

Chapter Three

THE REST OF THE CONFERENCES

The *Inter-American Conferences on Mathematics Education* have continued to take place, more or less regularly, now making a total of nine. The following are the last seven:

Third Conference in Bahía Blanca, Argentina, November, 1972;
Fourth Conference in Caracas, Venezuela, December 1975;
Fifth Conference in Campinas, Brazil, February 1979;
Sixth Conference in Guadalajara, Mexico, November 1985;
Seventh Conference in Santo Domingo, Dominican Republic, July, 1987;
Eighth Conference in Miami, USA, August 1991; and
Ninth Conference in Santiago, Chile, August 1995.

Six years passed between the *Second Conference* and the *Third Conference*. The objectives that had been so clear in the first two were no longer so strongly present and many of the organizations and institutions that had been involved had lost interest.

In the first two *Inter-American Conferences on Mathematics Education*, the objective was very broad, but at the same time very precise: to carry out the reform of mathematics teaching at the secondary level. That was the motivating idea and it sought very important ends that were very concrete. In the following conferences, more specific topics were selected, around which there were presentations and discussions, but they did not have the wide impact throughout the region of the first two. By the *Third Conference*, the President of IACME, Marshall Stone, in his opening address, complained of the difficulties that had occurred in carrying out the meeting and denounced the lack of interest in many organizations. Perhaps that was why there were six years between the *Second Conference* and the *Third*.

During the *Third Conference* there was still an obvious effort to implement the teaching of modern mathematics, in the primary level as well as in those places where it had not yet been tried. However, in that and subsequent conferences it was well noted that the results of the reform were not as planned and that there had been tremendous difficulties. Criticisms over various aspects were felt. For example, in the *Third Conference* Lore Rasmussen (USA) said:

"In practice, the reform could not achieve many of its goals. The concern with the use of a precise language such as the distinction between number and numeral and equivalent and equal were imposed artificially. The insistence of implementing the language of sets, the abuse of certain notations, the mention of the commutative, associative and distributive

*laws hampered on many occasions the intuitive confidence for mathematics in the teachers as well as in the students."*¹

In the *Fifth Conference*, Emilio Lluís (Mexico) also expressed the difficulties that were present in trying to substitute teaching Euclidean Geometry in the usual way with a presentation from the point of view of Linear Algebra and the loss that this represented pedagogically.

In spite of the fact that the objectives of the conferences changed, they have continued to be an excellent discussion forum about the problems of mathematics teaching in these countries, and for many years they represented the only such forum in the Latin American region.

With respect to their functioning, the *Third* and *Fourth Conferences* maintained a structure that was similar to the first two. That is, in each case the Committee selected four themes that they considered important for mathematics education in the American countries and, addresses and short presentations were given on those topics, as well as round table discussions. In addition, the majority of the participating delegates presented reports on the state of mathematics teaching in their countries. Finally, based on the reports and the discussions some agreements were reached in the form of recommendations directed to the institutions and organizations that had to do with mathematics teaching.

For the *Fifth Conference*, the Committee decided on having three keynote addresses given by distinguished mathematicians who selected their own topics. Later, as had been the case in previous conferences, four themes were treated in detail, but this time using panel discussions in order to promote greater participation. Additionally a few seminar-workshops were presented on very specific topics. We note that beginning with this conference there were no longer reports presented by delegates from the countries.

The structure of the *Fifth Conference* was maintained in the *Sixth, Seventh, Eighth* and *Ninth*: general invited keynote addresses (three, three, two and five, respectively) with topics chosen by the presenter, four discussion panels on specified topics, and seminar-workshops. However, in each of these the participants gave a large number of short presentations. These short presentations were not actually the equivalent of the reports of the first conferences, but, instead, the presentation of proposals, experiences and specific ideas on various aspects of mathematics and its teaching, especially methodological considerations.

For practical purposes we can divide the ideas and structure of the conferences into two stages. The **first stage** was made up of the first four conferences in which the primary objective was to change the kind of mathematics being taught at the secondary and primary level in the participating countries, especially in Latin America (there was the most emphasis on this in the first two *Conferences*). In those *Conferences* the preoccupations centered around which type of mathematics programs were most appropriate, what topics should be included or excluded from those programs, how should teachers be prepared in order for there to be some chance of success with the proposed changes, etc. However,

psychological and pedagogical aspects related to students, and the real possibilities of carrying out reform were rarely taken into account. Very few of the communications or addresses in this stage were concerned with analyzing problems related to pedagogy, or teaching methods, or any topics related to them. The reports of the delegates were limited to giving statistics (when they existed) or a perspective on how the various aspects of change in mathematics teaching were advancing. Some delegates reported difficulties and obstacles encountered in the process.

A **second stage** was reached in the other five *Conferences*, although the *Third* represented a transition. A change in objectives can be noted. Even though the general ideas were not abandoned completely, principally through the keynote addresses, a new concern appeared for more specific topics, especially those of a pedagogical nature. In addition to giving importance to what should be taught there was importance given to how it should be taught. This is reflected very clearly in the short presentations, especially in the last three *Conferences*.

Those who participated as delegates in the first *Conferences* accepted a mission: changing the teaching of mathematics in their countries by introducing new curriculum, with the topics and the way of developing them that was proposed in the *Conferences*. Thus, an important aspect of the *Conferences* in the first stage (something that does not appear in the second) was the establishment of a series of recommendations that, although not obligatory, did indeed encourage many of the delegates to try to do something in their respective countries. Therefore, by way of the addresses and the recommendations, the *Conferences* in the second stage have not had that missionary character and this has resulted in them being less influential. This is quite apart from the rapid development of Mathematics Education internationally that has given rise to a different context that has influenced and continues to influence IACME.

Below is a brief summary of the programs from the *Third* to the *Ninth*.

THE THIRD CONFERENCE

The *Third Conference* was held in Bahía Blanca, Argentina, in 1972. The selected topics were²:

Topic I: Computing and its Teaching at Various Levels.

For that topic there were five presenters:

The Impact of Computers on Mathematics, Jean Paul Jacob (USA);

Didactic Aspects of Teaching Computing in the Secondary School, Roger Mascó (Argentina);

Computing: The Arithmetic of the Future, Jaime Michelow (Chile);

Computing and its Teaching in Secondary Education, Victor Sánchez Carrasco (Chile);

Computers in Secondary Teaching, Conrad Wogrin (USA).

Also a few short presentations were given:

Computing in Secondary Teaching, Hugo Acevedo (Argentina);

A Few Reflections on Introductory Computing Courses at the University Level, Rogelio Morán (Argentina);

Consideration on the Bachelors in Science in Computing, V.M. Setzer (Brazil).

Within this topic the presenters described and commented on experiences with computing in various places and, in general, proposed the gradual introduction of computing and the use of computers in the teaching of mathematics, as both a tool and a source of new problems. In that respect, Jean Paul Jacob highlighted the importance of computing as an aid that permitted the development of applied mathematics. In general he emphasized the significance of computing from various points of view: the cultural-informative, as a useful tool, its formative value, its vocational value, etc. The problems in this matter basically referred to what aspects of computing to teach and how to teach them. They proposed some topics that should be taught such as the history of computing, physical and mathematical aspects that permit the construction of a computer, description of computers, the binary system, fixed point and floating point arithmetic, what is a computer program, a language such as mini-FORTRAN and some applications to solving systems of equations, etc.

Topic II: Modern Mathematics in Primary Teaching

There were five main presentations within the framework of this topic:

The Modern Focus in Teaching Mathematics at the Primary Level, M Chouhy Aguirre and Elsa de Martino (Argentina);

Minicomputer, Frédérique Papy (Belgium);

Early Childhood Mathematics Education, Lore Rasmussen (USA);

The Production of Textbooks for Teaching Mathematics in the Primary School, Alonso Viteri (Ecuador);

Methods of Teaching Mathematics in Primary Schools in England, Elizabeth Williams (UK).

Also some short presentations were given:

Experiences in Instruction in Conceptual Algebra in the Primary School, José Ipiña Melgar (Bolivia);

On the Solution of Mathematical Problems, Horacio Rimoldi, Nora de Figueroa, Ana Haedo (Argentina);

Modern Mathematics in Primary Teaching, María Teresa Onaindia (Argentina).

In general terms, the importance of introducing some of the concepts of mathematics in primary education was highlighted, but, at the same time, certain dangers of not taking into account psychological and pedagogical aspects were pointed out. On the other hand there were comments on the problems that can occur when modern mathematics is introduced into the primary school. With respect to difficulties, María M.O. de Chouhy and Elsa de Martino indicated that some of the difficulties were finding adequate textbooks, and the

impossibility of teaching primary mathematics from an axiomatic, abstract, deductive point of view. In his presentation, Lore Rasmussen critiqued the form in which the reform had been carried out and suggested that the place of the child in the total effort should be reformulated and that consideration of psychological aspects was needed. He added that there was a need for continuous professional development of teachers.

Topic III: Modern Mathematics in Applied Sciences and Technical Schools.

Presentations:

Modern Mathematics and Applied Mathematics, Héctor Fattorini (Argentina);
Some Consequences for Mathematics of the Expansion of Higher Education in Applied Sciences, Guilherme de la Penha (Brazil);
The Notion of Approximation in Secondary Teaching, André Revuz (France);
Modern Mathematics and the Mathematical Preparation of Engineers, José Tola (Peru).

Short presentations:

On the Teaching of Mathematics in Non-Mathematical Specialties, Edmundo Rofman (Argentina).

Within the framework of this topic, several of the presenters indicated agreement with the need to teach mathematics for non-mathematical specialties in the "modernist" tradition, particularly in the preparation of engineers. In that respect, for example, José Tola proposed the teaching of modern mathematics in engineering programs and also the teaching of topics from classical mathematics, but from the point of view of modern mathematics, which he characterized as having the following elements: abstraction, logical rigor, formalizations and creativity. Héctor Fattorini even proposed that there was a need to create an interdisciplinary program: mathematics-engineering.

Topic IV: The Transition from Secondary School to the University: Adjustments in Teaching during that Period.

Presentations:

Articulation of Elementary and Higher Mathematics: Some Observations, André Delessert (Switzerland);
Mathematics and University Drop Outs, Antonio Diego (Argentina);
Toward Mathematical Literacy, Howard Fehr, (USA);
The Evolution of Mathematics in Colombia, Ricardo Losada (Colombia).

The presenters exposed the difficulties that students who have just left secondary school encounter in being successful in their first university mathematics courses, especially because of inadequate preparation that is usually received at the secondary level. André Delessert stated that the collaboration between secondary schools and universities should not be limited just to the definition of a list of topics to be covered. For him, of most importance were the attitudes developed in secondary school students that would permit them later to understand the theory of modern mathematics. Thus, students should be guided "to desire and conceive a form of mathematical reflection and action".

Therefore, the secondary school should refer to professional mathematicians to help them in that aspect, and professional mathematicians should be interested in very concrete didactical problems. Consequently, then, a continuous collaboration between the University and the School is necessary. He further suggested that the lack of collaboration had been a source of much of the misunderstanding with respect to the teaching of modern mathematics. He gave a very eloquent example: the case of teaching set theory. The use of sets was very important for professional mathematicians because it permitted them to develop a very comfortable language, but children do not use a level of mathematics in which the language of sets provides an economy of thought, and, therefore, sets are presented to children as a mathematical topic in its own right, and not as a tool that serves to organize and solve problems that they encounter. Thus, "mathematicians did not know how to show the role that they thought reasonable for set language. Secondary teachers tried to guess their intentions, but were lost".

In a section on various topics there were four presentations:

The Institute for the Development of Mathematics Teaching in the Netherlands, Hans Freudenthal (Holland);

In the Beginning Was ... Calculus ..., Maurice Glayman (France);

Tests of Verbal and Mathematical Reasoning, Marta Moraschi (Argentina);

The Support of INEC to Mathematics Teaching, Beatriz Palau (Argentina).

DELEGATE REPORTS

Delegates from the following countries presented reports:

Argentina (Atilio Piana), Bolivia (Moisés Arteaga), Brazil (Arago de Carvalho), Chile (Teodoro Jarufe), Colombia (Ricardo Losada), Costa Rica (Enrique Góngora), Ecuador (Alonso Viteri), Guatemala (Jorge Rodríguez), Honduras (Edgardo Sevilla), Paraguay (José Luis Benza), Peru (César Carranza), Uruguay (Enrique Cabaña) and Venezuela (José A. Rodríguez).

Some of the characteristics that were present in mathematics teaching in the region at that time can be seen in the reports. In general there was concern about updating curriculum. Curriculum was presented in some detail, with explanation, bibliography, etc.; however, generally the programs still did not reflect the structural unity that one would wish for. It was concluded that there was still a long way to go, given that several aspects needed attention. With respect to pre-service and in-service teacher education, the efforts undertaken in the various countries were noted, but with questions about what results had actually been attained so far. Also textbooks for the primary and secondary level had been published in various countries, but not many materials had been published specifically for teachers.

RECOMMENDATIONS

In the final session of the *Third Conference* a series of recommendations were approved that can be summarized as follows:

On Computing and Teaching at Various Levels:

The teaching of computing should be introduced at the secondary level in order to achieve an adequate preparation in posing and solving problems; a use of algorithms, flow charts, and other such tools; and an understanding of how calculators and computers function. Also, computing should be included in the preparation of mathematics teachers and in the professional development of in-service teachers. In general, computing courses should be included in degree programs of all universities, and research should be carried out to determine the possibility of introducing computing in the primary school.

On Modern Mathematics and Primary Education:

Children should begin the study of modern mathematics concepts by introducing topics such as sets (intuitive notions), order and equivalence relations, functions, natural numbers, structural properties, numeration systems, place value, rational numbers, real numbers, measurement, approximations, units of measurement, the metric decimal system and others, notions about space, open and closed curves, interior and exterior, figures in the plane and in space, the notion of vector, transformations (symmetry, rotations, translations and dilations), and finally, introduction to probability and statistical inference.

On Modern Mathematics in Applied Sciences and Technical Schools:

There should be regional planning on teaching and transfer of mathematical knowledge. There was a need to provide a solid mathematical background in the first years of university. Research into applications of mathematics should be encouraged.

On the Transition from Secondary School to the University:

Efficient communications should be established between secondary schools, universities and other institutions of higher learning. University programs should be restructured to establish better articulations between secondary school and university mathematics. New counseling should be created in secondary schools to better prepare students.

The creation of an IACME information bulletin was also recommended. It was suggested that official sanction and funding be requested from the OAS.

Also, the creation of multinational committees to modernize programs for teaching mathematics, and a union of American mathematicians was recommended

THE FOURTH CONFERENCE

The *Fourth Conference* was held in Caracas, Venezuela, in 1975. The following topics were presented at that conference³:

Topic I: Applications of Mathematics in Teaching and Learning.

Presentations:

Applications of Mathematics in the First Cycle of Secondary Schools, Emma Castelnuovo (Italy);

On the Teaching of Mathematics and Statistics and Economics, Colette Andrieu-Bui (France);

On the Teaching of Mathematics and Statistics Related to the Social Sciences, Bui-Trong-Lieu (France).

With respect to this topic the presenters indicated some ideas on the teaching of applications of mathematics. Emma Castelnuovo stressed the need to teach from both abstract and concrete perspectives in secondary schools in order to motivate students. In contrast to the usual teaching practice of presenting theory and then showing some applications, she gave some examples appropriate for the first years of secondary school.

Topic II: Mathematics in the Last Years of Secondary School.

Presentations:

Teaching of Mathematics in the Higher Classes in Secondary School and its Relation to Mathematics Teaching in the University, Jean Dieudonné (France);

Mathematics Education in the Last Years of Secondary School in Venezuela, Héctor Pantoja, José Sarabia and Ennodio Torres (Venezuela);

Considerations on Teaching Mathematics in the Last Years of Secondary School in Colombia, Carlos Vasco, Mary Falk, Jairo Charris and Ricardo Losada (Colombia).

Some experiences on mathematics teaching in the last years of high school [ciclo diversificado] were expressed. Jean Dieudonné's point of view was that students cannot receive a weak secondary education because many of them will later go to universities where they will study in areas such as engineering and physics that require solid mathematical knowledge. For Dieudonné mathematics teaching in the last years of secondary school can be summarized in three fundamental themes: the idea of approximation which is the same as the basis for the experimental sciences, the idea of linearity which is the basis of functional analysis, and the idea of probability. Pantoja, Sarabia and Torres established the following goals for teaching mathematics in the last years of secondary school: development of a capacity for abstraction, understanding of scientific phenomena and the interpretation of their technological effect, and preparation for university studies. According to them the way to achieve that was using applied mathematics. They proposed some topics that should be taught at that level: sequences, progressions, exponential and logarithmic functions, vectors, trigonometric functions, complex numbers, statistics, induction, combinatorics, polynomials, inequalities, conics, matrices, determinants, probability.

Topic III: Extracurricular Teaching of Mathematics.

Presentations:

The Role of a Teachers Organization in Improving Mathematics Education, Glenadine Gibb (USA);

An Experiment in Distance Education at Simón Bolívar University, J. Jiménez and Eduardo Lima (Venezuela);

Building Computers in Secondary Schools, Jaime Michelow (Chile).

In this section, specific experiences related to mathematics teaching outside the framework of formal education. In her presentation Glenadine Gibb indicated some of the achievements in work carried out in the USA and Canada by the National Council of Teachers of Mathematics (NCTM) and emphasized the importance of teacher organizations in the development of mathematics and its teaching. Romero and Lima talked about a program at Simón Bolívar University in Venezuela using distance education that led to the title of Mathematics Teacher or Physics Teacher. The presentation by Jaime Michelow referred to a very concrete situation in which a group of students in Chile built a computer.

Topic IV: Mathematics and Development. The Problem of Teacher Preparation.

Presentations:

Mathematics and Ideology, Daniel Crespín (Venezuela);

Objectives and Tendencies in Mathematics Education in Developing Countries, Ubiratan D'Ambrosio (Brazil);

Mathematics and Development, Paul Dedecker (Belgium);

Preparation of Teachers and the Improvement of Mathematics Education, Howard Fehr (USA);

Teacher Preparation Program in Mathematics for Developing Countries, Mauricio Orellana and Saulo Rada (Venezuela).

This topic was very important because it attempted to establish broad guidelines that should be followed in teaching mathematics, particularly in developing countries. Thus, for example, Daniel Crespín emphasized the need to teach Arithmetic "because it is required in daily life in modern society". He also indicated that there was a need to teach Infinitesimal Calculus as the basis for scientific and technological development. He emphasized the importance of preparing applied mathematicians in order to advance science and technology, while at the same time not neglecting to prepare pure mathematicians, but in smaller numbers.

Ubiratan D'Ambrosio argued for the need to delineate a philosophy that permitted developing countries, despite their modest material resources, to progress in a way that resulted in improvements that would bring about more dignified living conditions of Latin Americans. He expressed that, instead of studying details of the curriculum within a philosophy of teaching abstract mathematics dictated by distant cultural traditions, we should be asking questions such as why study mathematics?, why teach mathematics?, and how can we teach mathematics to six or seven year olds so that it has a more direct influence on improving their lives? He added that the answers should be found by Latin American countries themselves and should be authentically Latin American.

Two round table discussions were also held:

- 1) Mathematics and Development. The panelists were: Daniel Crespín (Venezuela), Ubiratan D'Ambrosio (Brazil), Paul Dedecker (Belgium), Carlos Imaz (Mexico), Hernando Mateus (Colombia), and Moderator, José Andonegui (Venezuela).
- 2) Problems of Reform in Mathematics Teaching. Panelists: Emma Castelnuovo (Italy), Luis Dante (Brazil), Jean Dieudonné (France), Howard Fehr (USA), Ricardo Losada (Colombia), Artibano Micali (France), Saulo Rada (Venezuela), Willy Servais (Belgium), Moderator, Tania Calderón (Venezuela).

DELEGATE REPORTS

Reports on mathematics teaching were presented by delegates from the following countries: Argentina, Brazil (Ubiratan D'Ambrosio), Colombia (Ricardo Losada), Costa Rica (Guillermo Vargas), Mexico (Olimpia Figueras), Paraguay (José Luis Benza, Ada Sanabria and Stella Marés, Peru (César Carranza), USA (Howard Fehr), Venezuela (Federico Martín).

It is notable that the reports were directed in general to giving information on the progress of mathematics teaching reform in the various countries. Little by little, in some countries more than others, the ideas of modern mathematics were being introduced in the primary and secondary levels in Latin America. It can be deduced from the reports that the efforts were oriented in various ways: changes in the curriculum, special publications such as textbooks and journals, preparation and professional development of teachers. None of the reports indicated how successful the efforts had been nor what repercussions they had had.

RECOMMENDATIONS

In the final session of the *Conference* a series of recommendations, that can be summarized as follows, were made:

Create research centers in each Latin American country. Create specific programs for teaching mathematics in the last years of secondary school. Here a specific program was not proposed, but each country should determine its own program based on its own possibilities. Some topics were recommended: real functions, linear algebra, computing, elements of infinitesimal calculus, probability and statistics. Organize science fairs and Olympiads. Improve mathematics teaching by using new technologies, collaboration with higher level mathematicians, etc. Improve the preparation and professional development of teachers.

THE FIFTH CONFERENCE

The *Fifth Conference* was held in Campinas, Brazil, in 1979⁴.

There were three keynote addresses at this Conference:

Hassler Whitney (President of ICMI) gave the address Learning Mathematics for Family Life.

Leopoldo Nachbin (Brazil): Talent, Creativity and Expression.

Emilio Lluis (Mexico), Geometry in Teaching.

The four panels were:

Panel A: The Situation in Geometry Teaching given the New Tendencies in Mathematics Education.

Participants on the Panel were:

José Velázquez, Moderator;

Luis Dante (Brazil), The Mosaic Method of Teaching Geometry;

José Pascual Ibarra (Spain), The Educational System in Spain and the Role of Elementary Geometry in General Education;

Luis Santaló (Argentina), Causes and Effects of Current Tendencies in Teaching Geometry;

Oscar Valdivia (Peru), Teaching Geometry via Transformations.

The central ideas discussed in this panel made it clear that there was a need for research on new ways of teaching geometry at the secondary level, in view of the difficulties presented in learning geometry with a strict modern mathematics approach. In fact, in his address, Luis Santaló critiqued the way that geometry is presented to young students from a purely axiomatic point of view: the problem arises from confusing mathematics as a research discipline with mathematics as a formative and informative discipline⁵.

Panel B: The Impact of Computers on Mathematics Education.

Participants:

José von Lucken (Paraguay), Moderator;

Francisco Figeac (El Salvador), Calculus Oriented by Computing;

Jaime Michelow (Chile), The Impact of Calculators and Computers on Mathematics Education;

José Valenti (Brazil), The Presence of Computers in Mathematics Teaching and Learning as an Extension of the Experience of Children.

The presentation manifested the phenomena of the appearance of pocket calculators that, one way or another, would affect mathematics teaching significantly. They discussed the criticisms that were being made at the time about the indiscriminant use of calculators,

such as: dependency, loss of abilities, mental atrophy. Despite those criticisms they painted a bright future for the use of both computers and pocket calculators. For example, they predicted that in the near future calculators would replace logarithm and trigonometric tables, simplify laborious calculations and, used well, permit doing things in class that up to then had been impossible. At the same time, there would be a greater understanding of some concepts. They recommended that these instruments be tried out and the results published for general knowledge.⁶

Panel C: Nontraditional Teaching Methods and Their Influence in Mathematics Education.

Participants:

Bernardo Morales (Guatemala), Moderator;

Enrique Góngora (Costa Rica), Why a System of Distance Education?;

Saulo Rada (Venezuela), Non-Traditional Methods of Teaching Mathematics in Venezuela;

Oswaldo Sangiori (Brazil), Non-Traditional Methods of Teaching Mathematics and Their Effect on Mathematics Education;

Bryan Wilson (UK), The Open University in the United Kingdom and its Effect on Mathematics Education.

Basically, the presentations of this panel were experiences in distance education on the country of origin of the presenter. Most of them just talked about distance education in general and said very little specifically about teaching mathematics. The one exception was Saulo Rada who told about secondary mathematics teacher education using a distance methodology.

Panel D: New Tendencies in Learning and Evaluation of Mathematics.

Eduardo Luna (Dominican Republic), Moderator;

Guy Brouseau (France), Evaluation and Learning Theory in School Situations;

Ricardo Losada (Colombia), New Tendencies in the Evaluation and Learning of Mathematics;

Geraldina Porto (Brazil), New Tendencies in Learning and Evaluation of Mathematics, a Multidisciplinary Approach;

Friederich Zech (Germany), New Tendencies in the Didactics of Mathematics.

The presentations of this panel were in agreement in considering mathematics teaching as a distinct discipline with its own subject matter. That is, it considers diverse circumstances and fields of knowledge in confronting teaching problems and not the implementation of just any mathematics. It attempts to lead to the adoption of the most adequate methodology that permits the students to understand mathematical concepts as well as possible.

Besides the formulation of critiques of the way in which the reform of mathematics teaching was carried out in the '60s, they expressed some ideas about methodology. In

general, it was considered important that mathematics teaching starts concretely and moves to the abstract, leaving formalization until students' psychological development permitted it. They also stressed the importance of research in the teaching (didactics) of mathematics⁷.

Five seminar-workshops were also held:

Curriculum Changes Caused by Increasing Demand for University Mathematics Courses, Luis Estrada (Costa Rica).

The Six Hundredth Anniversary of Joaquim Gomes de Souza, the Best Brazilian Mathematician, Jonofon Guei Séates (Brazil).

Proposal for the Establishment of a Panamerican Mathematics Olympiad, Ed Jacobsen (UNESCO).

Invention of non-Conventional Instruments to Explore Mathematical Abilities, Horacio Rimoldi.

Attitudes to Mathematics, Nélide Rodríguez Feijóo.

THE SIXTH CONFERENCE

The *Sixth Conference* was held in Guadalajara, Mexico, in 1985⁸.

The three keynote addresses were given by:

Terezinha Nunez Carraher, Brazil

César Rincón, Mexico

Richard Shumway, USA

There were also the following invited presenters:

José Manuel Aroca, Spain

Enrique Antoniano, Mexico

Emma Castelnuovo, Italy

Ubiratan D'Ambrosio, Brazil

Luis Dante, Brazil

Olimpia Figueras, Mexico

Octavio García, Mexico

Claude Gauthier, Canada

Carlos Imaz, Mexico

Edward Jacobsen, UNESCO

Emilio Lluis, Mexico

Eduardo Mancera, Mexico

Jean Pedersen, USA

Juan José Rivaud, Mexico

Hassler Whitney, USA

The four panels were:

Panel I: Cultural and Historical Roots of the Teaching of Mathematics.

Participants: Víctor Albis (Colombia), Angel Ruiz (Costa Rica), Patrick Scott (USA), Elfriede Wenzelburger (Mexico), Luis Moreno (Mexico).

Panel II: Programmatic Changes Influenced by Calculators and Computers.

Participants: German Bernacer (UNESCO), Octavio García (Mexico), Peter Hilton (USA), Walter Taylor (USA), Carlos Velarde (Mexico), Alfinio Flores (Mexico).

Panel III: The Modelling Process in the Formulation and Solution of Problems.

Participants: Jesús Alarcón (Mexico), Antonio Jose Lopes (Brazil), Jean de Lange (Holland), Alicia Villar (Uruguay), Edgar Becerra (Mexico).

Panel IV: Failure in Mathematics: The Identification of Causes and Possible Solutions.

Participants: Yolanda Campos (Mexico), Emiliano Fernández Bermejo (Spain), Manuel Fernández (Canary Islands), Eduardo Luna (Dominican Republic), Lilia del Riego (Mexico).

There were also various other presentations.

THE SEVENTH CONFERENCE

The *Seventh Conference* was held in Santo Domingo, Dominican Republic in 1987⁹.

There were three keynote addresses:

Enrique Calderón (Arturo Rosenblueth Foundation, Mexico), Experimental Learning of Mathematics;

Lelis Páez (Venezuela), Old Problems, New Realities;

Pedro Suárez (Dominican Republic), Comparative Studies of the Teaching of Mathematics: A Caribbean Contribution.

The four panels were:

Panel A: Integration of the Sociocultural Context into the Teaching of Mathematics.

Participants in the panel were:

Angel Ruiz Zúñiga (Costa Rica), Moderator;

Luis Arboleda (Colombia), Social History and the Formation of a Scientific Culture;
Roberto Ribeiro Baldino (Brazil), Cooperative Learning [aprendizaje solidario] in Higher Education: Toward a University without Tests;
Angel Ruiz Zúñiga (Costa Rica), Mathematics: A Historical-Philosophical Reconstruction for a New Teaching;
Martha Villavicencio (Peru), Integration of the Sociocultural Context in order to Improve Mathematics Teaching for Indigenous Populations: Peruvian Experiences.

Some of the main ideas that were discussed in this panel are discussed below. There is more and more evidence from studies on the nature of science that scientific development is not independent of the social context. In particular, the predominant use of the deductive style of mathematics teaching was criticized, as well as the enormous influence of the belief that somehow mathematics is finished and complete. This has a lot to do with the predominance of rationalism, which has determined the methods, curriculum, textbooks, etc. They stressed the need to consider the cultural and social environment in teaching mathematics. They also emphasized the need to teach mathematics from a historical perspective, which is, using history to structure the teaching of concepts. Also, they insisted on an emphasis in a concrete and intuitive approach to the physical world and social environment.

Panel B: How to Develop Student Problem Solving Abilities?

Participants:

Claude Gaulin (Canada), Moderator;

Rodney Bassanezi (Brazil), Models as Methodology for Teaching Mathematics;

Cipriano Cruz (Venezuela), How to Develop Student Problem Solving Abilities;

Antonio José Lopes (Brazil), Demystification of Mathematical Knowledge by Building Mathematical Language and Models - Experiences in Mathematical Production in the Classroom.

This panel highlighted the importance of problem solving in the process of teaching-learning mathematical concepts. Specifically, problem solving can serve to demystify mathematics since it permits students to experiment and "create". Problem solving also allows students a certain amount of autonomy in constructing their own thinking. Problem solving can be developed among students by building mathematical models.

Panel C: Innovative Uses of Calculators and Computers in Mathematics Teaching.

Participants:

Asunción Comas, Moderator;

Jorge López (Puerto Rico), Innovative Uses of Calculators and Computers in Mathematics Teaching;

Carlos Mansilla (Argentina), Computers and Mathematical Problem Solving;

Fidel Oteiza (Chile), Mathematics Learning and Logic Programming;

Richard Wolfe (Canada), Learning Mathematics by Using Computers outside the Classroom.

Among the ideas expressed in this panel was a recommendation by the panelists for more use of microcomputers in teaching mathematics.

The use of computers in teaching could be considered from two points of view. On the one hand, computer assisted instruction and, on the other, programming because it can be instrumental in developing concepts and a medium for developing mental abilities. Expanding the use of computers in teaching can result in various advantages such as:

- increased motivation,
- a way of using new technologies,
- a means of helping to develop problem solving abilities,
- a tool for implementing an efficient database.

Panel D: How to Improve the Teaching of Geometry in Primary and Secondary Schools.

Participants:

Emilio Lluís (Mexico), Moderator;

Emma Castelnovo (Italy), The Teaching of Geometry to Students from 11 to 14 Years Old;

Luis Dante (Brazil), How to Improve the Teaching of Geometry in Primary and Secondary Schools;

Alan Hoffer (USA), Geometry, Research, and Computers.

In this panel they discussed some of the difficulties in teaching geometry, among the most notable were:

- Few textbooks.
- Little connection made in geometry classes to other branches of mathematics.
- The imposition of deductive geometry.
- Little clarity as to how and when to make the connection between experimental (concrete) and deductive geometry.

They also pointed out the need to teach geometry dynamically, linked to the concept of function and connected to daily life, design, art and history.

Hoffer indicated three aspects of interest in geometry: as an invention of the human mind that provides suggestive ideas that can be used with children so that they will reason, as a source of psychological research that can help us understand how children learn, and finally, as a means to investigate the power of computers.

There were also four Working Groups:

The Teaching/Learning of Mathematics and Social Reality;

Teaching via Problem Solving, coordinated by Antonio José Lopes and Pilar Martínez;

Preparation of In-Service Mathematics Teachers and the Possibility of Regional Cooperation, coordinated by Lelis Páez;

Advanced Mathematical Thinking, coordinated by Lilia del Riego and Gontran Ervynck.

During this conference 78 short presentations were given that dealt with very diverse topics, from recommendations on teaching certain topics to topics of a philosophical and epistemological nature.

THE EIGHTH CONFERENCE

The *Eighth Conference* was held in Miami, USA, in 1991¹⁰.

For this *Conference* there were two keynote speakers:

Angel Ruiz Zúñiga (Costa Rica), Modern Mathematics in the Americas: Philosophy of a Reform;

Peter Hilton (USA), The Joy of Mathematics.

The four panels were:

Panel A: Integration of the Sociocultural Context into Mathematics Teaching.

The panelist were:

Martha Villavicencio (Peru), Moderator;

Elisa Bonilla (Mexico);

Ubiratan D'Ambrosio (Brazil).

They expressed the need for teaching mathematics in connection with social and cultural environment. This should take into account the universalization of education. The ethnographic¹¹ focus in mathematics research can contribute elements for approaching the reality of the school and provide a distinct conception of schooling.

Panel B: Effective Teaching of Mathematics.

The panelists were:

Eduardo Luna (Dominican Republic), Moderator;

Sarah González (Dominican Republic), The Effective Teaching of Mathematics: A First Effective Step in the Dominican Republic;

Patricio Montero (Chile), Effective Teaching of Mathematics;

Eileen L. Poiani (USA), Effective Teaching of Mathematics.

The presentations of this panel highlighted the efforts made in various countries to try to achieve a more effective teaching of mathematics. Patricio Montero indicated that such effectiveness should be seen from two points of view. External effectiveness that has to do with the relevance of the learning as a function of society and the personal development of the student. Internal effectiveness is related to all the factors involved in the teaching/learning process.

Some of the aspects that were pointed out as important in improving the effectiveness of mathematics teaching were: coherent policies aimed at improving results and processes, evaluation of existing methodologies, carrying out studies on retention and follow-up, and development of new methodologies, teaching strategies, educational materials and evaluation instruments.

Panel C: Innovative Uses of Calculators and Computers in the Teaching of Mathematics.

Participants:

Fidel Oteiza (Chile), Moderator;

Elfride Wenzelburger (Mexico), Computers in Mathematics Education;

Leonel Morales (Guatemala), Mathematics - Computing - Education;

Francisco Quesada (Costa Rica), Some Considerations on the Informatics Education Program in Costa Rica;

Douglas Brumbaugh (USA), Using the Computer as a Tool for Teaching Mathematics.

There was consensus in the panel of the growing importance of considering calculators and computers as elements in the process of teaching and learning mathematics. One of the important ideas pointed out was that computing can permit the teaching of certain aspects of mathematics as if they were experimental sciences. This can be done by using processes of exploration, collection of data, posing and examining hypotheses, and the construction of concepts in a more efficient and motivating way. There were also comments on the panel of the possibilities that languages and software packages such Logo, Derive, MathCAD, Maple, etc. have in the teaching of mathematics.

Panel D: Curricular Change for the 21st Century.

Participants:

Carlos Vasco (Colombia), Moderator;

Celia Castiblanco (Colombia);

Carlos Mansilla (Argentina);

Alba Thompson (USA).

The discussion in this panel focused on possible changes in the curriculum of school mathematics. Basically the central idea was that a great change in topics to be covered is not necessary. Instead, what are needed are changes in the processes that are used to teach existing content. In that regard, Celia Castiblanco presented the theoretical framework of the new mathematics curriculum in Colombia, which is based on a "systems" focus for the contents. That is, it identifies the basic mathematical systems, what are its objects, what operations are applied to those objects, and the existing relations among them. It is proposed that first they work on conceptual understanding and then introduce the use of symbolization and formal definitions.

Alba Thompson declared the importance of learning to think in concrete situations and in the relations between the quantities involved in those relations. She proposed the use of what she called "quantitative reasoning" in teaching mathematics, that is, reasoning based on relations, reasoning more on the relations between quantities than on the quantities themselves. Thus, the curriculum should be organized based on the development of mental operations.

There were also four discussion groups:

Mathematics Laboratories in Secondary Schools, Doris Cetina and Ofelia Vizcaino (Mexico).

Problem Solving, Luis Dante (Mexico).

Audiovisual Technology in Mathematics, Javier Domínguez (Spain).

Teacher Education, Beatriz D'Ambrosio (Brazil).

There were also 48 short presentations given during the conference on a variety of topics related to mathematics and its teaching.

THE NINTH CONFERENCE

The *Ninth Conference* was held in Santiago, Chile, in 1995¹².

For this Conference the keynote addresses were given by:

Nicolas Balacheff (France), Distance Teaching of Mathematics, What Competencies Should We Teach?;

Ubiratan D'Ambrosio (Brazil), A New Mathematics Education for New Times;

Eduardo Luna (Dominican Republic), Technology and the Teaching of Mathematics: Some Experiences;

Claude Gauthier (Canada), Priority Matters in Research on the Learning and Teaching of Geometry;

Miguel de Guzmán (Spain), Visualization of Concepts and Methods of Mathematical Analysis.

The four panels were:

Panel 1: Political Tendencies and Focuses.

Participants on this panel:

Alvaro Poblete (Chile), Moderator;

Cristian Cox (Chile), Martha Villavicencio (Peru), Pedro Gómez (Colombia), Dan Fendel (USA), Freddy González (Venezuela).

Panel 2: Curriculum and Evaluation Standards.

Participants:

Hernán González (Chile), Moderator;

Thomas Romberg (USA), Richard Wolfe (Canada), Claude Gaulin (Canada).

Panel 3: Informatics and Mathematics Education.

Participants:

Patrick Scott (USA), Moderator;

Pedro Hepp (Chile), George Dawson (USA), Edward Jacobsen (USA), Fidel Oteiza (Chile).

Panel 4: Research and Mathematics Education.

Participants:

Ismenia Guzmán (Chile), Moderator.

Jeremy Kilpatrick (USA), Patricio Montero (Chile), Carlos Vasco (Colombia).

There were also 12 parallel sessions with 124 short presentations and discussion sessions on specific topics. In this *Conference* there was the complementary presentation of workshops and talks for primary and secondary teachers.

Notes

¹ *Educación Matemática en las Américas III*, p. 95.

² The data were taken from *Educación Matemática en las Américas III. Informe de la Tercera Conferencia Interamericana de Educación Matemática, Bahía Blanca, 1972, UNESCO, 1973.*

³ Data taken from *Educación en las Américas IV. Informe de la Cuarta Conferencia Interamericana de Educación Matemática, Caracas, 1975, published by UNESCO, 1976.*

⁴ The data given here were taken from *Educación Matemática en las Américas V. Informe de la Quinta Conferencia Interamericana de Educación Matemática, UNESCO, 1979.*

⁵ In this respect Santaló pointed out: "... the difficulties in teaching geometry at the secondary level, which have motivated its nearly complete elimination, stem from the idea that teaching has a linear structure, with bases impeccably grounded, from which everything is logically developed, with no possibility of deviating from the general approach that has been selected. The construction of geometry in this way can be very important and often is, from an academic point of view, but it is not very clear that it is equally important from the point of view of learning..." (*Educación Matemática en las Américas V*, p. 62.)

⁶ In reality, the constant development of computing at that time had already had effects on mathematical practice, more than on its teaching at the primary and secondary level. The use of computers presented an important rebirth of concrete mathematics. In this respect see Kuntzmann Jean, *Where Is Mathematics Going? Problems in Future Teaching and Research. Siglo XXI, 1978.*

⁷ The need to consider the importance of pedagogy in teaching mathematics was already present in many places. Jean Kuntzmann said in that respect: "The establishment in teaching of new ideas requires a long process of pedagogical "digestion" that only secondary teachers can bring

about. They are the only ones capable of carrying out the detailed adaptations that lead to a genuinely effective teaching." (op. cit., p. 63)

⁸ Data taken from the information bulletin of the *Sixth Interamerican Conference on Mathematics Education*, Guadalajara, 1985.

⁹ The information was taken from *Mathematics Education in the Americas VII. Actas de la Séptima Conferencia Interamericana de Educación Matemática*, Santo Domingo, 1987, published by UNESCO, 1990.

¹⁰ The data are taken from *Educación Matemática en las Américas VIII. Actas de la Octava Conferencia Interamericana de Educación Matemática*, Miami, 1991, published by UNESCO, 1992.

¹¹ A description of these matters can be found in a compilation of the works of Ubiratan D'Ambrosio entitled *Etnomatemáticas: Raíces Socio-Culturales da Arte ou Técnica de Explicar e Conhecer [Ethnomathematics: Sociocultural Roots of the Art or Technique of Explaining and Knowing]*, published in Campinas, 1987.

¹² Data taken from *Program of the Conference. IACME Information Bulletin (Year 3, No. 2, October, 1995)*.