CHAPTER FIVE

PERSPECTIVES

The analysis of the perspectives on the Interamerican Mathematics Education Conferences should be established in the broadest possible framework, as indeed such was their origin. It is necessary to return to what was the point of departure, the Modern Mathematics reform movement. It should be pointed out that in the latter half of the 70s the reform entered into a period of crisis. Funding for projects and institutes that had been created everywhere decreased considerably; and institutional support fell before a new perspective on the international situation of both education and the political world. But above all, what carried the most weight was the rejection by many of the social sectors that were involved: elementary and secondary teachers, parents, and - of course - the students themselves. The teachers complained that they had not received the training nor the instructions nor the instruments nor the materials nor the clarity of purpose to put the reform into practice. The parents balked because the reform impeded their action as they were unable to help in the "modern" preparation of their children. The students found that mathematics, which had always been difficult, appeared to them in such an abstract and incomprehensible way that it fomented a rejection. But, also, everyone felt that the new mathematics was confusing, weakening the basic preparation that had been provided by the traditional teaching of mathematics. Many of the voices that had been critical of the reform, such as those of René Thom[1] [2] and Morris Kline[3], who in those years were suffocated, have been rescued by a new group of thinkers in mathematics and mathematics education.

At the end of the 70s, in much of Europe a "back to the basics" movement was developed: in some places the counterreform forced even the abandonment of the name of mathematics and a return to that of arithmetic[4].

The groups of reformers changed their attitudes[5], the projects died or were transformed into other conditions[6], professional mathematicians returned to their universities, and a new atmosphere was created in mathematics education.

It can be said that something failed because, although it was something good and correct, there was a lack of practical capacity and maturity in the field and, therefore, it was unrealizable. But also something can fail because it is based on erroneous premises and because inappropriate objectives were proposed. With respect to the reform in Modern Mathematics we have the second situation. Let's see why:

First: it was appropriate to try to improve and modernize the teaching of mathematics, but this does not imply the introduction of the modern university mathematics into the contents of preuniversity mathematics[7]. In second place: it was inappropriate to presume the same curriculum for everyone assuming a continuation on to university; most people don't

go to the university and many less pursue scientific and technical careers. (Remember, as a very significant example of the intentions and aspirations of the mathematicians, proposed in the Cambridge Conference in the second half of 1963, was that students finishing high school would have a mathematics preparation equivalent to what was then three years of university study.)[8] In third place: it was inappropriate to think that mathematicians were qualified to determine the preuniversity mathematics curriculum simply because they were competent professional mathematicians; neither was it certain that they were endowed with the most appropriate educational philosophy and vision. But, also, in fourth place: both the Bourbaki ideology and the supposed philosophers from whom it gathered support, were and are of doubtful validity. One last point: it was thought, and many still think, that mathematics is more important than it is[9], it was thought that the role of mathematics in science and technology can be transmitted mechanically to education: something like if someone learns group theory, category theory and topological vector spaces, this in itself mechanically supports science, technology and national development. This is not true.[10] It isn't that way, first, because not all mathematics serves science (let's be honest: there is an almost infinite cloud of mathematical results and publications that only serves so that many mathematicians can justify their salaries) and, second, the contribution to science, and from there to technology and society, depends on a very dense and complex collection of theoretical and practical mediations. For the simple fact that something is mathematics or modern does not affirm that it is useful, intellectually formative or promotes the progress of humanity: we must be careful with that fallacy.

In the reform, then, there were erroneous premises, mistaken theoretical precepts, and inadequate objectives: it could not turn out to be a success[11].

The reform, however, brought about results that were very important for mathematics, and in, particular, for mathematics education of the present and future, whether by its very evolution in confronting reality[12] or in reacting to it.

One of the most important things that happened in those years was the development of an important mystique among Latin American mathematicians, who usually had been condemned to university ostracism. There was a social mission to carry out, and that was a stimulating element among professors. In various parts of Latin America, the flag of preuniversity modern mathematics reform served as leverage to give identity to the community of university mathematicians. The mathematicians saw themselves called to play a "protagonistic" role, there was an ideology that reaffirmed their value and role as professionals. Without a doubt, the reform served in many countries to develop communities of higher mathematics, independently of whether or not their ideas were mistaken.

It should be pointed out, in the same order of things, that through the various actions of the Reform it was possible to strengthen the ties of Latin American mathematicians and mathematics teachers to the international mathematics and scientific community.

On the other hand, the presence of university mathematicians in the plans for preuniversity educational reform was also positive because it contributed to exercising somewhat of a counterweight against what had been the dominant vision in a good part of the Americas: the overestimation of the didactic, psycho-pedagogical aspects and of curricular matters in educational practice. For decades there has been a strong influence of specialists in pedagogy with no direct contact with the disciplines that should be taught. Often the result was to the dramatic detriment of instruction of content and a debilitating of the quality of education. The teaching of mathematics is only possible if one knows mathematics and so it is with the teaching of other cognitive disciplines. A working knowledge of content is the starting point for mastering the pedagogy of that content. Pedagogy in the abstract, of universal application, is either trivial, or, even worse, can lead to grave errors. In the same way, it is not possible to make great contributions to the curriculum of a discipline if that discipline is not well understood. The specialist in curriculum at the margin of a discipline tends to generalities. The reform in modern mathematics, by emphasizing the relevancy of the contents of the discipline, even inadequate ones, contributed in some measure to counteract this inappropriate "pedagoguism" and "curriculism".

The most significant aspect of the history of the reform and of mathematics education in the last thirty years is the creation of a new profession, or, more exactly, of new professional specialists[13]: mathematics educators[14]. Mathematicians either were converted or have returned to mathematics research in their universities; thus many educational administrators that participated in the first years of the reform do not occupy the level of importance that they had previously. Let's explain our position. It is not that previously there were no mathematics educators (which is obvious). What we desire to underline is that, in the thirty years there has been a genuine professionalization of the teaching of mathematics[15], that has advanced unequally in the different latitudes[16]. The face of this discipline that used to be conceived of as lower level mathematics or as a kind of mixture of mathematics and didactic without complete articulation is continually progressing. Put in other terms: there has been an extraordinary advance in the construction of an authentic scientific community around mathematics education.

Another very important thing has happened, although linked to the above: the extraordinary development of fields of systematic research[17] not so much in political and curricular aspects as in theoretical and academic matters[18]. Now holistic or general or ideological research does not predominate, but essentially concrete and specific research, with which there is an attempt to obtain data and results that will serve the educator[19]. Thematic specialization, specific and applied pedagogy, that harmoniously and creatively integrate contents and their teaching-learning, are continually gaining ground.

There has been enormous progress, which can been seen in the agendas of the majority of the mathematics education congresses that are held throughout the world: problem solving[20], teaching of algebra, teaching of geometry, use of calculators and microcomputers in teaching, etc. It is possible to see the presentations and realize that the research has become concrete and specialized, with a more pragmatic purpose.

In another order of things and from a theoretical point of view: the new tendencies, in the 90s, that favor an integration of constructivism and socioculturalism in the teaching of mathematics perhaps can be seen, also, as a "reaction" against the ideology of the reform of previous decades. Above the particular aspects: a methodological and theoretical starting point is an understanding that mathematics education should be grounded in a cognitive sociocultural construction where the subject participates actively (and through confronting problem situations) and where, also, the teacher has an active role as the central conductor of a different and special educational experience.

These new realities define a new situation in the mathematics education of the present[21]. As was the case in the rest of the world, the reformers and their plans were modified in this direction, and in the Interamerican Conferences on Mathematics Education the same has happened[22]. The major lines of development in mathematics education have had an effect in Latin America. Professionalization has run a certain course and, also, as we have summarized, the main themes of international interest are present in the Conferences. And, reciprocally, certain key themes of current research, such as those relative to sociocultural influences in mathematics, have been developed precisely by professionals linked to IACME[23].

Finally, from the perspective of mathematical education of the current historical moment, we wish to point out two matters of much importance: the role of technology and the role of philosophy.

We should mention, to begin, that the use of microcomputers and special calculators in the teaching of mathematics has served as a lifesaver for many groups of ex-reformers and institutes after they lost their financial and institutional backing in the 70s. This needs to be said. But it is not bad. It has helped (or will help) to accelerate the transition towards the new mathematics education.

But that is not most important: but the historical sense of computing and informatics is. It is not a matter here to point out common places[24], but to extract practical conclusions. The development of informatics and of the technology of electronic computing has created a foundation for a substantial cognitive revolution throughout the planet. The new rhythms of processing, communication and ordering of information will substantially modify all of the processes that are linked to culture and education in the next decades. As mathematics educators we do not want to just "suffer it", but perhaps to direct it in our field of action. The theme has been included in the conferences of IACME for quite a while; what we wish to emphasize is not just its importance, but also its historical and epistemological sense.

Although it is an unequal and combined process in the different countries, it is important to understand its most profound significance. The teaching of mathematics is going to be modified substantially in the new era by the impact of new developments in the technology of calculators, computers, telematics, etc. In less than two decades, calculators, microcomputers, cd-roms, multimedia, the Internet will be resources available for almost

everyone. What will be the mathematics education of the new historic order? We must prepare ourselves now for these conditions. It will not be the same for all, but successfully riding this reality has become decisive, especially for countries such as those of Latin America where the force towards development requires special rhythms and much clarity.

What most research in mathematics education on specific and concrete matters should do is not reduce the importance of the study of global dimensions, of theoretical epistemological and philosophical foundations. On the contrary we will have a great constellation of results that will be isolated and disperse and sterile in the long run. The vision of the nature of mathematics is changing. There are many indication of this. Each day, more people question the model of an infallible, absolute mathematics, distant from empirical intuition and worldly reality, which has until now dominated the urbi et orbe. More and more there is room for a new paradigm[25] on the nature of mathematics, a paradigm that is at the same time empiricist[26] and constructivist, a paradigm that appeals to sensory intuition, a paradigm that integrates social and cultural influences, that appeals to the history of mathematics and science as the inspiration not only for anecdotes but to establish the intellectual logic that more properly sustains educational practice[27].

Without any doubt, in the new historical context Mathematics Education is called to occupy a very important place, given that mathematical preparation at all levels constitutes an essential instrument for scientific and technological development. The ideas, projects, institutions that are created in an attempt to strengthen those disciplines are going to be, then, very relevant for the progress of the American nations.

In particular, for Latin America these years are decisive, and, despite whatever bad omens there may be, there is still much room for optimism. The reform left deep tracks in our territory, some good and others not, but a new firmament of open possibility exists. At least from the 80s we have seen a radical transformation of worldwide culture and knowledge. Without a doubt, the progress that has been made in mathematics, natural and social science, education, philosophy and, in the same way, the powerful technological progress, especially in the world of telecommunications and information processing, point to new horizons. Social and political changes also point in the same direction. The Interamerican Conferences on Mathematics Education have been for more than thirty years an extraordinary medium for strengthening mathematics education throughout the region, not only by sharing experiences and stimulating dreams, but also by establishing links with international communities concerned with mathematics and its teaching. The significant national and international participation that was achieved in the last Conference, in Santiago, as well as the high quality of the meeting, are a sample of the expectations and, at the same time, responsabilities of the IACME in the new historical order. With our eyes in the new millennium without a doubt the IACME can be a first class instrument in Mathematics Education. The valuable possibilities that the Conferences have opened in knowledge and in the international social world should continue to be vigorous realities that contribute to knowledge and education, and that promote progress and the quality of life in the region.

Notes

[1] His most famous criticism was expressed in the well-known article "Modern Mathematics: Does It Exist?".

[2] René Thom pointed out the following: "It is certain that within current mathematics, the use of algebra method of proof is without a doubt important, even decisive. But it would be reasonable to ask if the needs of professional mathematicians should be taken into account in the moment that we consider secondary teaching. Mathematicians of the current generation, impregnated with the bourbakian spirit, have a completely natural tendency to introduce into secondary and university teaching the algebraic theories and structures that have been so useful in their own work, tendencies which have been triumphant in the spirit of the mathematics of their time. But it is necessary to ask if, at least in secondary education, it is convenient to incorporate the latest findings of the technique of the moment... Is modern mathematics a pedagogical and philosophical error?" in the book by Piaget, et al, *Teaching of Modern Mathematics*, Madrid: Alianza, 1980, pp. 117-118.

[3] Cf. Kline, Morris, *Why Johnny Can't Add. The Failure of New Maths*, London: St. James Press, 1973.

[4] In Germany it is possible to contrast the attitude toward the reform between the Kulturministerkonferenz of 1968 and that of the 3rd of December in 1976. In 1976 the word arithmetic was reestablished as a symbol of the new times.

[5] Some early doubts with the reform were put forward by enthusiastic leaders fairly early on: see for example Begle himself in "The Role of Research in the Improvement of Mathematics Education", *Educational Studies in Mathematics*, p. 238, 1969. Begle recognized here that a theoretical foundation for mathematics education did not exist; and even - with extraordinary vision - proposed from then "careful empirical research".

[6] In France the Institutes des Recherche des Matematique (IREM) had been created regionally with the spirit of 68; they were influenced by the reform until 1975. Later they were directed to other things, among them informatics. See Moon, Op. cit. p.104-105, 118.

[7] The theme of the reform of contents versus reform of methods in the modernization can be studied in the article by W. Servais, "Continental Tradition and Reform", in the *International Journal of Mathematics Education, Science and Technology*, 6, 1, pp. 37-58, 1975.

[8] See Fehr, et.al., Op. cit. p.8.

[9] This "chauvinistic" overestimation of mathematics can be seen in the answer that Dieudonné gave in the *American Scientist in January-February*, 1973, to an article by R. Thom.

[10] See an interesting article by Morris Kline on mathematical research: "The Nature of Current Mathematical Research", in the three volume book edited by Douglas Campbell and John C. Higgins: *Mathematics, People, Problems, Results, Belmont, California: Brigham Young University*, 1984 (volume three).

[11] One of the harshest judgements was that of Morris Kline:

[12] In fact, in the second half of the seventies possibilities of financing the reform were restricted or eliminated.

[13] In all these countries from a small, almost amateurish, group of educators in mathematics there arose a professional class that could be appreciated in full abundance in the 1980 ICME in Berkeley, California.

[14] Cfr. Moon, Op. cit. p.68.

[15] A recognition of the new discipline can be seen for example in Mathews, G. and Brown, M. "Summary of European Seminar", *International Journal of Mathematics Education, Science and Technology*, 6, 1, pp. 77-79, 1975.

[16] The mere fact that this legion of professionals exists is good; but it should be said that it is not enough. This is so above all because the preparation they receive is overloaded with rationalism and formalism. It is necessary to recycle all this personnel along different lines that emphasize heuristics,

construction, sensory intuition, the fallibility of mathematics, graphical and aesthetic methods, the relationship with the sciences, etc.

17 An interesting issue of the *Journal for Research in Mathematics Education* that deals with the role of research is number 5 of volume 17 from November of 1986. It contains, among others, the articles of Jere Brophy*: "Teaching and Learning Mathematics: Where Research Should Be Going", and "Where Are the Data?: A Reply to Confrey";* and from Jere Confrey*: "A Critique of Teacher Effectiveness Research in Mathematics Education".*

18 It can be confirmed that research gained force in the 70s by doing a comparative study of the work presented in the ICME of Lyon in 1969 and the ICME in Exeter in 1972. See Moon, Op. cit., p. 59.

19 In research institutes and in departments of mathematics education, research has detached itself from the reformist motivation of the 70s; see the report of the Karlruhe Conference in the UNESCO report of 1979.

20 This is very special research; a well-known expert in this field is Alan Schoenfeld, see for example "Measures of Problem-Solving Performance and of Problem-Solving Instruction", in the *Journal for Research in Mathematics Education,* January 1982, 13, 1, pp. 321-49. More of his work can be seen in his book *Mathematical Problem Solving.*

21 Some affirm that the zenith of the reform was the meeting in Lyon, ICME of 1969, and that the beginning of the new era was in Exeter, ICME of 1972.

22 The process of professionalization of mathematics education in Latin America still has a long road to travel; much in the same way that research still requires significant impulse, and that is a key, yet difficult, matter to realize given the weakness of the systems of science and technology and of higher education.

23 But, besides, this double process of professionalization and research in mathematics education can be seen as well apart from the IACME. For example, there have already been eight *Central American and Caribbean Meetings of Teachers and Researchers in Educational Mathematics;* and in August of 1994 there was great success with the *Second Iberoamerican Congress of Mathematics Education* in Blumenau, Brazil.

24 A somewhat descriptive but good study on the use of microcomputers in the teaching of school mathematics is that of Paul Ernst "The Role of Microcomputers in Primary Mathematics", in the book edited by the same author: *Mathematics Teaching: The State of the Art,* London: The Falmer Press, 1989, pp. 14-27.

25 To consult a synthesis of a modern philosophy of mathematics, of a philosophy of mathematics education, and that also suggests a social constructivism with Popperian influence, see the excellent book by Paul Ernst, *The Philosophy of Mathematics Education,* London; The Falmer Press, 1991.

26 A profound reflection on the philosophy of mathematics that suggest a new philosophy can be seen in the book by Philip Kitcher, *The Nature of Mathematical Knowledge,* New York: Oxford University Press, 1983.

27 A vision of the problems of the philosophy of mathematics that suggests a new philosophy can be seen in the book by Angel Ruiz *Mathematics and Philosophy,* San José, Costa Rica: Editorial de la Universidad de Costa Rica, 1990.