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The Hungarian Universities and Their Mathematical Education

Lajos TAMÁSSY

Let me begin this lecture by a brief exposition of the past of higher education in Hungary.

The first Hungarian university was founded at a relatively early date, in the 14th century, by the king of Hungary. Owing to disfavourable historical circumstances, this university soon ceased its activities. The direct predecessor of what is today the University of Budapest was founded in 1635 by the Roman Catholic primate of Hungary. For more than a century it was located in a city belonging at present to Czechoslovakia, and it was transferred to Budapest, the capital of Hungary, only in the second half of the 18th century. Between the two world wars our country had already four universities and a technical university. The universities were located at Budapest, Debrecen, Szeged and Pécs respectively, while the technical university's seat was Budapest.

The universities had faculties of philosophy, law, theology and medicine, while the technical university was divided into faculties of machinebuilding, chemistry, architecture and economy.

Entrance to the universities was not limited. The only condition was a valid certificate of maturity. However the fees to be paid, including laboratory and examination fees, the cost of the textbooks and the living expenses meant a considerable financial burden, which could be borne only by those possessing sufficient financial resources. Only to a limited number of students could the universities give a certain amount of financial help. Another factor severely limiting the number of university graduates was the difficulty to find jobs requiring a university diploma.

Before going to the university, the student had to absolve the eight classes of gymnasium. Children went to gymnasium at the age of ten, after four years of primary schooling, and they obtained their certificate of maturity (baccalaureate) at the age of eighteen. The gymnasium was a rather selective school, with high teaching standards. E.g. complex numbers and the elements of calculus were taught in our gymnasia already at the beginning of this century. Only a small proportion of children of ten years went to gymnasium, and only half or one third finished their studies. Prior to world war I even part of those finishing the gymnasium failed to obtain the certificate of maturity, the qualification "fit for university studies". Among the teachers there were many scholars, conducting active scientific research besides their teaching activity. The "private-docents" of the universities were, almost all of them, gymnasial professors. Such professors were held in high esteem by their schools. E.g. Frédéric Riesz began his career in a gymnasium. Zoárd Geöcze, known for his research in the theory of surfaces and for constructing an everywhere continuous but nowhere differentiable function was also a gymnasial professor.

The universities considered their task to be the cultivation of science. Teaching was directed towards exposing scientific results, students were educated to enable them to follow the development of science, possibly to engage in active scientific work. To impart

* Institutum Mathematicum Universitatis Debreceniensis, H-4010 Debrecen Pf. 12, Hungaria.

ハンガリー国のデブレツェン大学の教授で 1976 年 10 月から 11 月に来日，11 月 13 日本学で講演した。教授の承諾を得て掲載する。

practical knowledge or to give special preparation for some profession was not considered to be a primary aim. It must however be remarked that at the medical faculties and at the technical university the gap between the knowledge imparted and the practical requirements of the corresponding profession was considerably smaller. Students of the philosophical faculty embraced with but few exceptions the career of gymnasial professor. In order to supply the pedagogical-practical knowledge not imparted by the university but required for this profession, Professorial Training Centers were adjoined to the universities' philosophical faculties. Frequentation of these centres was not obligatory, but a student could obtain no professorial diploma without satisfying his requirements too.

The universities enjoyed a rather considerable autonomy. This was however limited by the fact that the universities financial means were almost completely provided by the state. Professors were nominated by the ministry for cult (the nomination bore the signature of the head of state). The nominee was however chosen from a list of applicants selected by the university. The ministry usually choose the first name listed, but there were some notable exceptions. The nomination was not temporally limited. A professor remained active till the retiring age of seventy, provided he remained able to discharge his duties. To a given chair only one professor was nominated, and he led the chair until he retired. If a chair had no laboratory, no experimental work to do, at most one or two assistants were adjoined to the professor. Even this was the case only if the chair had a greater number of students to look after. Assistants were usually nominated on a temporary basis, and their financial situation was precarious. There were however chairs (in the faculties of philosophy, law and theology) which had no assistants at all.

Each faculty of a university had its Council. The members were the professors, and they choose from among themselves a dean, who remained in office for a year. Often professors were elected to be deans in order of seniority. Matters regarding the faculty were dealt with by the faculty's council. The head of the university was the rector, elected for one year.

The professors enjoyed full liberty in choosing the subject of their lectures. Sometimes the result was that from the lectures the students learnt only about that narrow subfield of science in which the professor specialized himself. (E.g. an eminent zoologist lectured for a number of years only about the nervous system of insects, anything else about insects, as well as the biology of mammals, birds etc. the students had to learn by themselves, as best they could).

Unregulated freedom was also great in other respects. E.g. it was possible in principle to absolve the philosophical faculty, without passing a single examination. True, the Professorial Training Center required three rigorosa in five years. Colloquia from diverse subjects at the end of the semester or of the year were required only for the remission of tuition fees or for obtaining stipendia (grants). There was no time limit set for the duration of university studies. Examinations could be repeated arbitrarily many times. It is only fair to say, however, that only few students used (or abused) university freedom to its extreme limits.

As far as mathematics was concerned, the situation was rather favorable. Between the two wars we had in Budapest Leopold Fejér (Fourier series), while in Szeged Frédéric Riesz (functional analysis) and Alfred Haar (topological groups, Haar-measure) were active. They and others assured a high level of mathematical training.

We have looked over the past of our higher education in a somewhat detailed manner, in order better to be able to characterize the direction and the depth of the changes made.

After the war, important changes occurred in Hungarian public education. Elementary school, beginning at the age of six and comprising six classes (the last two of which were omitted by children going to the gymnasium) was replaced by a basic school comprising eight classes. Thus the obligatory minimal age of schooling rose from twelve to fourteen years. After having absolved the basic school, children can get their secondary education in two types of institutions: gymnasium and special high school. Gymnasium gives a good general education and prepares for continued studies at a university or a college. As to the special high school, it sets more modest aims in the field of general education, but on finishing it, the pupil gets qualified for a particular job. Only few pupils of the special high schools go further to get a university education, and even these usually choose a speciality connected with that particular branch of labor they studied at school.

It was characteristic of the changes that the number of high school pupils, as well as that of university and college students became several times higher. Also characteristic was specialization; much more than previously, teaching aimed at giving preparation for a certain career, for a certain profession. This tendency characterized the creation of special high schools, and it was clearly discernible also in university, and in particular in college education. Also the medical faculties of the universities were formed into independent universities, subject to the control of the ministry of health. In 1950 the theological faculties were detached from the universities, in order to continue their work within the bosom of the respective churches. At the same time faculties of science were formed from the mathematical and scientific chairs of the philosophical faculties. The number of universities remained unchanged, but several technical universities were founded outside Budapest. Also, there came into being at Budapest an independent University of Economics.

At the Budapest technical university new faculties for electrical engineering and for transport engineering were founded. The technical universities outside Budapest had faculties of machine building, of mining, of metallurgy, of chemistry and of forestry. At the same time a large array of colleges was created. These prepare each for a given profession, and give a somewhat lower qualification than the universities. E.g. technical universities frain planning and developing engineers, the technical colleges however so called plant-engineers, who organize, direct and control the process of production. Similarly, the universities form high school professors, and the colleges specialized teachers and teachers for the basic school. University education lasts as a rule five years, college three or four years.

The number of university and college students has increased considerably. Today nearly 10% of a given age group conducts superior studies.

After the war, the Professorial Training centers ceased to exist. The corresponding training became the task of the university faculties, and they gave to all their students professorial diplomas, although a smaller percentage of these did not embrace the pedagogical career. Instead, these became newspaper men, librarians, archaeologists, insurance mathematicians, geologists, research workers or university lecturers. Where the need for such specialists became numerically important, special training for them was instituted. E.g. computer operators first came from among mathematics teachers, from the late fifties onwards, however, special training for them began.

We shall soon say a few words about the program of this special training, but let us first point out a few changes of a basic nature. First of all, teaching and study are now strictly regulated activities with a bound program. Students and professors know only from vague reminiscences those times, when the professor was free to choose the subject of his lectures, and the students selected the lectures to be attended according to their own liking. Today everything is strictly regulated by plans and programs. The plan

Table 1. Plan of subjects

Subject	Term 1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Introduction to algebra and number theory	2+3									
Linear algebra and geometry	4+4	3+4								
Algebra			2+2	2+0						
Number theory					3+1					
Set theory					2+0					
Mathematical logic								2+0		
Introduction to analysis	4+4									
Differential and integral calculus		3+4	3+3							
Theory of functions				2+0						
Measure- and integral theory			2+3							
Differential equations				2+4	3+3					
Topology			2+0							
Functional analysis					2+2	2+2				
Orthogonal series						2+2				
Differential geometry				3+1	2+0					
Probability theory		3+3		3+3						
Stochastic processes							2+2	2+2		
Mathematical statistics						3+2	2+3	3+3		
Information theory					2+2					
Linear programming						3+2	2+2			
Numerical mathematics							1+3	1+3		
Mathematical machines			2+4	1+3						
History of mathematics					2+0					
Professional practice									0+24	
Special subjects						2+0	2+0	4+0	2+0	4+0
Seminars							0+2	0+4	0+2	0+4
Physics						3+3	3+3	2+2		

lists the diverse subjects, and the number of weekly hours to be devoted to them. The program describes the material to be taught within the framework of each subject. Satisfying the requirements of the obligatory program usually fills a student's whole time. Thus, although students still have the right to attend any lecture delivered at the university, they only rarely attend lectures outside their obligatory curriculum.

Let us now speak about students specializing in mathematics at Debrecen University. They have to choose between two branches of training, centering around a) statistics and b) cybernetics. The two branches differ only slightly. Here we expose the program of the branch statistics. In sums $a+b$, a stands for the number of weekly lectures, and b for the number of weekly tutorials.

Let me expose in a few words the contents of the different subjects:

The teaching of analysis starts of course with differential and integral calculus in the I-st semester of the I-st year. The teaching of analysis extends to three semesters, with a fairly high number of lectures. In the first year there is "Introduction to analysis and topology." Here sequences and series, limits and continuity are discussed, together with the main pertaining theorems. Topology means here only the notion of topological space, and its use in discussing the notion of continuity. There are four lectures weekly, and four tutorials. Tutorials are being held for groups of 20 to 25 students. They are devoted to discussing examples and solving problems, sometimes even additional theoretical material is included. E.g. if the lecturer has proved the theorem concerning the addition of two convergent sequences, it might be the tutorials task to establish the analogous result for the multiplication of sequences. Imparting theoretical knowledge is however task of the lectures, at tutorials only slight complements can be added, their main task being to provide exercises and applications.

The student's work is being controlled by oral examinations of 20 to 30 minutes duration, attached to diverse subjects. These oral examinations called colloquia do not however take place in each subject at the end of each semester, because the number of examinations the students can be burdened with is strictly limited by existing regulations. This limitation has its advantages as well as its disadvantages.

Students have much difficulty in understanding this introductory course of analysis. This difficulty is mainly due to the notion of limit, so greatly different from anything they have learnt in high school. Here a peak students must climb, not the highest but probably the steepest in the course of their studies. Failure rates at the corresponding examination are high, up to 50%. An unsuccessful examination can be repeated after 7–10 days, two repetitions being permitted.

In the second and the third semesters there follows calculus in one and in several variables. Here the lecturer has two possibilities: he can treat the case of one variable in the second semester and the case of several variables in the third, or else he can discuss differential calculus first, and integral calculus afterwards.

In the fourth semester, after an introductory treatment of real functions, complex function theory follows, up to and including Cauchy's integral theorem and the residuum theorem. There are two lectures per week and one tutorial.

Also in the fourth semester the study of differential equations begins, based on classical analysis. In view of its importance for practical applications, this discipline is given ample space by the curriculum.

In the 4th semester 2+4 hours per week are devoted to the following subjects: ordinary differential equations, systems of equations, elements of the calculus of variations, the Euler-Lagrange equations. In the 5th semester 3+1 hours per week are devoted to partial differential equations, special emphasis being laid on physical applications.

In the 4th semester, there begins also a discussion of the more modern aspects of analysis. In the 4th semester there is a lecture on Measure theory and integration, taking 2+3 hours weekly. The notion of measure space, the properties of measure, the abstract Lebesgue integral, L^p spaces, Lebesgue-Stieltjes measure, comparison of Riemann and Lebesgue integrals, the structure of measurable functions, these are the main topics discussed. The students are enabled to place their earlier notion of integral within the framework of the general theory here exposed. This lecture lays the foundations of functional analysis, and at the same time it makes possible a measure theoretic build up of probability theory. The great number of tutorials makes possible a seminary-like, enlarged treatment of the subject. This means that certain pertinent questions are worked out individually by the students, and then the result of individual work is being subjected to collective discussion at the tutorials.

In the 4th and 5th semesters there follows a lecture on Functional analysis. (2+2 hours and again 2+2 hours per week.) The students learn to know the foundations of functional analysis, its methods of proof and its applications. This helps to develop their faculty for abstraction. The main topics discussed are: Banach spaces and their linear operators, an introduction to Banach algebras, Hilbert spaces and their operators, and integral equations.

Finally, there is a lecture on Orthogonal

Series, which takes 2+2 hours weekly in the 6th semester. Here Fourier series and the polynomials Legendre, Hermite and Laguerre are discussed, and contact is established with the computational methods of theoretical physics.

The study of different branches of analysis closes with the end of the third year.

The chair for algebra starts its program with an Introduction to Algebra and to Number Theory in the first semester. In 2+3 hours weekly, this lecture deals with the elements of combinatorics; complex numbers; algebraic equations, polynomials, the fundamental theorem of algebra; divisibility and the basic notions of number theory.

Topics requiring much calculation, and usually taught in the first few semesters, are supplemented by a great number of tutorials. In the later semesters the number of tutorials diminishes, sometimes there are none.

In the 3d and the 4th semester Modern Algebra is being taught in 2+2 and again 2+2 hours. Here the program consists of the basic parts of group, ring and field theory.

In the sixth semester 3+1 hours weekly are devoted to Number Theory. This lecture deals with number theoretic functions, prime numbers, algebraic number fields, diophantic equations, the elements of geometric and of additive number theory and with diophantic approximation.

Also in the 6th semester there is a lecture on Set Theory (2+0 hours weekly). Here cardinal and ordinal numbers, as well as certain questions related to axiom systems are discussed.

In the 8th semester there is a lecture on Mathematical Logic (2+0 hours weekly). Here the calculus of propositions and the narrower logical function calculus, the notion of formal system, recursive functions and algorithms are discussed. Some results of Gödel are touched upon.

Algebraic and geometric questions are both dealt with in the important lecture Linear Algebra and Analytic Geometry of the first year. In the first semester this lecture takes 4+4 hours, in the second semester 3+4 hours weekly. Topics: Vector spaces, matrices, determinants, linear forms, systems of linear equations, linear mappings, euclidean vector space, bilinear and quadratic forms, principal axis transformation, quadratic forms; dual vector space, tensors.

Within the framework of geometry, in the 3d semester Topology is being taught in 2+0 weekly hours. Here the students get acquainted with the basic facts of general topology. Such knowledge proves useful also in their further study of analysis and of differential geometry.

The study of Differential Geometry starts in the 4th and continues in the 5th semester (3+1 hours and 2+0 hours per week, respectively). The first part deals with curves and surfaces in 3-dimensional Euclidean space, and with vector analysis. The second part is devoted to the basic notions of non-metric and of metric differential-geometric spaces (affinely connected space, Riemannian space).

From probability theory, statistics and closely related subjects our specialized students get a somewhat more intensive training. In the 2nd semester there is an Introduction to Probability Theory in 3+3 hours per week. It acquaints the students with the elements of probability theory over an algebra of events containing finitely or countably many elementary events. Emphasis is laid on the ability to solve probabilistic problems of combinatorial type.

In the 4th semester there follows a course entitled Probability Theory (3+3 hours per week). Using the bases laid by the course on measure and integration, here the measure theoretic model of probability theory is exposed. Here the main topics are: Probability fields, random variables; important distributions, the laws of large numbers, characteristic functions; central limit theorem, conditional probability, expectation.

In the 5th semester 2+2 hours weekly are devoted to Information Theory. Here models of communication system, coding and decoding, and the measurement of the quantity of information are dealt with.

After probability theory there follow three semesters of Mathematical Statistics beginning with the 6th semester, the number of weekly hours being 3+2, 2+3 and 3+3 respectively. This lecture is of course of basic importance for students specializing in this direction. The topics dealt with are: Theory of sampling, statistical estimation, point estimations, the method of maximum likelihood, interval estimates, the analysis of hypotheses, parametric samples, order statistics, analysis of regression, analysis of correlation, dispersion analysis, statistical quality control, Monte Carlo methods.

In both semesters of the fourth year there is a lecture on Stochastic Processes, in 2+2 and again 2+2 weekly hours. Here the main topics are: Markov chains, Markov processes, integer valued processes, point processes, stationary processes, Gauss and Wiener processes.

Lectures related to computer science:

Linear programming, in the 6th semester 3+2 hours, in the 7th semester 2+2 hours per week. Here the students learn to prepare optimal programs; they reach a level where they can use linear programming methods in an independent manner for the solution of economic problems. In the course of the tutorials, the students solve concrete problems and construct algorithms corresponding to the theoretical methods learnt.

In teaching Numerical Mathematics, great emphasis is laid on independent problem solving. Accordingly the number of hours is as follows: 7th semester 1+3, 8th semester 1+3. Here the aim is to expose the most efficient algorithms of the basis numerical approximation methods, with emphasis on the realization by computer. Topics: error and interpolation theory, numerical differentiation and quadrature, approximative solution of ordinary differential equations, different approximations to functions, solution of systems of equations, inversion of matrices, eigenvalues and eigenvectors.

In the second year there is a lecture on Mathematical Machines. It takes 2+4 weekly hours in the third semester, and 1+3 hours in the fourth semester. Here the emphasis lies on the use of modern computing equipment, as needed by the students in the course of their further studies, and later in their professional activity. At the tutorials the students prepare programs and run these on computers.

In the 5th semester two hours per week are devoted to the history of mathematics.

Besides the obligatory courses just enumerated, there are some freely chosen by the students from among the possibilities available. These are the so called special courses, the name being due to the fact that here the lecturers usually speak of their particular field of research. The topics discussed change from year to year, the number of weekly hours is two. In the 6th and in the 9th semester the students have to choose one, in the 7th, 8th and 10th semesters two such special lectures.

Also, in the 7th and in the 9th semester the students have to participate in a seminary, and in the 8th and 10th semesters in two different seminaries. Seminaries give the students an initiation to independent work: here, under the guidance by a lecturer, they work upon and discuss advanced problems.

The program is supplemented by some non-mathematical lectures. Thus there are lectures on Physics during three semesters, the number of weekly hours being 3+3 (6th semester), 3+3 (7th semester) and 2+2 (8th semester). These lectures are partly devoted to the foundations of theoretical physics with particular emphasis on the application of mathematical methods, and partly to such parts of experimental physics as are indispensable for a proper understanding of modern computing machinery (in particular electronics).

All these lectures fill up the first four years of study. In the first half of the 5th year students work on computers so as to acquire professional routine, while in the second half of the same year they work on their diplom paper. The diplom paper must be the fruit of independent work upon some problem, theoretical or practical, but it must contain some work done on computer.

The students take on mathematics three general examinations (rigorosa), at the end of the 5th, of the 6th and of the 8th semester respectively. At the end of the 10th semester they close their studies with a so-called state examination, based upon which they obtain their mathematicians diplomas.

Students specializing in cybernetics learn somewhat less about statistics and about stochastics processes. They learn however about system theory and system planning. Special lectures and seminars are very helpful in giving the student's training a special turn. Indeed these are chosen by the students in conformity with the direction of their specialization. At Budapest University students of mathematics usually specialize in program planning, while at Szeged University computational mathematics stands in the foreground.

The nearer a mathematicians work is to practical life, the more he must know about industry and economics. The University, however, is unable to impart such knowledge to its students, and this for two reasons: these subjects could only be introduced at the expense of mathematical training; moreover, the universities have no adequately trained teaching personnel. This is the reason why the University of Economics also trains mathematicians. These spend about one third of their time with the study of mathematics. Thus their level of knowledge, in particular with respect to theoretical questions, remains considerably below that of students trained at the universities. Nevertheless, they are eminently useful at certain places. One can only hope that their work will contribute to a better cooperation between mathematicians and economists. Similarly, the Technical University too has started training so-called engineer mathematicians. The first of them will finish their studies in the near future.

The Science Universities train now about 200 mathematicians yearly. The Economic University and the Technical University have, each of them, a yearly output of about 30.

An important part of the work of programming can be effected without higher mathematical education. Such jobs were first filled with people having absolved high school, and they got the necessary initiation in the course of their work. Later courses of longer or shorter duration were organized for computer operators. Today such programming mathematicians are trained at two colleges. Programming mathematicians are also being trained at the universities. The duration of their studies amounts to three years. During this time they become competent computer operators. On the practical side they often know more than the five-year mathematicians, but their theoretical baggage is of course much more modest. Their number at the science universities amounts to 100–150 per year. In the opinion of certain people, the proportion between mathematicians with full university training and medium-level mathematicians is not correct; the number of the first should decrease, that of the second should increase. There are also fears that even if the situation is satisfactory at present, there will be an overproduction of mathematicians in the near future. The problem is not very grave insofar as the number of students admitted to the different universities is centrally regulated, and so a reduction in the number of those trained in mathematics is always possible.

As already mentioned, at the philosophical faculties only high school teachers are trained, i.e. every student receives a professorial diploma. This diploma enables him also to work as a newspaper man, as an interpreter, etc. In Hungary a high school teacher has two specialities, e.g. mathematics and physics, Hungarian language and history, chemistry and physics, etc. At the faculties of science, about one half of the students are teacher candidates. The other half consists of mathematicians, physicists, chemists, biologists, who

Table 2. Plan of subjects for teacher candidates in mathematics and physics

Subject	Term									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Introduction in algebra and number theory	2+2									
Linear algebra and geometry	4+2	3+2								
Geometry			0+3							
Introduction in analysis and topology	4+2									
Differential and integral calculus		3+3	3+2							
Topology			2+0							
Theory of functions				2+1						
Differential geometry				3+2	2+0					
Differential equations				2+2						
Foundations of the geometry					1+0					
Algebra					2+0	2+0				
Measure-theory and integration					2+0					
Othogonal series						2+1				
Probability theory						3+2				
Projective geometry							2+2			
Number theory							3+1			
Set theory							2+0			
Mathematical logic								2+0		
Applications of the mathematics								2+3		
History of mathematics									2+0	
Special subjects							2+0	2+0	2+0	
Seminars							0+2	0+2	0+4	0+4
Professional practice									0+12	0+12

get trained only in one speciality. There is surely a case for training teacher candidates too in one speciality only, an attempts has been made in this direction, but the requirements of smaller schools force us to maintain the present system. Indeed, in a smaller school teaching, say, only biology or only geography would not fill up the whole working time of a professor.

Teacher candidates specializing in mathematics and physics learn, of course, also an equal amount of physics, and part of their studies is devoted to pedagogy. Thus they devote only about 40% of their study time to mathematics. Accordingly their syllabus differs essentially from that of mathematics students.

Here is the mathematics part of the syllabus of teachers candidates specializing in mathematics and physics:

One sees that this syllabus in essentially a subset of the one for mathematicians. This makes it possible to deliver lectures to a mixed audience of teacher candidates and mathematicians. Thus the teaching burden of the mathematical staff is somewhat diminished, which generates more time for scientific research.

Mathematics is being taught at the universities not only to mathematics students and to teacher candidates. Also students of physics devote 25–30% of their time to studying mathematics. Students of chemistry are also taught mathematics in the course of 2 or three semesters the total number of hours (lectures and tutorials) amounting to 5–7 weekly. To a somewhat lesser extent students of biology are also taught mathematics. Thus the Department of Mathematics of Debrecen University deploys many sided teaching activities. The situation is the same at the other faculties of science.

Of course, all students of the technical universities, as well as those of the economic university also learn mathematics. There are now some differences in the mathematical training of engineering students. Students of electrical engineering learn a considerable amount of mathematics: not less than 10 hours weekly during three years. However students of forestry or of architecture receive only about one third of this amount. Teaching of mathematics to these students is centred around the applications. Giving a broader and deeper mathematical background would indeed overburden the students who are subjected to many-sided requirements.

As already said, the number of new students to be admitted yearly is centrally regulated for each of the universities and colleges. This number varies from year to year. Young people having finished high school must apply for admission, and they are admitted after a successful entrance examination, which extends to two subjects. At the medical universities e.g. these subjects are biology and physics, in our case mathematics and physics. The examination has a written and an oral part. Its material does not surpass what is taught in every gymnasium. The questions of the written part are the same throughout the country, and they are worked out everywhere simultaneously. Great emphasis is being laid on the impartiality of evaluation. The correctors do not know the names of the students. The oral examination takes place before committees at the different universities. Besides the result of the entrance examination, an equal weight is given to the result reached during the four years of high school from the same subject. On the basis of all this, each candidate receives a number of points. Admissions are made essentially on the basis of this number. Against the decision of the university, recourse can be made to the minister. About 5% of the total number of places is reserved for this emergency. At the colleges the system of admission is the same. Entrance examinations stand always in the focus of public interest. The system of admission just described is now nearly two decades old, and it has proved on the whole just and satisfactory.

Of course the interest of young people is not evenly divided between the different specialities. E.g. for the 20 places yearly available at the College of Theatrical Art, there are always 300–400 applicants. There is always a considerable spillover of applicants also at the College for Physical Education, and at the different philosophical faculties. The situation is that while the interest of high school pupils is roughly spoken evenly divided between the different subjects: literature, history, foreign languages, mathematics, biology, geography, those interested in, say, history have a much smaller number of places to choose from, than those interested in mathematics. As a matter of fact, for about 70% of all places in higher education, mathematics forms part of the entrance examination. The interest in these specialities is less than in the nonmathematical ones. Sometimes the number of applicants hardly surpasses the number of available places. This, of course, reduces the possibility for selection.

Teaching is gratuitous at every level. There are neither teaching fees, nor laboratory or examination fees. To most students living at places different from that of the university, the university assures accomodation in students hostels. This means board and lodging, for which the students pay a moderate fee, dependent on the parents income. At the same time students receive a differentiated social support. The amount of this either remains below the hostel's fees, or else it balances or even slightly surpasses them. Moreover, independent of the parents income, students receive a certain stipendium dependent on their study results.

Here are a few hints concerning university regulations:

The first semester lasts from september 10 to December 20. The time between December 20 and February 10 is devoted to examinations. The second semester lasts from February 10 to May 15. The second half of May and the whole of June are again devoted to examinations.

At the exercises (tutorials) students receive marks evaluating their work. For theoretical subjects there usually are colloquia at the end of the semester. These are oral examinations of 20–30 minutes duration, the examiner being the lecturer of the subject. There are also a few more comprehensive examinations, so called rigorosa. These are oral examinations of 30–40 minutes duration before a committee of 2–4 members. Students of mathematics have three such rigorosa. The first, at the end of the 5th semester, is from algebra and geometry, two branches of mathematics the study of which closes by that time. The second rigorosum takes place at the end of the 6th semester, from analysis. (By that time, the study of analysis too closes.) The third rigorosum, at the end of the fourth year, is devoted to subjects of an applied nature: probability theory, statistics, numerical and machine mathematics. University studies are closed, at the end of the fifth year, by a state examination. This is an oral examination of 30–40 minutes duration, taking place before a committee based upon the material of the students diplom work and related questions.—An unsuccessful state examination can be repeated twice. After a definitive failure the unsuccessful student can repeat the last year (but only once). In practice, however, failure at the state examination constitutes a rare exception.

At the faculty of science of Debrecen University about 80% of first year students obtains a diploma.

Teaching begins Monday in the morning and lasts until Saturday noon. The total number of a student's weekly hours (lectures+tutorials) amounts to 28–30.

The possibilities for the students sport activities are good in Debrecen. The university is located at the edge of the city in a green zone, and there is ample space for different establishments of physical culture.—The youth organization often organizes meetings with the participation of interesting personalities of public life. Often intellectual and sporting contests take place, and sometimes prominent personalities from outside the university are asked to deliver lectures on actual questions. University life centers around students hostels. If a student of average ability economizes his time well, then he is able fully to participate in this life, without prejudice to his studies.

The students have possibility to join scientific work already at an early stage. For experimental subjects this means participation in the respective chairs laboratory work. As far as mathematics are concerned, scientific cooperation between students and teachers comes about at special lectures and seminaries. However, the same purpose is being served also by the Students Scientific Circles which form part of the youth organization. This circle gives its members possibility for exposing their work. From time to time the mathematical sections of all the countries student circles devote joint sessions to an exposition of the best results obtained.—Besides this, the Hungarian Mathematical Society organizes yearly a contest for students. This contest is of a high level. 10–12 problems are proposed, which must be solved within a week. For solving the problems, knowledge of the university material, or even knowledge of a slightly superior level is required.

Young graduates leaving the university have no difficulty in finding jobs. The number of jobs to be filled during the next 4–5 years can be foreseen with a fair accuracy, and the admission numbers are determined accordingly. Finally, let me say a few words about the universities organization and about scientific work.

The most important organizational unit is even today the chair. Debrecen University has five mathematical chairs: Geometry, Algebra and Number Theory, Probability, Analysis and Computer Science. There is also a Computational Center. At a chair, there work 10–12 mathematicians. The direction of both teaching and scientific activities has a direct, personal character. The head of the chair is a professor or a docent. Usually the man with the most important scientific work is chosen to be a head, but certain qualities of leadership and organization are also required. The mandate for leading a chair is valid for 3 or for 5 years. It is given by the rector of the university, on the basis of a proposition by the dean of the faculty in question.

At most chairs there are several scientific groups. E.g. at the Chair for Analysis one group works on functional equations, but some members of the chair do research on differential equations and on operator theory respectively. This heterogeneity has a salutary effect on teaching, because it makes it easier to get for the teaching of diverse subjects the proper specialists. Of course, from the point of view of scientific work, it is more advantageous to belong to a numerous group. The size of a chair depends primarily on the amount of its teaching duties. The Chair for Meteorology has a staff of only two. On the other hand, at the Chair for Experimental Physics there work about 30 physicists and an equal number of technicians and laboratory assistants.

To our Faculty there belong about 30 chairs. In faculty matters, decision lies partly with the Dean elected for 3 years, partly with the Faculty Council. The latter consists of the heads of the chairs, of six elected members from among lecturers, and from representatives of university youth. The dean is aided in his work by two vice-deans. The leadership of the University as a whole is organized along similar lines. The mandate of the Rector is valid for 3 years. There are propositions according to which the chairs should be replaced by greater units, or else greater units should be interpolated between the chairs and the faculty. E.g. the mathematical chairs could be united for a department of mathematics.

A much discussed question is the one of the relation between universities and colleges. Some people are for a two-stage higher education. The first stage would mean the college level, the second stage the university level. E.g. in engineering plant-engineers represent college level, planning, developing and directing engineers university level. The special teachers of the general elementary school represent college level (they teach pupils of 10–14 years diverse subjects), the gymnasial professors (teaching pupils of 14–18 years) represent university level. The higher level could be a continuation, with a smaller number of students, of the lower level, or else it would become separated from college training after 2 or 3 years. The remaining students would receive their college diploma after one more year. There is already some realizations of all these ideas, but at present the separation of university and of college education is the generally accepted solution.

Two-stage training could be realized by joining the lower stage too to the university, or at least by putting it under university supervision. This would raise the level of college training and education. Also, the unified organization would be less expensive, and a better selection for higher studies would become possibe. However, there are also arguments to the contrary. From the point of view of high level training the use of time at the lower level is far from being optimal and to change this would make training at the lower level too theoretical. Also, the unifying reorganization of already well-established institutions, sometimes at a considerable distance from each other, would be connected with difficulties. In the student body bifurcation could cause a certain tension. The colleges are for the most part against these proposed changes.—This two stage training would be similar to the English system, but not identical with it.

Fewer concrete steps have been done for an extension and a better organization of postgraduate training. At present a small number of young graduates obtains the possibility of spending two more years at the university on the basis of a state stipendium. Each of them is adjoined to a chair. They spend their time in doing scientific work, in preparing for their Ph. D. After the lapse of the two years, most of them become university lecturers.

Hungarian scientific life centers upon two foci, the Hungarian Academy of Sciences and the universities. The Academy has several research institutes, among them also a Mathematical Research Institute, in which some 50 mathematicians are working. These research institutes stand in close contact with industry and with production in general. Besides theoretical scientific work, it is their aim to promote the practical application of scientific results, and to investigate questions with the solution of which will help production.

It is the Academy's task to supervise to direct and to evaluate scientific activity in the whole country. Accordingly the Academy gives scientific degrees. The system of scientific degrees is as follows: Young scientists have to obtain first their Ph. D. from some university. More advanced researchers are given by the Academy the degree of "candidate". For mathematicians this means an average of 10 published papers. Both the Ph. D. and the candidate's degree are adjudicated on the basis of a dissertation and of an oral examination. For the candidate's degree a linguistic examination is also required. In both cases, the dissertation is judged by two referees. The Academy gives also a higher scientific degree, namely that of "doctor of sciences" D. Sc.. This degree can be obtained on the basis of extensive, high level scientific work. It is usually being given on the basis of a dissertation, but sometimes also for the whole life-work of a scientist. At the Universities D. Sc. a necessary requirement makes for nomination to full professorship; the candidate's degree and the Ph. D. are required for docentship and for senior lectureship respectively. At other institutions of higher learning where mathematics is only an auxiliary subject (Technical Universities, Economical University) requirements are somewhat lower. At the Colleges scientific requirements are more modest. There are at present in Hungary some 40 D. Sc. mathematicians and some 130 candidates.

Besides the universities, scientifically qualified people work at academical research institute, in laboratories, in the civil service, etc. The greater part of scientific capacity is however to be found at the universities. It is from them that the greater part of scientific output originates, particularly in the field of fundamental research.

In the course of this lecture I was of course not able to discuss all the relevant questions in detail, but I hope that I have succeeded in describing some of the essential features of the Hungarian university system in general and of the teaching of mathematics in particular.