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DEVELOPMENT OF TEACHING AND RESEARCH IN PURE MATHEMATICS IN BRAZIL: CURRENT VIEW

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Abstract

This article presents an overview on the development of teaching and research in Pure Mathematics in Brazil from 1811 until the year 2010, within the current view. Therefore, the object of study is the discussion of teaching and research in Pure Mathematics in Brazil, comparing the studies and development of the current with what has been done in Pure Mathematics in developing countries. In this work we focus on the first visiting professors who worked in the 1930s and 1940s at the University of São Paulo and the University of Brazil.

Keywords: Teaching and Research in Pure Mathematics; Royal Military Academy; Brazilian universities; FFCL of the USP, FNFi of the University of Brazil; Brazilian mathematical community.

Resumo

Neste artigo apresentamos uma visão panorâmica do desenvolvimento do ensino e da pesquisa em Matemática Pura no Brasil a partir de 1811 até os anos de 2010, com visão atual. Portanto, o objeto do trabalho é abordar o ensino e a pesquisa em Matemática Pura no Brasil, comparando seus estudos e desenvolvimento com o que de atual se fazia e se faz em Matemática Pura nos países desenvolvidos. No trabalho abordamos os primeiros professores visitantes que trabalharam, nas décadas de 1930 e 1940 na Universidade de São Paulo e na Universidade do Brasil.

Palavras-chave: Matemática Ensino e pesquisa em Matemática Pura; Academia Real Militar; universidades brasileiras; FFCL da USP; FNFi da Universidade do Brasil; comunidade matemática brasileira.

Introduction

This article aims to present an overview of the development of teaching and research in Pure Mathematics in Brazil from 1811 until 2010. Therefore, the object of study is to discuss teaching and research in Pure Mathematics in Brazil, focusing on its stages and the first visiting professors who worked at the University of São Paulo and the University of Brazil, as well as the Mathematicians who transmitted their teachings to the young students, contributing to the formation of the current thriving Brazilian mathematics community.

Throughout this work and in a chronological study, the reader will perceive that for many years and in alternating periods, teaching and research in pure mathematics were established and developed in higher education institutions headquartered in the cities of Rio de Janeiro and São Paul. From the 1950s on, this process has been spread to other parts of the country.

City of Rio de Janeiro

The process began in Rio de Janeiro. The teaching of mathematics in higher education in Brazil was initiated on April 23, 1811, when activities were started at the Royal Military Academy, established by Emperor D. Pedro II in Rio de Janeiro on December 4, 1810. The basic institutional course was Mathematics, with a four year duration. This institution trained officers on various weapons for the Brazilian army. As a matter of fact, it was in this first phase that occurred the teaching of Elementary Mathematics in higher education.

The curriculum of mathematics courses consisted of the following subjects: Arithmetic, Classical Algebra, Euclidean Geometry, Plane and Spherical Trigonometry, Plane Analytical Geometry, Infinitesimal Calculus and Descriptive Geometry.

The faculty of mathematics courses in the Royal Military Academy was formed by undergraduate students from the University of Coimbra and the Military Schools of Portugal. We know that, despite the reformation the University of Coimbra went through in 1772, it still remained for many years an institution of medieval style, in the sense that the professors and their courses did not assimilate the development of sciences that occurred in Europe in the eighteenth and nineteenth centuries. So this was the teaching style, not only regarding mathematics but also other sciences, that was transferred to Brazil when the Royal Military Academy was created.

In this educational institution, and its successors over the years till the creation of the Polytechnic School of Rio de Janeiro in 1874[1], mathematics was taught only as an indispensable tool for training army and navy officers, and then as an indispensable tool for the training of military, civil, geographic and cartographic engineers. It means that, in 1811

[1] The Imperial Decree nº 5600 of 04.25.1874, granted a new status to the Central School, the successor of the Military School and the Royal Military Academy, transforming it into the Polytechnic School, the exclusive institution for teaching of engineering courses. Decree No. 2221 of 01.23.1896 has given new status to the Polytechnic School, now renamed the Polytechnic School of Rio de Janeiro.

and as for many years, there was no higher education institution in Rio de Janeiro devoted exclusively to the formation of mathematicians and professors of mathematics. It only became a reality in the first half of the twentieth century, when in 1935 it was created in Rio de Janeiro the School of Science, as part of the University of the Federal District, an initiative of Anísio Teixeira. We will later resume focus again on the teaching and research in pure mathematics at institutions located in Rio de Janeiro.

City of São Paulo

The first initiatives by the small scientific community began in the 1930s, in the effort to create conditions to establish institutions of higher education through the offering of courses in training of mathematicians and mathematics teachers for basic education. The government of São Paulo put into practice the ideas regarding the creation of a high-quality State University. Thus at the beginning of 1934 the University of São Paulo – USP was founded, and one of its departments was the Faculty of Philosophy, Sciences and Letters – FFCL in 1934, offering as one of its courses a BA in Mathematics.

It should be noted that all FFCL courses in USP, especially mathematics, were initiated and maintained at a high standard of quality. Professors of various courses in FFCL were mostly recruited in Europe, among the most qualified and experienced willing to work at USP. This was a wise and successful initiative of the committee that created the USP and the FFCL.

So the three year duration bachelor's degree in mathematics was created in the FFCL, with the goal of developing qualified human resources for teaching in higher education and scientific research. The following is the curriculum of the course Bachelor of Mathematics (Sciencias Mathematicas) in 1934.

1st Year - Projective and Analytical Geometry, Mathematical Analysis.

2nd Year - Calculus, Vector Calculus and Elements of Infinitesimal Geometry, General and Experimental Physics.

3rd Year - Rational Mechanics and Elements of Celestial Mechanics, General and Experimental Physics, History of Mathematics.

It was observed in FFCL of USP in Brazil the first manifestation of up-to-date teaching and research in Higher Mathematics for the time. It was the institution that initiated the process of continued research in pure mathematics in our country, forming research boards before the institutionalization of stricto sensu graduate programs in the 1960s by the Federal Government. In 1934 the great Italian mathematician Luigi Fantappiè came to USP as a titular professor. He, who specialized in Functional Analytic and Functional Analysis, was the creator of the Theory of Analytic Functionals, an important subarea of Modern Analysis then.

To organize and begin the course of Mathematics in the FFCL department of USP, L. Fantappiè taught many up-to-date syllabus subjects, such as Modern Analysis, Differential and Integral Calculus, Abstract Algebra and Geometry, all based in an up-to-date syllabus, and he also organized and created training seminars, what was new to the academic environment nationwide. He was concerned with the training of disciples, young talented people who would carry on his work of teaching and research in mathematics in

Brazil. He obtained from the Italian government a full scholarship to one of his disciples, Omar Catunda, who went to Italy and took courses in several institutions in that country. Fantappiè also commenced the formation of the USP Library of Mathematics, hitherto non-existent.

In 1936, and at the initiative of L. Fantappié, the Italian geometer Giacomo Albanese came to USP as a titular professor, and the two promoted in USP studies of current mathematics. Giacomo Albanese in turn, taught courses on Projective Geometry, Algebraic Geometry, Differential Geometry and stimulated good students to the study of geometry. He set the first steps in Brazil for the teaching and research in Algebraic Geometry, a subarea of mathematics which was at the time much studied by Italian geometers. He also contributed to the formation of the Library of Mathematics in FFCL of USP, and assembled a broad collection on Algebraic Geometry which was later used by André Weil when he was working at USP.

Algebraic Geometry was created by Max Noether, in Germany. But the Italian school, led by B. Segre, G. Castelnuovo, F. Enriques and F. Severi, built an impressive structure for this subarea of mathematics, though its rationale was unstable.

The concepts developed by the Italian school were not well defined; the hitherto existing statements were insufficient. Thus, Algebraic Geometry, despite its beauty and importance, had long since fallen into disrepute to many mathematicians because of its lack of strong foundations. At the time, the 1920s, Algebraic Geometry was in upraise (see VAN DER WAERDEN, 1971). Oscar Zariski and Giacomo Albanese were descendants of that school. At that time André Weil was in Rome to attend courses and lectures given by members of the Italian school.

The correct actions practiced by managers in FFCL of USP in the country to start a proper course of mathematics were later very fruitful. The first degree of Doctor of Science (Mathematics) granted by Brazilian universities was conceded by USP through a request for tender. By that we remind the reader of a good example given by USP that at the time helped professors produce mathematical works of high quality.

With the beginning of the Second World War, L. Fantappiè and G. Albanese were forced to return to Italy. Their academic positions were occupied by students like Omar Catunda and Candido Lima da Silva Dias. When taking the direction of the Department of Mathematics in FFCL of USP, Omar Catunda was concerned about giving continuity to the institutional project of keeping one or more excellent foreign mathematicians as advising professors.

The departure of those two major Italian mathematicians, who started the process of good quality teaching, research, human resource training and a nice library in mathematics, was also a matter of concern to the deans of Mathematics in USP. Omar Catunda became the most important mathematician of the institution alongside Candido Lima da Silva Dias, and was appointed head of the Department of Mathematics in FFFCL of USP. From then on, apart from the constant concern to maintain the quality of the faculty of the Department of Mathematics FFCL of USP, he worked hard to have USP hiring renowned foreign mathematicians as Visiting Professors.

With the purpose of maintaining USP as a stimulating environment in teaching and research in Pure Mathematics, and profiting from a trip to the United States in 1944, André

Dreyfus, then Director of the FFCL of USP and sensitive to the suggestions of Omar Catunda, Candido Lima da Silva Dias and other professors, made contact in New York City with his friend Claude Levy Strauss, who introduced him to André Weil, a great French mathematician who was working there, but in a modest institution. André Weil was granted the Rockefeller Foundation scholarship, that was part of a program of sheltering Jewish scientist refugees.

André Dreyfus contacted André Weil and invited him to work at USP. He accepted the employment contract and suggested that Oscar Zariski, who worked at the Johns Hopkins University, should also be invited.

Between 1937 and 1947 Oscar Zariski was very interested in extending the concepts of modern algebraic geometry derived from the classical algebraic geometry of the Italian school for arbitrary bodies.

At this stage that coincides with his stay in Brazil, Oscar Zariski completely reoriented his research interests and began introducing the ideas of Abstract Algebra in Algebraic Geometry. With the collaboration of B. L Van der Waerden and André Weil, he undertook the process of rewriting the foundations of Algebraic Geometry without the use of topological or analytical methods.

By sharing this interest with André Weil, Oscar Zariski established close contacts with him shortly after his arrival in the United States of America in January 1941. André Weil met Oscar Zariski in Rome during his stay in Italy between 1925 and 1926, where he participated in conferences held by F. Severi and F. Enriques on the Theory of Algebraic Surfaces. André Weil went off to Italy to study Functional Calculus with Vito Volterra.

André Weil's interest was in Number Theory, especially in the Theory of Diophantine Equations. But seeing the great connection between the works that Oscar Zariski was performing in Algebraic Geometry with his studies on the Theory of Diophantine Equations, André Weil realized that it was necessary to rebuild the foundations of Algebraic Geometry, which was what Oscar Zariski was doing at the time. In this period, while in the United States of America, Oscar Zariski, and André Weil exchanged several letters on the subject. "Zariski commented on this regard as follows: You might say that we were just friends who fought". In (PARIKH, 2009, p.72).

Regarding the extremely productive period in the career of Oscar Zariski math, he put it this way:

> *In the fifteen years that followed the writing of Algebraic Surfaces, Zariski's work was marked by an extraordinary outpouring of original and creative ideas. Having discovered that many of the classical Italian "proofs" were incomplete and imprecise, he set to work to develop an abstract theory of algebraic geometry valid over an arbitrary ground field. Abandoning topological and analytical methods, he turned wholeheartedly to the new algebra as a means of elucidating basic geometric ideas* ... (PARIKH, 2009, p. 67)

We conjecture that it was the common interest of both in the foundations of Algebraic Geometry the reason why André Weil has asked André Dreyfus to invite Oscar

Zariski to work at USP in São Paulo, so they could discuss it further. And that is what happened indeed, especially while they went for their frequent hikes.

So they began work at USP. They arrived in São Paulo in January 1945. Oscar Zariski remained at USP only during the academic year of 1945. In São Paulo, both have continued and expanded studies and research in Number Theory, Algebra, Algebraic Geometry and Analysis. In 1945 André Weil taught a course at USP (in French) on *Differential Forms, De Rham Theorems, and Hilbert spaces.*

In the same year Oscar Zariski taught a course in Italian at the request of the Department of Mathematics on *Modern Algebra and Introduction to Algebraic Geometry*. The lecture notes of his course were written by L.H. Jacy Monteiro and published in the form of texts entitled: *Introduction to the Theory of Ideals, Rings and Places generalized concept of a Single Point Algebraic Variety*.

While still in São Paulo, Oscar Zariski wrote and published a paper in which he presented a new concept of certain special rings and their completion, later named "Zariski rings" … (see PARIKH, 2009, p. 80). This paper was *Generalized semi-local rings.* Summa Bras. Math., V. I, fasc. 8, p. 169-195, 1946. Before returning to the United States of America in 1946 to take an academic position at the University of Illinois at Urbana, O. Zariski flew to Lima in Peru, where he lectured upon invitation. For a list of published works by O. Zariski (see PARIKH, 2009, Appendix B, p. 183). In the 1950 Oscar Zariski and André Weil were already the main exponents of Algebraic Geometry.

Later came to USP as Visiting Professors other leading French mathematicians such as Jean Dieudonné, Jean F. A. Delsarte, A. Grothendieck[2] (who was born in Germany), Jean-Louis Koszul, C. Erhesmann, and L. Schwartz. USP maintained a tradition of quality in teaching and research in mathematics, also maintaining the primacy in relation to the University of Brazil. Thus it was very important for Brazil the influence of the Bourbaki group and Oscar Zariski (which was not a member) in education, research and training of many Brazilian mathematicians. But this importance is yet to be explained to the mathematical community in Brazil. We hope that some fellow mathematician do it someday (see AZEVEDO, 2009).

It is important to mention that most mathematicians mentioned above were not exclusive faculty members of USP. Many of them taught courses, seminars and lectures at institutions located in Rio de Janeiro. For example, Jean Dieudonné taught at FNFi of the University of Brazil, during the second half of 1952, the course entitled *Harmonic Analysis*. Therefore, several scientific Bourbaki also exerted influence on some mathematicians who lived in that city. Pierre Samuel was one of them. Some of the mathematicians mentioned

[2] A. Grothendieck is one of the most important mathematicians of the second half of the twentieth century, to whom we owe, in particular, a complete reconstruction of Algebraic Geometry. This systematic reconstruction allowed the solution of several important problems in number theory, including the final step in the proof in 1973 of the conjecture of A. Weil on the eigenvalues of the Frobenius endomorphism by P. Deligne (this conjecture concerning the algebraic geometry), and the solution of Fermat's Last Theorem by Wiles. In 1966 he was one of the winners of the Fields Medal. The coming of Grothendieck to USP in 1952 was due to, in addition to the interest of the institution's administration, the intervention of his friend Paulo Ribenboim that made contact with Candido Lima da Silva Dias, suggesting that the University of São Paulo invite him to spend time in Brazil. He taught a course at USP on Topological Vector Spaces. He stayed in Brazil for two and half years. His scientific activities in Brazil are related in (AZEVEDO, 2009, p. 40-41).

above who were still in Brazil in the 1940s and 1950s also participated in scientific activities carried out in Rio de Janeiro in the Scientific Technical Center at Fundação Getulio Vargas, which was brought up in 1945.

As a result of this phase of living science, here are some mathematicians cited in random order: Oscar Zariski, André Weil, Jean Dieudonné, Jean F. A. Delsarte, A. Grothendieck, Jean Louis Koszul, C. Erhesmann, L. Schwartz, who worked at USP, professors Candido Lima da Silva Dias, Omar Catunda, Fernando Furquim de Almeida, Elza Gomide, Chaim S. Hönig, L. H. Jacy Monteiro, José de Barros Neto, and others who were influenced by them scientifically.

Perhaps the arrival of André Weil to USP in 1945 had been a matter of chance. But certainly this accident was a result of global conditions during and after the Second World War, and also because of Claude Levy Strauss who helped his friend André Dreyfus, the latter seeking in the United States of America a great mathematician to work at USP. In fact, since its creation in 1934, this institution had received three missions of French professors. Probably this fact had also weighed in the decision of André Weil to come to work at USP.

Following the teachings and guidance of the great mathematicians who worked at USP, like Luigi Fantappiè's, and destined to start in the country a continued formation of Doctors of Science (Mathematics), the FFCL of USP initiated the postgraduate courses in mathematics in 1942. It is important to mention that postgraduate studies were not yet institutionalized in the country, but the visionary managers at USP saw the need for postgraduate studies, so they could develop qualified human resources in various sciences, including mathematics, so they should continue with the specialized work of their masters, and have the competence in mathematical research set in.

To formalize the postgraduate studies at FFCL of USP, federal intervenor in the State of São Paulo Mr. Fernando Costa signed the Decree No. 12.511 of January 21, 1942, which reorganized the FFCL of USP. Article 64 of the Decree established the following:

> § 1. The diploma of bachelor doctor will be awarded to whom defend thesis of outstanding value, after at least two years of studies under the guidance of a cathedratic professor in the field the work is developed, and pass the examination in two subsidiary subjects in the same section or related.
>
> § 2. The title of doctor will also be awarded to whom be approved in all selective process in request for tender of professors.

To Mathematics laureates, the degree awarded was the degree of Doctor of Sciences. So research in mathematics started to be done systematically in Brazil since the 1940s.

Under the influence of André Weil, the FFCL of USP and other higher education institutions in the country suffered a metamorphosis in Mathematics Education. The teaching of Functional Analysis, Abstract Algebra, Linear Algebra, Algebraic Geometry, Differential Geometry and Topology began to be taught more in a more vanguardist spirit.

More foreign mathematicians began work within the state of São Paulo, more specifically in the School of Engineering of São Carlos of the USP, Technological Institute of Aeronautics – ITA. Some of them were Achille Bassi, J. P. Cecconi, Richard Ubaldo, K. T. Chen and F. D. Murnagham[3], who greatly contributed to the training phase of Brazilian researchers by ministering also courses at the graduate and doctoral training seminars, advising and guiding young professors in their doctorate studies.

By the 1950s, the small Brazilian math community had already shown signs of strength. Area managers and leaders of this community realized that the stage of hiring outstanding foreign mathematicians in order to train qualified personnel in Mathematics had ended - that happened in the 1930s, 1940s and 1950s. It was necessary to implement effective public policies to strengthen scientific research in the country and continue the training of qualified human resources.

The National Council for Scientific and Technological Development - CNPq was created with the goals recommended by the Brazilian Academy of Sciences. Also in the 1950s were created the Coordination of Improvement of Higher Education Personnel - CAPES, the Institute for Pure and Applied Mathematics - IMPA, the Brazilian Colloquium of Mathematics and several programs of incentive, training and selection of young talented students to undertake doctoral studies in renowned universities abroad. These initiatives aimed to transform the national scientific environment, generating critical mass and conditions for scientific research to flourish and be consolidated. It was also intended that at the same this effort Brazil would acquire expertise in S & T and Higher Education.

From the 1950s on, staff members of the faculty of mathematics at USP kept up with good and correct administrative policies in order to continue the maintenance of the good environment in the institution, conducive to the study and research in mathematics. The courses and seminars offered in mathematics remained at high level.

Nowadays the Institute of Mathematics and Statistics of the University of São Paulo - IME / USP is an important center for teaching and research in Mathematics in Brazil and South America.

For the creation of Program formats and postgraduate studies in our country we must take into account the Federal Board of Education - CFE Opinion / CES No. 977/65, which defines the characteristics of doctoral programs and master's degrees. Due to this initiative, new generations of leaders emerged in the country, particularly in the USP, who in turn expanded the ideals of their masters and became their disciples, keeping alive the burning ideal of discipleship and an autonomous and excellent math production in Brazil.

Thus, they were stimulated and created ideal conditions for the emergence of centers of excellence in mathematics, in universities located in various states, with support from the federal government and its agencies.

Among the subfields of Pure Mathematics, Mathematical Analysis was the one that was implanted earlier in university studies and scientific research in our country, followed not necessarily in this order by Differential Geometry, Dynamical Systems and Abstract Algebra. The wide application of analysis in other subfields of mathematics, in

[3] F. D. Murnagham before coming to work in the ITA was a colleague of O. Zariski in the Mathematics Department at Johns Hopkins University.

Applied Mathematics and other sciences may justify the interest first in their studies and research.

The current pace adopted by those who nowadays do research in mathematics in Brazil allows us to provide the best auguries about the future of research in mathematics in our country. We have no doubt that in the medium run Brazil will be included in the Group V of the International Mathematical Union - IMU.

The desires and actions of leaders in the small Brazilian math community in the 1940s, 1950s and 1960s reflected on the actions of talented students who were willing to follow their advice and guidance, so that with these actions new generations of talented Brazilian mathematicians arose.

In fact, students who were instructed by Leopoldo Nachbin, Mauricio Matos Peixoto, Candido Lima da Silva Dias, Elon Lages Lima, Chaim Samuel Hönig, Paulo Ribenboim, among others, got their doctorates at universities located in the cities of Rio de Janeiro, São Paulo, the United States of America and Europe, and upon return to their home institutions have continued the process of training young mathematicians.

We call attention to the Seminars held in the city of Rio de Janeiro in the 1950s by Mauricio Matos Peixoto, Leopoldo Nachbin, Elon Lages Lima, among others, in the Brazilian Center for Physics Research - CBPF, the Institute of Pure and Applied Mathematics - IMPA, the National School of Engineering - ENE and also in the Scientific Technical Center of Mathematics of Fundação Getulio Vargas. In the city of São Paulo and in the same decade and thereafter, seminars and courses were conducted by Omar Catunda, Candido Lima da Silva Dias, Chaim Samuel Hönig, Alexandre Augusto M. Rodrigues, among others.

We point out also the first meetings, in the 1950s and 1960s, of the Brazilian Colloquium of Mathematics, and the creation of specialized scientific events from the 1970s on, such as: Algebra School, Differential Geometry School and the Brazilian Seminar of Analysis. These scientific activities were part of the set of activities, actions and targets set by the leaders of the Brazilian mathematical community to boost the raining of young scientists and circulate information among those who developed scientific research in common areas of interest.

Let us return to the city of Rio de Janeiro, now in 1935. We will first mention the School of Sciences, with the course of mathematics, which belonged to the University of the Federal District - UDF. As we know this institution was created in 1935 by the Federal District Government under the inspiration of Anísio Teixeira, and was extinguished in 1939. Students and professors were absorbed by the FNFi in the University of Brazil, which was established by Decree No. 1190 of 04/04/1939. The same decree established the following core curriculum for the three year course of Bachelor of Mathematics:

> 1st Year - Mathematics, Analytical and Projective Geometry, General and Experimental Physics;
> 2nd Year - Mathematical Analysis, Geometry and Complements of Geometry, Rational Mechanics;
> 3rd Year – Higher Analysis, Higher Geometry, Mathematical Physics, Celestial Mechanics.

This was the curriculum during the period 1939-1946. In 1947 the course of mathematics changed to a four year curriculum, and so the teaching degree in Mathematics was created.

Regarding the initial stage of the Mathematics Department of the FNFi of University of Brazil:

> *The teaching activity began to focus on the university studies and basic research, an attitude inherited from the UDF, reflecting the design of Anísio Teixeira and other educators of the time. The Brazilian government hired several foreign teachers to achieve this goal...* (MEDEIROS; GOMES, 1996, p. i, ii)

After the Second World War, the excellent Portuguese mathematician António Aniceto R. Monteiro was hired by the FNFi of University of Brazil. In fact it was the physicist Guido Beck, his friend, who managed to bring António Aniceto R. Monteiro to work in the Mathematics Department at FNFi of the University of Brazil.

The nonclassical mathematician scientifically influenced many young talented Brazilian mathematicians and contributed to periods of effervescence formation in the mathematical environment in Rio de Janeiro and Brazil. Among those who took his courses and seminars were: Alvércio Moreira Gomes, José Abdelhay, Leopoldo Nachbin, Maria Laura Mouzinho Leite Lopes, Marília Chaves Peixoto, Mauricio Matos Peixoto, Paulo Ribenboim, F. M. de Oliveira Castro and Luis Adauto Medeiros.

António Aniceto R. Monteiro introduced his students to mathematical subjects that were current at the time, such as Hilbert Spaces, Functional Analysis, Ordered Sets, Boolean Lattice Algebra, Filters and Ideals, General Topology. He created training seminars that attracted many of the young and talented, and scientifically influenced many of those who attended his lectures and his workshops. He created the series *Notes on Math*, disclosing on the achievements by Brazilian and foreign mathematicians.

City of Recife

In the 1950s teaching and research in Pure Mathematics, influenced by the scientific environment in São Paulo and Rio de Janeiro, reached the northeast of Brazil. In 1954 the visionary physicist Luiz Freire founded in the University of Recife, currently the Federal University of Pernambuco - UFPE, the Institute of Physics and Mathematics. This organ was the key factor for the promotion of a good environment for teaching and research in physics and mathematics that currently exists at the Federal University of Pernambuco - UFPE.

With the encouragement of Leopold Nachbin and financial support of funding agencies for training of qualified human resources, such as CNPq and CAPES, Luiz Freire hired the great mathematician Alfredo Pereira Gomes Portuguese, who arrived in Recife in 1953 and had an academic position at the University of Nancy - France. As a suggestion of this mathematician were invited as visiting professors to the University of Recife the French mathematicians Armand Denjoy French, Roger Godémart and François Bruhat, who

taught classes on *Differentiable Manifolds, Lie Groups and Algebra*, all drafted and published in the collection *Mathematics Texts*, created in 1955 by A. Pereira Gomes.

Also at the suggestion of A. Pereira Gomes were then hired as visiting professors the Portuguese mathematicians Manuel Zaluar Nunes, José Cardoso Morgado Jr., the latter, like A. Pereira Gomes, a political dissident of the government of António de Oliveira Salazar. Later came to the University of Recife the Portuguese mathematicians Hugo Batista Ribeiro, who was in the United States of America, and Ruy Luis Gomes, who spent a short period in Argentina. These Portuguese mathematicians formed what became the *Portuguese School of Recife*.

The Portuguese mathematicians boosted the environment in teaching and research in mathematics in Recife, encouraging talented young people towards the studies of mathematics. In addition to their regular classes in undergraduate courses at the University of Recife, they conducted training seminars to attract young people to study and research in mathematics. With their guidance, these people created the basis for the subsequent creation of a Master's degree in Mathematics. Several major Brazilian mathematicians from Pernambuco were the first disciples of these Portuguese mathematicians.

The talented students studied doctorate in first-class universities located in Brazil and abroad, and returned to join the faculty of the Mathematics Department at UFPE, renewing, continuing, expanding and consolidating the work begun by the Portuguese mathematicians. These, with the fall of the Salazarian government, returned to Portugal and resumed their academic work. The exception was Alfredo Pereira Gomes, who opted for an academic position at the University of Nancy - France.

Currently UFPE is one of the most important centers of creation and dissemination of mathematical knowledge in our nation. Mathematicians who work at Federal University of Pernambuco - UFPE, conduct research on: Birational Geometry of Projective Varieties, Arithmetic and Homology of Graded and Local Algebra, Differential Geometry with EDP, Hiperkähler Metrics in Coadjoint Orbits and Groups Ties, Mathematical Analysis.

Current View

In the early 1970s there were three hundred articles by Brazilian mathematicians published annually in praiseworthy journals of international circulation and covering several subfields of Pure Mathematics such as: Commutative Algebra, Theory of Ideals, Algebraic Geometry, Differential Geometry, Mathematical Analysis, Non-Linear Analysis, Non-Linear Functional Analysis, Ordinary Differential Equations, Partial Differential Equations and Optimal Control, Dynamical Systems, Fluid Dynamics.

Nowadays the research produced in Pure Mathematics at Universities and research institutes in Brazil are in a very high stage of development and maturity. There are about one thousand and two hundred articles published annually in various subfields of mathematics such as Mathematical Analysis, Functional Analysis, Non-Linear Algebra and Number Theory, Commutative Algebra, Algebraic Geometry, Differential Geometry, Dynamical Systems, Differential Equations, Differential Equations and Partial Curves, Homological and Koszul Algebra, Algebraic Theory of Singularities, Extrinsic Geometry

of Algebraic Varieties, Graph Theory, Theory of Matroids, Birational Geometry of Projective Varieties, C* - Algebras among others.

An example of this high maturity stage are the doctorate programs already established and existing in various public institutions of higher education, with their research groups of excellence and its scientific production consolidated. It classifies Brazil, for the purpose of research activity, into Group IV in the classification of the IMU[4].

We point out that currently some of the Pure Mathematics major subfields that were not developed in the country are already being studied and researched, such as Algebra and Lie Groups, Low-Dimensional Topology, Number Theory and Cryptography, Game Theory, Quantitative Theory of Differential Equations and Classical Geometry. These subfields are being developed with the vigor that is characteristic of the mathematical community in Brazil, enabling the country also in these subfields of human knowledge.

Nowadays, in universities and research institutions there are research groups working in Mathematical Analysis, Differential Geometry, Dynamical Systems, Abstract Algebra, among other subfields of Mathematics.

Several groups develop lines of research in the following subfields of Pure Mathematics: Theory of Singularities, Finite Groups and Permutation Groups, Ring Groups, Presentation and Representation of SL2 Groups, Invariant and Groups Defined by Generators and Relations, Computational Methods in Group Theory, Theory of Rings, Galois Theory, Finite Geometry, Algebraic Curves and Singularities Theory, Associative Algebras, Non-Associative Algebras, Representation Theory, Homological Algebra, Universal Algebra.

Commutative Algebra, Algebraic Geometry, Local Theory of Automorphic Forms and Lipschitzian Operators, Diophantine Equations, Theory of Bodies and Valuations, Queuing Theory, Differential Equations and their Symmetries, Integro-Differential Equations, Systems of Partial Equations and Lie Pseudo-Groups, Dynamical Systems and Ergot Theory, Differential Geometry, Algebraic Topology, Numerical Analysis, Number Theory, Existence and Stability of Bifurcation Theory for Non-Linear Equations, Numerical Linear Algebra, Number Theory and Algebraic Galoisian Co-Homology, Topology of Manifolds, Semigroup Theory and Applications to Stochastic Processes.

Stability of Holomorphic Fields, Foliations, Non-Linear Functional Analysis, Non-Conservative Systems, Theories of Bifurcation and Disorders, Quadratic Modules, Riemannian Geometry, Minimal Surfaces, Minimal Submanifolds, Immersions with Constant Mean Curvature, Symplectic Manifold, Ordinary Differential Equations: Stability and Asymptotic Behavior, Functional Differential Equations: Existence and Stability, Dynamics and Holomorphic Foliations Complex.

CONCLUSION

It was from 1934, with the arrival of Luigi Fantappiè to USP in Brazil, that the process of training young mathematicians started. This first phase was not a process of

[4] The promotion took place in January 2005.

continuous training of Brazilian mathematicians, but it soon spread to FNFi of University of Brazil, in Rio de Janeiro. This institution hired some Italian mathematicians in the 1930s and the 1940s after the Second World War, as well as a Visiting Professor the excellent Portuguese mathematician António Aniceto Monteiro, who exerted a strong influence on gifted science students.

Starting in 1945 and on to 1950, USP hired as Visiting Professors excellent foreign mathematicians, as: André Weil, Oscar Zariski, Jean Dieudonné, Jean Delsarte and A. Grothendieck, who enhanced the environment for teaching and research in higher mathematics in various universities in Brazil, particularly in the USP, as in 1946 two of the most important members of the prestigious French *Nicolas Bourbaki group* were working at USP. Even at this hiring phase of foreign mathematicians we should highlight the good work performed by the managers of USP *campi* São Paulo and São Carlos, the ITA and the University of Recife, the current Federal University of Pernambuco, which aided by some leaders of the tiny Brazilian math community, knew how to implement bases in their institutions to consolidate the environment in teaching and research in mathematics. We point out the University of Recife hiring excellent Portuguese mathematicians. This phase is known as the *Portuguese School of Recife*.

Following this phase of hiring good foreign mathematicians, young Brazilians, after completing their degrees were doing graduate internships in mathematics at excellent universities located abroad, carried on the task of formation of qualified human resources in S & T. Among these young mathematicians we mention the following: from São Paulo - Omar Catunda, Candido Lima da Silva Dias, Domingos Pisanello, L. H. Jacy Monteiro, Alexandre Augusto M. Rodrigues, Elza Gomide, and Chaim S. Hönig; from Rio de Janeiro - Leopoldo Nachbin, Mauricio Matos Peixoto, Marília Chaves Peixoto, Maria Laura Mouzinho Leite Lopes, Paulo Ribenboim, Luis Adauto Medeiros, Elon Lages Lima. This was not a process induced by the Federal Government, in fact the young mathematicians sought on their own initiative the good mathematical centers located abroad.

In their return to Brazil, these young mathematicians initiated altogether with the Federal Government in the 1950s the process of creating legal instruments to support what came next; the formal grant by the Federal Government of scholarships for completion of the doctoral programs abroad, and the legal institutionalization of the country's post-graduate studies.

Thus, with the end of the cycle of incoming foreign mathematicians to work in universities and institutes in Brazil, emphasis was given in the process of recruiting young talents to undertake a doctorate in mathematics in good universities abroad, and later continued training of researchers in mathematics by Brazilian institutions during the 1950s. The Opinion CFE/ CES n º 977/65 of December 3, 1965 was the legal instrument created by the Federal Government for the institutionalization of postgraduate studies.

In this context[5], in the 1950s and 1960s the federal government together with Brazilian math community leaders created mechanisms to recruit talented young undergrads in order to send them to complement their training in mathematics in good

[5] We recall that the social construction of science, particularly mathematics, as a force for modernization of the Nation took over between the years 1950 and 1980 the direction of development.

universities located abroad and, and upon their return to the country, create a critical mass of doctors necessary to the continuation in formation of a good environment for teaching and research in mathematics in the country. The mathematician Leopold Nachbin had a prominent role at this stage. In the period from 1952 to 1956 he devoted himself, with the help of Candido Lima da Silva Dias and others, to the arduous task of organization of IMPA, its activities and its library.

With the return of the young doctors in Mathematics from abroad, the critical mass necessary to create and maintain first-class stricto sensu undergraduate and postgraduate studies in mathematics was being formed at several public universities. We noticed that the first two generations of Brazilian mathematicians obtained their training in excellent universities located abroad.

We should not minimize the mathematical production and the administrative efforts of mathematicians who experienced Brazilian university before the 1960s. It is true that their scientific output was not significant when compared with the global context of that time, because they were part of a small scientific training community. However, mathematicians such as Leopold Nachbin and Mauricio M. Peixoto, for example, produced important results at the time that were incorporated into the mathematical literature worldwide.

As in any complex process of creation, organization, development and decision making of a nation under construction, many political mistakes were committed by the Federal Government; for instance to prioritize substantial sums of values for the training of qualified personnel for the development of a particular subfield of mathematics at the expense of other subfields of equal importance. This problem was later minimized. Already in the early 1970s the Brazilian mathematicians were spread out and started working in a quite balanced distribution in the following subfields: Mathematical Analysis, Differential Geometry and Topology, Abstract Algebra, Dynamical Systems and also in Applied Mathematics. This fact was not due to chance. It was planned by part of the Brazilian math community, targeting country's needs even within internal struggles in the spheres of mathematics influence.

So this is a brief summary showing how the process of formation of the Brazilian math community was. The next step was the development phase and expansion of research in mathematics in Brazil and what happened from the 1980s on. The above mentioned process was due to a proper public policy and funding inducing held by the Federal Government through National Plans of Postgraduate and Basic Plans for Scientific and Technological, and with the support of the Brazilian math community leaders. In the 1970s the Brazilian mathematicians already published each year about three hundred articles in praiseworthy journals with international circulation.

These facts contributed to today’s good quality of autonomous mathematical production. Presently, prestigious Brazilian mathematicians have participated in important international scientific events, and so has been the intense flow of foreign mathematicians visiting universities and research institutes in Brazil and vice versa.

Nowadays the research in pure mathematics produced in universities and research institutes in Brazil are in a very high stage of development and maturity. Annually, about one thousand and two hundred articles are produced and published in various subfields of

mathematics such as: Mathematical Analysis, Functional Analysis, Non-Linear Algebra and Number Theory, Commutative Algebra, Algebraic Geometry, Differential Geometry, Dynamical Systems, Differential Equations, Partial Differential Equations, Algebraic Curves, Homological and Koszul Algebra, Algebraic Theory of Singularities, Extrinsic Geometry of Algebraic Varieties, Graph Theory, Theory of Matroids, Birational Algebraic Geometry of Projective Varieties, C*- Algebras, Discrete and Profinite Groups, among others.

The consolidation and development of mathematical research in Brazil can be found through the following indicators:

a) The existence of excellent mathematical training centers located in various public institutions of higher education;
b) The existence of scientific research groups registered in the Support Program for Centers of Excellence - PRONEX of CNPq;
c) Continued distinguished participation of Brazilian mathematicians in important international scientific events;
d) Increase in the flow of foreign mathematicians visiting Brazil, and vice versa, developing scientific research projects together;
e) Significant increase in the number of articles written by Brazilian mathematicians and published annually in praiseworthy journals with international circulation;
f) Periodic realization of specialized scientific meetings and some other non-specialized such as Algebra School, School of Differential Geometry, Brazilian Seminar of Analysis, Brazilian School of Differential Equations, National Meeting of Mathematical Analysis and Applications, Brazilian Meeting of Topology, Meeting on Commutative Algebra and Algebraic Geometry, Brazilian Mathematics Colloquium, Indo-Brazilian Symposium in Mathematics, Brazilian School of Dynamical Systems, Biennial of Mathematics of the Brazilian Mathematical Society, among others.

But despite the efforts made by leaders of the national mathematics community, the number of doctors trained in Pure Mathematics and active working in various public institutions of higher education and industries of the country is below the desirable number for the needs of the nation. In 2009, 56 doctors achieved completion in degrees of Pure Mathematics in institutions of higher education in Brazil.

Right this moment the Brazilian math community faces three major challenges:

a) Increase the number of researchers;
b) Increase the interaction of mathematics with other areas of human knowledge;
c) Train large numbers of professors (masters and doctors) to work in higher education.

REFERENCES

AZEVEDO, A. Grothendieck no Brasil. *Revista Matemática Universitária*, 44, p. 39-42, 2008.
AZEVEDO, A.; COLLI, E.; MELO, S. T. Paulo Ribenboim: seis décadas de matemática. *Revista Matemática Universitária*, 45, p. 20-43, 2008.
DELIGNE, P. La conjecture de Weil: I. *Publications mathématiques de l'I.H.E.S.*, 43, p. 273-307, 1974.
MEDEIROS, L. A. da J. *Trajeto da Matemática no Rio de Janeiro.* Ciência e Sociedade, 03/01, CBPF, 2001.
_____. *Núcleo Técnico Científico de Matemática da Fundação Getúlio Vargas (1944-1946)*. Rio de Janeiro: Instituto de Matemática – UFRJ, 2004.
_____. *Certos Aspectos da Matemática no Rio de Janeiro*. Boletim da SBMAC, 1984.
MEDEIROS, L. A. da J. ; GOMES, A. M. José Abdelhay. *Trabalhos de Matemática. Obra Póstuma*. Rio de Janeiro: IM/UFRJ, 1996.
PARIKH, C. *The Unreal Life of Oscar Zariski*. New York: Springer, 2009.
RAYNAUD, M. André Weil and the Foundations of Algebraic Geometry. *Notices of the AMS*, **46**, n. 8, p. 864-867, 1999.
SILVA, C. P. da. *Aspectos Históricos do Desenvolvimento da Pesquisa Matemática no Brasil*. São Paulo: SBHMat/Livraria Editora da Física, 2009.
_____. *Início e Consolidação da Pesquisa Matemática no Brasil*. Brasília: Edições do Senado Federal, **98**, 2008
_____. *A Matemática no Brasil. História de Seu Desenvolvimento.* 3ª Ed. São Paulo: Editora Edgard Blucher, 2003.
SOUZA, G. S. de. *Influência dos Professores Portugueses na Formação do Departamento de Matemática da Universidade Federal de Pernambuco.* Coimbra: Palestra proferida na Universidade de Coimbra em outubro de 2007.
Disponível in http://www.dmato.ufpe.br/historia/arquivos/geraldo_souza.pdf . Acesso em março de 2010.
VAN DER WAERDEN, B. L. The Foundations of Algebraic Geometry from Severi to André Weil. *Arch. Hist. Exact Sci.*, **7**, n. 3, p. 171-180, 1971.
WEIL, A. *The Apprenticeship of a Mathematician.* Basel: Birkhäuser Verlag, 1992.

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