**Modern Mathematics in Brazil: the promise of efficient and democratic teaching**

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The modern mathematics movement, originated in Europe and in the United States, reverberated in Brazil, more than in any other Latin American country. Among the impacts of modern mathematics in Brazil, several study groups dedicated to the teaching of mathematics were established, systematic courses for teachers were given for 15 years, didactic books were reformulated, and new topics were included in the curricular programs of primary and, particularly, of secondary schools.

As in other Latin American countries, modern mathematics movement in Brazil underwent American and European influence. Invitations to Brazilian teachers to participate in teachers education programmes and the spread of new textbooks were some of the main forms this influence was exerted. However, external pressure can't explain the intenseness and wideness of the engagement of Brazilian teachers in school mathematics reform. In order to understand the extension of this movement in Brazil, we have to consider elements of the Brazilian urban reality in the 1960s as well as the local interpretations and appropriations of the curricular proposals built in central countries.

**Secondary education in the beginning of the 1960s**

Since the 1930s, Brazil underwent an intensive industrialization process, oriented for the domestic market, unparallel in Latin America (Fonseca, 1987). During the second half of the 1950s, this process was accelerated: industrial increase grew at an average of 11% annually, strengthening the so-called "key industries" – iron and steel, transport, and energy, among other –, the production of capital goods, and the local automobile industry was established (Nunes and Xausa, 1987).

Urban growth was also intense during this period: between 1940 and 1960, urban population increased from 31% to 45% of the total Brazilian population (IBGE, 2007). The diversification of jobs, and the increase in the contingent of urban workers and of the so-called "intermediate sectors" increased the demand for secondary education [2].

Until the 1930s, secondary education had a weak structure, and was offered by a few institutions, consisting mostly of isolated, non-serial courses, which were preparatory for

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[2] In the mentioned period, primary education lasted four to five years, and secondary education was organized in two cycles: the first cycle, so-called "ginásio", with four years, and the second cycle, so-called "colegial", with three years.

higher education. In the beginning of the 1960s, it still included only an elite: secondary education students corresponded to approximately 8% of the population between 12 and 18 years of age (Gouveia and Havighurst, 1969). The access to secondary school was regulated by an "admission exam", in which the mathematics test played a selective role.

Despite being provided only to few, secondary education was, however, the aspiration of increasingly larger urban sectors. Between 1933 and 1958, the number of students enrolled in the first cycle of secondary education increased more than ten times, from approximately 65,000 to 659,000 (IBGE, 2007), and would continue to grow in the 1960s.

São Paulo, the largest Brazilian urban and industrial center, concentrated a large part of this expansion. The number of first cycle secondary schools (ginásios) grew from three in 1940 to sixty five in 1958 (Bontempi Jr., 2006). The participation of public education in student admission, in São Paulo, was also higher than the national average (IBGE, 2007).

This expansion entailed deep changes in the structure of secondary education.

First of all, there was a significant demand for teachers. When the Higher Schools of Philosophy (Faculdades de Filosofia) were created since the 1930s, the title of licensed teacher was established as a reference of teaching training and practice in secondary education (Valente, 2005). In 1960, however, "lay" teachers were still predominant, to which the possibility of making their position official through training courses and a "sufficiency exam" was offered.

Didactic book production followed the growth in secondary education. Teacher training courses, offered by joint initiatives of the department of education of the state government and by publishing companies throughout the state, were efficient mechanisms to disseminate these books.

At institutional level, the traditional secondary school Colégio Pedro II, established in 1837, was still a reference for secondary education in Brazil. Ordinances 966 and 1.045 of 1951 by the Ministry of Education and Health determined the programs and methodology instructions adopted by that school as mandatory.

However, teaching standardization based on Colégio Pedro II was challenged by a wider group of licensed teachers sought towards professional identification and acknowledgement. This was one of the catalysts of the first National Mathematics Teaching Congresses, held in 1955 and 1957, organized by the Schools of Philosophy of the Federal Universities of Bahia and Rio Grande do Sul, respectively.

In the 1950s, experiences of pedagogical innovation in secondary education were also articulated. Most of them, such as the experimental lessons and Application Schools of Higher

Schools of Philosophy, focused on methodological innovations, seeking more intensive student participation, and reflecting the influences of escolanovismo [3]. In the Ginásios Vocacionais [4], established in São Paulo since 1962, concerns with the social reality and a general sense of overcoming an exclusively propedeutic focus were present. The teaching of mathematics was also subject of innovation experiences, with the adoption of new materials and approaches, many of which were reported in Education Congresses.

**Modern mathematics movement in São Paulo**

The modern mathematics movement emerges in this context – not as an effect of aspirations, discussions, and experiences of secondary education, but finding a favorable environment for the dissemination of renovation proposals. The teaching of mathematics was already a matter of debate among secondary and university teachers that saw themselves as responsible for improving programmes, teaching methods and students' learning. Governmental concerns towards "lay" teachers education helped to extend the reach of that debate, enlarging its audience.

The creation of the Grupo de Estudos em Ensino de Matemática (Study Group on Mathematics Teaching – GEEM), in São Paulo, in 1961, is one of the landmarks of the modernization movement. The Group derived from a teacher-training course, which was organized similarly as a seminar offered at that time by Kansas University and attended by Osvaldo Sangiorgi, an already sucessful author of didactic books. The course included the topics Set Theory, Linear Algebra, Mathematical Logics, and "modern mathematics practices".

The structure of the course itself already suggested, in this first local initiative, the reproduction of two elements that guided the modern mathematics movement in central countries: the sense of adapting school mathematics to university mathematics, with the adoption of new topics and consideration of language accuracy; the unification of mathematics through sets and algebraic structures.

Nevertheless, the dissemination of these modernization proposals also emphasized education demands frustrated by the lack of places at public secondary schools and by disapproval in the admission test. Modern mathematics, in the GEEM discourse, didn't focus on the preparation of an educational elite, as it was the case in United States and in European

[3] Educational movement that emerged in the 1920s in Brazil, concerned with the democratization of the access to education, and supporting active models, influenced by the ideas of John Dewey.

[4] Experimental secondary schools, not vocational as the name could suggest.

countries (D'Ambrosio, 1987). GEEM discourse promised overcoming an elitist and inefficient education, promoting interest, inquisitiveness, and learning. One of the main pillars of the promise of a more efficient education was the correspondence appointed by Piaget (1955) between intelligence structures and "mother structures" of the mathematical building designed by the group of Bourbaki. The representation of the child's thought should coincide with the formal language adopted by higher mathematics.

GEEM also revealed escolanovismo influences to oppose concept understanding to algorithm mechanization. A widely used example was the maximum common divisor of two numbers, in which the understanding the "common divisor" as a result of an intersection of two sets replaced the blind application of the traditional method of Euclid. The formalist bias present in the definition of fraction as "an ordered pair of natural numbers, the second not being zero" (Sangiorgi, 1971, p. 208) coexisted with overt concerns towards intuition and familiar contexts: a "special clock" with which real numbers could be produced, having one pointer and ten marks corresponding to the digits (Sangiorgi, 1967); a film showing an emptying recipient, presented backwards in order to illustrate the multiplication of two negative numbers (Babá, 1965).

The intended purpose of a more advanced, more correct, and, at the same time, more accessible mathematics was supported by the composition of the Group. On the one hand, GEEM involved the participation of mathematicians[5], who bestowed modern mathematics with the academic authority of the acknowledged University of São Paulo. Their adherence to the movement may be partially ascribed to the French influence, particularly to the structuralist aspect present in the origins of the Higher School of Philosophy. Connections between correctness and effectiveness of mathematics teaching were already elements of the academic culture that prevailed among mathematicians and that was seen as distinctive face to engineers education.

On the other hand, licensed secondary teachers, engaged in innovative experiences, such as those of the Application School and Vocational School of Brooklin[6], also participated in GEEM. The "demonstration lessons" given in all teacher training courses showed the concern in certifying the feasibility of the innovation proposals, and to "translate" higher mathematics concepts into school mathematics language. In its first years, GEEM promoted weekly

[5] Two of them were Alesio de Caroli, Vice-President of GEEM, and Benedito Castrucci, President of the Consulting Board of GEEM.

[6] Lucilia Bechara was one of GEEM leaders and taught mathematics at Vocational School of Brooklin. In the Fifth Brazilian Mathematics Teaching Congress, in 1966, Lucilia Bechara and Elza Babá Akama reported an experience on geometry teaching implemented at that School.

meetings on Saturdays, when teachers would come, report and debate their classroom experiences. So, if on the one hand, it is true that "reform was definitely not done systematically and rarely was formal evaluation conducted" (D'Ambrosio, 1987, p. 196), it must be acknowledged that GEEM animated educational debate among teachers and stimulated participation in educational changes as a kind of militant action.

D'Ambrosio (1987) points the multiplicity of authors and projects that influenced GEEM's discourse as resulting in eclectic and inconsistent curricular proposals. The main influence can be ascribed to School Mathematical Study Group (SMSG)[7], but mathematicians and educators like George Springer, Marshall Stone, Lucienne Félix, George Papy, Zoltan Dienes and Caleb Cattegno also gave lectures in seminars sponsored by GEEM. In a more optimistic approach, such eclecticism can be interpretated as an openess towards different views that prevented GEEM to be taken as merely adherent to this or that European or American group.

The leadership of Prof. Osvaldo Sangiorgi favored the access to the press and the support of government agencies. But the appeal of GEEM discourse was partly due to its existence as a teachers' group, autonomous in the face of governments. It was no longer the case of school programs written by a few specialists and being imposed to all. The introduction of elements of modern mathematics in the official curriculum was preceded by many debates, including the unanimous approval of a new secondary school program at the IV Brazilian Mathematics Teaching Congress, that happened in 1962, in Belém do Pará.

New textbooks disseminated changes in programme and in the adopted language, pressing teachers to change their school practices. Inservice courses were offered with Department of Education support, gathering tens and hundreds of secondary and primary teachers. Teachers were expected to study mathematics, mainly algebraic structures, in order to be able to improve classroom teaching. During the V Brazilian Mathematics Teaching Congress, that happened in 1966, in São José dos Campos, many courses were offered, dealing with topics such as Set Theory, Modern Algebra, Mathematical Logics, Analytical Geometry.

**Regional dynamics of the modern mathematics movement**

GEEM was the first, but not the only group organized in Brazil in the 1960s with the purpose of promoting change in the teaching of mathematics. NEDEM (Study and Diffusion Group on Mathematics Teaching) was created in Curitiba in 1962. GEEMPA (Study Group

[7] SMSG was founded at Yale University in 1958, according to D'Ambrosio (1987).

on Mathematics Teaching of Porto Alegre) was created in 1970 in Porto Alegre, bringing together teachers who had been already engaged in teaching reform. In Salvador, CECIBA (Science Studies Center of Bahia) was an organ that promoted courses and debates around modern mathematics issues (Duarte, 1997). In Niterói, Arago Backx led experiences of renewal of the teaching of mathematics in an important public school [8], under the influence of the project developed by George and Frédérique Papy in Belgium (Soares, 2001).

The path followed by each of these groups had its own peculiar dynamics, which was only partially influenced by GEEM. GEEMPA took part in an international project of research directed by Zoltan Dienes. The Group's concerns concentrated on primary school and methodological issues. The experiences in Niterói, carried out under the influence of Papy, took the form of craftwork and meticulous change while GEEM promoted massive campaigns.

However, modern mathematics dynamics in São Paulo can be still considered the most decisive as it was responsible for changes in most widespread textbooks and for disseminating the idea of a necessary and urging reform in the teaching of mathematics. Modern math imposed itself as an over-all and claimed to be consistent alternative of innovation in the face of local experiences that proposed small changes in the programs or novelties in the teaching of particular subjects. Among primary and secondary teachers, the presence and the authority ascribed to licensed teachers, who were up-to-date with formal language and had studied algebraic structures, favored the acceptance of adapting school mathematics to university mathematics.

**Modern mathematics in a country that wished to be modern**

Modern mathematics mobilized thousands of teachers, promoted changes in didactic programs and books, was frequently present in the front-page of newspapers in the 1960s (Soares, 2005). It would not have achieved this standing if were not by the militant action of groups such as GEEM, which locally appropriated propositions for the renovation of the teaching of mathematics (Búrigo, 1989; 1990).

But the reach of a movement that promised the "modernization" of teaching, and that identified modernization with democratization, must be also understood within a context of optimism and belief in the benefits of technical progress. Such was Brazil in the early 1960s: a society bearing significant social conflicts but that saw itself as a "developing" nation. The

[8] The experience was developed since 1970 in the Centro Educacional (Educational Center) of Niterói. Papy's influence was already present in an experience developed in the traditional Colégio São Bento, in Rio de Janeiro.

debate between a "nationalist" and popular direction and one of development "associated" to foreign capital was terminated in 1964, with the establishment of a military dictatorship that would last 20 years. However, the optimism was extinguished much later – in the 1960s, the dominant image in the country was still of a "developing" nation, capable of producing steel and cars, of generating jobs and training specialists. In a country where fundamental rights have been limited or even suppressed, the opportunities for consumption, specially amongst urban middle layers, were even increased up to middle 70s.

Following the path of United States and other European countries, in the 1960s the Ministry of Education and departments of education of state governments supported projects that intended to improve mathematics and science teaching. Such initiatives can be understood, partly, as attempts to overcome a literary and humanist tradition that still prevailed at secondary schools and, partly, as components of an effort towards the scientific education of future technicians in a country that underwent an industrialization process. The modern mathematics movement could claim for official support as, on the one hand, it promised a more "scientific" education and relied on external endorsement and, on the other hand, didn't establish links with pedagogical movements that overtly contested the regime.

Modern math achieved high levels of publicity, what is uncommon when one thinks about other curricular reforms. The wideness of its audience can be partly due to the fetish school mathematics was invested with, but was also related to the enthusiasm towards modernization that permeated national beliefs and minds. Locally manufactured cars were modern, the architecture of the new capital [9], inaugurated in 1960, was modern, Brazilian rock was modern. The teaching of mathematics had to be modern, such as Brazil wanted and expected to be.

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[9] The city of Brasília, its main monuments and governamental buildings were designed by the modernist architects Lucio Costa e Oscar Niemeyer.

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