



SOCIEDAD MATEMATICA PARAGUAYA

Dr. César López Moreira 693 entre Migone y Nstra. Sra del Carmen
Barrio Las Carmelitas, Asunción – Paraguay

August 12, 2016, Asuncion, Paraguay

**Helge Holden,
IMU Secretary
NTNU Trondheim,
Norwegen**

In ref.: Associate Membership of the Sociedad Matemática Paraguaya - SMP to the Internacional Mathematical Union


Dear Helge Holden,

Your contact was given to me by Marcelo Viana.

Enclosed please find a document that we plan to submit to the International Mathematical Union - IMU - together with an application to become an IMU Associate Member. We are aware of the limitations that our country faces in the mathematical discipline, and at the same time we are also making strong efforts in order to improve our mathematical skills, at all levels. Hence we believe that at this point it is crucial for us to be a associate member and to begin interchanging experiences with the IMU and with some of its members.

Let me thank you in advance for all advice aimed at turning this major objective of being a participating member of IMU into reality. We look forward to being a candidate as soon as possible, and we will be glad to receive your comments regarding the attached document contents, as well as the application procedure.

Best Regards,


**Christian Schaerer,
President SMP
Asuncion - Paraguay**

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PARAGUAY'S REPORT TO THE INTERNATIONAL MATHEMATICAL UNION (IMU)

PARAGUAYAN MATHEMATICAL SOCIETY (SMP)

The Paraguayan Mathematical Society (SMP, for its acronym in Spanish) was founded in the year 1964. The purposes of the organization are, among others: i) to promote, foster, disseminate and consolidate the mathematical activity, and activities related to it in Paraguay; ii) to contribute to the development of mathematical sciences, and to foster, support and carry out research in the field of Mathematics and its applications; and iii) to encourage the development of scientific, cultural, unions and social relations among Paraguayan mathematicians, and people with interests in the mathematical activity in Paraguay.

The early years of the Paraguayan Mathematical Society are recorded in the 14 SMP Journals published from 1964 to 1968. Later, the organization went through an unstable period almost becoming extinct. Activities were resumed from the year 2000 to 2005, restoring communications with the international community. At the Meeting of Latin American Mathematical Associations, communications with Dr. Michel Jambu, Dr. Roberto Markarián, the Royal Spanish Mathematical Society (with which a reciprocity agreement was signed), and with the members of CEMAT (Mathematics Spanish Committee) were restored. These relations resulted in the opening of the first Master's Degree in Mathematics in Paraguay. Also, during this period, the organization's historical documents and library were retrieved.

In April 2009, the organization called an extraordinary meeting in which a new Board of Directors was elected with the purpose of restructuring the society and bringing together all mathematical activities diversely conducted by several organizations.

Currently, the Mathematical Society is a place of convergence for mathematical activities, and this is its main strength. The most remarkable characteristic of Mathematics and sciences in general in Paraguay is its gradient of positive growth. Such growth is mainly observed in the development of programs which foster science and knowledge. Thus, graduate programs have been launched, which aspire to achieve high standards of academic excellence, equally comparable to the ones required at a regional level.

CURRENT SITUATION OF THE EDUCATION SECTOR IN PARAGUAY

According to the 2012 National Census of Population and Housing, Paraguay has a population of 6,672,631. The distribution of population is fairly even between men (50.52%), and women (49.48%). By age group, the population under 24 years old is 52.68%. The range between 10 and 19 years old is represented by 20.95%, the 15 to 24 range is 19.99%, and the 10 to 24 range is 30.66%. As for the ageing population, people above 65 years old are represented by 5.28%, and the population over 80 years old is 0.9%.

The institutions responsible for national education are the Ministry of Education and Culture (MEC, for its acronym in Spanish) and the National Council on Education and Culture (CONEC, for its acronym in Spanish). This body proposes educational policies and encompasses their



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implementation.

In its Magna Carta of the year 1992, Paraguay acknowledges that every person has the right to integral and life-long education. The government must guarantee the right to learn and equal opportunities to access the benefits of humanistic culture, science, and technology, without any discrimination. Education is a fundamental right of all human beings, which allows them to acquire knowledge and lead full social lives. Law N° 1,264, of May 14th, 1998, expands this constitutional principle granting education a priority role to reduce inequality and offer new opportunities to the whole country's population. The country's acknowledgment and commitment to education is reaffirmed with the ratification of a series of international treaties, statements and conventions that enshrine the right to education.

However, many studies show the alarming situation that the education system is undergoing. According to the Global Competitiveness Index (GCI) prepared by the World Economic Forum (2013-2014), the quality of the Paraguayan education system ranks 138th out of 148 countries assessed. Regarding the teaching quality of Science and Mathematics, Paraguay is ranked 142nd, whereas in terms of availability for training and research it holds the position 134.

According to the results of the Third Regional Comparative and Explanatory Study, (TERCE, for its acronym in Spanish), carried out by the Latin American Laboratory for the Assessment of the Quality of Education in the year 2013, Paraguay is below the average in relation to participating countries in all areas assessed, being categorized as "below regional average". The country was unable to achieve similar scores to neighboring countries, including Peru, in any of the areas. Performance was better in private schools than in official schools, and in urban schools than in rural schools for both grades in all areas assessed. Regarding performance in Mathematics, Paraguay was one of the three countries that presented no improvement in third grade, and one of the two countries that presented a lower performance in sixth grade (OREALC/UNESCO, 2014).

TERCE's report includes recommendations based on the results of the research. At primary school level, teacher training is required, also, the review of curricula for the development of scientific and research skills, the promotion of reading and bilingualism, the access to educational services and early childhood care, and equality in the access to inclusive quality education. Furthermore, the improvement of reading spaces in homes and the participation of boys and girls in cultural activities should be encouraged.

MATHEMATICS EDUCATION AT UNIVERSITY LEVEL IN PARAGUAY

Paraguay has mainly two traditional universities: the National University of Asuncion and the Catholic University of Asuncion. Over the last few years, the number of private universities has increased substantially. This is due to the great demand of the young population to access university education. In particular, new universities offering a degree in Mathematics focus on training high school teachers. At present, the development of Mathematics is limited to the metropolitan area.

The National University of Asuncion has three mathematics departments in the School of Engineering, School of Exact and Natural Sciences, and Polytechnic School. The mathematics



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departments of the Engineering and Polytechnic Schools support mainly the training of engineers. Discussions are being held for the Mathematics Department of the School of Engineering to offer a more complete training to the students in the area of mathematics, including components of pure mathematics.

The Polytechnic School, in its Graduate Degree in Computer Science, offers an area and a laboratory of Applied Mathematics. Around twenty students have graduated from the Graduate Degree in Computer Science (Master's and PhD; both academic and research programs), and it currently has around twenty students pursuing the scientific master's and PhD.

The School of Natural and Technological Sciences from the National University of Concepcion, offers a Bachelor's Degree in Mathematics and Physics, with a duration of 4 years, as well as a Bachelor's Degree in Applied Mathematics (a reconversion of the Bachelor's Degree in Mathematics and Physics, 4 years) and Civil Engineering (5 years). They have been operating since 2014, with a common study program in the first four semesters.

The Mathematics Department of the School of Exact and Natural Sciences of the National University of Asuncion (FACEN, for its acronym in Spanish), offers a Bachelor's Degree in Mathematics with emphasis on pure mathematics and statistics. They both have an eight-semester duration, four of which are common. The content of the subjects is simple, and in the case of statistics, it is basically oriented to the training of technicians.

FACEN offers a Master's Degree in Mathematics with the main purpose of providing higher education to undergraduates in Mathematics and related fields, so as to install and consolidate a quality referent in the mathematical activity, teaching and pure and applied research, which contributes to a qualitative improvement of science and technology. The program's graduates are expected to contribute to the integration of a solid academic-scientific community, which is able to meet the challenges brought about by this so-called era of knowledge in order to foster the strengthening of basic sciences through Fundamental and Applied Mathematics.

The National University of Asuncion has begun the strengthening process of the undergraduate programs and the creation of graduate programs as an improvement mechanism of the academic standard. Within this context, **researcher professors with exclusive dedication** were incorporated into the National University.

The first PhD program of the National University was in Computer Science and the Laboratory of Computational and Applied Sciences was created (with a division of Applied Mathematics). Both the graduate and the laboratory have received more than 40 professors from universities in Europe and the Americas. This graduate program has been chosen as one of the six Excellence Programs by the CONACYT of Paraguay, and all its researchers have been categorized by the PRONII (National Program of Incentives for Research), as well as assessed by international external peers.



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STRENGTHENING OF MATHEMATICAL EDUCATION

The Paraguayan Mathematical Society supports the following activities and programs which are fostered by the Multidisciplinary Organization of Support to Teachers and Students (OMAPA).

• **Mathematical Olympiads**

Paraguay has participated in the International Mathematical Olympiads since the year 1986 with the participation of hundreds of students. Despite being ranked in the last positions of international qualified candidates at the beginning, today the country is better positioned.

Since the year 1986, OMAPA has been promoting the undertaking of national mathematical competitions, where students, schools and teachers participate voluntarily. These are contests among students separated into categories who compete in problem solving.

Over the last few years, the National Mathematical Olympiads have had 30,000 participants per year. In the year 2012, this number grew to 150,000 students and by the year 2014, more than 300,000 students have participated, 2,500 schools, and more than 5,000 teachers from all over the country.

An impact evaluation completed in 2014 under the supervision of José Daniel Bogoya shows that those schools which have participated for many years in the Mathematical Olympiads have a higher performance in mathematics in 6th and 9th grades compared to those who have participated fewer times.

• **Young Talents Program**

Through the Scientific Initiation Program with an emphasis in Mathematics for Young Talents, outstanding students from the Mathematical Olympiads are invited to participate in intensive mathematics courses and in training and participation in International Olympiads such as Southern Cone, Riverplate, Latin American and International Olympiads.

This program has significantly increased its coverage: starting with approximately 40 participants, between the years 2011 and 2013 more than 500 students from 13 different provinces have participated in the program. Around 20 graduates are now pursuing undergraduate or graduate degrees in prestigious universities in the United States (MIT, Columbia, Stanford, Cornell), in Spain, Italy, Brazil, Argentina, India, and others.

• **Paraguayan Olympiads of Astronomy and Astronautics**

This competition is directed to all third cycle students of Elementary and Middle School Education who have an interest in any of these disciplines. Engineer Miguel Volpe and the Paraguayan Astrophysics Club are in charge of its academic direction. It also has the support of the Paraguayan Mathematical Society.



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PROMOTING RESEARCH

The National Council of Science and Technology (CONACYT) has been implementing the National Program of Incentives for Research (PRONII) since the year 2011, with the purpose of strengthening and expanding the country's scientific community. This initiative seeks to foster the researcher career in Paraguay, through its categorization, assessment of its scientific and technological production, as well as through granting economic incentives.

It is worth noting that supporting research in all its areas is very recent in Paraguay. Nonetheless, important steps have been taken. Below, we mention actions related to the area of mathematics:

1. Categorization of Researchers:

- a. Reference research doctors in the field established in the country: Benjamín Baran (Optimization), Diego Pinto (Optimization), Horacio Legal (Mathematical Morphology), Christian Schaerer (Numerical Methods), Marcos Villagra (Complexity Theory), Denis Redwitz (Analysis).
- b. Paraguayan doctors living abroad with a possibility of immediate return: Mauricio Poletti (Dynamic Systems), Carlos Galeano (Fluid Dynamics), Hugo Checo (Fluid Dynamics), Andrés Codas (Optimization).
- c. Soon to graduate doctors: Carlos Sauer, Inocencio Ortiz.
- d. In addition to the aforementioned, there are around ten Paraguayan students pursuing the PhD in Mathematics.

2. **PROCIENCIA.** The Paraguayan Program for the Development of Science and Technology (PROCIENCIA), with an investment of \$125 million for the period 2014-2018, aims at strengthening national skills for scientific research and technological development so as to contribute to the increase of productive capacity and competitiveness, and improve life quality in Paraguay.

Within the framework of PROCIENCIA, research and graduate projects are being funded. For example, in the area of Mathematical Education, the Master's in Didactics of Sciences with an emphasis on Mathematics, Physics and Chemistry of the National University of Concepcion has been created in addition to projects related to the sub-space of Krylov, Control, Mathematical Models and the Theory of Complexity.

3. **BECAL.** “Don Carlos Antonio López” National Scholarship Program for Study Abroad to Strengthen Research, Innovation and Education in Paraguay aims at increasing the levels of knowledge generation and application in the fields of Science and Technology; as well as the learning levels in education through the improvement of the supply of advanced skilled human capital in said fields. This program expects to increase the number of researchers with PhD and Master's degrees in the fields of Science and Technology, and in other relevant areas for the country's development, as well as to increase the number of educators with Master's in Education, and with training in diverse



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fields of knowledge. This program is led by a Committee of Strategic Coordination, coordinated by its UEP which reports to the Ministry of Finance and directly related to the Ministry of Education and Culture (MEC), with the National Council of Science and Technology (CONACYT), and with the Technical Secretariat for Planning of Economic and Social Development (STP, for its acronym in Spanish). The program is funded by the **Fund for the Excellence of Education and Investigation** (FEEI, for its acronym in Spanish), and by the **Inter-American Development Bank (IADB)**. This program has \$70 million to be invested in student grants. An important percentage is being allocated for mathematics.

MATHEMATICAL RESEARCH

The SMP has had participation in the constant outlining of strategies for the development and consolidation of research in Paraguay. In fact, many of its members are active researchers. The production of publications with researchers' participation has been growing over the last few years. In Annex 1, there are references to articles and research carried out from 2004 to 2011.

Paraguay has participated in the “Mathematics in Latin America and the Caribbean: Challenges and Opportunities” (2014) report, drafted by the Commission of Developing Countries of the International Mathematical Union. On this report, Paraguay's growth in mathematics stands out as well as the efforts that are being made for the strengthening of mathematics in the country and its insertion in the continent: *“Paraguay is an example in which the joint efforts of local mathematicians (who also obtained state contributions), UMALCA (particularly some of the member countries) and European countries (France and Spain) succeeded in producing a germ of mathematical development that should be still supported for some years to produce lasting effects and to contribute to the fact that the benefits reach the teaching of mathematics in primary and secondary schools”.*

Year	Number of publications: refereed articles and congresses
2004	1
2005	1
2006	3
2007	4
2008	5
2009	14
2010	32
2011	31



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2012	11
2013	19
2014	43
2015	18
2016	6 (to this day)

Table: Evolution of publications in Computer Science and Mathematics with active participation of members of the SMP since 2004.

ACTIVITIES IN EDUCATION

The **Ibero-American Symposium on Mathematics Education**, held in Paraguay on September 20th, 21st and 22nd of the year 2010, was directed mainly to Paraguayan teachers and students, and had the participation of Mathematics researchers, teachers, and students from different countries. Its objectives were: i) to analyze the educational demands for the sustenance of the purpose of mathematical training activities at different levels of Ibero-American education systems; ii) to update and disseminate mathematical knowledge among Spanish and Portuguese speaking teachers through the incorporations of new technologies aimed at implementing the teaching-learning processes of mathematics; iii) to formulate new approaches that make the action-research in a Mathematics class more efficient, and iv) to promote cultural interaction among Portuguese and Spanish speaking teachers with ideas, emotional reactions and behavioral standards.

Applied Mathematics and Computing for Engineering Workshop, held on October 25th and 26th of the year 2010, at the National University of Asuncion (UNA). It was organized by the School of Engineering - UNA and the SMP.

First Paraguayan Colloquium of Mathematics and Related Sciences, held from October 10th to 15th in 2011 at the National University of Asuncion. Prof. Dr. Juan Migliore of the Notre Dame University (USA), and Prof. Dr. Chris Peterson from the University of Colorado (USA) lectured the *Algebraic Geometry* course. *The Introduction to Functional Analysis* course was lectured by Dr. Roberto Markarián, from the University of the Republic (URUGUAY), Prof. Dr. María Laura Schuverdt, from La Plata University (ARGENTINA) presented the *Optimization with Algorithms* course. Prof. Dr. Alexander Arbieto of the UFRJ-Brazil lectured the *Dynamic Systems* course. Prof. Dr. Eduardo Wagner developed the course on *Functions*.

Course on Introduction to Analysis on the Line, held from 8th to 26th of July in the year 2013. It was lectured by Mauricio Poletti from the Institute of Pure and Applied Mathematics (IMPA, for its acronym in Spanish) from Rio de Janeiro, Brazil and current member of the SMP. The course was offered at no cost and it had 33 attendees. The best students were encouraged to attend the summer course offered by IMPA. Three students received student grants to attend such course.



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Course on Analysis on the Line, held between July 7th and August 1st of the year 2014, with a 6-hour per week class load, totaling 24 hours of theory, lectured on Mondays, Wednesdays and Fridays from 2:00 to 4:00pm. The lecturer was M.Sc. in Mathematics Mauricio Poletti, from the Institute of Pure and Applied Mathematics (IMPA), Rio de Janeiro, Brazil.

Likewise, other lecturers were Roberto Viveros, student at the Master's degree from the IMPA and Luis Nasi, student at the School of Engineering of the National University of Asuncion. The content of the course was: **1- Set Theory:** sets, injective, over-injective and bi-injective functions. **2- Natural Numbers:** mathematical induction, finite and infinite sets, countable sets. **3- Real Numbers:** Properties of real numbers. **4- Sequence:** limits of a sequence, inequality, and operations with limits, infinite limits. **5- Line Topology:** open, closed and compact sets.

The SMP launched Paraguay as a candidate for holding the Congress of Computational Interdisciplinary Sciences (CCIS, for its acronym in Spanish) in the year 2014, together with the Laboratory of Scientific and Applied Computational Science from the Polytechnic School of the National University of Asuncion.

The III Congress of Computational Interdisciplinary Sciences was held from September 30th to October 3rd, 2014 at the campus of the National University of Asuncion, directed to researchers and students who work in the different fields of science which make use of computational science in their research projects. The event was organized by the SMP, the Polytechnic School of the National University of Asuncion, the Autonomous University of Asuncion, and the Pan-American Association on Computational Interdisciplinary Sciences – PACIS.

The objective of the congress was to seek, in an innovative manner, an inter- and multidisciplinary dialogue in which researchers from different fields could share their experiences and find solutions to their IT problems. Also, to strengthen the links between basic and applied research and theoretical and experimental methods which involve Computational Science and Computational Mathematics. Master lectures, as well as ordinary sessions and tutorials were held, all related to Computational Mathematics, Computational Physics, Computational Astronomy, Computational Chemistry and Computational Biology, apart from topics such as calculation methods applied to space and Environmental Sciences, Technology, Innovation, Economics, among others.

Fifty-three scientific presentations were carried out through posters sessions, and for the oral presentations, research papers from all over the world were received, totaling around 100, which were selected by a scientific committee. The papers came mainly from Argentina, Germany, Belgium, Brazil, Chile, Italy, Japan, Mexico, The Netherlands, Paraguay, Poland, Spain, Switzerland, The United States, and Uruguay. Furthermore, the conferences held were lectured by the following speakers: Flavio Fenton from the School of Physics, Georgia Tech (USA), Anne De Wit and Geneviève Dupont from the Université Libre de Bruxelles (Belgium), and David Laroze from the High Investigation Institute (Chile). Also, conferences were presented by Luiz Bevilacqua from the Federal University of Rio de Janeiro (Brazil), Dr Alberto Paccanaro from the Royal Holloway, University of London (England), and Dr. Paul Bourguine from the Ecole Polytechnique (France), among others.

The Summer School of **Computational Algebra and Number Theory** was held from the 5th to



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the 10th of December 2014 in the city of Montevideo, Uruguay. It was organized by the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy. The event featured speakers from the University of Buenos Aires, University Rennes 1 from France, and the University of Leiden from The Netherlands. The objective of such school consisted in presenting the latest theoretical advances in Algebra and Number Theory, as well as computational techniques that allow solving the stated problems efficiently.

Three topics were addressed: i) Arithmetic Nullstellensätze and Applications by Teresa Krick (University of Buenos Aires); ii) Elliptic Curves and its Applications to Cryptography by Christophe Ritzenthaler (Université Rennes 1); ii) Algebraic Number Theory by Peter Stevenhagen (Universiteit Leiden).

The school consisted of: i) theoretical lessons and computational simulations open to questions and debates; ii) solving problems given by teachers in mixed groups; iii) presentation of results (theory and computational simulation) of the group before the class, debating and defending the proposed solution.

Visitors: César Caretta, professor and astronomer of the University of Guanajuato, visited Paraguay to lecture classes at the Autonomous University of Asuncion, at the School of Exact and Natural Sciences - FACEN (for its acronym in Spanish), at the Polytechnic School of the UNA - FPUNA (for its acronym in Spanish), in the Program for Young Talents of OMAPA and at the Club of Astrophysics of Paraguay. More than 400 people attended his talks.

Course on Abstract Algebra with Applications in Engineering, held on July 20th to 31st in 2015, at the Polytechnic School, UNA's campus - San Lorenzo City. The free course was lectured by teachers Juan Carlos Migliore and Christopher Peterson from the University of Notre Dame and Colorado State, respectively. Also, teacher Andrea Solotar gave a talk and participated in work meetings with colleagues in order to delineate a development strategy in the area of Algebra in Paraguay for the years 2016 and 2017.

INTERNATIONAL CONGRESSES

- **School of Mathematics of Latin America and the Caribbean - EMALCA** (for its acronym in Spanish).

The School of Mathematics of Latin America and the Caribbean in its EMALCA PARAGUAY 2009 edition, was organized by the SMP and supported by the School of Engineering - FIUNA, and the School of Exact and Natural Sciences - FACEN, both from the National University of Asuncion, and the Union of Mathematical Societies in Latin America and the Caribbean - UMALCA. It was held at the School of Engineering at the university campus, which had the appropriate infrastructure to conduct the school. FIUNA and FACEN supported the event financially, along with the Association of Universities "Group of Montevideo" (AUGM, for its acronym in Spanish), and the South American Program of support to the activities of cooperation in Science and Technology PROSUL (Brazil). It also had the support of OMAPA and CONACYT from Paraguay, of the IMERL from the University of the Republic (Uruguay) and from the Institute of Pure and Applied Mathematics - IMPA (Brazil).



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This EMALCA edition was the third one organized in Paraguay as a continuation of the activities for the strengthening of Mathematics in the country. Previous events include the EMALCA PARAGUAY 2005, the EMALCA 2007 and the courses: Analysis on the Line, Linear Algebra and Introduction to the Probability Theory and Metric Spaces. This way, the continuation of activities in the area allows valuing, fostering and stimulating the post-graduation process that is being developed in Paraguay, and it also shows the seriousness of the consolidation work of mathematics.

The EMALCA PARAGUAY 2011 was organized in parallel with the First Paraguayan Colloquium of Mathematics and Related Sciences, which allowed the interaction of high school and university teachers.

- **International Congress of Mathematicians.**

In August 2014, José Vázquez presented a research paper at the International Congress of Mathematicians – ICM, held in Seoul, Korea, (<http://www.icm2014.org>). It is important to mention that this is the first time in history that a Paraguayan presents a research paper at the ICM.

- **Congress of the Americas.**

Juan Carlos Cabral participated in the Congress of the Americas in the city of Guanajuato, Mexico, with the support of the Graduate Program in Computational Sciences from the Polytechnic School of the UNA. Likewise, he has also participated in organizational meetings for the confirmation of the Council of the Americas. The SMP is a member of the Council of the Americas since its foundation, and it has supported the Congress of the Americas undertaking from the beginning.

NETWORKS AND ALLIANCES

- **Mathematical Modelling Center, University of Chile.**

In the year 2014 a bi-ministerial mission was carried out by Ministers David Ocampos and Luis Lima Morra to Chile to visit the Mathematical Modelling Center - CMM (in Spanish) from the University of Chile, as well as the Foundation INRIA - Chile <http://www.inria.cl>. In it, intentions of collaborative work were signed and agreed in order to support Paraguayan institutions in the corresponding areas of the visited institutions. The Paraguayan Embassy in Chile organized an honor reception to the ministers with fellow colleagues and researchers from Chile.

OMAPA, which works as a partner institution with SMP, has encouraged the creation of the Mathematical Education Upgrade Project, with the support of the CONACYT. The main objective of this project is to investigate the cause and effect relations in the educational work for groups of 1st to 6th grades of Basic School Education. Another main objective is to implement an innovative proposal to update Mathematical Education. The project has the advice of specialists from the Mathematical Modeling Center of the University of Chile, for the development of the academic proposal as well as for the design, implementation and interpretation of the results of the research. Also, six Paraguayan educators are currently pursuing the Certificate Course in Mathematical Education Updating, lectured by experts of the CMM.



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- **School of Education, Boston University.**

The upgrade project in Mathematical Education encouraged by OMAPA has the support of the School of Education of Boston University. The support consists in the provision of 26 didactic units of teacher trainings in Fractions, Geometry and Number Theory to incorporate into the academic proposal.

- **ICMI – CANP 5 Andean Region and Paraguay.**

The Capacity and Networking Project-CANP has as its main objective to establish a network of contributions among developing countries to meet the challenges of a skilled mathematical education; it is encouraged by ICMI (International Commission of Mathematical Instruction) with the support of the IMU (International Mathematical Union), UNESCO (United Nations Organization for Education, Science and Culture) and ICSU (International Council for Science).

In February 2016, a Paraguayan delegation participated in the Fifth edition of the event CANP, held in Lima, Peru. For this, a report about the initial and continuing training in mathematics in Paraguay was elaborated. In these exchange spaces with specialists, contacts and counseling with doctors Masami Isoda, Ferdinando Arzarello, Vicenç Font, Luis Radford, Patrick Scott and Michèlle Artigue have been created.

Currently, we are working together in the elaboration of the Standards for Essential Mathematical Skills in Teachers of Elementary and Middle School Education. One hundred Problem Solving Didactic Units from Alan Schoenfeld have been supplied (K6 to K-12).

- **UMALCA.**

The SMP is a member of the Union of Mathematical Societies in Latin America and the Caribbean - UMALCA. We have participated in the drafting of the new bylaws for the UMALCA, and in new regulations for the Latin American Congress of Mathematics - CLAM (in Spanish).

- The SMP is a member of the Mathematical Council of the Americas - MCofA.

ANNEX I

Below, participations in events with references are presented, as well as scientific articles published by the researchers in Mathematics and Computational Science related to the SMP. It is important to highlight that the list below is only indicative and does not constitute a strict or complete assessment of the publications in the country.

2016

1. Lino Chamorro, Fabio López-Pires, Benjamín Barán, "A Genetic Algorithm for Dynamic Cloud Application Brokering". Accepted at 4th IEEE International Conference on Cloud Engineering (IC2E 2016). Berlin, Germany.
2. Sara Arévalos, Fabio López-Pires, Benjamín Barán, "A Comparative Evaluation of Algorithms for



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- Auction-based Cloud Pricing Prediction". Accepted at 4th IEEE International Conference on Cloud Engineering (IC2E 2016). Berlin, Germany.
3. Jammily Ortigoza, Fabio López-Pires, Benjamín Barán, "A Taxonomy on Dynamic Environments for Provider-oriented Virtual Machine Placement". Accepted at 4th IEEE International Conference on Cloud Engineering (IC2E 2016). Berlin, Germany.
 4. Diego Ihara, Fabio López-Pires, Benjamín Barán, "Many-Objective Virtual Machine Placement for Dynamic Environments". 8th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2015). Limassol, Cyprus.
 5. Enrique Dávalos, Cristian Aceval, Victor Franco, Benjamín Barán. "VNE-MOILP: A Multi-objective approach for VNE problem". Aceptado para su publicación en "CLEI Electronic Journal" – 2016.
 6. Enrique Dávalos, Cristian Aceval, Victor Franco, Benjamín Barán. "VNE-MOILP: A Multi-objective approach for VNE problem". Aceptado para su publicación en "CLEI Electronic Journal" – 2016.

2015

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2. Fabio López-Pires, Benjamín Barán, "A Many-Objective Optimization Framework for Virtualized Datacenters". 5th International Conference on Cloud Computing and Service Science (CLOSER 2015). Lisbon, Portugal.
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