students and teachers at the department. Attempts have been made to develop forms of activity which meet students at all stages of their studies. The following programmes were active in 1998-2000.

Tutoring. All the beginning students were divided into small groups meeting their own tutor regularly. During the sessions the teachers gave general instruction on studying mathematics and advised their students in details of courses in which they took part. Later on all students were invited to contact one of these tutors.

Instruction groups. In connection with the main analysis course (Differential and integral calculus I) the students took part in special instruction groups in addition to usual lectures and problem solving classes. In these groups the students worked together with the instructor on problems presented ex tempore. In 2000 this activity was the version of tutoring in use for first year students.

Problem seminar. This elementary seminar consisted of a few groups. The leading theme was the mathematical problem posed in the course Differential and integral calculus I, but any questions arisen from any course were discussed as well. Also some more theoretical courses are added to the scope of this activity.

Pro gradu seminar. In this seminar different aspects of producing a mathematical document were covered varying from the use of a text processor to the art of mathematical writing. The students also gave talks on their M.Sc. theses.

Study group. In fall 1998 a new kind of learning environment was added. About 20 students started in this programme in fall 1998, about 30 students started in fall 1999 and about 15 students started in fall 2000. These students study together the central portion of the cum laude level mathematics. The work is based on approaching entire courses (or mathematics in general) from general phenomena related to their central problems. This form of instruction directed especially to teacher training.

In general, the students are encouraged to organise study groups, problem sessions etc. of their own. The department traditionally offers 2-4 cu for this kind of studies. During the recent years 2-3 such groups have been working annually.

A typical mathematics course consists of 50-60 lectures (a lecture lasts 45 minutes) and 20-30 hours of problem solving classes in small groups. A typical course is worth 5 cu.

Oral skills of the students are trained during the problem solving and instruction group meetings. Typically students solve six mathematical problems during one meeting which lasts two lecture hours, and every problem is solved by participating students under the supervision of an instructor. Moreover, the students may give seminar talks on the advanced level course topics, mainly during the last year(s) of their studies at the department. Writing skills are trained, for example, with the written assignment on Differential and integral calculus I, which is compulsory for all mathematics majors. On the other hand, writing skills are also well trained when the students present solutions to exam problems.

Evaluation of learning process is traditionally made in forms of mid term and final exams. Instruction group activity may give some extra points in the evaluation. It is possible to take some courses at least partly by writing essays as well as by participating seminars and giving seminar talks.

Students of the department and foreign students willing to study at the department may participate in some international exchange programs, such as SOCRATES and NORDPLUS. However, this activity has not attracted the students widely, the average numbers of exchange students studying abroad and foreign students studying here has been 4 and 3 per year, respectively. The main obstacle for this activity to spread more is the lack of sufficient funding, also other social aspects have influence on the students willingness to study abroad.

Lately one important area of development at the department has been to offer course material via internet. Traditionally the central course material has been the teachers notes offered for copying (or published by some local publisher), but the quality of the notes is indicated to be quite varying. Moreover, students (teachers as well) have appreciated to have the course material in Finnish, and internationally published books (usually written in English) are therefore not used widely; the books are also high-priced, notation is not standard, and joining the contents of books may be difficult.

Teacher education

Basically the courses and the types of teaching in mathematics are common to both the students following the teacher mathematics curriculum and the other mathematics majors. However, as mentioned above, in recent years the department has launched a pilot programme called study group. This programme is directed especially to teacher training.

Summary

Indicated strengths of the educational process at the department:
- Versatile range of teaching types.
- Competent teachers.
- Given special value to the prospective teacher training.

Indicated weaknesses of the educational process at the department:
- Traditional lectures are not attractive enough.
- Classes much too big on the freshman level.

- Courses are too wide and demanding when taken into consideration students' previous knowledge in mathematics.

A.3 Outcome

Finnish universities are undergoing rapid changes: the number of students has risen considerably and universities are expected to produce higher numbers of Master's degrees and doctorates. In order to ensure possibilities for long-term work in universities the Government is committed to secure the positive development of university core funding by legislation.

Throughput

The Department of Mathematics is one of the most productive departments of the university measured by the credit points awarded yearly. The total amounts of the students' credit points at the department in 1998-2000 were as follows:

Year	1998	1999	2000	Total
Credit points (cu)	13331	13074	14715	41120

The numbers of M.Sc. thesis in each programme in 1998-2000 are given in the following table. The number of graduates is rather low as compared to the student intake. One reason for this is the nature of mathematics, which makes great demands on the students. Another reason for the drop-out is that many students are not intending to graduate in mathematics but rather use the first year mathematics studies as a preparation for admission to other degree programmes or universities. It is remarkable that the teacher mathematics programme produced 52 % of the graduates in 1996-2000.

Year	1998	1999	2000	Total
Mathematics	9	17	15	41
Teacher's	24	20	26	70
Applied math.	4	18	8	30
Total	37	55	49	141

The M.Sc. degree usually demands at least five years of full-time study, while the less extensive B.Sc. degree can be reached in 3-4 years. However, one tendency in M.Sc. degree programmes seems to be that the studies take longer than five years. The average time is approximately 6.5 years.

Follow-up

The employment prospects for mathematics graduates have generally been good and they are expected to remain so. Indeed, a mathematical education provides an almost unlimited choice of careers that can be expanded even further by a postgraduate degree. The recent study (by the faculty) of employment shows zero level unemployment for recently graduated mathematics majors.

Most mathematicians are employed by teaching in comprehensive and upper secondary schools, technical colleges, and universities. University teachers are usually also researchers; this is in particular the case with the Department of Mathematics. Research in mathematics offers the best possible combination of an international career and the exciting world of mathematics. Researchers in applied mathematics often act as consultants in industrial mathematics or participate in research projects of other fields of science.

The traditional area of employment for mathematicians, the insurance companies, continues recruit graduates as insurance mathematicians and actuaries. In fact, the curriculum in insurance mathematics is currently being expanded. There is also a growing demand of mathematicians in finance. An area offering high prospects and interesting perspectives into the various field of technology is industrial mathematics. The department launched a special programme in industrial mathematics a few years ago. Information technology is another field that calls for students with mathematical or mathematically oriented degrees.

Economy

Education at the Department of Mathematics can willingly be regarded as satisfactory in relation to its cost. Teaching requires no expensive equipment, and the most significant expenditure is qualified labour.

Summary

The strengths of the outcome:
- The department is one of the most producing departments of the university measured by the awarded credit points.
- The employment prospects for mathematics graduates are excellent.

The weaknesses of the outcome:
- The number of graduates is rather still low.
- Many students are not intending to graduate in mathematics and they interrupt their studies.

A4. Comprehensive assessment

The most important strengths of the department identified by the self-assesment:
- Fresh ideas on teaching methods.
- Competent teachers.
- High-standard research.
- Flexible mathematics programmes for the students.
- The employment prospects for mathematics graduates are excellent.

The most important weaknesses of the department identified by the self-assesment:
- Insufficient state university budget for effective first and second year studies.
- On the average, previous mathematics knowledge of new students is getting worse.
- The number of graduates is still rather low.

Part B: Graduate studies.

Beyond the M.Sc. degree there are two graduate degrees, the Ph.Lic. (Licentiate of Philosophy) degree and the Ph.D. (Doctor of Philosophy) degree, of which the latter has higher quality requirements. The major subject can be mathematics, applied mathematics, or computer mathematics. For each graduate student, an individual study programme is designed outlining the field of specialization, the topic of the thesis and the contents and schedule of the other required studies. A personal advisor is also assigned to each student.

The requirements for the Ph.Lic. degree in mathematics, applied mathematics, and computer mathematics are as follows:

1. A M.Sc. degree in mathematics, applied mathematics, or computer mathematics.
2. Courses and seminars, 40 cu.
3. Ph.Lic. thesis.

The studies in part 2 normally consist of advanced level courses and seminars in the major subject and some courses in the minor subject(s).

The requirements for the Ph.D. degree in mathematics, applied mathematics, are computer mathematics are as follows:

1. A Ph.Lic. degree in mathematics, applied mathematics, or computer mathematics, or parts 1 and 2 of the requirements for Ph.Lic.
2. Ph.D. thesis.

Thus a student aiming directly at the Ph.D. degree need not complete the Ph.Lic. programme. The Ph.D. thesis is required to be based on original research of the student.

The following table indicates the numbers of postgraduate students and the numbers of awarded graduate degrees in 1998-2000. All of the students who awarded a Ph.D. degree during these three years were male. However, a minor percentage (10-20 %) of postgraduate students are female. The numbers vary greatly from a year to another. For example, in 2001 there were 10 Ph.Lic. degrees in mathematics.

Year	1998	1999	2000	Total
Postgraduate students	60	70	70	
Ph.Lic. degrees	5	4	4	13
Ph.D. degrees	2	1	1	4

A rough estimate of the average time the postgraduate students finished their licentiate studies is 3 years (after graduation), whereas the average time of the finished doctoral studies is 3 years more adding to 6 years.

In 1999-2000 of the postgraduate students 26 worked at the department as assistants or as researchers financed by the university, the Academy of Finland, the graduate school, or a private grant. A graduate school in mathematical analysis and logic, common with other universities, commenced at the beginning of 1995, with six hired students in the department in each year 1998, 1999 and 2000. Moreover, the department has a postgraduate programme in industrial mathematics which is a part of the European programme ICMI.

The department has offered graduate seminars in the following areas: analysis, geometric analysis, mathematical physics, functional analysis, transformation groups, algebraic topology and algebraic geometry, mathematical logic, mathematical thinking, philosophic logic, stochastics, stochastic models, stochastics and finance, mathematical economics, insurance and finance mathematics, MCMC methods, and digital communication.

Summary

Indicated strengths of the graduate studies:
- Versatile range of the graduate courses.
- Number of postgraduate positions is big enough when compared to the number of graduates.
- Competent advisors.
- High-standard theses.

Indicated weaknesses of the graduate studies:
- Insufficient number of the postgraduate degrees, which effects on the state university budget allocated according to the formula.
- Salaries of postgraduate students are not competitive so students tend to seek employment outside universities after having a Ph.Lic. degree.
- In mathematics it has been difficult to adopt the new system so that doctoral studies take 4-5 years only.

Self-assessment for Mathematics, Mathematical Statistics and Numerical Analysis at Lund University

Introduction

A couple of peculiarities concerning mathematics and related fields at Swedish universities should be explained at the beginning. In contrast to the situation in some other countries, probability theory and numerical analysis have traditionally not been considered to be parts of mathematics. A few decades ago, at a typical Swedish university there would be one Department of Mathematics, doing research and teaching in traditional Mathematics, i.e. Algebra, Analysis and Geometry. There would be an independent Department of Mathematical statistics, responsible for the two branches of its field: Probability theory and Statistics. Finally there would be a Department of Information processing, with research and teaching in the two branches of that field, namely Administrative information processing and Numerical analysis. Since then, the situation has changed, and there has been a development of merging the former one-subject departments into larger units, but still Mathematical statistics and Numerical analysis are considered to be separate subjects and not merely branches of Mathematics like for example Algebra and Geometry. This circumstance is reflected in the following text.
The Swedish academic system was originally modelled on the German one, and one can still find traces thereof, but in the last forty years various reforms have changed the picture. Until forty years ago, the only permanent positions for teaching at the universities were the professorships, but to meet the rapid expansion of academic education in the sixties, new types of positions were created: Lecturers and Assistant teachers. These positions were originally intended for teaching only (i.e. not for research); in the seventies almost all undergraduate teaching were performed by these new categories and by the graduate students, and the professors lost or gave up almost all contact with the teaching at this level. Since then, there have been made (successful) efforts to turn this development; to stimulate scientific research among the lecturers and encourage the professors to take part also in the basic education.
The extent of a course at a Swedish university is measured in credit units, where 40 units correspond to an annual full-time equivalent. In other words, 1 credit in the Swedish system (used throughout this report, if not explicitly stated otherwise) corresponds to 1,5 ECTS credits.

Part A: Undergraduate studies

A1. Structure and Resources

Contents

The Centre for Mathematical Sciences was formed on 1 January 1999 from the former departments of mathematics and mathematical statistics and the research group in numerical analysis, which previously was part of the department of computer science. It is subordinated under two of the faculties of Lund University: the Faculty of Science (Matematisk-

naturvetenskapliga fakulteten, MNF) and the Institute of Technology (Lunds tekniska högskola, LTH).
The Centre is divided into four divisions: Mathematics MNF (MMNF), Mathematics LTH (MLTH), Mathematical statistics (MS) and Numerical analysis (NA). The two latter divisions perform research and teaching at both faculties.

When describing the programmes offered, one should make a distinction between so called free studies and education leading to a profession. At the Faculty of Science, the studies are essentially free, which means that the students, although they formally may be enrolled in a programme, have extensive liberty in choosing courses according to their taste and interest. An exception from this is the group of students aiming to be secondary school teachers. The school of Teacher Training belongs to Malmö University College, which is separate from Lund University, but by an agreement between Malmö and Lund, the students get their subject theoretical education (i.e. mathematics for example) at Lund University, whereas the pedagogical training is provided by the Teacher Education College in Malmö. At the Institute of Technology the education leads to a profession, namely graduate engineer (Master of engineering).

At the faculty of science (MNF), there are the following categories of students:
1. Those who follow the four-year study programme "Mathematics and science", and who begin their studies with basic courses in mathematics with the intention to continue with physics, geology, computer science or chemistry afterwards.
2. Those who study a single subject course in mathematics and/or related fields.
3. Those who are aiming at becoming secondary school teachers.

In practice, there is very little difference between the conditions for the students of the first two categories; it is possible to choose freely from the courses offered. As the student influx has been decreasing in the last years, the formal numerus clausus does not imply any real obstacle.
For an overview of the courses offered by MMNF, see the appendix.

The Institute of technology (LTH) educates graduate engineers. There are twelve study programmes containing mathematical courses: Biotechnology, Fire Protection Engineering, Information and Communication Engineering, Computer Science and Engineering, Electrical Engineering, Engineering Physics, Industrial Management and Engineering, Chemical Engineering, Surveying, Mechanical Engineering, Civil Engineering and Environmental Engineering. These programmes have a common compulsory course "Mathematics, Basic course" of 16 credits (24 ECTS). This course contains Calculus in one variable I (4 credits), Calculus in one variable II (4 credits), Linear algebra (4 credits) and Calculus in several variables (4 credits). The first three parts belong to the first year, the last one to the second year.
At the intermediate level, the programmes Engineering Physics, Electrical Engineering, Computer Science and Engineering and Industrial Management and Engineering have compulsory courses in mathematics comprising 9-10 credits. There are also optional courses, based essentially on the Basic course. For Engineering Physics there is another compulsory course, Nonlinear Dynamical Systems and for Mechanical Engineering there is another compulsory 5 credit-course in the second year. In other programmes there are no further compulsory mathematical courses after the Basic Course.
Within the programme Engineering Physics, there is a direction "Systems and applied mathematics" with two different profiles, one of which is directed towards differential

equations and the other one towards mathematical image processing. The latter is designed in collaboration with Mathematical Statistics and it has led to many Master's Theses.
MS gives a compulsory course "Mathematical Statistics, Basic course", comprising 5-6 credits ath the programmes Computer Science and Engineering, Electrical Engineering, Engineering Physics, Industrial Management and Engineering, Chemical Engineering Surveying, Mechanical Engineering, Civil Engineering and Environmental Engineering, and an optional 5 credit course for the four first mentioned programmes.
NA gives compulsory 4-5 credit courses for Computer Science and Engineering, Engineering Physics, Industrial Management and Engineering and Civil Engineering and an optional 4-credit course for Chemical Engineering.

Lund University is not involved in the education of primary school or lower secondary school teachers, but only in upper secondary school teachers. The students (formally registered at Malmö University College and not at Lund University) take the mathematics courses (20 credits) from level A (Mathematics 1 alpha, Mathematics 1 beta), 20 credits from level B (Multivariable Analysis, Linear Algebra and either Fourier Analysis or Discrete Mathematics). In the third semester they take a 10 credit-course "Mathematics for Teachers" which contains traditional school mathematics like Euclidean geometry and also some history.

Service teaching in mathematics and mathematics as a minor subject

Physicists normally follow the same curriculum as other students of mathematics. They typically begin their studies by Mathematics 1 alpha and Mathematics 1 beta in the first semester, then Multivariable Analysis, Linear Algebra and Fourier Analysis in the second semester. Then they pass on to the Department of Physics, and when they feel that they need it, they come back and choose one or more from the 5 credit courses in Mathematics.
Chemists and biologists often do not have the need of or interest in that much mathematics. A few years ago our course system was reorganised, and one of the purposes was to offer to this category the possibility to take 10 credits of Mathematics (i.e. Mathematics 1 alpha) with curriculum that would be reasonable for them. Nevertheless, we intend to reintroduce a course titled "Mathematics for Scientists" in the next autumn, aiming primarily at chemists and biologists. This will be an application-oriented course with less mathematical rigor than in the standard courses and more of heuristic reasoning.

Teacher Education

The syllabus for teacher education has partly been described above. The department comes in contact only with future upper secondary school teachers (school years 10-12). They study the same curriculum as other students in the first year (levels A and B). In the third semester they take the course Mathematics for teachers, combined with two 5-credit courses in Mathematical Statistics and in Numerical analysis, respectively. This amounts to 60 credits in Mathematics and related fields.
A secondary school teacher usually has a first and a second subject. The requirements are (until now) 80 credits in the first subject and 60 credits in the second. If they want to have mathematics as their first subject they thus need 20 more credits. These can be chosen freely from the 5-credit courses on the higher levels or among the courses in mathematical statistics or numerical analysis.
The education is completed with 40 credits of pedagogy and teacher training at Malmö University College.

Diploma in mathematics

The programme for Mathematics and Science at Lund University leads to degrees corresponding to Bachelor's degree or Master's degree. Both degrees presuppose a main subject. For the Bachelor's degree at least 120 credits are required, thereof at least 60 credits in the main subject, including a thesis of 10 credits, and at least 20 credits in other subjects. The Master's degree requires 160 credits, thereof at least 80 in the main subject (including a thesis of 20 credits) and at least 40 in other subjects. Apart from these constraints, the courses can be chosen quite freely within the university. In this connection all the three subjects in the Centre for Mathematical Sciences are counted as Mathematics. The restrictions (compulsory courses) are implicitly given by the admission requirements to other courses, and this means essentially that the courses MAT121 and MAT122 are compulsory for everyone aiming at a degree in mathematics.

Economy

The number of students is counted in full-time equivalents (FTE); one FTE corresponds to one student studying full time for one year. The table below gives the data in SEK per full-time equivalent in the year 2000.

Allocation of financial means, year 2000						
	Mathematics		Mathematical Statistics		Numerical Analysis	
	MNF	LTH	MNF	LTH	MNF	LTH
SEK/FTE, according to budget	27900	36600	39200	43300	52000	32200
SEK/FTE, actually registered students	34600	35400	39800	37000	-	40300
Side costs (rent etc.)	10200	11600	10200	11600	10200	11600
For teaching	24400	23800	29600	25400	-	28700

Admission and recruitment of students

As mentioned above, there is a numerus clausus, but in the last years it has had no practical effect because of the decreasing student influx. There are general eligibility requirements that one has to fulfil in order to be admitted to undergraduate education. These are the same for all Swedish universities and for all programmes. The methods for recruiting students consist in distributing information brochures to the upper secondary schools in the region. Every year some teachers and "student ambassadors" make tours, visiting the schools and making propaganda for their university.

The students

The student numbers (registered for the first time) in the last three years are shown in the following tables. The number of admitted students is relevant only for the first course in mathematics.

Mathematics, MNF:

Level	Year	Admitted	Enrolled	Female	FTE
A	1999	501	350	115	151
	2000	454	330	112	139
	2001	275	229	69	92
B	1999		276	72	69
	2000		285	68	71
	2001		371	92	107
C	1999		197	33	25
	2000		225	29	28
	2001		175	34	22
D	1999		57	10	7
	2000		35	2	4
	2001		70	8	9

Mathematical statistics, MNF:

Level	Year	Enrolled	Female	FTE
A	1999	21	6	10
	2000	28	9	14
	2001	42	9	13
Service	1999	90	49	11
	2000	90	49	11
	2001	86	53	11
B	1999	41	20	5
	2000	51	16	6
	2001	41	17	5
C/D	1999	23	14	3
	2000	36	10	4
	2001	44	12	5

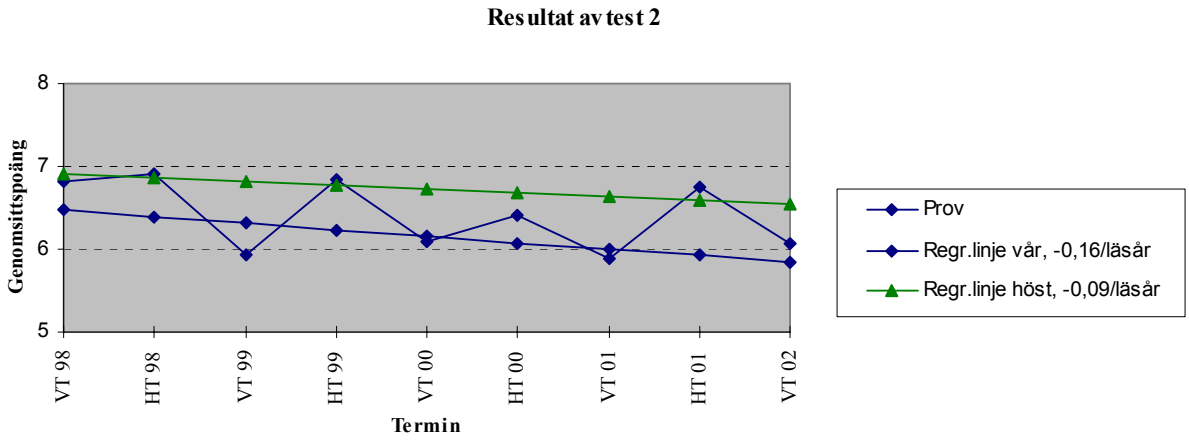
At the LTH about 1250 students are admitted each year. For MLTH the amount of teaching is 550 FTE and MS has 137 FTE at the LTH. NA had only 2 FTE at the MNF and 31 FTE at the LTH in the year 1999/2000 and 6 FTE at the MNF and 56 FTE at the LTH in the year 2000/2001.

To study mathematics one has to have completed upper secondary school at the technical or scientific programme. In reality, the previous knowledge of most students is far from what would be desirable. This is a general problem that has been discussed even publicly in the last years. In Lund there is time series information from diagnostic tests, confirming that the situation is getting worse. The same test is given every year, on the first day of the first semester. In the 1998, the test was changed, since it could be critisized for being obsolete, but the tendency in the years 1991—1998 was the same as the one illustrated below.

The present test consists of 16 questions. It is of multiple choice type with four or five alternatives for each question. The following table gives the result (average number of correct answers for all semesters (S=spring, A=autumn) since spring 1998:

Semester	S98	A98	S99	A99	S00	A00	S01	A01	S02
Number of participants	107	211	155	150	132	176	110	84	140
Average (max=16)	6,82	6,90	5,93	6,84	6,08	6,42	5,89	6,74	6,06

The diagram below shows the lines of regression, for spring semesters and autumn semesters separately. The upper slanted line corresponds to autumns. Its slope is –0,09units/year. The slope of the lower line, corresponding to springs is –0,16. (VT means spring, HT means autumn).



Academic teachers

There are the following categories of academic teachers: Professors, lecturers (with or without venia legendi; the former will be referred to as senior lecturers), research assistants, associate lecturers (in Swedish “adjunkt”), graduate students and finally students employed as non-permanent teachers, paid on an hourly basis. The professors carry the main responsibility for the scientific activity. They teach mainly, but not only, postgraduate courses. The lecturers are in charge of the undergraduate teaching, but they also have some time for own research. The research assistants do not have permanent positions. In general they have a four-year contract. In that time they are expected to qualify themselves for permanent positions. The supply of teachers at the Centre for Mathematical Sciences at Lund University and an overview over their duties is shown in the table on the next page. About 25% of the teaching is carried out by the non-permanent teachers, mainly exercises and problem demonstration. The lecturers are entitled to get 20% of their time reserved for own research. The university regularly offers courses to younger unexperienced teachers to develop their teaching skills.

	Number				
		Research	Undergraduate teaching	Postgraduate teaching	Administration
Professors	15				
MMNF	4	35%	30%	30%	5%
MLTH	2	40%	15%	25%	20%
MS	7	35%	20%	20%	25%
NA	2	40%	20%	20%	20%
Senior lecturers	15				
MMNF	6	25%	55%	10%	10%
MLTH	6	26%	44%	10%	20%
MS	1	40%	50%	10%	
NA	2	5%	75%	10%	10%
Lecturers	26				
MMNF	3	10%	75%	5%	10%
MLTH	16	12%	81%	1%	6%
MS	6	37%	51%	3%	9%
NA	1		100%		
Research Assistants	3				
MMNF	2	80%	20%		
MLTH	1	80%	20%		
MS	0				
NA	0				
Adjoint lecturers	6				
MMNF	1		60%		40%
MLTH	4		100%		
MS	1		100%		
NA	0				
Graduate students	51				
MMNF	13	81%	19%		
MLTH	14	82%	18%		
MS	22	84%	16%		
NA	3	84%	16%		
Non-permanent teachers[1)]					
MMNF	10		100%		
MLTH	40		100%		
MS	15		95%	5%	
NA	13		100%		

1) The non-permanent teachers serve to an extent of only 15% of full time.

Infrastructure

The department has at its disposal, within its own premises, one lecture hall with 160 seats, 9 seminar rooms with 30-40 seats each and two computer rooms with 15 personal computers in each. In addition, a large number of lecture halls, seminar rooms and computer rooms are available for rent. Since most of the teaching takes place in the morning, a couple of seminar rooms can be reserved for students in the afternoon. There they have the possibility to study together.
The supply of computers for the students is rather good, and every employee, including graduate students, has his/her own computer.
The library maintains a high standard with respect to higher education and research. The supply of literature for the undergraduate level is more modest.

Summary

Strengths:
Mathematics: The divisions MMNF and MLTH have highly qualified teachers with a long experience from teaching. Many textbooks in mathematics have been written by academic teachers in Lund, and some of these are being used at other academic institutions in Scandinavia. The scientific tradition is very strong.
Mathematical statistics: Within MS there is a good cooperation between the two faculties. The division is successful in obtaining external financial support and it has good contacts with other fields and with the society.
Numerical analysis: Small but effective staff of enthusiastic teachers.
Weaknesses:
Mathematics: Decreasing student influx. Students' background knowledge decreasing. Labour market insecure for students of mathematics.
Mathematical statistics: Decreasing student influx. Weak connection between the mathematics taught by MMNF and the mathematically interesting parts of mathematical statistics.
Numerical analysis: Weak ties in the educational administration of the faculties. Understaffing has made contacts to the industry difficult. The situation in this respect is, however, improving.

It should be remarked that a surprisingly large number of beginners (165) enrolled att the introductory course Mathematics 1 alpha in January 2002, compensating for the surprisingly low number of beginners in September 2001.

A2. Educational process

Didactics, types of teaching, examination forms

The two main types of teaching are the lectures (for all students in a certain course, up to 150 listeners) and the lessons for groups of about 30 pupils. In the course MAT121 (1 alpha) there are lectures Monday, Wednesday and Friday mornings (two hours each) followed by two hours lessons. On Tuesdays and Fridays the students are offered tutor-led exercises aiming at improving the basic problem-solving skills. On level B there are normally two hours of lectures combined with two-hour lessons twice a week. In the lectures the theory is presented and the lessons are essentially devoted to discussing problems that the students are expected

to have solved before the lesson. The students present their solutions at the blackboard. There are also larger projects for the students to treat and present in front of the group. The purpose of this is to train the communicative skills. In the courses on higher levels, where the student numbers are small, the lectures and lessons are merged.
At the LTH there are essentially only written examinations. At the MNF there are written examinations at all courses, followed by an oral examination for those who passed the written test. In the oral examinations the student is asked for definitions, theorems and proofs. Those who do not pass the oral examination can repeat it one week later. Those who fail at the second attempt have to repeat also the written test. Exceptions are the courses MAT121 and MAT241, where there are no oral examinations.
Every division has a student advisor to guide and advise the students. There are also student advisors in the central administration for more general guidance.
At the end of each course there is an inquiry to give the students the opportunity to give their opinions and viewpoints on the course, the teaching, the literature etc.

Summary

The educational process is rather traditional. Much effort has been spent on adapting to the fact that the basic skills of beginning students are getting weaker. A valuable feature of the education is the communicative training given to the students. The students as well as the teachers appreciate the system with oral examinations also on undergraduate courses, which is quite uncommon in Sweden. There is a close contact between the undergraduate and the graduate teaching.
The future school teachers study together with other students and they are subject to the same examination procedure as the others.
A predominant concern of the department is the recruitment of students.

A3. Outcome

Through-put

The following table shows the performance (through-put) in relation to the number of enrolled students and the number of Mastes's theses in the period 1997-2000

	Mathematics		Mathematical statistics		Numerical Analysis	
Level	MNF	LTH	MNF	LTH	MNF	LTH
A	68%	62%	50%	80%	79%	71%
B	53%	88%	47%	70%	-	40%
C/D	50%	67%	44-79%	79-86%	-	-
Theses	13	40	46		10	

Around 30 students are admitted to teacher training each year. About one third of these interrupt their studies.
The median time of study is exceeds the stipulated period of studies of study by approximately 15%.

Follow-up

Mathematics has a general educative and competence increasing rôle. Many students study mathematics at level A to strengthen their ability in basic studies of other subjects. Among the students at higher levels one finds several who have made an academic carreer in other fields, many of them are professors. A third group consists of those who become teachers in public schools. Finally there is a category of students who get an employment related to mathematics or become graduate students.
Students with a master's degree in mathematical statistics or graduate engineers directed towards mathematical statistics find employment in pharmaceutical manufacturing, information technology, insurance companies; some of them proceed to graduate studies.

Summary

The decreasing student influx is a problem which, however, is shared with scientific education in general all over Sweden. Given these conditions, the throughput and the level of the education must be said to be reasonable.
An indication of the quality of the education is given by the fact that The Swedish Association of Scientists twice gave the award of best Master's thesis in mathematics to theses written in Lund (the prize has only been awarded twice). A similar prize for applied mathematics was last year given to a thesis from Mathematical statistics in Lund. Furthermore, it has turned out that students from Lund who could not find a graduate student position in Lund have been welcome at other universities, and they have been successful there.
The financing has been quite weak for a couple of years, and in particular MMNF suffers from being understaffed.

A4. Comprehensive assessment

The worries and the causes for rejoicing are essentially the same in Lund as at other Swedish universities. At short sight the small number of young people implies recruiting difficulties and in the long run the receding interest in natural science and technology, and thereby also in mathematics, is a serious problem. Many students have weaker prerequisites than earlier, and this tendency will probably be strengthened in the next years. At the same time the personnel situation is troublesome. In the forthcoming decade many academic teachers will be retired.
On the positive side it can be mentioned that Lund offers an environment that is attractive to the students, and this is an important factor when it comes to choosing a university. The department has a strong academic tradition, and the creation of the Centre for Mathematical Sciences offers good possibilities to construct educations suitable for meeting the increasing and diversified need for mathematics in different areas. These possibilities have yet to be fully exploited.

Part B: Graduate studies

B1. Structure

Contents

The Centre for Mathematical Sciences manages research education in Mathematics, Mathematical statistics and Numerical analysis. At MLTH the education has an applied profile and can be directed towards computer vision and mathematical image processing. According to Swedish law, a graduate student can be admitted only when the department is able to provide financial support to the student throughout the stipulated period of studies (which, by full-time studies, is four years), so a graduate student is actually employed by the department. She or he normally uses 80% of the time for research and studies and 20% for other duties, like teaching in elementary courses. Teaching here means holding lessons, not lectures. Under these conditions the nominal period of studies, four years, is prolonged to five years. The divisions get each year gets financial means from the faculty to manage this system. The allocation is i.a. based on performance, that is the number of graduates in recent years. The positions as a graduate student are advertised irregularly, at MMNF on the average twice a year. The education consists of two parts: advanced courses to an extent of 60-80 credits and a thesis worth 80-100 credits. The thesis shall be of such quality that it can be accepted for publication in a recognized international scientific journal. For each of the three subjects there is one syllabus for each of the two faculties.

Organization

At each of the divisions MS and NA there is a director of studies for the graduate studies. The two divisions of mathematics have a coordinator for the courses. Normally a position as a graduate student is advertised in the subject (mathematics, mathematical stistics or numerical analysis) without further specification, unless there are special circumstances, like external financing from the National science council or from industry for a special project.
The divisions of mathematics have a joint committee which rank the candidates and gives a suggestion to the head of the department, who gives a proposal to the faculty. Formally it is the faculty who choses among the candidates.
After admission, a supervisor (professor or senior lecturer) is selected in consultation with the student. Also a deputy supervisor shall be appointed. The supervisors and the student shall establish a syllabus and a plan for the individual student. The individual plans are kept by the head of division and are to be revised every year.

The students

The number of students enrolled in recent years as well as the number of interruptions can be seen in the following table

Admitted graduate students (and interruptions)

Year	MMNF	MLTH	MS	NA
1995	3	1	3	
1996	1	2(1)	5(1)	
1997	3	5(1)	8(2)	
1998	4(1)	1	2	1
1999	1	3(1)	5	2
2000	2	3(1)	3	0(1)
2001	3	3(1)	2	2

The teachers

The requirement for a supervisor is the venia legendi. This means that the professors and the senior lecturers ar qualified. In reality, only a few of the senior lecturers are still active in research, which is a necessary condition for suitability for this task. The assistant advisors are supposed to have a doctorate.

The infrastructure

The department has a porter who is in charge of the printing office. The library keeps a high standard, and there is a full-time employed librarian. The graduate students, like all the staff, have their own personal computers. There are offices available for them, but normally two graduate students share one small office.

B2. Process

Courses

The two parts of the graduate education, the thesis and the courses, are assigned approximately the same number of credits and therefore the same time should be spent on them. The character of the courses differs between the divisions, but at MMNF the syllabus prescribes 60-80 credits of courses (the courses are worth 5 credits each, see the list of graduate courses in the appendix). At least 15 credits should be chosen in analysis, 15 credits in algebra and 10 credits in geometry/topology. The rest is chosen freely, but of course many course are chosen in the field of the thesis.

The thesis

There is the possibility to make a socalled licentiate examination prior to the doctorate. This comprises 80 credits. In these there is included a thesis worth at least 40 credits. The thesis

may later be a part of the doctoral thesis. The licentiate examination is not compulsory, but it is strongly recommended by the faculties. A dissertation may contain joint work from several authors, but then it has to be possible to identify the individual contriubutions.
The dissertation can either be a monography or a collection of essays with a summary.

Interruption

Sometimes a student choses to leave the doctoral studies withoupt a degree. The frequency is indicated in the table on the previous page. A student can also be suspende for various reasons, but this happens very rarely.

B3. Outcome

Graduation

The following table shows the number of doctoral theses (licentiate theses) in each of the last three years:

Year	MMNF	MLTH	MS	NA
1999	3 (1)	2 (1)	3 (2)	1 (0)
2000	2 (1)	0 (2)	3 (1)	0 (0)
2001	1 (3)	2 (0)	3 (2)	0 (0)

The median time for doctoral studies is slightly more than five years. The median age for the students finishing their doctoral studies is roughly 30 years.
Presently MMNF has 13 graduate students, five of which are female; MLTH has 14 students (1 female), MS 22 students (four female) and NA has three graduate students, one of which is female.
It is easy for the graduated doctors to find employment. The pure mathematicians can get a lecturership at some university or some smaller university college. The demand is large. Of the graduates from applied mathematics, mathematical statistics or numerical analysis, however, about 75% immediately find emplyoment outside the university system. In total, about 60% remain in the univesity, 20% go to information technology or computer industry and 10% each to pharmaceutical industry and health care and to manufacturing industry, respectively.

B4. Summary

The general remarks under A4 apply also to the graduate education. Here one can add the good labour market for doctors of mathematics.
Qualitatively the graduate education in mathematics at Lund University keeps up very well. Prizes have been awarded by the Swedish Association of Scientists not only to master's theses (as mentioned above) but also to doctoral dissertations from Lund.
Quantitatively there are more worries. The measures taken to increase the recruitment and the trough-put have just started to give results.

As a university department, the Centre for Mathematical Sciences is a very heterogeneous institution. Very different cultures are prevailing in the four divisions, a state of things that can be fruitful to the activities but sometimes it can also imply paralysing strains. This makes the management of the Centre to a difficult and delicate task.

Appendix: Courses offered by the Centre for Mathematical Sciences for students at the Faculty of Science

Course	Code	Credits
Mathematics		
Level A		
Mathematics 1 Alpha	MAT121	10
Mathematics 1 Beta	MAT122	10
Level B		
Multivariate Analysis	MAT231	10
Linear Algebra	MAT241	5
Fourier Analysis	MAT242	5
Discrete Mathematics	MAT243	5
Mathematics for Teachers	MAT224	10
Level C		
Algebra 2	MAT311	5
Special course – Algebra 2	MAT321	5
Analytic Functions	MAT312	5
S.c. – Analytic Functions	MAT322	5
Differential Geometry	MAT313	5
S.c. – Differential Geometry	MAT323	5
Ordinary Differential Equations	MAT314	5
S.c – Ordinary Differential Equations	MAT324	5
Number Theory	MAT315	5
S.c. - Number Theory	MAT325	5
Topology	MAT316	5
S.c. – Topology	MAT326	5
Degree project, 10 cr.	MAT391	10
Level D		
Distribution Theory	MAT411	5
S.c. – Distribution Theory	MAT421	5
Functions of Complex Variables	MAT412	5
S.c. - Functions of Complex Variables	MAT422	5
Group and Ring Theory	MAT413	5
S.c. – Group and Ring Theory	MAT423	5
Integration Theory	MAT414	5
S.c. – Integration Theory	MAT424	5

Linear Functional Analysis	MAT415	5
S.c. – Linear Functional Analysis	MAT425	5
Partial Differential Equations	MAT416	5
Special Course	MAT426	5
Degree Project, 10 cr.	MAT491	10
Degree Project, 20 cr.	MAT492	20

Graduate Courses

Integration Theory	5
Functional Analysis	5
Spectral Theory	5
Distribution Theory and Fourier Analysis	5
Harmonic Analysis	5
Analysis of Functions of One Complex Variable	5
Analysis of Functions of Several Complex variables	5
Dynamic Systems	5
Partial Differential Equations	5
Analytic Number Theory	5
Differentiable Manifolds	5
Differential topology	5
Riemannian Geometry	5
Algebraic Topology	5
Algebraic Geometry	5
Commutative Algebra	5
Number Theory	5
Representation of Finite Groups	5
Representation of Lie Algebras	5
Galois Theory	5
Holomorphic Spaces	5

Mathematical Statistics

Mathematical Statistics, Basic Course	MAS110	10
Probability Theory	MAS203	5
Markov Processes	MAS204	5
Inference Theory	MAS207	5
Statistical Models and Methods	MAS208	10
Design of Experiments	MAS209	5
Stationary Processes	MAS210	5
Analysis of Survival Data	MAS213	5
Math. Stat. for Biologists & Geologists	MAS215	5
Time Series Analysis	MAS216	5
Math. Stat. for Chemists	MAS217	5
Math. Stat. for Physicists	MAS219	5
Design of Experiments for Natural Science students	MAS220	5
Monte Carlo Methods for Stochastic Inference	MAS221	5
Nonlinear Time Series	MAS222	5
Multivariate Analysis	MAS224	5
Clinical Trials	MAS225	5
Applied Probability	MAS227	5

Statistical Image Analysis	MAS228	5
Financial Statistics	MAS229	5
The Mathematical Basis for Probability Theory	MAS230	5
Math. Stat. for Secondary School Teachers	MAS240	5
Epidemology	MAS513	5
Degree Project in Mathematical Statistics	MAS194	10
Degree Project in Mathematical Statistics	MAS195	10
Degree Project in Mathematical Statistics	MAS196	20

Numerical analysis

Numerical methods for computer graphics (CAGD)	NUM117	5
Numerical Analysis I	NUM121	5
Numerical Analysis II	NUM122	5
Numerical Linear Algebra	NUM115	5
Programming in computational mathematics	NUM131	10
Numerical methods for hyperbolic partial differential equations (with applications in fluid dynamics)	NUM116	5
Seminar Course in Numerical Analysis	NUM115	5
Master Thesis in Numerical Analysis	NUM191	5
Special Topics in Numerical Analysis	NUM201	5

Abbreviations and terminology

MNF	Faculty of Science (Matematisk-naturvetenskapliga fakulteten)
LTH	Institute of Technology (Lunds tekniska högskola)
MMNF	Division of Mathematics at the Faculty of Science
MLTH	Division of Mathematics at the Institute of Technology
MS	Division of Mathematical Statistics
NA	Division of Numerical Analysis
FTE	Full-time equivalents; one FTE corresponds to one student studying full time for one year or to two students studying half-time for one year etc.

Upper secondary school – School years 10-12, immediately preceding university
Graduate studies – Studies leading to a doctorate or licentiate

Self-evaluation of the Department of Mathematical Sciences of the University of Oulu within the trilateral LUMA-project

Part A: Undergraduate studies

A1. Structure and Resources

Contents

1. The Department of Mathematical Sciences has three disciplines, those of Mathematics, Applied Mathematics and Statistics. The Department's degree programme consists of five specialisation lines, i.e.

Teacher Education (secondary and upper secondary school)
Mathematics
Mathematics and Information Technology
Applied Mathematics, and
Statistics.

2. The Teacher Education Programme includes a minimum of 98 credits of studies in mathematics (with the Master's thesis accounting for 15 credits), while the other programmes (Mathematics, Mathematics and Information Technology, Applied Mathematics, or Statistics) require at least 120 credits of mathematics studies (23 credits for the Master's thesis).

3. Primary School, 5–9 credits (mathematics education)
Lower Secondary, majoring in mathematics, 98 credits
Lower Secondary, minoring in mathematics, 53 credits
Upper Secondary, as for Lower Secondary above.

Service teaching in mathematics and mathematics as a minor subject

1. The Department is providing teaching for physics, chemistry and economics students, and there are also students from the Faculty of Technology taking part in certain courses.

2. Two basic courses are provided separately for the physics and chemistry students, while in other courses the students of the various subjects join the mathematics students. The economics students are offered courses of their own in mathematics and statistics (4 courses altogether).

Teacher Education

1. The Teacher Programme comprises 98 credits of mathematics studies, or 53 credits for those minoring in mathematics. Compulsory studies account for approx. 45 credits, while the Advanced Studies represent some 23 credits and the Master's thesis accounts for 16. The main bulk of mathematics courses are taken during the first three years of study. Teaching practice (53 credits) is most often taken in the fourth year. The Master's thesis is usually written at the end of the studies. The decision to specialise as a teacher in mathematics is made after the first year of study. Also see next section.

Master's degrees in mathematics

1-2. Compulsory courses that have to be attended by students in all the specialisation lines include

Basic Methods I (8 credits)
Analysis I (8 credits)
Analysis II (8 credits)
Linear Algebra (8 credits).

The prospective subject teachers shall also take Algebra I (8 credits). A 8-credit course usually includes 56 hours of lectures and 42 hours of exercises. The same courses are also taken by the future teachers who are studying mathematics as a minor subject. The basic (cum laude) level courses shall account for approx. 53 credits.

In the Teacher programme, 23 credits of advanced (laudatur) courses need to be taken for the Master's degree, while in other programmes the required number of credits is 38. These can be selected quite freely depending on the student's own interests from among the courses offered by the Department. A Master's thesis shall also be written, with a scope of 15 credits in the Teacher Programme and 23 credits in the other programmes.

3-4. Quite a few areas of mathematics are represented in the Department: Formal languages, Group Theory, Number Theory and its Applications, Topological Algebras, Inverse Problems, Mathematical Modelling, Nonlinear Analysis and Applications, Nonlinear Problems in Ordered Spaces, Biostatistics, Econometrics, Medical Imaging.

Organization

1. The Departmental Board meets at intervals of 2 to 3 weeks during the academic terms. A decision of the courses to be made available is made annually in a Lecturers' Meeting. Decisions on any matters within the Head of Department's jurisdiction are made on a continuous basis.

Economy

1. The Department's funding from the university's budget amounts to a total of 2 200 000 € . The labour costs account for 1 700 000 €, the facilities for 200 000 € and other operational costs for 300 000 €. External funding to the Department amounted to approx 250 000 € in 2001.

Admission and Recruitment of students

1-2. Our aim is to get one hundred new students every year. Those who have scored *laudatur* or *eximia* in the advanced mathematics test in the matriculation examination are admitted without any entrance examination, as are those with *magna cum laude* in the above test, provided that they also have scored either *laudatur* or *eximia* in the Finnish language or the humanities and natural sciences test. Approx. 85 % of the students are selected on the basis of

these criteria, while the remainder are chosen on the basis of the entrance examination alone or the matriculation and entrance examinations together.

3. We have paid a number of visits to upper secondary schools in recent years, talking to the school students about academic studies in mathematics. We have also been offering two courses for upper secondary school students via the Open University.

The students

1. Accepted in the last three years:

	accepted	male (%)	started	male (%)
1999	270	42	110	40
2000	273	42	142	43
2001	298	47	92	44

2. The basic assumption is that the students shall master the advanced upper secondary school curriculum in mathematics. This is not, however, commonly the case, which is why the studies need to start from the elements in the case of mathematical demonstration in particular.

3. The differences in the level of the students have grown, making teaching increasingly difficult. Starting level tests have not been carried out at the Department.

Academic teachers

1-2. The Department's staff is shown below:

	mathematics	applied mathematics	statistics
professors	5	2	3
lectures	2	1	1
senior assistants	6		1
assistants	6	1	2
instructors			1

Agreement on the duties and responsibilities is made in a discussion held every year.

3. Permanent staff represents about 95 % of the staff, with non-permanent teachers accounting for approximately 5 % (assistants are counted to permanent teachers).

4. The lecturers teach 300 to 380 hours annually, while the senior assistants and assistants teach approx. 200 hours. After deducting the time required by preparation for teaching and departmental tasks, usually some 500 (lectures) to 1000 (assistants) hours of the total annual working hours (1600 h) remain for research work.

5. The number varies annually but amounts on the average to approx. 60 to 70 % of all teaching.

Infrastructure

1-2. The external prerequisites for work are good, with everyone having a personal computer, and the selection of journals available at the Department is quite good.

Summary

The main issue is to find good students. The competition has become significantly harder in recent years, as the number of student places has been increased abundantly especially in information technology. It is also more difficult than before to find students who wish to become secondary teachers. Our main strength is that the student can carry out a variety of studies in mathematics in our department. Our graduates have been successful in finding employment.

A2. Educational process

Didactics, types of teaching, examination forms

1-3. We use lectures, exercises and tutoring on an equal basis in our teaching. The Department has some 25-30 senior students who supervise first-year students and are paid a little for their work. This system has turned out to be good, as it provides good training especially for the future teachers in mathematics. The students are also participating more actively than before in teaching and have the courage to ask for advice when they have problems. The examinations are usually written ones in the traditional manner, but other alternatives are also being experimented with.

Teacher education

1. See above.

2. The subject department is responsible for the mathematics studies, while the Teacher Education Department and the Teacher Training School are responsible for issues related to teaching practice and didactics (53 credits). In recent years there have been joint projects in which Master's theses, for instance, have been supervised in co-operation between the subject department and the Professor of Didactics at the Teacher Education Department. This has helped to add didactic stuff to the theses.

Summary

Some 50 Masters have graduated from the Department annually in recent years. About half of them have become teachers in secondary or upper secondary schools. The number of students graduated from the other programmes has increased considerably, which has also been our goal. The difficulty in getting enough students to choose the Teacher programme is likely to be largely caused by the fact that the school as a workplace cannot compete successfully with the other alternatives. There is also a constant discussion about how the pedagogical studies could be fitted in better with the other studies.

A3 Outcome

Throughput

1. Statistics for the graduates in the last three years:

	total	teachers
1998	45	27
1999	55	39
2000	49	28

About a third of new students drop out at some point, with a remarkable share of them doing so in their first year of study.

2-3. See above.

4. The Master's degree was designed such that it should be completed in five years on an average, but the average time taken by the studies now is about 6 years.

Follow-up

1. The teachers are mostly employed by schools, while the others (and some of the teachers) mostly end up in IT companies in the Oulu region. Those graduated in recent years have had little difficulty finding jobs that meet their skills.

Economy

1. How to measure it?

Summary

See next item.

A4 Comprehensive assessment

1. The Master's education provided by the Department is a many-sided whole that functions well, which I consider to be an important strength. The major causes of concern are to find a way to add to the attraction of mathematics teacher education and to be successful in the competition for recruitment of good students.

Part B: Graduate studies.

B1. Structure

Contents
1. At the department postgraduate studies are given in the following programs: Mathematics, Applied mathematics and Statistics.

2. In all these programs one can study for a Licentiate examination (approximately within 3 years of studies) and also be awarded a Ph.Lic.

A licentiate thesis should prove that the author is able to independently understand a new problem in a modern research area and use applicable standard methods for this problem. The student has to study at least 40 Finnish study weeks of his main and secondary subject.

To be awarded a Ph.D. the student must also show that he/she has the ability to make his/her own contributions to some research area of a non-routine character.

Organization
1. See part A.1. Section Organization.

2. Supervision of the graduate students is organized in such a way that every student has his/her own supervisor. The supervisor is mostly a professor, but could also be a lecturer. The student and the supervisor have private oral communications concerning the studies and the work.

The students
1. This table shows the number of graduate students during the last years. There is no separation to the individual programs.

	1998	**1999**	**2000**	**2001**
Ph.Lic.	19	28	19	23
Ph.D.	9	10	13	14

There are no exact statistics how many of the students are female. The percentage of female graduate students is quite low.

The funding of the students comes from many different sources. Some are working in the industrial companies and been paid to do their Ph.D. Some are working at special graduate schools. In these cases the students don't have teaching assignments. Those working at the department, namely assistants, have to take part in teaching.

The teachers
1. At the department there are 10 professors. There are also 4 lecturers and 7 senior assistants. The division to different programs is in the following table.

	Mathematics	Applied mathematics	Statistics
Professors	5	2	3
Lecturers	2	1	1
Senior assistants	6		1

Among the professors there are no women, but there are 2 female lecturers.

B2. Process

Courses

1.-2. There are no compulsory courses that a student has to attend to. The student can freely choose the courses he/she wishes to be included in the graduate studies. The courses are then announced together with the subject of the thesis (Licentiate's or Doctoral) when the person applies for the graduate student position. Courses can't be chosen from the basic level courses. Total amount of courses has to be 40 Finnish study weeks (approximately 60 credits)

The thesis

1. There are two routes to the Ph.D. degree. One can first prepare a Licentiate's thesis and then continue to the Ph.D. thesis. One also has an option to advance straight to Ph.D. from the master's degree. Even if the Licentiate's degree is not compulsory, it has been very common step on the way to Ph.D.

In mathematics program it is usually the department/supervisor that proposes the thesis subject. In the applied mathematics the subject might also come from the needs of the industrial company funding the studies.

2. Even if quite a lot of graduate students belong to some research group, the work is been done individually with the support from the supervisor. The thesis itself might be a part of a bigger research project.

3. The thesis may be in a form of number of published articles summed up with a summary written by the student. It can also be a monography. If the thesis is a monography, the student doesn't have to have published articles in refereed journals. At the department the monography has been to more common way of publishing the thesis.

Interruption

1. The exact number of students that leave doctoral studies without a Ph.D. degree can't be determined, since some might finish their Ph.D. after years of non-active period. As a rough estimate we can say that around one out of three students never finish their Ph.D.

B3. Outcome

Graduation

1.-3. We give some tables showing the number of licentiate examinations and Ph.D's the last years.

Number of licentiate and doctoral examinees

	1998	1999	2000	2001
Ph.Lic.	3	2	3	3
Ph.D.	3	1	1	0

Out of the licentiate examinees 3 of 11 are female. One of the doctoral examinees is a female. There are no statistics collected of median times of doctoral studies and the median ages of students that are awarded their Ph.D.

B4. Summary

Indicated strengths of the graduate studies at the department:

- The department is involved in 3 graduate schools and it coordinates one of them
- The theses made are of high standard

Indicated weaknesses of the graduate studies at the department:

- There are problems on getting funding for the students after the dissertation
- Not all the graduate students finish their Ph.D.

Self-evaluation for mathematics at Szeged.

Part A: Undergraduate studies

A1. Structure and Resources

Contents
The University of Szeged was reformed in 2001 integrating several universities and colleges, but it mainly operates in the old structures. Therefore there are still two mathematics departments working independently. The self-evaluation only concerns the unit of Bolyai Institute of Mathematics. The other department is responsible for the primary school teacher training, its work could be studied during the site visit. The Bolyai Institute – which is led by a chairman and it is subordinated to the Faculty of Natural Sciences, which is led by a Dean - is organized in five departments: Analysis, Applied Analysis, Algebra, Geometry, Set Theory and Logic departments.

The Institute offers two five-year full-time programs:

Programs	Number of students admitted in 2001	Compulsory pts (ECTS) in mathematics	Optional pts (ECTS) in mathematics
Mathematics	48	175	30
Math Teacher	77	116	54

The department also gives courses in other programs within the Faculty of Natural Sciences:

Programs	Number of students admitted in 2001	Compulsory pts in mathematics	Optional pts in mathematics
Computer Science (B. A.)	113	48	10
Computer Science (M. A.)	123	44	28
Computer Science / Economics	124	44	5
Teaching in Computer Science	47	44	10
Biologist, Biology teacher	161	5	10
Biophysicist	7	22	10
Physicist, Astronomer	14	41	10
Physicist / Computer Science	14	29	18
Chemist, Chemistry teacher	72	4	10
Clinical chemist	14	11	10
Environmental Science	33	8	10
Geologist / Computer Science	20	8	10

Service teaching in mathematics and mathematics as a minor subject
By the request of the responsible department, in the different programs mathematics is taught chosen especially for the specific programs.

Teacher education
To get a diploma as a secondary school teacher someone has to have 240 pts, out of which at least 147 pts must be in mathematics, and the thesis is worth 20 pts. More detailed information in Appendix A.

Diploma in mathematics
The Mathematical program requires at least five years of full studies and contains a thesis worth about 40 pts. The first three years of studies consist of compulsory courses: 133 pts in mathematics and 33 in computer science and only a couple of optional courses, 6 pts. After this one can specialize in four directions: mathematics, computer science, economics or finance. Here one has again mainly compulsory courses, at least 30 pts. In Appendix B one can find more detailed information.

Economy
In 2001 the university got about 489 000 HUF per annum for each full-time student of the Faculty of Natural Sciences. Math teacher students bring half of this amount unless they participate another teacher training program (like chemistry, biology, etc). The Dean Council using a very complicated system decided that the Bolyai Institute had 157 113 000 HUF for that year. Besides this, based on the number of professors of the Institute, we had 8 587 000 HUF from the Ministry of Education. About 90 percent of these were used for payment of teachers and 10 percent for overhead-costs. About 10-12 full-time students are needed to afford one lecturer.

Admission and recruitment of students
In each year the university plans the maximum number of new students, but basically the Ministry of Education decides about the concrete admission. In general the students are admitted according to the following system: Based on their high school results they can earn max. 60 points plus 1-3 point(s) for certain language certificates. They have to write a university entrance exam, max. 30 points, and after that they have an oral exam, too, max. 30 points. So the max. score is 120 point. After the exams, with the results in hand, the Ministry of Education decides on the lowest entry score. This system is mainly valid for students outside of the Bolyai Institute. In the case of math teacher and mathematics students, due to the very low interest in this program, students are often admitted based on their high school grades of mathematics, if they have good grades in the last two years, they are admitted to the program without any exams. Unfortunately there are vacancies (20 %) in this program as we can see from the following table:

Program / Year	2001			2000			1999			1998			1997		
	l.s.	p.	a.	l.s.	p.	a.	l.s.	p.	a.	l.s.	p.	a.	l.s.	p.	a.
Mathematician	106	50	47	74	58	52	72	35	26	89	25	22	106	15	17
Math teacher	60	92	70	72	107	74	72	110	92	85	120	96	82	135	134

l.s. = lowest entry score, p. = planned number of students, a = number of students admitted

The students
The decreasing number of students in our two programs could result in serious financial problems in the very near future. Therefore a committee was formed to handle this. According to their suggestions, we are taking the following actions to recruit new students: besides the open-school-day event, we are going to visit many high schools in the region and send an advertising poster to every secondary school.
In both programs there are more female students, somewhere over 60 percent. Even without diagnostic tests it is clear that the students' previous knowledge dramatically changed for the worse in the last decade. Hence we established some new introductory courses, increased the number of hours (per week) of several courses, and reduced the requirements of passing an examination. Despite of these efforts a very large number (30 percent) of students leave the program in the first two years.

Academic teachers
The following table shows the different categories of academic teachers, the number of teachers in each category (full and part time together) and their teaching load as it is today.

Categories	No.	Teaching load (hours/week)
Professors (4 of them are member of the Academy of Science)	13	4-6
Associate professors (docens)	16	6-8
Lecturers (adjunktus)	10,5	8-10
Assistant professors (tanársegéd)	10,5	8-10
Doctoral students with teaching duties	8	2-4
Others (mainly undergraduate students)	10	2-3

There are several seminars for the teachers to develop their knowledge and teaching skills organized within the Institute.

Infrastructure
All teachers have computers in their own offices, and we have an employee to manage the data systems. There is an office to administrate the necessary things, printing, copying, etc. Very importantly the Institute has one of the best mathematical libraries in Hungary. Unfortunately we are forced to cut back on several papers because of

financial reasons. The increasing number of students in other programs causes the problem of room-shortage, which should be solved as soon as possible.

Summary
Our strengths are the well-qualified teachers and the good infrastructure.

The weakness is the lack of suitable rooms, the decreasing number of students in our programs, the students' decreasing basic knowledge and the low financial support.

A.2 Educational process

Didactics, types of teaching, examination forms.
The planed and expected five-year of university studies consists of 10 semesters (two in each year). One semester is made up of 14 weeks of lecture-recitation and 6 weeks of exam periods. In the first three years the education is generally provided in the classical form of lectures (for the whole group) and recitations (for groups of less than 25 pupils), later they mainly have lectures. The education requires a considerable amount of self-activity from the students.
In one semester a student usually has 21 scheduled hours in mathematics. On the recitations they write two midterms, and based on these they are graded 1-5. If some fails (graded 1) then he may try again once. If he fails again he may not take the exams, so he has to repeat the semester next year (interrupting his studies for a half year). In general there are 6 exams in a semester (one for one week). The exam can be oral written or both and they are also graded 1-5 (the passing grades are 2-5). An exam can be retried twice. To continue one has to pass all his exams. All together one can repeat semesters only twice.
Starting form the fifth semester one has to pass the proficiencies exams (analysis, algebra, geometry). In the last year a student writes a thesis with the aid of a lecturer, has to defend it in front of a committee, and finally has to complete the final exam. To get a diploma one also has to have a language certificate, because of this it is not unusual that someone does not graduate on time.
This system will be changed significantly after the introduction of the credit system in September 2002.

A.3 Outcome

Through-put
The following table shows the number of graduating students in the last five years

Program / Year	2001		2000		1999		1998		1997	
	s	g	s	g	s	g	s	g	s	g
Mathematician	14	1	21	14	15	3	9	5	11	7
Math teacher	126	61	172	66	152	106	172	95	111	80

s = number of students started the program 5 years ago, g = number of students graduated

According to this data 40% leaves the programs, and the average time of studies is 5,5 years.
Follow-up
The Institute has very little knowledge of what happens to the students after finishing their studies. But we fear that in the case of math teachers at least 20% of them do not work as high school teachers. The reason of this is very simple: a teacher's wage is unacceptably low in Hungary.

Part B: Graduate studies

B1. Structure

Content
The Ph.D Program at Bolyai Institute was accredited by the Hungarian Accreditation Committee in 1993. The Program is based on courses taught by lecturers and a thesis written by the student.

The following subprograms are parts of the graduate program: Algebra, Analysis, Dynamical Systems and Stochastics, Geometry and Combinatorics.

One can study for a Ph.D (nominally 3 years of full times studies, without writing a thesis) in any of these programs.

In 2001 a new form of the Ph.D Program was started. It is based on the old one and includes some new features, e.g. quality insurance system and credit points.

Objectives
The main objective of a graduate student is to acquire expansive but extensive knowledge and to start the first steps in research. A Ph.D-awarded student knows the modern store of learning and is up-to-date in his/her own chosen area of discipline.

Organization
The Mathematics Program is a program of the Doctor School which has another program as well (Computer Science Program). Both are controlled by Program Councils.

The Doctor School was founded by the Founder Members (43 people). Members of a Program Council are elected by the Foundation Members. There is also a member from the graduate students. The Program Council elects a Program Leader and a Co-leader.

The Doctor School is controlled by the Doctor School Council. Its members are the Doctor School Leader (Council Leader), the Doctor School Co-leader (Council Co-Leader), 2-2 delegates from the Program Councils and the graduate members of the Program Councils.

The Program is led by the Leader and the Co-leader. Each subprogram has its own leader. The theme leaders are chosen by the Council.

Bolyai Institute (Mathematics Department) is a part of the University of Szeged. (USz). The Department is subordinated by the Faculty of Natural Sciences at USz. More information about the organization hierarchy can be found on http://www.u-szeged.hu (USz) and http://www.math.u-szeged.hu (Bolyai Institute).

The students
Here is a table showing the number of doctoral students admitted during the last years.

2000	1999	1998	1997
4	4	4	2

During these years 10 men and 4 women were admitted. Now there are 42 students (32 men and 10 women) whose studies are still open (including those students who interrupted their studies).

The teachers
There are 18 full professors and 20 senior lecturers, all active in research. Among the teachers there are 2 women. 33 lecturers are employed; 5 lecturers are members of other universities in Hungary. 23 lecturers were theme leaders working together with 1 to 7 students.

The infrastructure
Although each student has his/her own table and chair as well as access to the Institute computer system, the infrastructure is far from desirable. Space is limited and there is a shortage of computers available to the students.

Copying and printing facilities are available, and our mathematical library is one of the best in the country.

Summary
The are many excellent teachers and supervisors. Many of the teachers of the Institute are well-known scientists of the world; in fact, their scientific potential is the main strength of the Ph.D Program. Traditions of famous professors like F. Riesz, A Haár, B. Kerékjártó, L. Rédei, L. Kalmár and B. Szõkefalvi-Nagy are the bases for the curricula of the Institute, including the undergraduate studies. (Also their heritage is the newspaper Acta Scientarium Mathematicarum, since 1922, while a new magazine called Polygon has been published by the members of Bolyai Institute since 1992)

B2. Process

Courses

The students need 10 courses in the doctoral lecture system to graduate. After this process one gets an absolutorium.

In the first year 3 courses of the general lectures (Algebra, Measure and Integral Theory, Topology, Discrete Mathematics) must be passed with an examination. Under the new system, the requirement is that the first general lecture must be passed in the first semester.

After the first year the graduate student has to choose 3 lectures (2x14 classes) from the 23 basic lectures (see a complete list on http://www.sci.u-szeged.hu/oktatas/matematika/doktori/magyar71.html#alap). There are also 76 special courses, one must pass 4 (2x14 classes) from these lectures (a complete list can be viewed on http://www.sci.u-szeged.hu/oktatas/matematika/doktori/magyar71.html#spec).

Course examinations may be oral and/or written, at the discretion of the annual lecturer. (The exams are mostly oral, due to the low student enrollment.)

Final examination
Having an absolutorium, the student has to prove his/her qualitative knowledge in 1 main (and 2 secondary, if the student is a private graduate) course.

Seminars and conferences
Students have to be regular participants and lecturers in the seminars of the departments of Bolyai Institute. All seminars are open to the public. Students are also welcome to attend the Conference for Mathematician Doctorandus in Hungary (http://www.math.u-szeged.hu/confer/mdk).

Reports
From the second year (or earlier) the study of each student is controlled by a theme leader. The theme leader is a member of the lecturers of the Ph.D. program. If the graduate student has no theme leader yet, a mentor person should help his/her work during the first year. The student must choose their theme until the beginning of the second year.

The students must write a report about their research every year. This report is evaluated by his/her theme leader or mentor.

Publications
At least 3 new full articles must be published in famous international newspapers, conference proceedings or books. The articles should be published in issues referenced by Mathematical Reviews, Zentralblatt für Mathematik or Science Citation Index. At least two articles have to be published in newspapers.

Thesis
The thesis may be written in Hungarian or English, in a subtheme of one of the 4 subprograms. A public discussion is organized for each student disputing about his/her thesis.

Knowledge of foreign languages
At least two, one of them must be English.

Cooperation partners
There is a cooperation within the country in form of guest lecturers, workshops, winter and summer schools. There also exists a collaboration with universities abroad.

Bolyai Institute has regular seminars in algebra and differential equations with participation of the leading mathematicians of the world. See http://www.math.u-szeged.hu/menuhtml/co.htm for details.

Due to the lack of available funding, not every student can take part in studying abroad.

Interruption
The throughput is quite slow due to the high requirements (mainly that the publications should be in very high rated articles). However, most students get an absolutorium.

Another problem is that many students continue their studies abroad after the first or second year. Better conditions in infrastructure and higher wages may cause the most talented students to stay at universities in Western Europe or in the USA. This is a significant problem, one related to about 35% of the students.

B3. Outcome

Graduation

2000	1999	1998	1997
2	2	2	2

Altogether 6 men and 2 women were awarded a Ph.D degree in mathematics during these years.

The average time for all of the doctoral studies was 4.5 years. However, that average includes one person with 1 year of study; without him, the average time was 5 years.

The students can be sure that they will find jobs that correspond to their qualifications, either in industry or at a university.

B4. Summary

35 students were admitted until 1997. Since 1998 there were 21 new Ph.D students at the Institute. 20 students are still taking part in the courses. 18 students got an absolutorium and are ready for getting a Ph.D degree. 10 students interrupted their studies.

During these years there has been an output of 8 Ph.D. in mathematics, where 2 of them are women. Unfortunately, this is too few, fewer than it is expected by the public organizations and the members of the Program Councils. However, if someone studies some years in the Ph.D School, the knowledge of his/her profession will be much deeper than before. In addition, trying to raise the number of the awarded persons might decrease the quality of teaching and the value of the Ph.D. degree which is not desirable.

The members of the Doctor School are now working on a construction that some kind of degree should be given to such students who get an absolutorium without planning to continue studying towards the Ph.D degree.

A comprehensive summary about the Ph.D program can be read on http://www.sci.u-szeged.hu/oktatas/matematika/doktori/info.html (in Hungarian language).

Appendix A

Program for math teachers

During their five-year studies the students has to complete the following compulsory mathematics courses (116 pts):

Course	PTS	Hours	Course	PTS	Hours
Introduction to number theory (lecture)	4	3	Projective geometry (l.)	2	2
Introduction to number theory (recitation)	3	3	Projective geometry (r.)	2	2
Continuity of functions in one variable (l.)	3	2	Complex and real functions (l.)	3	3
Continuity of functions in one variable (r.)	3	3	Complex and real functions (r.)	2	2
Elementary Geometry (r.)	2	2	Constructive geometry (l.)	2	2
Classical algebra (l.)	3	2	Constructive geometry (r.)	1	1
Classical algebra (r.)	2	2	Probability theory (l.)	2	2
Differentiation of functions in one variable (l.)	3	2	Probability theory (r.)	2	2
Differentiation of functions in one variable (r.)	3	3	Set theory (l.)	2	2
Integration of functions in one variable (l.)	4	3	Introduction to math logic (l.)	1	1
Integration of functions in one variable (r.)	2	2	Graph theory (l.)	3	2
Analytical geometry (l.)	3	2	Elementary mathematics I. (r.)	2	2
Analytical geometry (r.)	2	2	Elementary mathematics II. (r.)	2	2
Introduction to linear algebra (l.)	3	2	Elementary mathematics III. (r.)	2	2
Introduction to linear algebra (r.)	2	2	Elementary mathematics IV. (r.)	2	2
Synthetic geometry (l.)	3	2	Elementary mathematics V. (r.)	2	2
Synthetic geometry (r.)	2	2	Elementary mathematics VI. (r.)	2	2
Abstract algebra I.(l.)	2	2	Teaching mathematics I. (l.)	2	2
Abstract algebra I.(r.)	2	2	Teaching mathematics I. (r.)	1	1
Abstract algebra II.(l.)	2	2	Teaching mathematics II. (l.)	2	2
Abstract algebra II.(r.)	1	1	Teaching mathematics II. (r.)	1	1
Functions of several variables (l.)	2	2	Teaching mathematics III. (r.)	1	1
Functions of several variables (r.)	1	1	History of mathematics (l.)	2	2
Introduction to differential geometry (l.)	3	2			
Introduction to differential geometry (r.)	1	1			

The students have to study further math courses (compulsory 16 pts., optional 54 pts., they can choose from more than 100 courses) and a couple of other courses (computer science, didactics, philosophy, …etc. 32pts.).

Appendix B

Program for mathematicians

In the first three years one has to take compulsory courses in computer science (31 pts) and the following compulsory mathematics courses (133 pts):

Course	PTS	Hours	Course	PTS	Hours
Banach algebra and operators theory (l.)	2	2	Introduction to linear algebra (l.)	3	2
Banach algebra and operators theory (r.)	2	2	Introduction to linear algebra (r.)	2	2
Classical algebra (lecture)	3	2	Introduction to number theory (l.)	4	3
Classical algebra (recitation)	2	2	Introduction to number theory (r.)	3	3
Combinatorial analysis (l.)	4	3	Linear algebra (l.)	3	2
Combinatorial analysis (r.)	2	2	Numerical analysis (l.)	3	2
Complex functions (l.)	2	2	Numerical analysis (r.)	1	1
Complex functions (r.)	2	2	Ordinary differential equations (l.)	3	3
Computer algebra (l.)	1	1	Ordinary differential equations (r.)	2	2
Computer algebra (r.)	2	2	Partial differential equations (l.)	3	3
Continuous and differentiable functions (l.)	5	4	Partial differential equations (r.)	2	2
Continuous and differentiable functions (r.)	4	4	Probability theory I. (l.)	3	3
Convex and discrete geometry (l.)	4	3	Probability theory I. (r.)	2	2
Convex and discrete geometry (r.)	2	2	Probability theory II. (l.)	2	2
Differential geometry (l.)	2	2	Probability theory II. (r.)	1	1
Differential geometry (r.)	1	1	Set theory (l.)	2	2
General algebra (l.)	3	2	Set theory (r.)	3	2
General algebra (r.)	2	2	The elements of functional analysis (l.)	3	2
Group theory (l.)	3	2	The elements of functional analysis (r.)	2	2
Group theory (r.)	2	2	The elements of graph theory (l.)	3	2
Integral geometry (l.)	2	2	The elements of graph theory (r.)	2	2
Integral geometry (r.)	1	1	The elements of probability (l.)	3	2
Integration (l.)	4	3	The elements of probability (r.)	1	1
Integration (r.)	4	4	Theory of real functions (l.)	3	2
Introduction to geometry (l.)	4	3	Theory of real functions (r.)	2	2
Introduction to geometry (r.)	2	2	Topology (l.)	3	2
			Topology (r.)	2	2

Completing these courses one can specialize in four directions:

1. Mathematician specialization

Here one has to take further compulsory courses in computer science (12 pts) and mathematics (30 pts) and from a large number of courses (mostly mathematics) one has to choose several courses worth 48 pts. The compulsory mathematics courses are:

Course	PTS	Hours	Course	PTS	Hours
Harmonic analysis (l.)	3	2	Stochastic processes I. (l.)	3	2
Harmonic analysis (r.)	1	1	Stochastic processes I. (r.)	1	1
Mathematical logic (l.)	4	3	Stochastic processes II. (l.)	3	2
Mathematical statistics (l.)	4	3	Stochastic processes II. (r.)	1	1
Mathematical statistics (r.)	1	1	Field and Galois theory (l.)	3	2
Geometry and computer (l.)	4	3	Field and Galois theory (r.)	1	1
Geometry and computer (r.)	1	1			

2. Computer science specialization

Here one has to take further compulsory courses in computer science (26 pts) and mathematics (31 pts) and from a large number of courses (mostly mathematics) one has to choose several courses worth 33 pts. The compulsory mathematics courses are:

Course	PTS	Hours	Course	PTS	Hours
Boole functions (l.)	3	2	Stochastic processes I. (l.)	3	2
Boole functions (r.)	1	1	Stochastic processes I. (r.)	1	1
Mathematical logic (l.)	4	3	Stochastic processes II. (l.)	3	2
Mathematical statistics (l.)	4	3	Stochastic processes II. (r.)	1	1
Mathematical statistics (r.)	1	1	Numerical mathematics (l.)	4	3
Geometry and computer (l.)	4	3	Numerical mathematics (r.)	1	1
Geometry and computer (r.)	1	1			

3. Economics specialization

Here one has to take further compulsory courses in computer science (5 pts), in mathematics (25 pts) and in economics (50 pts), and from a large number of mathematics courses one has to choose a couple of courses (10 pts.). The compulsory mathematics courses are:

Course	PTS	Hours	Course	PTS	Hours
Dynamic models of economics (l.)	3	2	Numerical mathematics (l.)	4	3
Dynamic models of economics (r.)	2	2	Numerical mathematics (r.)	1	1
Practice	2	2	Stochastic processes I. (l.)	3	2
Mathematical statistics (l.)	4	3	Stochastic processes I. (r.)	1	1
Mathematical statistics (r.)	1	1	Stochastic processes II. (l.)	3	2
			Stochastic processes II. (r.)	1	1

4. Financial specialization

Here one has to take further compulsory courses in computer science (4 pts), in mathematics (29 pts) and in financial science (39 pts), and from a large number of mathematics courses one has to choose a couple of courses (18 pts.). The compulsory mathematics courses are:

Course	PTS	Hours	Course	PTS	Hours
Mathematics of life insurance (l.)	3	2	Time series (l.)	3	2
Mathematics of life insurance (r.)	2	2	Time series (l.)	2	2
Practice	2	2	Stochastic processes I. (l.)	3	2
Mathematical statistics (l.)	4	3	Stochastic processes I. (r.)	1	1
Mathematical statistics (r.)	1	1	Risk processes (l.)	3	2
None life insurance	3	2	Risk processes (r.)	2	2

Report from the site visit to Mathematical Sciences at Budapest University of Technology and Economics.

Reviewer: Lennart Frennemo and Lassi Päivärinta

Date for the visit: March 23-27

Sources: Prof. Peter Moson, Prof. Béla Barabas, Prof. Màrta Làng-Làti and Prof. Anikò Csákány.

Self-evaluation within the LUMA-project

ACADEMIC STAFF

There are about 100 teachers involved in the education of mathematics. 13 of them have the higher doctor degree and 36 of them a Ph D. Besides this they use students at the end of their master studies or doctoral students as teachers, especially in exercises.

Teaching workload for professors and associate professors varies from 4-8 hours a week. Only undergraduate education is counted then and graduate education and supervision are not included. The teachers are quite free to choose teaching activities.

The formal appointments of new teachers are prepared by committees at the department, at the faculty and at the university level.

They seem to be satisfied with the situation.

Conclusions: The teaching-staff seems to be well qualified, and the use of students as teachers in exercises, especially in service teaching is common for technical universities.

RESOURCES

The number of students and credit points are a basis for the financial resources. Ph.D students are financed separately.
It seems that the Technical University has somewhat better better rescources than Eötvös Lóránd University, although they work in the same city. They also seem to have a somewhat better infrastructure.

The librarian resources are quite okey according to their own opinion.

The students have access to Linux-based pc's for laboratory works.

All teachers have opportunity to read AMS math.rewiev in form of math.sci.net. There is at least one computer in every office.

The resource management is centralized and the department has a lack of free money to use according to their own preferences.

Conclusions: As in Eötvös Lóránd University there are not enough free rescources be adequate.

STUDENTS

Most of the teaching activities are in fact service teaching, which is common in technical universities

Admission of students is essentially based on he grades in six subjects from school. 90 percent of the students is admitted this way. The rest have to use an entrance examination. There is the same test for all technical students. The Technical University still has good students and no serious deficiencies in standard of the beginning students.

The study language is almost entirely Hungarian, except in programs for international students where the main language is English.

There is a self-assessment after each course, with a standardized enquiry, equal for all courses. This enquiry seems to be quite simple and useful and has a computer-based compound.

The number of students in the Mathematical program is quite small. The admission is only about 35 students each year, and after a period nearly one third leaves the program.

It is in practice impossible to contine with graduate studies in mathematics from the technical programs.

Conclusions: The Mathematical program seems to have a too small number of students to be optimal. There also ought to be some opportunity to continue with doctoral studies in mathematics from some of the technical programs.

ORGANIZATION OF STUDIES

In principle every student have to take a masters degree, which nominally takes at least five years, including writing a thesis.

They seemed to be quite content with the organization of studies.

About 10 –20 percent of the students fail with their studies, which is quite normal for technical universities.

For the students there are non-educaional services such as student hotels etc.

Conclusions: The organization of studies seems to be satisfactory.

EDUCATIONAL PROCESS

The students at the mathematical program have about 24-30 hours of lectures and seminars each week. Today the proportion between lectures and seminars are such that there are the double amount of lectures compared with seminars. In the near future this will be changed to 50 percent each.

There are 4 hours per week under the first two semesters with applied mathematics and modelling tutored by teachers from other departments than mathematics.

They have laborations in mathematics with the traditional programs like Mathlab, Maple and Mathematica. Tutorial is used to a certain extent according to the self-evaluation.

The examinations are mostly in written form with a supplemantary oral examination. As in other Hungarian universities there is an examination which summarize almost all courses after three semesters.

We asked for examination papers in a number of standard courses and, compared with for example Swedish technical universities, the type of problems and difficulties are about the same. There certainly is an intenational standard in those courses.

Conclusions: The course in applied mathematics and modelling tutored by teachers from other departments seems to be of interest for other thechnical universities.
The content and the examination difficulties of a number of standard courses at technical universities seems to be very much alike in all three countries included in the LUMA-project.

TEACHER EDUCATION

Although there formally are no teacher education at the department, there are some doctoral students in didactics.They mainly study the use of technical means in education, or is working on a thesis in connection with this.

Report from the site visit to Institute of Mathematics at Eötvös Lóránd University of Budapest.

Reviewer: Lennart Frennemo and Lassi Päivärinta

Date for the visit: March 23-27

Sources: Prof. István Hortobágyi and prof. András Ambrus.

Self-evaluation within the LUMA-project

ACADEMIC STAFF

As a total there are about 120 teachers at the institute. Twenty-two of them are full professors and most of the others associate professors. Very few of the teachers are part-time employed.

Their teaching workload in undergraduate courses seems to be about 4-6 hours a week. Teaching in graduate education or supervision for graduate students is formally not counted when teaching workload is measured.

Most of the teachers have an equal proportion between their own research and education.

Before new appointments of teachers the subject is decided upon at faculty level. There is committee's at the institute, at the faculty and at the university level to prepare the appointments. Most new professors are recruited from inside the department. This unfortunate situation seems to be the case in all Hungarian universities.

At large they find the adequacy of the teaching staff quite satisfactory, but there is a certain lack of assistant professors.

Conclusions: The institute seems to have well qualified teachers, where almost all of them take part in the undergraduate education. Most of the teachers have the higher doctor's degree.

RESOURCES

In principle it is the number of students that give the amount of resources in form of teachers.

The institute has a lack of computers and other facilities such as copying machines. As a curiosity we mention that the department doesn't even has an own fax-machine.
The teachers all have an access to internet.

The library seems to be enough supported with new books, although there is a lack of books in didactics. On the other hand there is lack of mathematical journals.

The students have access to 25 Linux-based pc´s for laboratory work. The students almost entirely use lecture notes in Hungarian, since international textbooks are too expensive.

The teachers have access to AMS mathematical review in form of math.sci.net via internet.

The free resources, which can be disposed by the department is far too low to be effective. Salary's for the teachers are paid directly from the state.

Conclusions: There is a lack of resources for computers and other means to support the work. There are not enough free resources to be effective.

STUDENTS

The yearly admission of new students is 60 in pure mathematics, 40 in applied mathematics and about 100 future teachers.

The admission of students in principle depends on grades from school, but about 50 percent of them have to make a supplementary written examination at the university to be admitted. The students pre-university knowledge seems to be worse compared with earlier days.

There is a tendency among teacher-students to turn to other subjects in hope to get a better and more well paid job.

The teacher students have no lectures or lessons in common with the other students.

Most of the master thesis' are made in pure mathematics.

The language in the education is almost exclusively Hungarian.

There is a formal self-assessment at the end of each semester for all students. It seemed to be the same questions for students in all type of courses, but less than half of the students answer the self-assessment.

Conclusions: The pre-university level in knowledge of the students has diminished, which begins to be a problem.

ORGANIZATION OF STUDIES

In the Hungarian system the students have to take a masters degree, which nominally takes five years including the writing of a thesis.

The organization of studies is conventional and seems to be satisfactory within given resources.

About 30 percent of the students fail in their studies, somewhat less for the teacher-students.

Conclusions: The organization of studies seems to be satisfactory within given resources.

EDUCATIONAL PROCESS

In total the students seem to have about 28 hours of teacher-led instructions each week, 50 percent in form of lectures and 50 percent in form of seminars.
There is a special course in problem-solving two hours per week during the first four semesters, which seems to be a very effective way of teaching mathematics.

The students have access to Matlab, Maple and Mathematica.

The examinations are mostly in written form, sometimes with a supplementary oral examination.

Every third semester there is an examination, which is a summery of almost all courses the students have participated in during that period.

Conclusions: The special course in problem-solving, as a complement to the usual lectures and seminars, seems to be something to learn from for the Scandinavian countries.

TEACHER EDUCATION.

We also asked for the minimum number of points measured in ECTS to become teacher at upper secondary school in mathematics. The answer was that they need at least 100 points measured in ECTS in mathematics, even if mathematics was a minor subject. This gives them a much better education in pure mathematics than in Sweden or Finland.
The biggest problem for the teacher training is the pre-university level of students. It has gone down dramatically since very few wants to be a teacher. This depends on the fact that teachers have a very low salary in Hungary. This causes the effect that the becoming teachers in mathematics are badly motivated and indeed not so mathematically talented as would be desired. Finally the circle is closed. Due to the not so well-motivated teachers in upper secondary schools, pupils will not get interested in mathematics and the knowledge of mathematics of students that are going to universities will drop even more. To prevent this development there need to be an increase in teacher-salaries.

Conclusions: The teachers in mathematics at upper secondary school have a to learn more theoretical mathematics in their education than they have to in the Scandinavian countries.

Site visit at the Department of Mathematical Sciences at Göteborg University and Chalmers University of Technology

O. Martio

The visit took place 16 - 17.4.2002. I mostly consulted Lennart Frennemo but also Vice-Dean Bo Johansson and Jan-Erik Andersson., Professor Peter Sjögren and a number of other people in the Department.

The Department of Mathematical Sciences is common to Göteborg University and Chalmers University of Technology. As such it is rather unique in the Nordic countries. There are other such places in the Nordic countries, like NTNU in Trondheim, with a similar arrangement. However, the common department of mathematics in Göteborg has a much longer tradition. There are three units inside the Department and the site visit, as well as the self-evaluation, concerned two of them, Mathematics and Mathematical Statistics. The third unit is Computer Science.

Mathematics and Mathematical Statistics together form the largest department of mathematics in the Nordic countries. There are 23 professors, 57 senior lecturers, 13 assistant professors and the office staff consists of 25 persons. Mathematics and Mathematical Statistics are called the Department in this report.

Research in mathematics and mathematical statistics has a wide profile: Harmonic analysis, complex analysis, partial differential equations, Fourier analysis, algebra, optimization, combinatorics and probability and statistics in the biological sciences. On a more applied side research in telecommunications, finite element methods and image and signal processing with wavelet techniques should be mentioned.

At the first glance the mathematical curriculum and the organization of studies appears complicated, but they have their natural explanation in this environment. The Department offers two study programs: Mathematical Program and Program for Industrial Mathematics. Intake is rather modest, 40 and 10, respectively. However, the Department takes part in 12 different study programs directed to engineers. In these programs mathematics could play, and very often does, a major role. In addition to these there are teacher education and service teaching. The Department offers a great variety of courses. Typical to the technical universities the basic courses in mathematics have plenty of students. In spite of the number of people in the Department the teaching load is rather high. This mostly concerns the lecturers.

There are plans for new study programs.

The teacher education can also be regarded as service teaching. This is not without drawbacks and more responsibility should be given to the Department. The practice now followed should, at least, be changed for those teachers who have mathematics as the main teaching subject. International studies show bad results in science teaching at school in Sweden. Here mathematics has a major role. Teacher education is now in a transition period. Drastic measures are needed to improve the present situation; in particular, the education of new science teachers is a serious concern. The new plans to organize the teacher education will not solve this problem. In fact it is likely that the situation will be worse in the future.

The annual budget of Department is around 140 milj. Skr. The financial situation is tight, most likely due to the great variety of courses which the Department takes care of. There is also a pressure to teach new courses and this pressure comes from many sources, in particular, from mathematically quickly developing engineering sciences. The Department should put up clear priorities in this respect.

In general, administration and finances are well organized. For the basic teaching the Department gets money from two sources. The first source is a number of (full time and teacher training) students and the second source depends on the number of students (1/3) participating a course and on the number of those students (2/3) who pass the course. Courses in mathematics are worth of 80 % of the courses in physics. Courses in physics are not necessarily laboratory coursers. Also some courses in mathematics require small exercise and study groups. In the present situation this very much concerns the first big basic courses in mathematics. Many universities in USA have followed the principles of the Calculus Reform: Lecture and exercise groups have been cut down to 25-30 students. Such a renewal in Göteborg would require a number of new teachers. The Department should study various possibilities to cope with the level of new students. The Department also gets money on the basis of graduate studies and research. The balance of the different sources is adequate.

The facilities are in good order. The mathematical library is extremely well organized with a very good selection of journals and books. It is in the top category in the Nordic countries. Computer facilities are good. The Department has a nice and well-organized building. Not surprisingly there is a lack of space.

The Department has little power to choose its students. This is a typical feature of the Swedish system. Because of the decline of preuniversity education in mathematics the Department has been forged to organize preparatory courses. An alternative is to change the existing courses so that they better meet the level of new students.

Studies in mathematics very much follow the traditional pattern in mathematics. Department is well aware of participation rates and failures, although there is no modern computarized feed back system from the students. Many teachers of the Department have received awards of excellent teaching performance. Young students (2 – 3 years of study) could be more used as teachers in exercise sessions. They know better the defects of preuniversity education.

In recent years there has been about 10 MSc in mathematics and mathematical statistics annually. The number reflects the system described above: Mathematics is mostly needed for service teaching. The number of licentiates has been around 12-14 and the number of doctors around 6 - 8.

The Department could certainly use more money to hire graduate students. It seems that the distribution of these finances in the University needs a new approach. There are many alternatives. For example, new professors should be able to get this money and if they are successful, then the financial support should be continued. There could also be excellent advisors of graduate students, not only professors, who do not annually produce five papers. The University should provide them an opportunity to exercise their skills since in many cases they have difficulties to get external funding.

The Department should have more freedom to use its teaching staff. At present the system is rather rigid and teachers at the Department, in particular the lecturers, have a high teaching load. The Department could offer half-year sabbaticals, say, for those professors and lecturers who have made

good progress in research or in advising graduate students. The money is then away from some other activity but a big department can most likely afford this. This requires a new policy and new priorities.

Site visit at the Chalmers University in Gothenburg

Zoltán Kovács

Visit date: 21th−23rd April 2002
Source: Lennart Frennemo, Jan−Erik Andersson

Chalmers was founded in 1829. The university is named after the major benefactor, William Chalmers, one of the directors of the successful Swedish East India Company in Gothenburg. University of Gothenburg has got newer traditions, it was founded in 1954. These two universities are large and very popular universities in Sweden. They take place near the downtown of Gothenburg, being a large area of campus with many lecture halls and other rooms for teaching, excluding dormitories.

Mathematics Sciences is a common department to both university in Gothenburg, consists of about 110 academic teachers (about 30% of them working in research projects as well). The department is regarded one of the best mathematics department in Sweden and it is the largest connected unit for this subject in the country. Last years there were founded lots of small universities in Sweden for similar purposes but the best students mostly choose traditional schools for their studies.

The department has a very good infrastructure and also has a rich library of books and newspapers. All the teachers and the students have very good possibilities to reach the computer resources and the internet using the own computer rooms of the department. There is a special stuff for maintaining the computer network of the department, which mainly consist of Sun Ultrasparc workstations and Unix operating systems. I experienced a very friendly environment both outside the building, in the campus, both inside, which gives an inspirative atmosphere for researching and studying as well.

There are 12 undergraduate and 2 graduate programs. About 1200 students are admitted to the undergraduate programs and about 15 students to the doctoral programs each year. Unlike in Hungary, teacher training does not belong to the direct tasks of the department, but there is a special department of pedagogy for teaching prospective teachers for didactics. There might be an advantage if a connection of mathematics and didactics would be organized for certain lectures for mathematics teacher students. As the colleagues described, the Swedish concept in teacher training will be changed soon, it goes towards training coaches instead of teachers with much less of mathematical knowledge and much more of didactics. This will obviously cause a retrogression in general level of the knowledge of mathematics in Sweden, because mathematics teachers will not be highly qualified anymore than before. In addition, a pupil growing in mathematics science requires much more a "superior leader" instead of a "friend".

Students and teachers are also well paid, Swedish government gives a satisfactory amount of money for education. However, teachers working in elementary schools earn much less than ones working in high schools. University teachers do not earn so much more than high school teachers, like in Hungary. Unfortunately, in Sweden it is also the fact that most students do not want to work as a teacher because school is not so attractive anymore for a working place than before. Its reason is probably that other scientific areas (e.g. information technology) currently seem to be more interesting than pure mathematics and wages were also raising in other areas recent years but not in education.

Visiting one lecture in multivariable analysis, I experienced an open relationship between the students and the teacher. I also saw some interesting wrinkles in trifles, such as projecting definitions and theorems to the wall during the lecture and using the blackboard only for practical situations. I noticed

that the teachers mostly teach from English books, forcing the students to prepare for their future scientific work which will certainly based on the English language. Unlike in Hungary, examinations are mostly in written form, however earlier it was usual in oral form as well.

The amount of graduate students might be larger comparing to the number of the university teachers. A difference to the Hungarian system, that in Sweden after the first year one can get a licentiate examination. In the industry many firms accept this type of degree as well for offering a job. Other difference, that teachers are not forced to take part in any research. A teacher gets an extra wage if he is taking part in any research project.

Visiting the coffee bar between two classes, I also experienced an open and friendly relationship among the colleagues as well. In general, Chalmers University seemed much more a friendly working place than any university in Hungary. Small ideas, for example, putting the photos of all teachers on the wall of the entrance hall, or establishing small corners for students for sitting down for conversation and learning, should raise the main attitude of students and teachers towards a positive direction.

The future of teacher training at Chalmers seems to be much cleaner and more stable than in Hungary. The constant support of the government, the relatively high wages and the continuing movement of changing in the different working sectors seems to assure that the teachers will play an important role in the Swedish society in future as well. However, as the culture has been being changed during the last 15 years in all over the world, the main teaching−learning situation between teacher and student seems also be changed. In my opinion it is important for the didactics that it should act upon the changing requirements, such as noticing − mostly the bad − effects of the television and the internet to the new generation, and working on finding new ways to take more interest for the pupils towards learning.

Report from the site visit at the Department of Mathematics at the University of Helsinki.

Per-Anders Ivert

The visit took place on Monday and Tuesday, March 18-19, 2002. I mainly had discussions with Prof. Olli Martio, who is the chairman of the department.

The Department of Mathematics is located in the downtown area of Helsinki, close to the Senate Square, but in the near future it will be moved into a new location together with related departments, and this will imply an essential improvement of the already rather good infrastructure. The department has slightly less than 40 teachers, one third of which are professors. Some 200 new undergraduate students majoring in mathematics start each year, part of whom stop at the BSc level. Annually nearly 50 MSc degrees with a major in mathematics are completed. Some 30 graduate students are currently in the PhLic and PhD programs. Annually about 3-6 PhLic degrees and about 4 PhD degrees are completed.

The Department of Mathematics provides good research facilities including an excellent library, the largest mathematical library in the country. The department represents high level of expertise covering many branches of mathematics including analysis (real, complex and functional analysis, and mathematical physics), algebra, applied mathematics, mathematical logic, stochastics, transformation groups and topology. Many research groups have received high international recognition. The Annales Academiae Scientiarum Fennicæ Mathematica are published by the department. Furthermore, the department has a close cooperation with the Rolf Nevanlinna Institute, which pursues research especially in applied mathematics.

The Department of Mathematics at the University of Helsinki offers programs leading to the basic degrees of Bachelor of Science and Master of Science, and the post-graduate degrees of Licenciate of Philosophy and Doctor of Philosophy. The BSc degree and the MSc degree closely correspond to the American BSc degree and MSc degree, and it takes about five years of full-time study to achieve the higher one. The PhLic degree is somewhat below the PhD degree and the latter corresponds closely to the American PhD degree. The PhLic degree requires about two years of full-time study after the MSc degree. The PhD degree is granted to a Master or Licentiate who has written and defended a PhD thesis containing a significant internationally publishable contribution to mathematics. The PhD degree takes about four years of study after the MSc degree and about two years after the PhLic degree.

There are four alternative curricula for studies in mathematics: general curriculum, teacher's curriculum, applied mathematics curriculum and computer aided mathematics curriculum. In practice this choice takes place during the second or third year of studies, and until then the requirements in each curriculum are the same. The curricula are in turn divided into specialization areas. Detailed information on these are given in the self-evaluation.

Studies typically consist of attending lecture courses and/or passing required examinations, taking part in seminars and writing the BSc or MSc thesis.
A typical mathematics course lasts one semester and consists of 50 - 60 lectures (a lecture lasts 45 minutes) and 20 - 30 hours of problem solving classes in small groups of about 20 students. Each course is examined individually with the grades 3/3 = excellent (usually 5/6 of maximum points), 2/3 = good, 1/3 = satisfactory (half of maximum points).
Basic (approbatur) and medium level (cum laude) courses have mid-term examinations (2 hours) each covering a part of the total material. A student who has passed these mid-term examinations, need not take any final examination at all. Advanced level (laudatur) courses usually have one written exam of 4 hours, however; the lower level courses can also be completed in this way. Although there are no official examination periods, the last mid-term examinations and the final exams of the advanced level courses tend to accumulate at the end of the term, i.e. in December and in May.

The problems recognised at the Department of Mathematics in Helsinki are much the same as those encountered in all countries, namely decreasing level of students' previous knowledge in mathematics. However there has been no measurements of this tendency, but the impression is based on the lecturers' experience.

The department has a large highly qualified teaching staff, and a large proportion of the staff is active in mathematical research.
Although the staff is large in number, it is barely sufficient, due to the heavy load of service teaching. It also seems that the system of allocating financial means is disadvantageous in the sense that it does not sufficiently take into account the strain of service teaching. In other words, the service teaching is insufficiently compensated financially.

All courses taught are evaluated in a computer-based system and the results are collected and put together in a vast report. A study of this report from the latest two years indicates that the students in general are very satisfied with the education offered by the department and one gets the impression of an agreeable atmosphere and good relations between the department and its students.

Site visit at the Center for Mathematical Sciences, Lund University

Lassi Päivärinta

The visit took place in March 2002. I had a meeting with Georg Lindgren, chairman of the Center for Mathematical Sciences, Anna Lindgren, then Director of Studies of Mathematical Statistics, Gunnar Sparr, head of division, Mathematics LTH and Per-Anders Ivert, head of division, Mathematics NF.

The Center for Mathematical Sciences at Lund is a rather new institution. It was formed only three years ago from departments of Mathematics and Mathematical Statistics. The group of numerical analysis formerly in computer science also joined the new center. At present it contains four units: Mathematics MNF, Mathematics LTH, Mathematical Statistics and Numerical Analysis. Two faculties subordinate the center: the Faculty of Science (MNF) and Institute of Technology (LTH). The department having 15 full professors is rather large. It has been one of the leading centers of mathematical research in Europe.

The infrastructure of the department is rather good. The department has its own library, one large lecture hall and 9 seminar rooms. Even the graduate students have their own computers. It is important both for research and for Ph.D. training that the library is close to the department and that the access to books and journals is facile. In centralized libraries this is not often the case.

The teacher education belongs to Malmö University College. However, by an agreement between Malmö and Lund the theoretical education such as mathematics is given by the University of Lund. In this sense the teacher training has to be regarded as service teaching. As is shown in international studies the level of science teaching has gone down in Swedish schools. This observation is supported by the diagnostic tests given by Lund University. The tests are given every year at the first day of first semester. They clearly demonstrate that the situation is dramatically getting worse. To ease the problem I recommend that the teacher education in mathematics will be taken back to the Lund University and that the students take only the necessary pedagogical training in Malmö. One should also consider the possibility that LTH takes part to the teacher training. It cannot harm if the becoming teachers of mathematics know something about image processing or computer vision. If drastic measures are not taken the mathematical level of students finishing the high school will cause serious problems for the Swedish industry.

The Center for Mathematical Sciences provides a large number of service teaching both at LTH and at MNF. For example the department plans a new course of mathematics oriented for biologists and chemists. These new courses will cause an increase of a teaching load for the department. The service teaching should be counted as a result of the institute similar as granting master and doctor degrees.

I was impressed how mathematical statistics was organized in Lund. In Finland statistics is separated from mathematics and has serious problems say in student recruiting. The number of master degrees in statistics has been modest in every Finnish university. In Lund mathematical statistics has responded to the changes in society. It has a lot of common programs with LTH, one of them being mathematical image processing. This cooperation has lead to a great number of Master's theses. After finishing their studies many of the mathematical statistics students find a job in information technology.

The outcome of the Center for Mathematical Sciences in terms of Master's degrees is modest Compared to the size of the teaching staff but the situation is improving. For the years 1997-2000 there have been in average 2-3 Master's theses both in mathematics at MNF and in numerical analysis and 10-12 master thesis both in mathematics at LTH and in mathematical statistics. For mathematical statistics the result can be considered as good. One of the reasons for the problems is the level of the students' intake as was discussed above. To improve the situation some teachers and some mathematics students have visited schools and making propaganda for the mathematics studies at Lund University. I believe that there is still much that could be done in more systematic way to make the career of a mathematician/statistician more attractive for school students.

The number of the doctor degrees has varied between 5 and 9 in last three years. The result for mathematical statistics has been three annually, which is good. The level of the graduate studies is closely connected to the activity of the scientific research. To keep the latter as good as it has been I recommend that the department should offer sabbaticals to those professors and lecturers that have been successful in research. This is, of course, a question of money, but it is also question priority.

Site visit at the Center for Mathematical Sciences, Lund University

Peter MOSON, Budapest University of Technology and Economics

The visit of the Hungarian delegation, leaded by Professor István Hortobagyi (ELTE, Budapest), members: András Ambrus (ELTE), and me (BUTE), took place on April 4-7. 2002. Professor Per-Anders Ivert helped us in the organization both of the professional and organizational part of the visit. On the plenary session (April 5) we could discuss the questions with all the directors and vice-directors of education of the departments of Lund University.

In this report I will concentrate mainly on the aspects related to the service training of engineers and other topics having special interest for my university.

General presentation

There are several **similarities** between Lund University and BUTE.

- Both institutions have a **long history**. (Lund University was founded in 1666, BUTE in 1782).
- They are **large educational and research centers.** Lund University has 7 faculties, with its more than 34 000 students enrolled, , is the largest unit for research and higher education in Sweden. BUTE has 8 faculties, with its more than 15 000 students enrolled, is one of the largest research and higher education institution in Hungary. Concerning mathematics there is a wide list of teaching and research activities, with important service teaching part, but relatively small teachers' training.
- However the institutions are "old", **the organization of the mathematics is new**. The Institute of Mathematics at BUTE was founded in 1996, Center for Mathematical Sciences at Lund in 1999.

There are **differences** as well.

- BUTE is mainly a university of technology, the training in Lund is wider, it includes medicine, law, arts etc.
- The organization of the mathematics is based on other principles. The Center for Mathematical Sciences at Lund contains 4 units: Mathematics MNF, Mathematics LTH, Mathematical Statistics, Numerical Analysis, its structure is mixed, but it follows mainly the teaching activities. The Institute of Mathematics at BUTE has 5 units: Departments of Algebra, Analysis , Differential Equations, Geometry, Stochastics. This structure is related mainly to the research activities.

Details

At the plenary meeting the Hungarian delegation formulated several questions[1] related to the document: "Self-assessment for Mathematics, Mathematical Statistics and Numerical Analysis at Lund University". The methodology was that the participants followed the report step by step. Here I mention only some elements[2]:

- The engineering programs at LTH are more specialized than at BUTE (e.g. by tradition there is a fire protection engineering program), but it does not affect importantly on the teaching of mathematics.
- The content of the basic compulsory courses in service teaching is similar (linear algebra, calculus - functions of one real variable, vector analysis, series, complex functions, differential equations etc., except that there is no statistics in Lund). The credits, hours in Budapest are slightly less (22 instead of 24 ECTS at Lund). Concerning the content there is more local independence in Sweden. In Hungary there exists a national accreditation body.
- The financial situation of Lund University is better, e.g. the full time equivalent paid for a student is twice of the Hungarian one.[3]. This is especially true related to the salaries of professors, Ph. D. students.
- The methodology of teaching, evaluation, experience of the advisory system was discussed in detail as well. I mention here a few **original elements** (e.g. tutorial consultation scheduled by timetable for the students, the professors start their courses by declaring, what

[1] After the general presentation of the 2 institutions, mathematical training, research.
[2] Their order follows the cited "Self-assessment for Mathematics, Mathematical Statistics and Numerical Analysis at Lund University", so in this summary can seem sometimes accidental.

changes, development they plan because of the previous students' evaluation), which can be useful in our teaching as well.

Some questions were touched relatively weakly in the manual used for the common joint self-evaluation. The site visit gave a possibility for their investigation. A few examples:

- **Support materials** (text books, lecture notes etc.). The language skills of Swedish students are better than those of the Hungarian ones. That is why in Lund English books are widely used[4]. On the other hand lecture notes from Lund are popular everywhere in Sweden.
- **Internet.** Both institutes have their own home page. BUTE[5]: www.math.bme.hu, Lund www.maths.lth.se . They contain much important information in English and in the local language, but at the moment there is no really interactive, e-learning type training.

Cooperation

Here I mention only a few possible themes:

- The undergraduate training at BUTE is diversified, it has 3 levels: bac+2 (AHVT-accredited higher level vocational training); bac+3 (college); bac+5 (university - this is the typical one). These levels are practically independent, to follow the studies on a higher level is complicated. Since 1990 Hungary (and BUTE) have followed the international (mainly EU) development, ECTS system, signature by the Hungarian Ministry of Education of the "Bologna Declaration" etc. The introduction of the 2 level **B.Sc. - M.Sc.** training (planned to be common in the European Educational Area) is the next task. In this work we would like to use the experience of our partner institutions.
- Lund University have been using "**Diagnostic Tests**" for several years, and measures by this way the knowledge of the input students. It is planned to prepare the Hungarian translation of this test and apply it to BUTE students. This experiment can give comparison at the moment among the students of different countries, institutions, and in long term allows to follow the changes in the input competence.

[3] But it corresponds to the differences of the general development level between the 2 countries.
[4] I remark that in Hungary the price of the books could lead to problems as well.
[5] BUTE Institute of Mathematics is working on an important development at this time.

- In both countries (but especially in Hungary where the number of students is quickly increasing at these years) the **decrease of mathematical knowledge** of incoming students is typical. The partners could work together methods **how to react** to this fact.
- Similar cooperation is possible in the output phase, as the first mathematicians at BUTE will graduate this year.

Finally I repeat that this report concentrated only the main elements of the site visit with special emphasis on the need of Budapest University of Technology and Economics.

Budapest, May 16, 2002.

Report from the site visit to Department of Mathematical Sciences at University of Oulu.

Reviewer: Lennart Frennemo

Date for the visit: April 24-25

Sources: Keijo Väänänen, Lassi Päivärinta, Alli Huovinen, Vesa Mustonen, Jukka Kemppainen.

A group of students from the different programs offered.

Self-evaluation made for the LUMA-project.

ACADEMIC STAFF

The department seems to have a well-qualified and experienced academic staff.
The teaching workload is about 5 hours per week for a professor and about 300-380 hours per year for a lecturer.
There are several research groups, some of them with an high activity.

The formal appointments of new teachers are made at the university level. There is an appointment committee and there are referees as usual to prepare the appointments.

The teaching staff seems to be well suited to the carriculum. The use of young students as tutors, as described later on in the text seems to be an effective way of teaching.

The department has been awarded pedagogic prizes by the ministry of education in Finland for good results in the education.

Conclusions: The staff is well-qualified and well experienced. The way they use students as tutors seems to be a very effective way of teaching.

RESOURCES

The university gets money essentially depending on the number of master degrees and the number of doctor degrees. The faculty then decides on the distribution of money between the departments.

The department of mathematics has an excellent infrastructure, very good laboratory facilities and learning resources.

The library is also excellent, with good possibilities for both teachers and students to get all information they need.

The access to information networks is also excellent.

The resources are distributed in a decentralized way, which seems to be effective.

Conclusions: The department seems to have quite good resources for the teaching as well as for the infrastructure. The decisions concerning the distribution of resources are decentralized, which seems to be very effective.

STUDENTS

The department has a yearly admission of about 100 students. The differences in the level of the students pre-university knowledge has grown. Most students, 85 percent, are admitted on the basis of grades in mathematics from the school. The rest have to pass an entrance examination, which is evaluated at the department.

The students are taken care of in an excellent manner. When they start their studies they meet a mentor system, where groups of about 10 students are helped by an older student who is paid for this mentorship. There is also a tutorial system, where second year students are paid (about 11 euro per hour) to help the younger students with their problems in the studies, especially with problem-solving.

The total amount of lectures and exercises are about 15-20 hours a week, and most students use the tutorial system about 4 hours a week as well.

The study language is mostly Finnish, but often supported with textbooks in English.

There are self-assessments after each course. The students have an evaluation group and there is also one whole day each year when the students and the teachers meet and when the students tell the results of the evaluations and also discuss the future.

Conclusions: One of the essential things that can be learned from the system in Oulu is the way of taking care of the students, especially the tutorial system

ORGANIZATION OF STUDIES

In principle every student have to take a masters degree, which for most students take more than five years including writing a thesis. Many teacher-students and also the other students work for shorter or longer periods at schools depending of the lack of teachers in Finland.
About 30 percent of the students drop out during the first year. Totally only about 50-55 percent manage to take their master degree, which is about the best in Finland.

The non-educational services (food, housing, mental and medical aid) are very good.

Conclusions: The students have excellent conditions in Oulu. This depends not only on the way they are helped with their studies but also on the excellent non-educational services.

EDUCATIONAL PROCESS

The essential progress in teaching methods is the tutorial system, which first started with the ordinary teachers as tutors. This did not work out so well until the new system with students as tutors was introduced some years ago.

Today the students have very good possibilities to succeed with their studies.

The examination methods are classical and almost all in written form.

Although the students pre-university knowledge seems to be worse compared with earlier days, the teacher says that the master thesis's have been improved the last years.

Conclusions: The educational process seems to be well adapted to the given rescources.

TEACHER EDUCATION

The education of teachers, which is ended up by writing a master thesis, seems to be quite well organized.
According to the situation in northern Finland with quite small secondary schools the teachers often have to teach in three or more subjects. As a result of this, there are newly examined teachers at upper secondary schools with mathematics as a minor subject with only 53 points measured in the European system.

Site visit at the Oulu University

Reviewer: Zoltán Kovács, University of Szeged
Date for the visit: 24−25 April 2002
Sources: Keijo Väänänen, Lassi Päivärinta, Alli Houvinen, Vesa Mustonen, Jukka Kemppainen, self evaluation made for the LUMA project, Lennart Frennemo's review, web page of Oulu University

University of Oulu, founded in 1958, is a campus island to the North from Oulu, outside the town. It is one gigantic building which hides a modern, colorful university area inside. There are about 15000 students altogether learning at the university.

About 30 academic teachers work together at the Department of Mathematical Sciences. There are 5 undergraduate programs (teacher education, mathematics, mathematics and IT, applied mathematics, statistics) and 3 postgraduate ones (mathematics, applied mathematics, statistics). An average of 120 students start the undergraduate program each year and cca. 50 of them finish the program (about 30 of them are future teachers). A difference to the Hungarian system, that in Finland after the first year of the graduate studies one can get a licentiate examination. In the industry many firms accept this type of degree as well for offering a job. About 20−25 students get licentiate degree and over 10 are those students who finished their PhD studies as well. Remarkable that number of diploms is growing each year.

The department has a very good infrastructure and also has a rich library of books and newspapers. All the teachers and the students have very good possibilities to reach the computer resources. There are computers on some corridors to help the students to have on−line contact on the internet for mailing or searching the web.

Unlike in Hungary, teacher training does not belong to the direct tasks of the department, but there is a special department of pedagogy for teaching prospective teachers for didactics. There might be an advantage if a connection of mathematics and didactics would be organized for certain lectures for mathematics teacher students. As the colleagues described, 10 years ago a new tutorial system was introduced to help the weak students to learn much easier. Students are paid (11 euro per hour) to help the other students in their problems in their studies, especially in problem−solving. This tutorial system is said to be one of the best features of the educational program, as the same opinion of teachers, students and foreign visitors as well and statistics also shows that in 10 years number of diploms grew up to 275%. Due to the university gets money essentially depending on the number of master degrees and the number of doctor degrees, this must be a relevant growth for the university, although the teachers say that recent years the master theses became better than before.

Students and teachers are also well paid, Finnish government gives a large amount of money for education. However, teachers are still underpaid in general in Finland. In addition, elementary school teachers earn much less than high school teachers. Unfortunately, in Finland it is also the fact that most students do not want to work as a teacher because school is not so attractive anymore for a working place than before. Its reason is probably that other scientific areas (e.g. information technology) currently seems to be more interesting than pure mathematics and wages were also raising in other areas recent years but not in education.

Future teachers have good conditions to find a job, especially in country, where sometimes schools are searching for teachers being expertized in 3−4 subjects as well. There is a shortage of high school teachers in country, so in conclusion, many students at the 4th or 5th years of their study go for practical teaching for such places. Unfortunately they do not have enough time to continue their studies

parallel, hence sometimes they studies may grow to 6 or 7 years as well. The reason why the study time is so long is that each student has to choose a major and a minor subject and the major subject needs 98 credits but minor subjects also need 53 credits which seem to be too much for those students who are expertized in 3 or 4 subjects in the same time.

Visiting one lecture in advanced analysis (spoken in English), we experienced a very high rate of mathematical skill of the lecturer. Most teachers educate in Finnish from English books, forcing the students to prepare for their future scientific work which will certainly based on the English language. Unlike in Hungary, examinations are mostly in written form. Other difference that a diplom may be written by two people as well and there is no final examination.

There are self−assessments after each course. The students have an evaluation group and there is also one whole day each year when the students and the teachers meet and when the students tell the results of the evaluations and also discuss the future. However, teachers and students did not have the same opinion in the effectiveness of this evaluation day.

The future of teacher training in Finland seems to be much cleaner and more stable than in Hungary. As the colleauges described, nature sciences have a decreasing trend since 1999 in Finland and technical sciences are increasing since then. In opposite, the constant support of the government, the relatively high wages and the continuing movement of changing in the different working sectors seems to assure that the teachers will play an important role in the Finnish society in future as well.

Site visit at the Bolyai Institute in Szeged

Per-Anders Ivert and Lassi Päivärinta

The University of Szeged, which together with its predecessors has a very interesting history, was reorganized in 2000 by merging the Albert Szent-Györgi Medical University, the József Attila-University and the Juhász Gyula Higher School for Pedagogical Studies and a few other university colleges. It now consists of ten faculties. Our visits, which took place April 11- 15 and May 12-14 was paid at one of the two mathematical institutes, the Bolyai Institute, which is subordinated to the Faculty of Sciences. This Institute has rich and prosperous traditions, and many mathematicians that were active in Szeged in the last century play an important rôle in the history of modern mathematics.

The Bolyai Institute is located near the very center of Szeged, in premises well adapted to their purpose. The infrastructure seems to have its good and weak sides. The library maintains a very high standard, with about 20000 books and an only slightly less number of volumes of periodicals. However, one should note that do to the financial situation the library could order now fewer periodicals than 10-15 years ago. Since the institute is financed according to the number of students the decrease of these numbers will cause serious financial problems in 3-4 years. Even right now there is a lack of computer facilities for the students.

The Institute publishes the renowned Acta Scientiarum Mathematicarum, founded in 1922 by Frigyes Riesz and Alfréd Haar. Since 1991, there exists one more periodical edited in the Institute, the "Polygon": a popular journal for college students and teachers of mathematics. Especially interesting are the articles of the history of mathematics where Bolyai institute plays a dominant role. As an example we mention an article about John von Neumanns letter to F. Riesz concerning ergodic theory.
The members of the Institute produce also course books to a large extent; there are the “Polygon Könyvtár” and the “Polygon Jegyzettár”, two series of books and booklets containing theory, examples and exercises from various fields of mathematics. These books appear in a uniform format and with a very nice layout. After examining some copies we have the impression that they are in general carefully written and organised, obviously by experienced academic teachers, and that they are very well adapted to their purpose.

There are two full-time programmes offered, both comprising five years (normal study time): Mathematics and Mathematics Teachers. Besides, a lot of courses are given in other programs like Computer Science, Physics, Chemistry etc. Descriptions of the curricula for the two main programmes are given in the self-evaluation.

The problems encountered by the Bolyai Institute are very similar to those known at other universities in other countries. In the last decade there has been a significant decline in the students’ prerequisites. This problem seems to be connected with the difficulties of attracting gifted students to mathematics. The situation is particularly troublesome in the programme for Mathematics Teachers, where only about 80% of the available places are filled. An explanation for this could be that the teacher profession is by far not as attractive as it has been, and the teachers are not well paid. This also reminds about the situation in Scandinavian countries.

The academic staff consists of 52 teachers, 13 of which are full professors. The division of the staff into professors, associate professors, lecturers and assistant professors is not the best possible. There is a constant need for more assistant professors at the institute. Typically for Hungarian universities the body of full professors is dominated by local people, only two of the 13 full professors come from outside Szeged. More academic mobility might do well for the system.

During the visit we spent more than 10 hours attending lectures, demonstrations and exercises, for the mathematics programme as well as for the teachers' programme. Our impression from these visits is that teaching maintains a high theoretical standard and that the Institute has committed and qualified teachers as its disposal. Also the atmosphere in classes is supportive.
One interesting session was when the teacher students had the task of presenting in 15 minutes some high school material, whereupon they gave self-criticism and received criticism from the other students. This was performed in an open and friendly atmosphere, and to us it looked like an excellent exercise for prospective schoolteachers.

Compared to the situation in Scandinavian countries, the examination rules are rather strict, for example with respect to the number of chances to repeat an examination. However, the system will be radically changed in the autumn of 2003, when a credit system will be introduced.

An essential strength of the Bolyai Institute is the tradition of high quality performance both in research and in education. The main problem now seems to be the recruitment. It should not be too difficult to provide the mathematically gifted and interested student with good reasons to come to Szeged and the Bolyai Institute, but the recruitment of students to the teachers education of course depends on factors in the society, like the conditions for teachers working in school.
Also one could recommend more freedom for the use of resources in the institutes. It can hardly be rational that the government decides even upon the make of the Xerox-machine that the institute is going to by.

When comparing the education at different sites in the different countries, the trends and the problems, we find the similarities more striking than the differences.