CANP National Report Series #2

Initial and Continuous Mathematics Teacher Preparation in Colombia, Costa Rica, the Dominican Republic and Venezuela

Report on the Initial and Continuing Preparation in Central America and the Caribbean. CANP Project, Costa Rica.

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Forward

From August 6 to 17, 2012, the *International Workshop on Building Capacity in Mathematics and Mathematics Education* was held in San José, Costa Rica. This event was the second of the Capacity and Networking Project (CANP) of the *International Commission on Mathematical Instruction* (ICMI); the first having been held in Mali in 2011. CANP 2012 brought together for two weeks a group of 66 Mathematics educators, mathematicians, university administrators, and elementary and secondary institutions from Colombia, Venezuela, the Dominican Republic, Panamá and Costa Rica.

Sponsored by ICMI, CANP 2012 was also supported by the *International Mathematical Union* (IMU) and the *International Council for Science* (ICSU). It was organized by persons associated with the Mathematics Education Reform Project in Costa Rica and the Inter-American Committee on Mathematics Education (IACME).

The goal of CANP was to promote progress in Mathematics Education in the region; as such it was a unique experience in the region. One of the most important results of this event was the creation of the *Network for Mathematics Education in Central America and the Caribbean* (REDUMATE - www.redumate.org).

During the event national reports were presented on the situation with respect to initial and continuing preparation of Mathematics teachers, an important reference in undertaking common development activities on the Teaching and Learning of Mathematics in the region. Subsequently the formal written reports were completed by authors in Colombia, Venezuela, the Dominican Republic and Costa Rica. They were published in Spanish in a special edition of the journal *Notes on Research and Preparation in Mathematics Education (Cuadernos de Investigación y Formación en Educación Matemática* - http://revistas.ucr.ac.cr/index.php/cifem/issue/view/1281).

This document is a summary of the works published in the *Cuadernos*. It is an excellent synthesis of the initial and continuing preparation for Mathematics Teaching in the four countries, from which comparative analyses can be made that show similarities and differences, and highlight various perspectives.

I want to express my gratitude to all the authors from the various countries that have provided these valuable materials.

This edition and the formatting of this document has been my responsibility.

The preparation and publication of this document constitutes a significant collective action that will strengthen the goals of the new *Network for Mathematics Education in Central America and the Caribbean*, and will help to strengthen the collaboration between teachers and researchers in the educational communities in our region.

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Colombia: Mathematics Education and the Preparation of Teachers. Consolidating a Professional and Scientific Field

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Summary

In this document[1] a succinct panorama of some of the background, structure, development and limitations of the initial and continuing preparation of Mathematics teachers in Colombia is presented. Particularly, some aspects of the political, social and, in some cases, academic transformations that have affected Mathematics teacher preparation will be mentioned. Also, the current tendencies in initial and graduate preparation will be considered. Finally, we will indicate some achievements and current challenges facing research in Mathematics Education and teacher preparation that are facilitating a consolidation of this discipline as a professional and scientific field in the country.

Keywords

Mathematics Teacher Preparation, Research in Mathematics Education, Mathematics Teacher Education, Colombia.

[1] This document is based on the article: Guacaneme, E., A., Obando, G., Garzón, D. y Villa, J. (2013). Informe sobre la Formación inicial y continua de Profesores de Matemáticas: El caso de Colombia. *Cuadernos de Investigación y Formación en Educación Matemática*, 8 (número especial), 11–49, available at http://revistas.ucr.ac.cr/index.php/cifem/issue/view/1281. This article is a final version of a report presented to the *Workshop on Building Capacity in Mathematics and Mathematics Education,* CANP 2, held in San José, Costa Rica, in August of 2012. This work is part of the Network for Mathematics Education in Central America and the Caribbean: www.redumate.org.

The Education System in Colombia and School Mathematics

It is natural to assume that the education of teachers in a country should be aligned with its education system. Therefore we are obliged to begin with a consideration of that assertion. It is equally natural that the preparation of Mathematics teachers should be aligned with the nature and specificity of school Mathematics. Therefore, other themes that we treat below are justified.

1.1 Features of the Education System in Colombia

Before the end of the last Century the enactment of the Constitution of 1991 changed the political and social dynamics of the Nation. Education was declared a social and cultural right, obligatory and free from pre-school through grade 9. Liberty in developing curricular approaches matched to the needs of their communities was proclaimed for the educational institutions serving those communities.

To develop what had been established in the Constitution, in 1992 Law 30 was enacted to regulate higher education and Law 115 (known as the General Law of Education) in 1994 to regulate elementary and secondary education. Law 115 restricts the functions of the National Ministry of Education (MEN) to formulating national curricular programs and grants it an orientation role with respect to public policy in education. Thusly, every educational institution in the country acquired the right to define its own curriculum which must be articulated with general guidelines formulated by the MEN as part of public education policy. Among the documents that regulate such policies with respect to school Mathematics are "Curricular Guidelines in the Area of School Mathematics" (Colombia, 1998) and "Basic Competency Standards in Mathematics" (Colombia, 2006).

The cited Laws establish, among other conditions, that education be organized by school levels and schooling cycles as is shown in Table 1.

Table 1

Organization by Cycles and Levels in the Colombian Education System

Level	Schooling Cycle		Age of the Students	Years of Schooling
Preschool Education	Preschool		Between 3 and 6 years	Up to 3 grades
Basic Education	Elementary		Between 7 and 11 years	1st to 5th grades
	Lower Secondary		Between 12 and 15 years	6th to 9th grades
Upper Secondary	Academic		Between 16 and 17 years	10th and 11th grades
	Technical			
Higher Education	Technological			3 years
	Professional			5 years
	Graduate	Specialization		Up to 2 years
		Master's		Up to 3 years
		Doctorate		Up to 5 years

Basic Education (Elementary and Secondary) is offered to almost all children, but there is a high dropout rate. There is both public and private Basic Education. The population from lower socio-economic levels usually attends public schools while private schools are attended by students from higher socio-economic levels. In general, the standard of quality is much higher in private education as compared to public.

Higher Education also has both public and private (not for profit) providers. Graduate education is not publicly financed, therefore students of Specializations, Master's and Doctorates pay tuition to fund such programs. The technical education cycle is considered non-formal education, and is oriented to developing a series of workplace competencies for specific crafts and trades, and does not require that students have completed academic Upper Secondary Education. It is offered by both public and private organizations and is not considered to be Higher Education.

1.2 Mathematics in the School Curriculum

The First Inter-American Conference on Mathematics Education (Bogotá, December 4-9, 1961) was a milestone in the introduction of modern Mathematics in Colombia. This movement declined in Colombia by the end of the 1970s, in part, for reasons associated with the educational model that it implied (e.g. behaviorism, management of the curriculum, production of educational materials, teacher preparation), and in part for difficulties with the abstract nature of the Mathematics itself as the basis for curricular reform (e.g. set theory, structure and modern algebra). With this decline, space was opened for a new reform that can be understood as the Colombian response to what is commonly referred to as the "Back to Basics Movement". This reform was supported by arguments taken from Piagetian theory and arguments against set theory as the curricular referent for school Mathematics. Instead, arguments supporting system theory[2] as the most appropriate curricular referent. Therefore, a solid psychological theory was used to explain the pedagogical processes that take place in the classroom. As a result of this reform, in the second half of the 1980s, the MEN promoted a new optional approach, that the Mathematics curriculum could be organized in relation to five mathematical systems (numerical systems, geometrical systems, measurement systems, data systems and logic systems), to which were added two topics (sets, and relations and functions). For each of those, details about contents, sequence, level of depth, interrelations and development of the focus were developed.

When the implementation of this approach had been in effect for only a few years, the country underwent a substantial change with the introduction of a new Constitution, which naturally affected the vision and implementation of education. In the development of this new political charter, laws[3] were established that defined the bases for educational transformation. One of the transformations implied the definition and adoption of Curricular Guidelines for Mathematics (Colombia, 1998) that more than programs of study, constitute road maps that, respecting the cultural diversity consecrated in the Constitution, orient the efforts of educational institutions.

The Guidelines did incorporate some aspects of the previous reforms while proposing new theoretical and methodological elements in an attempt to update the curricular structure of school Mathematics. Among the elements are three that stand out. First, is the introduction of the different types of mathematical thinking[4] (numerical, spatial, measurement, variational, and random). Second, is the contexts in which school Mathematics should be developed (mathematical, daily life and from other sciences). Finally, there is the insistence on the importance of the development of processes (solving and posing of problems, reasoning, communication, modeling, and the elaboration, comparison and practice of procedures). Together these permit the learning of Mathematics in contexts significant to students, using problem situations as the central axis for said contextualization.

Among the theoretical elements and methodologies of the Guidelines is the call for interdisciplinarity. This is not only from the perspective of teacher preparation, but in classroom practice given that in this document elements of teacher professional knowledge and ways that teachers work in the classroom are discussed. At one point in the document the MEN points out that "… the future teacher should receive a preparation intrinsically interdisciplinary that is distinct from what has happened in the past [that is], a conglomeration of courses that students must add up at their own risk" (Colombia, 1998, p. 124). And a Calculus course, for example, is added which should include its history, its epistemology, and its teaching from a modern sense of how it should be the result of inquiry in interdisciplinary and even inter-institutional work groups.

Parallel with what is reported above, in the last twenty years the Colombian education system has had an ongoing series of discussions, shaped by educational policies, on the development of basic competencies[5] (focused primarily on competencies in Mathematics , Spanish language, and Natural and Social Sciences), (general and specific) workplace competencies[6], and citizenship competencies,[7] These competencies seek to create an equilibrium between a solid academic preparation, and preparation for work and citizenship.

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[2] To provide language to unify the different branches of Mathematics and other sciences, the concept of "system" was proposed as the basis for organizing the curricular processes in Elementary and Secondary Education, emphasizing that the approach to any mathematical system should include at least three components: the concrete, the symbolic and the abstract. For details see Vasco (1994).

[3] Law of Higher Education or Law 30 in1992, and the General Law of Education or Law 115 in 1994.

[4] For a detailed synthesis see Obando (2004).

[5] Basic competencies seek to generate conceptual constructions and the capacity to utilize scientific and humanistic knowledge in processing, interpreting and solving problems related to the surroundings, school environment, and science and technology.

[6] Workplace competencies are oriented to the development of a set of knowledge and techniques that prepare the individual to be a productive member of society. The general competencies are cross-cutting and transferable to any context in which they are present in any academic or

In this competencies development framework, specifically for the case of education in Mathematics, early in the new century a document was published with basic competency Standards for Mathematics (Colombia, 2006). In that document the concept of competency was presented broadly "as a set of socio-affective and psychomotor understandings, abilities, attitudes, knowledge and cognitive dispositions appropriately related among themselves to facilitate a flexible, effective and sensible performance when faced with new and challenging activities". In this sense, more than speaking of "mathematical competence", the idea of "mathematically competent" was proposed. Those responsible for the education system were invited to see Mathematics as a human activity inserted into, and the result of, cultural processes characteristic of the time and place. They were also invited to view Mathematics as the result of successive processes of reorganization of the practices of people in relation to the quality of their lives.

The term competency promulgated in the Standards document highlighted other dimensions associated with school Mathematics. In that sense, Valero (2006) points out that:

The adoption in Colombia of the language of mathematical competence emphasizes dimensions of Mathematics Education that had not necessarily been so explicit in the past. As Vasco (2005) noted, matters of quality and equity, of the social and cultural value of Mathematics, and its contribution to the development of citizens and the consolidation of democracy in the country are dimensions now being highlighted. (p. 1)

Thus, the Standards (Colombia, 2006) call for mathematical development to not consume itself with disciplinary contents, but instead that the school should be rehabilitated to offer an ideal mathematical development in the development of the citizen: A citizen is formed when Mathematics is learned. The notion of a mathematically competent citizen works on the least pragmatistic dimensions in relation to the notion of competency (knowing what to do in a given context). This is done in pursuit of a more holistic perspective, where the focus is the understanding of Mathematics on the part of the individual. Hence, there is the development of a set of abilities, capacities, conceptualizations, forms of action, etc., that permit in-formed (formed from within) decision making with Mathematics and from Mathematics.

2 The Preparation of Mathematics Teachers in Colombia's Historical Context

2.1 The Initial Preparation of Mathematics Teachers

The design and functioning of Mathematics teacher preparation programs is a "Constitutional Right". In Colombia it is oriented by national regulations and interpreted by the Higher Education institutions in which such programs are developed under State supervision (Guacaneme, Bautista & Salazar, 2011). Despite this legal condition, reality and tradition on occasion define a *de facto* policy that supersedes the "*legal policy*". It is precisely this condition that leads to the vision of the initial preparation of Mathematics teachers for lower and upper secondary education and for general teachers for elementary education that will be presented below. Later, additional considerations on initial preparation of Mathematics teachers will be presented.

2.1.1 Teacher Preparation for Lower and Upper Secondary Education

In the development of the current Constitution, enacted in 1991, laws[8] were established that define the bases for the transformation of initial and continuing teacher education. Thus, for example, these laws, their decrees and resolutions: delegate the academic and professional preparation of teachers to the universities and professional institutions of Higher Education, give the name "licentiate" to graduates of an undergraduate in education who work professionally as teachers, define a Register of Teachers used to rank teachers according to their academic and professional trajectory, require that educator preparation programs should fulfill quality accreditation processes, and establish Mathematics as one of the nine required and fundamental areas of General and Upper Secondary Education.

workplace activity. On the other hand, specific workplace competencies refer to particular contexts related to activities characteristic of a group of professions.

[7] Citizenship competencies refer to the development in the individual of a set of values, actions and behaviors needed by society, a critical and reflexive nature in facing situations that present themselves in the ongoing practice of citizenship, and an active participation in the life of the community.

[8] Law 30 in1992, Law 115 in 1994 and Law 1188 in 2008 (also known as the registration of qualified Higher Education programs).

It is precisely a look at the regulations of the last two decades that governed the preparation of teachers in Colombia (Guacaneme et al., 2011) that permits us to recognize, among others, the following descriptions and reflections.

An intention to move from an emphasis on Mathematics towards Mathematics Education

With the new century came a new directive that promoted moving from that which is discipline specific (i.e. Mathematics) towards Pedagogy, in the new Mathematics teacher preparation programs. This directive, combined with an intense academic dynamic in the Mathematics Education community in the 1990s, promoted the opening of important discussions on the teacher preparation curriculum guided by Mathematics Education discourse. This generated a certain "territorial rivalry" among those in charge of the mathematical preparation and those in charge of Mathematics pedagogical knowledge, in which general humanistic discourse was displaced or diminished. This place for Mathematics Education was nourished by curricular dispositions consecrated for the school Mathematics proposed by the MEN (Colombia, 1998, 2006). Thus, the *Curricular Guidelines* (Colombia, 1998) declared that school Mathematics and Mathematics Education are disciplinary fields of the Mathematics teacher. It was established that the *Basic Competency Standards for Mathematics* (Colombia, 2006) "…constitute a guide for: … the formulation of programs and projects, for the initial preparation of teachers, as well as for the evaluation of in-service teachers" (p.11).

By the end of the first decade of this new century a new normative component, the introduction of the language of basic and professional competencies for teachers, was added that brought further tension to the duality in teacher preparation. It was intended to contribute to a clearer definition of the place that professional educators had in society and the contemporary requirements that were imposed upon them by society.

The Education of the Mathematics Teachers Depending upon the School Level in which They Would Teach

Before the end of the last century new programs were established for the initial preparation of Mathematics teachers. A Bachelor's Degree in Basic Education with an Emphasis in Mathematics (LEBEM) was created for future teachers in elementary and lower secondary. For upper secondary, the program became a Bachelor's Degree in Mathematics (LM). Those new programs were based on the characterization, identification and differentiation of what was considered particular for teachers in each of those two levels.

Nevertheless, this transformation was not accompanied by a change in the culture of work in the educational institutions that contracted the new graduates. Those with the Bachelor's Degree in Mathematics continue to be hired both lower and upper secondary, and those with the Bachelor's Degree in Basic Education are hired to teach all subjects in elementary schools.

A Place for Research in Teacher Education

The Mathematics teacher preparation regulations express various positions with respect to the relation between research and teacher education. One of the regulations refers to the need for future teachers to receive preparation in research and consult state of the art Mathematics Education research. In another it is proclaimed that lines of research exist that support the relationship between teaching and research in preparation programs. In the *Guidelines* (Colombia, 1998), research is conceived as "… the place from which knowledge in a disciplinary field is created. This part of professional preparation begins with Master's degrees and is consolidated in doctorates, where the scientific community of Mathematics educators is developed" (p. 125).

Given this multifaceted view, it is natural to present the relationship between research and teacher education as a theme or challenge that merits public reflection and discussion on the part of the Mathematics teacher education community in order to come to agreements on how to realize what is proposed. This reflection must include the fact that elementary and secondary teachers, except in a very few cases, do not work in conditions in which it is possible for them to generate and develop research projects that might improve their teaching or their students learning.

The Need to Educate in and for the Use of Information and Communication Technologies (ICT)

Perhaps the first reference to the need to include aspects relative to the use of ICT can be found in the *Guidelines* (Colombia, 1998). In that document there is a summary of the relationship between technology and curriculum, and a mention that the effective use of new technologies in education is a field that requires research,

development and teacher preparation. To develop this idea the MEN published a document specifically on the relationship between technology and curriculum (Castiblanco, Camargo, Villarraga, & Obando, 1999). It also supported a large project called "The Incorporation of New Technologies in the Mathematics Curriculum of Lower and Upper Secondary Education in Colombia" (Castiblanco, Urquina, C amargo, & Moreno, 2004). That project had various effects on initial Mathematics teacher preparation programs. Some preparation programs developed complementary activities to existing courses in which the importance and the possibilities of the incorporation of technology into educational environments were considered. Other programs incorporated courses on the use of technology either as a means of developing the learning necessary to be a teacher or as instruments to promote innovative student teaching experiences.

In the second decade of the century, the Bachelor's Degree programs are facing the challenge to develop basic competencies so that graduates will use information and communication media and technologies in responsible ways, and understand the opportunities, implications and risks in using them in collaborative work and in participation in virtual communities. Nevertheless, the curricular implications that this will have on initial Mathematics teacher preparation programs in not known.

The Quality Control Processes in Teacher Preparation Programs

During the 1990s the regulatory and institutional conditions were present for the creation of a *National System of Accreditation* (whose objective is to guarantee for society that the institutions that are part of the education system reach the highest levels of quality, and achieve their purposes and objectives). A *National Council of Accreditation* (CNA) was also created and was made up of, among others, the academic and scientific communities. Thus, at that time all teacher preparation programs had to be approved by the State with respect to their quality based on an evaluation process carried by the institution itself (using a self-evaluation process), the academic communities (using a process of peer evaluation) and the CNA.

These accreditation processes for initial teacher preparation programs on behalf of the State began simultaneously with the offering of the new programs at the beginning of the century. They have aided in the development of a new learning environment by many teacher educators who have incorporated the design and implementation of self-evaluation processes into their teaching practice as a guarantee of program quality.

2.1.2 Teacher Preparation for Elementary Education

Historically, the Normal Schools had the responsibility to prepare teachers to orient educational processes (not only in Mathematics) for children in Elementary Education and, fundamentally, education at that level in rural areas. This responsibility dates from the 19th Century, with the construction of the first Normal Schools for teacher preparation (Normal Schools for Males) that were charged with bringing basic literacy to the children of the country, particularly in rural areas.

Throughout their nearly two centuries of existence, the Normal Schools experienced various changes that were basically changes in educational public policy. Among the most important milestones were: (i) the moment, in the middle of the 19th century, when Normal Schools were recognized as institutions of pedagogical knowledge; (ii) in the second half of the 19th Century, at which time the first Normal Schools for Females were created; (iii) the beginning of the 20th Century, a time in which it was recognized that there was a need for a rural preparation for the populations living in the countryside, and an industrial and commercial preparation for those living in the cities, and, as a consequence, such preparation was considered in the Normal Schools, and Rural Normal Schools were created that were charged with preparing teachers for rural elementary schools; (iv) the emergence of the first Faculties of Education in country's universities, some of which were the result of the transformation of existing Normal Schools[9], and the consequent limiting of the role of Normal Schools to the preparation of teachers for Elementary Schools; (v) the reconfiguration, at the end of the 20th Century, of the Normal Schools into Upper Normal Schools, with the charge to prepare Preschool and Elementary teachers; (vi) the creation, at the beginning of the new century, of programs to prepare teachers for Upper Secondary schools offered by Upper Normal Schools in collaboration with universities that have Faculties of Education, and with the objective of promoting a

[9] Thus the Feminine Pedagogical Institute in Bogotá, became the National Pedagogical University in Bogotá, and the Male Normal School in Tunja became the Pedagogical and Technological University in Tunja.

more profound knowledge of an area that had been part of Elementary Education[10]; (vii) by the end of the first decade of the century, the agreements between the Normal Schools and the universities concerning Upper Secondary Education had been dismantled so that universities are no longer collaborating with the Upper Normal Schools so that the preparation of elementary teachers is much like the preparation in technical schools.

2.2 Additional Considerations

2.2.1 The Structure of Mathematics Teacher Preparation in Colombia

Near the end of the last century a policy on the structure of professional knowledge for teaching (Decree 272 of 1998) proposed that there are four nuclei of pedagogical knowledge (educability, teachability, the historical and epistemological structure of pedagogy, and social and educational realities). The curricular approaches for the initial preparation of Mathematics teachers in various programs were molded from those nuclei. Nevertheless, in 2008 it was recognized that those nuclei did not offer a satisfactory referent into which the educational reflections and actions of teachers could be fully and coherently situated (Bautista & Salazar, 2008).

This is verified by identifying that the majority of initial teacher preparation programs contain a structure in which one usually finds Mathematics courses, courses on curricular knowledge and knowledge about teaching mathematical content (in which practical knowledge is included), courses that develop general pedagogical knowledge, and courses centered on aspects of communication (reading, writing and speaking). Eventually, there may also be Physics or Computer Science courses; this in programs that are preparing teachers for Mathematics and another discipline.

In general terms, for example, the Mathematics courses include Calculus, Arithmetic and Algebra, Geometry, and Probability and Statistics. The course(s) on curricular knowledge and knowledge about teaching may include a consideration of the thinking or mathematical systems presented in the *Guidelines* and *Curricular Standards* (Colombia, 1998, 2006). Another possibility is courses that take a look at lines of research in Mathematics Education.

2.2.2 Recruiting Students for Initial Teacher Preparation Programs

Graduates from Upper Secondary Schools have a wide variety of Higher Education programs to choose from (in both public and private institutions). Among the options offered by the universities are programs in initial Mathematics teacher preparation for Elementary, Lower Secondary or Upper Secondary levels. Thus, unlike some other countries, Colombia does not require that future teachers complete a degree before entering teacher preparation programs (for example, a Bachelor's Degree in Pure Mathematics). That is, preparation as a Mathematics teacher constitutes professional preparation.

Thus, students who enter a Bachelor's Degree program know from the beginning that they are being educated to be Mathematics teachers. However, it must be recognized that for some students becoming a teacher is not their first career choice. Some accept admission into teacher education programs in the hope that later they will be able to transfer to a program with higher social status (e.g. engineering). Some with such intentions, change their minds and remain in teacher education. It must also be recognized that Mathematics teacher preparation programs do not have a particularly high demand, despite the fact that there is a need for more Mathematics teachers[11].

Finally, another point to be made is that the students in teacher education programs do not have the highest scores on the admissions tests used by the universities. Perhaps that is why the government has launched a program of funding undergraduate studies for students who will enter initial teacher preparation programs.

2.2.3 Face-to-Face Instruction as the Main Mode of Delivery

Upon observing the national panorama of initial teacher preparation programs it is obvious that the majority of them are face-to-face. There a very few programs offered at a distance. This means that the preparation of teachers is carried out mainly in universities in large cities or in regional branches of those universities.

[10] Along these lines, and for a few years, some universities that offer programs for the initial preparation of Mathematics teachers supported the creation of programs for Upper Secondary Mathematics in Normal Schools whose graduates were then given a Bachelor's Degree by the university.

[11] One indication of the need for Mathematics teachers is that the great majority of students in the last semesters of the Mathematics teacher preparation programs have already been hired by private schools before they graduate.

2.3 The Continuing Development of Mathematics Teachers

The continuing preparation of Mathematics teachers has at least two modalities: diplomas or permanent teacher development programs, and advanced preparation. Below, an analysis of graduate academic programs (advanced preparation) that currently have a significant impact on teacher preparation is presented.

2.3.1 Specialization Programs

Castrillón and Solis (2009) reported on thirty-six academic programs (12% of the total) that had an area of specialization in Mathematics Education, Mathematics or Physics. They also pointed out that a hybrid or blended model of face-to-face and distance was more common that simply face-to-face. Currently there are ten programs for specialization in Mathematics Education and all but one are face-to-face. They last between two and three semesters and generally focus on the professional practice of in-service teachers. Nine of them include courses in Mathematics.

The reduction in the number is mainly explained by the fact that in the last decade the specialization programs, related to the preparation of Mathematics teachers, have been developed under a tension generated by the implementation of the Teacher Statute (Laws 1278 of 2002 and its regulatory decrees). These regulations, among other matters, govern the academic careers of teachers in the public sector, including conditions to ascend on the salary scale. One of its conditions limited the possibilities of ascending via the title of specialization and incentivized preparation at the Master's and doctoral levels. The reduction can also be explained in terms of a State policy that encouraged the creation of Master's degrees focused on teaching rather than on research.

2.3.2 Master's Degree Programs in Education

Castrillón and Solís (2009) identified 79 Master's Degree programs concentrated in five cities: Bogotá, Medellín, Manizales, Cali and Bucaramanga. Of this total only ten (13%) offer Mathematics Education.

It should be emphasized that academic programs at the graduate level are subject to national regulations. The regulations establish the goals of specialization, Master's and doctoral programs; present some of the features of such academic programs; and indicate that Master's Degree programs shall have two modalities: one focused on teaching and the other on research.

When the institutional contexts in which the programs are developed and the curricular structures that they propose are examined, it is possible to identify at least three types of programs:

- Those that arise in Faculties or Institutes of Education. Their common component is philosophical, pedagogical and educational development, articulated with a conceptual and research-based foundation in Mathematics Education. That foundation is in turn based on Didactics of Mathematics with the historical-epistemological, sociocultural and cognitive characteristics. These are much like what is often called a Master's in Education with an Emphasis in Mathematics Education.
- Programs that emerge in Faculties or Departments of Science. These programs have as their main reference a disciplinary preparation in Mathematics. To that is articulated a foundation in relation to education, teaching and curriculum, as well as research. This type of program has some of the features of a Master's in Mathematics Teaching.
- Those whose curricular structure is organized in relation to the foundations of Mathematics Education as a field of research. They establish their curricular focus in the foundations of Didactics of Mathematics, cognition, curriculum, a sociocultural focus and evaluation, all articulated with a research component. These can be called Master's in Mathematics Education.

The development of academic Master's Degree programs has also generated changes in some universities. While some have opted to replacement specialization programs with Master's focused on teaching, others have decided to preserve the specialization programs articulated with Master's programs or conserve/promote the research Master's. There is obviously an absence of a general structure for the functioning of teacher preparation programs at the graduate level.

Also, the academic community of Mathematics educators, has been moving forward with a broad debate on the meanings, scope and limitations in the implementation of Master's programs focused on teaching. Indeed, in so far as these programs have among their purposes the improvement of the professional practices of Mathematics teachers and their research component mobilizes the *praxis* in relation to their teaching practices, research groups

are faced with the need to structure theoretical and methodological approaches that address the practice of teaching and the professional development of teachers of Mathematics.

2.3.3 Doctoral Programs

The country recognizes four doctoral programs in Education and Social Sciences:

- The Inter-Institutional Doctorate in Education[12] with an Emphasis in Mathematics Education with various lines of research: History and Epistemology of Mathematics, Language and Mathematical Argumentation in the Classroom, Language and the Construction of Mathematical Knowledge, Language and Mathematics Didactics, Semiotic Processes in Geometry, the Transition from Arithmetic to Algebra, and Mathematics Didactics.
- The Rudecolombia[13] doctorate. This program had and emphasis in Teaching of Sciences and a course in Mathematics Education at the University of Quindío.
- The Doctorate in Education with an Emphasis in Mathematics Teaching at the University of Antioquia, in which there are emphases in Statistical Education and socio-cultural perspectives on Mathematics Education, among others.
- The Doctorate in Social Sciences, Childhood and Youth (not specifically Education), offered by the University of Manizales and CINDE, in which there have been dissertations on Mathematics Education.

2.3.4 The Diversity of Approaches

A look at the graduate programs related to the preparation of teachers of Mathematics in Colombia must recognize the diversity of their curricular structures, research components, and treatments of theory and practice. This diversity also reveals an absence of a system of advanced preparation of teachers that articulates the various levels of preparation, allows students to circulate easily through the system, and facilitates professor and student exchanges.

An examination of the activities of the research groups that support the preparation programs at various levels reveals the following areas that can be highlighted as possible descriptors of their work and a further indication of the diversity: Didactics and Pedagogy, Cognition and Evaluation of Competencies, Information and Communication Technologies, Mathematics Education, History, Epistemology, and Philosophy of Mathematics and of Mathematics Education.

The elements expressed above highlight the features of an academic community that is still in a process of formation and expansion. If the goal is to create a national identity in the advanced preparation of teachers of Mathematics, it is necessary to strengthen the intra/inter research groups that support the preparation programs at various levels, reconsidering the sense and scope of collaborative work. To do so, strategies aimed at strengthening the configuration of networks of researchers in the field and networks of teacher preparation programs must be implemented. Perhaps this strategy will support the qualitative improvement of initial and continuing teacher preparation. That is the challenge for the next few years.

3 Some Mathematics Education Achievements and Challenges in Colombia

Without a doubt, currently in Colombia, Mathematics Education is a developing discipline and an academic enterprise or life project of many academics. Evidence of its status can be found in the configuration of the academic community, in the recognition that its preparation programs and academics receive, and in certain actions of the State.

Indeed, as is expressed by Guacaneme and colleagues (Guacaneme, Obando, Garzón & Villa, 2013), since the 1980s various groups dedicated to Mathematics Education have been formed in Colombia. Today they are visible on the *Scienti Platform* of the Colombian Institute for the Development of Science, Technology and Innovation (COLCIENCIAS). Equally important in the development of the community has been the emergence and the consolidation of the Colombian Mathematics Education Association (ASOCOLME). Along with ASOCOLME other communities and networks have emerged that have helped in the consolidation of various aspects of Mathematics Education. These groups include the Latin American Ethnomathematics Network (RELAET), the

[12] A program developed by the University of Valle, the National Pedagogical University, and the District University "Francisco José de Caldas".
[13] A network made up of the universities of Atlántico, Cartagena, Cauca, Caldas, Magdalena, Nariño, Quindío, Tolima, the Technological of Pereira, and the Pedagogical and Technological of Colombia.

Colombian Network for Modeling in Mathematics Education (RECOMEM), the Colombian Network of Mathematics Teacher Educators, and the inclusion of Mathematics Education as a chapter of the Colombian Mathematics Society. The strengthening of various national Mathematics Education events and the growing participation of Colombian researchers and professors in international events are further evidence of the state of development of the national academic community.

In the last decade the programs for initial and advanced teacher preparation have been subject to processes of self-evaluation and accreditation that have revealed their actual states of development. They have permitted an important recognition of the national community as it initiates its projection onto the Latin American scene. Equally, Colombian researchers in Mathematics Education have increased in number and have improved in preparation. Recently, the National Pedagogical University and ASOCOLME prepared a directory of individuals with doctorates in Mathematics Education. The list numbers almost sixty[14], the majority of whom carry out research in the country or are linked to it.

In a natural way the consolidation of the community is reflected in the number of research studies and publication in Mathematics Education. It is very probable that this growth is also due to the self-recognition by Colombians of the quality of their academic activity and the need to make their results visible.

Another aspect that has been influencing the consolidation of Mathematics Education in a positive way are government programs that support the continuing and advanced preparation of teachers. Indeed, in some regions of the country, although only a few, the governments have addressed education as a fundamental aspect of their policies and have implemented actions so that teachers, including those in Mathematics, can have access to graduate programs in Education. In a similar way, the MEN has developed processes to support the improvement of initial teacher preparation programs through actions that involve academic peers in outstanding programs.

The extent to which Mathematics Education as in discipline in Colombia is institutionalized, as is evidenced above, seems to continue to be insufficient to attend to all the needs for Mathematics teacher preparation particularly for professional development in their "local realities" and not just to improve the scores that their students receive on standardized tests. What is needed then is a *national policy on teacher preparation* that goes beyond getting teacher "buy in" with respect to the curricular orientations promoted by the MEN. Instead, it must transcend to teacher preparation that permits them to understand *in situ* the role of Mathematics in a comprehension of school contexts and to support the development of more mathematically competent students. The policy must give teachers a professional and academic status in Mathematics Education. That is, the professional participates actively in the mathematical cultural of Colombian society to benefit the construction of human values that transcend disciplines and knowledge.

4 Final Considerations

In accordance with what has been argued by Guacaneme et al. (2013), the current structure of the Colombian education system, and, hence, school Mathematics preparation, has been the product of political, social and academic transformations. As a consequence, the role of the MEN has evolved from being a "regulator" of contents, to a generator of dispositions and orientations that support school autonomy with respect to curricular organization. In general, the education system has passed from the ideal of basic literacy to the ideal of preparing a citizen with capacities and competencies oriented to both knowing and doing. Coherent with that, more autonomy has been given to the institutions that prepare teachers so that they can provide actions that permit teachers to understand their roles as social and knowledge agents of the future generations. Nevertheless, more research is still necessary to provide evidence as to the ways that these institutions can come closer to reaching their goals.

As Agudelo-Valderrama (2006, 2008) suggest, there exists among Colombian Mathematics teachers, a certain resistance to develop in their classrooms practices that are articulated with the curricular guidelines issued by the MEN and aligned with the results of national and international research. She therefore suggests that Mathematics teacher preparation institutions should put into practice strategies that position change as an active factor. Thereby, teachers should question their conceptions of mathematical knowledge, their school practices, but above all, their roles as social agents in their communities.

[14] This number, still insufficient, is much great than the three who graduated before 1990.

According to what has been presented in this document, there seems to be a consensus among the majority of the institutions that prepare Mathematics teachers that it is through a strategy centered on preparation in/from research that future Mathematics teachers will be able to generate continuous knowledge on the realities in which they work. However, there is still not sufficient evidence about how this strategy has impacted school realities, the mathematical practices in classrooms. Particularly given that in school contexts there are usually insufficient conditions to do research, and that even those who do manage to do research do not receive adequate recognition within the current rewards structure. Faced with this reality, new questions emerge concerning the relationship between teaching and research, and the way to guide research by in-service and pre-service teachers.

Finally, it is worth mentioning that currently both the MEN and the Ministry of Communications have indicated a way to get technology to highlight competencies and ways that any teacher can integrate the technology. Thus it is hoped that integration of technology in the classroom will lead to innovation. However, these actions by the ministries apparently have been undertaken without knowledge of the research that has been done on the configuration of networks and innovations by various groups and institutions concerned with the teaching of Mathematics. A space must be opened to do interdisciplinary research on the integration of technology into the teaching and learning of Mathematics, and networking strategies must be strengthened.

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6 Appendix: Meanings of Acronyms

Acronyms	Meanings
ASOCOLME	Colombian Mathematics Education Association
ACOFACIEN	Colombian Association of Faculties of Science
ASCOFADE	Colombian Association of Faculties of Education
BID	Inter-American Development Bank
CENDOPU-Univalle	Documentation Center, University of Valle
CESU	National Council of Higher Education
CIAEM	Inter-American Committee on Mathematics Education
CINDE	International Center for Education and Human Development Foundation
CNA	National Council of Accreditation
COLCIENCIAS	Colombian Institute for the Development of Science, Technology and Innovation
ERM	Regional School of Mathematics
LEBEM	Bachelor's Degree in Elementary Education with an Emphasis in Math
LM	Bachelor's Degree in Mathematics
MEN	National Ministry of Education
MTIC	Media and Technologies for Information and Communication
RECOMEM	Colombian Network for Modeling in Mathematics Education
RELAT	Latin American Ethnomathematics Network
SCM	Colombian Mathematics Society

Costa Rica: The Initial and Continuing Preparation of Mathematics Teachers

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Summary

This work[15] begins with a brief description of the Costa Rican education system and the stages of its historical evolution and ends with a consideration of the strengths, weaknesses, threats and main challenges currently faced by Costa Rica in its quest to improve the quality of Mathematics Education. The initial preparation of Mathematics teachers for elementary and secondary education will be described with an indication of the main characteristics of the institutions that provide the preparation and the corresponding programs of study.

Elements of continuing professional development in the country will be mentioned and a review of Mathematics Education research in Costa Rica will indicate an important strength in possibilities for improving the teaching of Mathematics in this country.

A profound reform of the school Mathematics curriculum approved in 2012 will also be described. It is a curriculum that utilized results from important international research and experiences in Mathematical Education with national goals to build higher cognitive capacities in this discipline. The new curriculum and its implementation (in an ambitious and bold project) has significantly affected the teaching practice in Costa Rica classrooms and the in-service professional development of teachers of Mathematics, and, also has served as an obligatory reference for change in initial preparation programs (which the majority of universities which prepare teachers have begun to incorporate). In particular, the close connection between the development and success of this educational reform, and the national research efforts in Mathematics Education and the relevant international backing that the process has received will be highlighted.

Keywords

Teacher Preparation, Mathematics, Mathematics Education, Education, Curriculum, Costa Rica.

[15] This document is based on the article: Alfaro, A., Alpízar, M., Morales, Y., Salas, O., y Ramírez, M. (2013). La formación inicial y continua de docentes de matemáticas en Costa Rica. *Cuadernos de Investigación y Formación en Educación Matemática*, 8 (número especial), 131–179, available at http://revistas.ucr.ac.cr/index.php/cifem/issue/view/1281. This article is a final version of a report presented to the *Workshop on Building Capacity in Mathematics and Mathematics Education,* CANP 2, held in San José, Costa Rica, in August of 2012. This work is part of the Network for Mathematics Education in Central America and the Caribbean: www.redumate.org.

1 General Description of the Education System

The structure of the Costa Rican education system is composed in levels: Preschool education, elementary education, secondary education, and higher education (see Table 1). At the end of the second cycle a diagnostic test is given to know, among other elements, the achievement in the previous grades. It does not have implications for continuing on to the next cycle.

There is another national test that is required at end of upper secondary school: the *Upper Secondary Test*. A student's grade is determined as a weighted average of a grade called presentation (the average of grades in social studies and civics, Spanish, English or French, Mathematics, Biology, Chemistry or Physics) and the Upper Secondary Test itself. Students receiving a passing grade are awarded an "Upper Secondary Diploma". This grade is not only important for passing Upper Secondary but, also, because the public universities use it as one of the main criteria for admissions.

Table 1

Structure of Preschool, General Basic, Upper Secondary and Higher Education in Costa Rica

Designation	Cycles	Ages and Grade Spans for Each Cycle	Offered by the MEP
General Basic Education	Cycle I	From 7 to 9 years (1º, 2º and 3º)	
	Cycle II	From 9 to 12 years (4º, 5º and 6º)	
	Cycle III	From 13 a 15 years (7º, 8º and 9º)	
Upper Secondary	Cycle IV	From 13 to 17 years (10º, 11º, (12º depending on the branch[16])	
Designation	**Degrees**		**Public and Private Universities**
Higher Education	Lower Undergraduate (Certificates and Teaching Degrees) Upper Undergraduate (Bachelor's and Licentiate Degrees) Graduate (Specializations, Master's, Doctorates)		

With respect to personnel, in 1971 there were almost 18,000 teachers and administrators, and in 1981 there were about 22,500 teachers. In 1983 the number of private universities began to increase. Forty-five new private universities were created between 1986 and 2000 (as of 2014 there are five public universities and 52 private universities). In 2011 there were 12,195 students that received degrees from public universities and 28,115 from private.

As a result of the growing number of universities and programs related to Education, the country is producing many more certified teachers, particularly in private universities. In 2004 there were 8948 graduates from Education programs (34% of the total) (*Estado de la Educación 1,* 2005). From 2010 to 2011 there were 21,446 new graduates in Education (*Estado de la Educación 4*, 2013, p. 36)[17]

In 2005 and 2006 more than 8000 students a year were receiving degrees in Education. The six most common areas were: Elementary, Preschool, General Education, Educational Administration, English and Special Education. By 2009 the number of Elementary teachers in the country had risen to 26,463 (43% of the total teaching force) (*Estado de la Educación 3*, 2011, p. 142).

2 Main Stages of the History of Education in Costa Rica

The history of education in Costa Rica can be seen by looking at particular periods and actions:

The Teaching House and the University of Santo Tomás

[16]Cycle IV (Upper Secondary) is subdivided into three branches: *academic* with a duration of two years (tenth and eleventh); *artistic*, also with a duration of two years; and *technical*, with a duration of three years (tenth, eleventh and twelfth); this last one is diversified into modalities: industrial, agricultural, commercial y services.

[17] Data updated in 2014.

According to *Estado de la Educación* 2 (2008), before the creation of the Teaching House of Santo Tomás, in the colonial period, the majority of educators were priests. In the last decades of the 18th Century and first of the 19th Century, education in Costa Rica began a process of the secularization of teaching; as an exclusively male career.

After Independence a new generation of teachers emerged, some prepared at the Teaching House of Santo Tomás and later at the university with the same name created in 1843 and closed in 1888. The Teaching House of Santo Tomás had been created in 1814. It can be characterized as neither elementary nor secondary, but as a mix of both (Rodríguez and Ruiz, 1995).

The Constitution of 1869 included the provision that education be free, obligatory and financed by the nation.

The Reform of Mauro Fernández

Between 1885 and 1888 there was a liberal educational reform that brought important changes in improving and centralizing public education. Elementary, secondary and university education were organized. Along with this, the management and supervision of elementary education passed to the Ministry of Public Education (Barrantes and Ruiz, 1995a).

The Normal School of Costa Rica

According to Barrantes and Ruiz (1995a), with the founding of this Normal School, in 1914, a new national phase of education began with respect to teacher preparation. This institution was the center of cultural and educational life in the country until the establishment of the University of Costa Rica (UCR)[18]. It developed new programs of study between 1925 and 1926 (Barrantes and Ruiz, 1995b).

The Creation of the University of Costa Rica

In 1940 the University of Costa Rica was created with a School of Pedagogy that was charged with preparing Elementary teachers (Barrantes and Ruiz, 1995c).

The Constitution of 1949 established the structure of cycles of education. According to Barrantes and Ruiz (1995a), the professional preparation for teaching secondary Mathematics began in 1959 when UCR began to offer a Teaching degree (*profesorado*) in Physics and Mathematics. In 1966 that program was separated into a Teaching degree in Physics and one in Mathematics. In 1968 the Upper Normal School was created. Among its objectives was the preparation of upper secondary Mathematics teachers (cited by Ruiz, Barrantes and Gamboa, 2009), but the program did not last long.

"Modern Mathematics" in Costa Rica

Barrantes and Ruiz (1995b) suggest that until 1964 there had not been significant evolution in (secondary) Mathematics. The main topics were arithmetic, algebra, geometry and trigonometry. Differences that did exist from one program to another were mainly in how to teach the Mathematics that was offered. The change in 1964 was the product of a reform that, for several years, had been on the international panorama: the so called "modern" Mathematics reform or "New Math". Between 1960 and 1970 development in the country was inspired by the great mathematicians of the moment, mainly those united in the French group called Nicolás Bourbaki.

New Universities

The 1970s saw the expansion of Costa Rican universities in response to the postwar demographic growth.

In 1971 the Costa Rica Institute of Technology (TEC) was created on the model of the Monterrey Institute of Technology in México. The National University (UNA) was founded in 1973 and its School of Mathematics in 1974. In 1977 the State Distance University (UNED) was created to attend to provide opportunity and access to higher education for persons living far from the capital, at risk populations, among others.

Because of a shortage of secondary Mathematics teachers, in 1992 Teaching degrees in Mathematics were created at UNED, UNA and UCR. This was done in a formal agreement with the MEP and with World Bank funds. Graduates of those programs are still teaching in the universities.

[18] In Appendix 1 there is a detailed list of the acronyms used in this report.

3 Initial Preparation of Teachers

The Case of Elementary Education

In Costa Rica, teachers for the first two cycles of Basic General Education teach various subjects to the same group of students. Generally in Cycle I they teach four basic subjects (Mathematics, Spanish, Science and Social Studies). In Cycle II some only teach two of those four subjects if the school has enough teachers.

There is a great diversity of programs and university centers offering programs in Costa Rica. For most of them all that is required for admissions is an Upper Secondary Diploma. The UNA and the UCR do require a certain score on the admissions examination.

The Case of Secondary Education

At present the panorama is very complex because of the great number of graduates, mainly from private universities. The Mathematics teaching programs at those institutions do not receive evaluations of quality standards that are offered by the National System of Accreditation of Higher Education. Also, the National Council of Private Higher Education (that is charged with approving and supervising the private universities) does not have efficient mechanisms to guarantee program quality.

At the end of 2012, four public universities and seven private universities had approved programs for initial preparation in the area of Mathematics Teaching.

UCR has had Mathematics programs since 1959. Currently the program offers both a Bachelor's Degrees (four years) and Licentiate Degrees (five years) with a lateral exit possible so that students can get a three-year Teaching degree (*profesorado*) in Mathematics Teaching. UNA offers the same three degree programs.

UNED has been offering Mathematics programs since 1992. Currently, a Teaching degree and a Bachelor´s Degree are offered in Mathematics Teaching. Beginning in 2014, they are also offering a Licentiate Degree. TEC has had a Mathematics program since 1996 and currently is offering a program called Computer-Assisted Mathematics Teaching. They offer Bachelor´s and Licentiate Degrees, but not the three-year Teaching degree.

A Brief Description of the Contents of Preparation Programs

Preparation Programs for Elementary Teachers[19]

The programs of study offered at UNA and UCR are divided into 16-week semesters. The other universities use a 12-week quarter system. A Bachelor's Degree is eight quarters. Most of them offer a Licentiate which implies three or four quarters past the Bachelor's. The public universities have a lateral exit to a Certificate[20], upon completing five quarters (in the case of UNED) or four semesters in the case of (UNA and UCR).

In the Elementary Education programs at both the public and private universities there are courses in philosophy, curriculum, planning, evaluation and general teaching methods. The programs also include content courses in the basic disciplines: Spanish, Sciences, Social Studies and Mathematics. Some also offer discipline-specific teaching methods courses. Some programs emphasize specific disciplines. For example, the University of San José (private) offers an emphasis in Spanish and English, and only requires one content course in each of the other basic disciplines. The Independent University (also private) has an emphasis in Spanish-Social Studies, and requires no Mathematics courses. Graduates from both those private universities are often contracted by the MEP for classroom assignments in which they will have to teach Mathematics.

Programs for the Preparation of Secondary Mathematics

In the public universities the schools of Mathematics teach the content courses while the schools of Education teach the pedagogical component (with the exception of TEC which does not have a school of Education). Currently, each of the four public universities (UNA, UCR, UNED, TEC) has approved programs of study at the Licentiate level.

In the case of the private universities that do offer programs on the Teaching of Mathematics, their programs of study are very similar to those at the public universities. A problematic issue is that the similarly named degrees at different universities may differ by as much as a year or more of studies (Ruiz et al., 2009).

[19] This analysis does not consider the program offered by the Open University of Costa Rica (private).
[20] Certificate in UNA and UNED or Teaching degree in UCR.

With respect to the relationship between theory and practice, as is the case with elementary teacher preparation programs, all the public universities include a course with supervised student teaching.

Master's and Doctoral Programs

The only institution with graduate degrees in Mathematics is UCR with its academic Master's Degree in Mathematics with an emphasis in Educational Mathematics, Applied Mathematics or Pure Mathematics. The emphasis in Educational Mathematics has been offered since 2003, but has had very few graduates. Its program is mostly Mathematics courses with two courses that contain Mathematics Education. Most of its graduates work at universities. An important consideration is that the MEP does not recognize the UCR graduate degrees as superior to the licentiate degrees (for contracting personnel for secondary schools), and consequently neither in Civil Service[21].

4 Continuing Preparation

The experiences with continuing preparation before 2011 were not very significant. Below information about some of those efforts will be presented. Beginning in 2011 the reform of Mathematics Education was begun in the country.

4.1 Preparation and Professional Development in Grades 1 to 8

Teacher professional development for grades 1 to 8 (cycles I and II) has been offered, mainly, by the following Costa Rican institutions: The College of Graduates and Teachers of Letters, Philosophy, Sciences and Art; the Omar Dengo Foundation; the MEP; the Uladislao Gámez Solano Institute for Professional Development (IDP-UGS, and public universities (Barrantes et al., 2010).

The efforts of the MEP to reinforce the idea of a process of continuing and permanent preparation of teachers were considered in the National Plan for Professional Development. That plan was approved by the Higher Council of Public Education in 1971 with the support of UNESCO. However, the efforts have been diverse, not well articulated and without significant consequences for professional development (Venegas, 2010, cited in *Estado de la Educación 3,* 2011).

Between 1991 and 1995, to support new programs of study, regional advisers and universities specialists provided professional development to almost 16,000 educators (*Estado de la Educación 3*, 2011). Beginning in 2006 a *Plan to Improve Achievement in 200 School Day*s (Plan 200 of the MEP) was proposed. One of the activities was the professional development of the teaching force. The last two weeks of every school year were chosen for this professional development (Venegas, 2010, cited by *Estado de la Educación 3*, 2011). However, these actions have not had a significant impact on classroom practice.

4.1.1 Public Universities

UNED has offered professional development since 2004. Their programs last approximately two years and have been offered in various regions of the country (Hume, 2009, cited by Barrantes et al., 2010).

In UNA, a university Project called *Education and Development in Costa Rica* has been offering professional development for cycle I and II teachers since 2008. This project is connected to Plan 200 of the MEP. The university provides human resources and creates materials, while the MEP establishes the topics and gives guidelines to follow (Víquez, 2009, cited by Barrantes et al., 2010).

In UCR, according to Valverde (2012), the Department of Elementary and Preschool Education, in its Section of Elementary Education has been offering professional development as modules for in-service teachers in the area of Mathematics.

Since 2008 TEC's School of Mathematics has been publishing a calendar for elementary schools in which they propose a problem for every day of the year. Using that calendar as the basis, in 2011 they provided some professional development to elementary teachers (Meza, 2012).

[21] State entity charged by the MEP to contract teachers, for both the elementary and secondary levels.

4.2 Preparation and Professional Development for Secondary Education

The priorities and guidelines from the MEP are usually planned through the IDP-UGS. Its structure is mainly administrative and, although it does have professionals in some areas, they are not enough to meet the needs in all regions of the country. Therefore this process has been carried by individuals with professional services contracts and since 2006 has been planned in Plan 200.

In March of 2010, the MEP gave Mathematics teachers a diagnostic test and generated a Project to offer them professional development. The results were low with only 43% showing a proficiency with secondary Mathematics[22]. The public universities UNA, UCR, TEC and UNED were contracted to provide the professional development (with an agreement Conare-MEP-Mathematics). An inter-university commission was created and the first course was offered in the spring semester of 2010 (approximately 50% of the secondary teachers who took the test were invited to participate). The participation included 841 secondary teachers in 41 distinct groups in 24 educational regions. A second course was planned for the first semester of 2011, but the MEP pulled its financial support and the agreement terminated.

In 2011, the nature of all the professional development for elementary and secondary teachers, offered by the MEP, changed drastically with the profound Mathematics curricular reform in all of pre-university education.

4.2.1 Professional Development in Events Sponsored by Universities and Mathematics Education Associations

Faced with the weaknesses in the continuing preparation offered by the MEP prior to 2010, various academic events became an alternative so that teachers (essentially secondary) could increase their preparation (although in a disorganized way and without a strategic perspective). Since the 1990s the events with the longest tradition are the *Costa Rican Symposia on Mathematics, Science and Society* (the first was held in 1993 and number 25 in 2012). These symposia have been organized by UCR's *Meta-Mathematics Research Program* in collaboration with other institutions. Other events:

- The *International Mathematics Festival* organized by the *Foundation of the National Center for Science and Technology*, that was initiated in 1998 and has been held eight times.
- The *International Congress on Computer-Assisted Teaching of Mathematics* of the TEC (eight events have been held since 1999).
- The *Meeting on Teaching Mathematics* of the Mathematics Teaching Program of UNED's School of Exact and Natural Sciences (four have been held since 2006).
- The *Meeting on Teaching Statistics, Probability and Data Analysis* (three held since 2009).
- At a regional level: the *Provincial Meeting on Mathematics Education*, organized by MEP's regional education advisers in Guanacaste with support from UNA (2011 and 2012).

In Costa Rica there is also a *Mathematics Education Association* that, although it has no more than 30 members, has generated various activities for teacher professional development.

5 Research in Mathematics Education

Research in Mathematics Education has been associated with the four public universities (UCR, UNA, UNED, TEC), in most cases with the department or schools in charge of teaching Mathematics. The research in those universities has been carried out through projects, programs and research centers. The results can been seen in conference proceeding, journals, books and in presentations at various national and international events on the teaching of Mathematics. Recently, articles have appeared in the official publications associated with the MEP.

There are significant differences in the importance given to research at each institution. Such difference are largely the results of the size and historical global maturity of each institution.

- At UNED research began recently in 2010.
- In the last decade TEC has developed research projects. Most of them have used qualitative methods. They have carried out documentary studies and various actions related to the use of technology.
- At UNA, specifically in Mathematics Education, there was outstanding work between 2001 and 2009.

[22] Data updated in 2014.

- UCR has not the most research in Mathematics Education and has played a leadership role.

The research that was carried out between 1974 and 1990 in the School of Mathematics at UCR (and in the rest of the country) was presented at the *National Congresses of Mathematics* (in 1983, 1985 and 1990) (Ruiz, Alfaro and Morales, 2003). Since 1990 the main venue has been the *Costa Rican Symposia on Mathematics, Science and Society*. The other academic events summarized above have also served as a means to report on research that has been done in the country.

The *Center for Research on Mathematics and Meta-Mathematics* (CIMM) was born at UCR in 1997. It is the only formal research center in the country that includes Mathematics Education as one of its main specializations.

Linked to the CIMM from 2001 to 2009, there was significant Mathematics Education research carried out at UNA's School of Mathematics (an institution that previously had been associated with very little such research). The generator of this special effort was a project called *Support for Research in the School of Mathematics*, designed by Angel Ruiz, with the support of Research Directorate and the School of Mathematics (Edwin Chaves, the School's Director, played a decisive role in the success of the project). This project was responsible for many research projects, including, in 2009, the *Program for Research and Preparation in Mathematics Education* (PIFEM), dozens of publications and the organization of many academic events. At the end of 2009, with the departure of Angel Ruiz from UNA, PIFEM was closed, the formal collaboration with CIMM ended, and research in Mathematics Education at UNA decreased considerably.

One of the results of the collaboration between CIMM and UNA's School of Mathematics was the creation in 2007 of an *International Program in Research and Preparation in Mathematics Education* that since 2011 has been called the *Center for Research and Preparation in Mathematics Education* (www.cifemat.com). Researchers from UNED and the MEP have also been integrated into the work of this Center.

Since the 1980s the research carried out at UCR and UNA has been under the leadership of Angel Ruiz.

An important dimension worth mentioning is the relationship that Costa Rican researchers have had with the international community, particularly the friendly rivalry between Edison de Faria and Angel Ruiz: De Faria with the *Latin American Committee on Educational Mathematics* for many years, and Ruiz with the *Inter-American Committee on Mathematics Education* (since 1987) and the *International Commission on Mathematical Instruction* (since 2010). A result of the international connections fostered by Ruiz was the realization in Costa Rica of the *International Workshop on Building Capacity in Mathematics and Mathematics Education* (CANP 2012). This event received more international support for the teaching of Mathematics than any other that has been held in the Central American region. It also permitted the creation of the *Network for Mathematics Education in Central America and the Caribbean* (www.redumate.org).

A crucial moment in the evolution of the teaching of Mathematics in Costa Rica occurred when various researchers at the *Center for Research and Preparation in Mathematics Education* wrote new programs for school Mathematics and began their implementation.

6 New Programs in Reform in Mathematics Education

In 2010, the Costa Rican Minister of Education, Leonardo Garnier, approached Angel Ruiz concerning a possible reform of the school Mathematics curriculum. An agreement was reached with authorities at the MEP to carry out the reform from first grade to the last year of academic upper secondary. The agreement included that the curricular reform would be the first step in an integral reform strategy that would include teacher development and support materials. It was further agreed that the development would be led by the inter-institutional group associated with *Center for Research and Preparation in Mathematics Education*. That group would be reinforced with in-service elementary and secondary teachers, and there would be a network of advisors and reviewers in Costa Rica and other countries to support the work.

In August of 2011 the first curricular proposal was presented to the Higher Council of Education (CSE). The CSE asked that the public universities study and evaluate the proposal. Before the final approval of the curriculum, the MEP and the reform team, in the second half of 2011, performed a national process of "socialization" of the proposal with in-service teachers. This process involved more than 7500 elementary and secondary teachers,

national and international experts, university academics, and specialists in curriculum design, Mathematics Education, evaluation, technology and other.

With the suggestions from the universities, in-service teachers and the writing team itself, a version of the new programs was presented to the CSE in April of 2012. On May 21, 2012 the new programs for elementary and secondary Mathematics were approved. Implementation began, gradually, in 2013.

The main approach of this curriculum is **Problem Solving, with a special emphasis on real contexts**. Although this terminology has been used in curricular experiences in various parts of the world, in the case of Costa Rica it has been done in a specific and original way: A pedagogical strategy in the classroom that breaks the dominant paradigms with respect to teaching Mathematics. Higher cognitive capacities are constructed in the students by starting from associations with real environments and with interesting challenges to promote learning and mobilize and apply knowledge adequately. With its contents and perspectives it aims to overcome the dominant "mathephobia" and make a qualitative leap in Mathematics learning that will serve the citizenry in using Mathematics and the related competencies to improve the quality of life for all.

To advance this educational reform, in 2012 a megaproject was launched: *Mathematics Education Reform in Costa Rica* which integrates various dimensions (www.reformamatematica.net). The project, coordinated by Angel Ruiz, is funded by the Costa Rica US Foundation for Cooperation (CRUSA) for three years (2012-2015) with the possibility of extension.

In addition to writing the final version of the new programs, the project has developed:

- Blended courses (that integrate face-to-face and online sessions).
- Pilot projects (to measure the progress of the project),
- Many support documents for teachers,
- A virtual Mathematics Education community and various means of communication and dissemination,
- Such as MOOCs (*Massive Open Online Courses*).

This synergistic combination of actions puts Costa Rica at the vanguard in the region.

This Project has disrupted the conditions of initial and continuing preparation of Mathematics teachers in the country. The nature of professional development has changed:

- More support from the MEP by involving secondary and elementary teachers (for years this later group had not received much support).
- Professional development that breaks with the face-to-face tradition offered by the universities,
- The blended and virtual nature of the professional development,
- An emphasis on the pedagogy specific to the Mathematics, in contrast to previous professional development that treated Mathematics and general pedagogy separately,
- It is not a "trickle down" scheme, but has two steps: one step with teacher leaders and another with large populations of teachers, and the leaders are facilitators in this second level of courses.

The Project is in charge of all the details of the design and presentation of the courses directly with the teacher leaders. This has been very successful, maximizing the development of the essential pedagogical leadership. The massive blended courses, although they are designed by the project and there are facilitators prepared by the project, are not served directly by the project. Instead, the IDP-UGS and MEP's regional directorates are directly responsible and, therefore, so far the national results have been quite varied. In some regions there has been great success while in others there have been serious difficulties. It will be in the medium and long term when it will be fair to evaluate the global achievement of this innovative modality for massive professional development.

With respect to initial preparation, UCR, ITCR and UNED are carrying out actions to bring about consistency between their preparation programs and the new school curriculum. So far, it is UCR that has advanced the farthest in this effort.

This educational reform will need considerable time to materialize, but very solid steps have been taken.

It is interesting to note the international connections that Angel Ruiz has brought to this project. Not only was there CANP 2012 (inaugurated by the Minister of Education and in which twenty ministerial advisors took part), but also in late 2011 an ex-President and the two Vice Presidents of the *Inter-American Committee on Mathematics Education* visited Costa Rica to present activities in direct support of the curricular change.

This reform of school Mathematics has put into motion in an integrated way factors that have been in development for many years, but did not necessarily guarantee what has fortunately happened. There has been significant research in Mathematics Education, high level international connections, and a homogeneous team committed to progress in this discipline. The political circumstances (perhaps fortuitous) of a Minister of Education who supported these actions paved the way for a change in the perspectives related to teaching this subject. Details on this process from it incubation to the present can be found in Ruiz (2013).

7 Strengths, Weaknesses, Threats and Main Challenges

Strengths

The increase in the level of preparation and degree completion of the teacher population constitutes a human base for launching actions for progress in Mathematics Education.

The four public universities that offer Mathematics teacher preparation programs have improved their administrative conditions and curricular coherence through a process of accreditation and self-evaluation.

The existence in the country of a consolidated Mathematics Education research team, with strong national and international connections and high level political support, is an important strength.

Costa Rica has an officially approved new high quality school curriculum and that is a powerful starting point. Simultaneously important actions for its implementation via the *Mathematics Education Reform in Costa Rica* project have been initiated. These two dimensions are strengths that can improve teaching and learning of Mathematics. And all the processes of initial and continuing preparation moving forward should be considered within this scenario.

Weaknesses

There are no mechanisms of support and selection in place in the universities with teacher preparation programs to be able to attract future teachers from among upper secondary graduates with the strongest academic backgrounds. The State and society do not grant teacher preparation programs sufficient self-supervision and control.

The universities that prepare Elementary teachers do not produce professionals with an appropriate mathematical preparation to achieve the higher standards in the teaching of this subject. Linked to this, the secondary Mathematics teacher preparation programs do not articulate the pedagogy and Mathematics courses very well. The programs do not present international Mathematics Education experiences and results, and are disconnected from classroom practice.

The State, the country's main employer of teachers, does not have clear professional profiles nor does it use adequate processes for contracting quality Mathematics teachers. The working conditions do not permit specific times during the work day for continuing preparation, classroom research and shared governance processes for improving teaching.

There is a lack of national strategic plans that integrate the different institutions (the MEP, universities, unions) to offer professional development for in-service teachers.

Threats

The absence State control of teacher preparation programs at the universities has meant that the private universities with lower program quality are now graduating more teachers. This has had repercussions on the status of the profession and in the possibilities for improving classroom teaching. If this situation persists, it will be almost impossible to have the appropriate conditions to meet the challenges faced in Mathematics teaching.

If the teacher preparation programs (both Elementary and Secondary) in the universities do not make significant changes based on research and international best practices that converge with the new curriculum approved in 2012, it will not be possible to assure continuity in the positive changes that have been introduced in the country.

The continuity of the *Mathematics Education Reform in Costa Rica* project is not assured. Also, it is not guaranteed that the impetus generated by the reform will more forward, as it depends on the MEP. Conspiring against such continuity is the lack of State policy to **not** modify positive and successful processes simply for convenience or out

of ignorance (In Costa Rica the government, and therefore the Minister of Education, changes every four years). Another threat is that it is possible that MEP officials who see themselves affected by curricular change and the pressure of new duties (they would like to reject) might be able to impose setbacks to the reform.

Challenges

Carrying out significant reform to the public university initial Elementary and Secondary teacher preparation programs is a challenge. It will also be necessary to reorient research in the public universities to support, significantly, not only initial preparation, but also other actions so that the ambitious educational reform processes in school Mathematics can be successful.

Increasing State control over Mathematics teacher preparation programs at private universities and creating within the MEP a competitive system for contracting Mathematics teachers that can ensure and improve the quality of the teaching force remain as challenges.

Establishing an aggressive policy of in-service teacher professional development based on a strategic plan that integrates initiatives from diverse stakeholders in another challenge.

A final challenge is to sustain the actions of the Mathematics teaching reformers and the new curriculum proponents, built on international quality parameters with national relevance.

8 Closing Statements

The progress in initial preparation of Mathematics teachers that can be achieved in Costa Rica will depend on the clarity, decisions and actions of many involved. What is done by the public universities will be decisive given the resources they possess, their educational trajectory and the social esteem they enjoy. However, for various reasons there is not an absence of inertia and paralysis in this realm.

But there are not only individual institutional responsibilities. The role of the State at this time in Costa Rica is decisive. A will to more aggressively exercise control and supervision over what is happening in initial teacher preparation programs is a necessary condition. This is also a responsibility of Costa Rican society in general, particularly given that adequate paths of action are not always taken (for example, accreditation of university Education programs is not a legal requirement). Without legislative support and the backing of civil society, the State cannot act.

The “Modern” Mathematics curricular reform of the 1960s and 1970s decisively determined that teacher preparation programs for decades in Costa Rica. Now, fifty years later, a new curricular and intellectual reform proposes an impact of similar proportions. But this time, the changes that have been introduced have adopted with clarity findings that have already been consolidated on the international scene by the field of Mathematics Education that has become a scientific discipline and independent profession.

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10 Appendix: Meanings of Acronyms

Acronyms	**Meanings**
CIMM	Center for Research on Mathematics and Meta-Mathematics
CSE	Higher Council of Education
IDP-UGS	Uladislao Gámez Solano Institute for Professional Development
MEP	Ministry of Public Education of Costa Rica
PIFEM	Program for Research and Preparation in Mathematics Education
TEC	Costa Rica Institute of Technology
UCR	University of Costa Rica
UNA	National University
UNED	State Distance University

Dominican Republic: The Initial and Continuing Preparation of Teachers

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Summary

This work[23] was prepared as a baseline document for the *International Workshop on Building Capacity in Mathematics and Mathematics Education*, CANP 2012. In this document a synthesis of the main aspects of the historical context of the preparation of teachers, the structures for the initial preparation of Mathematics teachers, the contents of teacher preparation based on the programs offered by institutions that have such programs, a discussion on programs of continuing teacher development, the most recent developments in initial and continuing teacher preparation, and the main strengths, weaknesses, threats and challenges of teacher preparation in the Dominican Republic are presented.

It is important to emphasize the impact that reforms and constitutional changes have had on education. Therefore, in this report, the analysis of the historical context has been organized in four stages that have been identified by experts on the history of Dominican education (Almánzar, 2008; Fiallo and Germán, 1999) who have identified the most important aspects of educational legislation related to teacher preparation.

Also, it should be pointed out that the Dominican education system is structured into four levels: initial, elementary, secondary and post-secondary. The Ministry of Education (MINERD) is in charge of the initial, elementary and secondary levels. The Ministry of Higher Education, Science and Technology (MESCYT) directs post-secondary education.

Currently in the Dominican Republic there are 42 institutions of post-secondary education and 22 (52%) of them offer programs in Elementary Education and 15 (36%) offer programs in Secondary Education with a major in Physics and Mathematics. These institutions base their teacher preparation programs on regulations established by the *Institute for the Preparation and Development of Teachers* (INAFOCAM). This organization, under the MINERD, is also responsible for establishing the profile of entering students, as well as graduates, and for indicating the number of credits in teacher preparation programs and the distribution of practice and theoretical hours for each subject.

The MINERD is responsible for continuing teacher development in collaboration with the continuing preparation department of the MESCYT. It is important to consider the situation described in this report to understand the working conditions of Dominican teachers.

Keywords

Teacher preparation, Mathematics Education, Dominican Republic.

[23] This document is based on the article: González, S., Cruz, I., Caraballo, J., Blanco, J., Matías, E., y Ramírez, L. (2013). Informe sobre la formación inicial y continua de Profesores de Matemáticas: República Dominicana. *Cuadernos de Investigación y Formación en Educación Matemática*, 8 (número especial), 51–87, available at http://revistas.ucr.ac.cr/index.php/cifem/issue/view/1281. This article is a final version of a report presented to the *Workshop on Building Capacity in Mathematics and Mathematics Education,* CANP 2, held in San José, Costa Rica, in August of 2012. This work is part of the Network for Mathematics Education Network in Central America and the Caribbean: www.redumate.org.

1 Brief Description of Education System in the Dominican Republic

Levels and Cycles in Education in the Dominican Republic

The educational levels in the Dominican Republic are divided into:

- *Initial* This level is divided into three cycles: 0-2 years, 3-4 years (from 0 to 4 years only in private institutions at the present time) and a third cycle that is obligatory for all 5 year olds. There are almost 240,000 students at this level.
- *Elementary (Basic)* This level is obligatory and is divided into two cycles: the first cycle (grades 1 to 4) and second cycle (grades 5 to 8). There are approximately 1,650,000 students at this level.
- *Secondary*: This level is not obligatory, but is offered by the State. It is organized into two cycles. The first is common for all students. The second cycle is classified by modalities: General, Technical Professional and Arts. There are almost 560,000 students at this level in addition to over 180,000 in a modality specifically for adults.
- *Higher* The Ministry of Higher Education, Science and Technology (MESCYT) is in charge of this level. It is structured into three kinds of Institutions of Higher Education (IES): Technical Institutes of Higher Studies, Specialized Institutes for Higher Studies and Universities. The Technical Institutes of Higher Studies only offer two and three-year technical programs. The Specialized Institutes for Higher Studies offer undergraduate and graduate degrees in the specializations for which they were created. The universities can grant undergraduate and graduate, including doctoral degrees. There are 42 Institutions of Higher Education in the Dominican Republic with over 435,000 students.

National Diagnostic and Obligatory Tests

In the Dominican Republic a national diagnostic test is given at the end of grade 4. It is intended to evaluate competency in reading comprehension and Mathematics in accordance with achievement indicators. The results of this test are used to take actions that will contribute to improving the learning process. Also, questionnaires are given to principals, teachers and students to collect information on the socioeconomic context and opportunities for learning.

There are also obligatory National Tests given at the end of each educational level. Those tests evaluate achievement in Spanish, Mathematics, Social Sciences and Natural Sciences. There are three opportunities to take them in Secondary Education and two in Elementary Education. The results have a weight of 30% on the final grade that determines whether or not a student will be promoted.

2 Some Historical Facts Relevant to the History of Education the Dominican Republic

The historians, Fiallo and Germán (1999) and Almánzar(2008), have organized the most important episodes of legislation and teacher preparation that have affected Dominican Education into four periods:

From the Rise of the Dominican State to the Rise of the Normal Schools (1844-1879)

During this period the first law concerning public instruction in elementary schools was enacted and with it the Dominican education system was created. The law created regulations for the management of the schools. It further established that schools should have exercises in grammar and arithmetic operations, as well as formal tests. In 1846 the government established programs of study for both elementary and secondary schools.

From Normal Schools to Occupation by the United States of America (1879-1924)

The Normal Schools were created in 1879. In 1881 the Institute for Young Ladies was created to prepare female teachers. The Normal Schools became Central Colleges in 1885, but began to reappear as Normal Schools beginning in 1900. Farm Schools and rural schools were created. It was during this period that education became obligatory for boys and girls from 7 to 14 years old in co-educational settings.

From the End of the Occupation by the United States of America to the Dictatorship of Rafael Trujillo (1924-1961)

In this stage, the teaching force and secondary schools were reorganized, and untrained teachers were given tests so they could be formally accredited as teachers. The principles of the "New School" were established with the help of a "Chilean Mission" supervised by the Secretariat of Education. In turn, new Normal Schools were converted into centers specialized in teacher preparation. Also, new programs were established for elementary, intermediate and secondary schools.

In 1951, a law was enacted related to public schools that required elementary teachers to be graduates of a Normal School, and that secondary teachers had to have a Bachelor's Degree or doctorate.

From the Birth of Democracy to Today

This period has seen the diversification of secondary education and the universities began to prepare secondary teachers. Massive programs for the professional development of in-service elementary teachers were carried out. An Inter-University Agreement (UASD, UCMM, UNPHU, SEEBAC y UNESCO) was signed for secondary teacher preparation (1972-73). This agreement led universities to create departments or schools of Education to prepare teachers in different areas. Several new programs were established: a Ten-Year Plan with new regulations for education; the Program for the Development of Elementary Education (PRODEP); an elementary teacher preparation program (UASD, PUCMM, INTEC, UCE); the creation of the Salome Ureña de Henríquez Teacher Preparation Institute (ISFODOSU); and the secondary teacher education program conducted by the universities under the supervision of the National Institute for the Preparation and Professional Development of Teachers (INAFOCAM).

3 Initial Preparation of Teachers

As was mentioned above, initial teacher preparation has been linked to the different historical periods. This preparation became important when the law was passed requiring teachers to be graduates of formal programs. It was supported by the Inter-University Agreements, and by the creation of common programs that were developed with assistance from UNESCO.

"Modern Mathematics" was implemented in the teacher preparation process. New textbooks and continuing teacher preparation programs were also developed to support "Modern Mathematics" (Gonzalez, 2011).

For the preparation of Mathematics and Physics teachers textbooks were used from the School Mathematics Study Group (SMSG) and the Physical Science Study Committee (PSSC) in the United States of America where both series had been used in high schools. In Algebra courses the book by Allendoerfer and Oakley (McGraw-Hill, 3ª ed. 1972) were used. Leithold and Swokowsky books were used for Calculus. In General Physics at the university level the books of Feynman and Sears were adopted.

In the 1990s, the State Secretariat for Education, Fine Arts and Culture (SEEBAC) established programs for the continuing preparation of teachers. At the Elementary level four universities implemented a program for teachers with Normal School degrees: the *Program for the Development of Elementary Education* (PRODEP). For teachers without higher education degrees the *Program for Professionalizing Teachers* (PPMB). Approximately 8000 teachers from throughout the country took part in both programs.

Also in this period the General Law of Education No. 66´97 was passed. In its Article 222 the Normal Schools and the National School of Physical Education were elevated to the level of higher education. Today they constitute ISFODOSU. This same law created INAFOCAM as a decentralized organization, affiliated with the Secretariat of Education and in charge of coordinating professional development programs offered to teachers.

3.1 The Structure of Initial Teacher Preparation

There are currently 42 Institutions of Higher Education (IES) in the Dominican Republic. Twenty-two of them offer programs in Elementary Education and 15 offer the program in Secondary Education with an Emphasis in Mathematics and Physics.

According to the *General Report on Higher Education Statistics 2006-2009* of MESCYT, the Education programs were the second most in demand in 2006, 2007 and 2008 with respectively 15%, 14% and 12% of the total enrollment. It slipped to fourth place in 2009 with 11% of the total. The graduation rate for four-year Education programs was around 24% (MESCYT, 2011). Most of the students were enrolled in Elementary Education programs and less than 1% were in the Mathematics and Physics programs.

The Elementary Education enrollment is concentrated in eight of the 22 IES that offer them and have 92% of the enrollment. For Mathematics and Physics four of the 15 have 82% of the total enrollment for that Emphasis.

3.1.1 The Elementary Teacher Education Program

Institutions of Higher Education that offer Elementary Education Programs must base their program of studies on Ordinance 1-2004 that was established by the National Institute for the Preparation and Professional Development of Teachers (INAFOCAM). This ordinance sets the student entrance and graduation profiles, and the distribution of courses to be taught. It also establishes the curriculum for the program with lists of courses, the number of credits for each course, the distribution of practical and theoretical hours for each course, as well as the organization of courses into academic periods.

This ordinance also establishes two concentrations for the Elementary Education program: one for teachers in the First Cycle (preprimary to grade 4) and another for the Second Cycle (grades 5 to 8). The programs of study have the first year in common. Beginning with the second year, some courses are in common and some are specific to the particular Cycle.

There have been modifications to improve this ordinance, but there are still reforms in progress that are not yet reflected in the current preparation programs. The curriculum requires courses in four basic areas: Mathematics, Spanish, Natural Science and Social Sciences. The Mathematics courses are organized as Integrated Studies in Mathematics I, II, III and IV. The other areas are similarly organized. The term "Integrated Studies" refers to integrating the content with the teaching and learning methodology specific to the area. In practice, in the majority of cases, specialist report that such integration is often not achieved.

We can group the courses in six strands in which the contents for teacher preparation are organized. The strands are the following:

1. General Education: Regular courses from those offered by the IES
2. Content Courses: Spanish Language, Natural Sciences, Social Sciences, Foreign Languages, Technology, Arts, Electives.
3. Mathematics Content Courses
4. Pedagogical Courses: Pedagogical Theories, General Teaching Methods, Guidance and Counseling, Psychopedagogy, Planning, Psychology.
5. Mathematics Teaching Methods
6. Student Teaching

For this document we have considered the programs at only the eight of 22 IES's that prepare 92% of future Elementary teachers. Of those eight, two are public and the rest private. However, it is important to mention that INAFOCAM does supervise the programs in the private institutions.

An analysis of the programs in those eight institutions shows that no more than 10% of the credits are in Mathematics content courses. Pedagogical courses oscillate between 26% and 40%, but less than 8% of those are specific to Mathematics Education. In all of the programs, student teaching is distributed in different parts of the curriculum, but always has teaching methods courses as prerequisites.

3.1.2 The Secondary Education Program with a Major in Mathematics and Physics

To analyze the components of the preparation in Mathematics Education with an Emphasis in Physics and Mathematics the four Institutions of Higher Education that had about 82% of the enrollment from 2006 to 2009 were chosen.

Below the courses are classified into the following six thematic strands:

1. General Education: Philosophy, Art, Introduction to University Life, Ethics and other general courses at each IES

2. Content Courses: Letters, Natural Sciences, Social Sciences, Languages, Technology, Physics, Arts, Electives.
3. Mathematics Content Courses
4. Pedagogical Courses: Pedagogical Theories, General Teaching Methods, Guidance and Counseling, Psychopedagogy, Planning, Psychology.
5. Mathematics Teaching Methods
6. Student Teaching

After analyzing these programs and reviewing other offers that were not part of the report and that contributed very little to the national enrollment for this Emphasis it can be affirmed that:

a) The programs include the majority of the contents of basic Mathematics that are taught in Secondary schools: Algebra, Trigonometry, Geometry, Advanced Algebra, Statistics and notions of Infinitesimal Calculus.
b) Mathematics teaching methods are concentrated in one course or in another case are presented as "Mathematic Teaching and Student Teaching".
c) The History of Mathematics is only found in two of the programs studied. In another, the history of Mathematics is integrated into a course on the History of Physics.
d) These programs do not include technology as a specific strand. Only 2% of the credits in the programs are related to technology topics and in no case is there a specific course on technology applied to Mathematics.
e) Student Teaching is present in different academic periods in the programs, but one of the programs does not include Student Teaching.

It is important to note that recently standards for the initial preparation of teachers have been established. They have been published by the MESCYT in a document called *Plan for Reformulation of Teacher Preparation* (Vincent, 2010). To operationalize the standards ten dimensions have been established: Curricular structure, general preparation, content preparation, pedagogical preparation (theory and practice), pedagogical content preparation, entry level profiles, organizational structure and management capacity, teaching and support personnel, infrastructure, learning services and resources, and evaluation systems. In addition to the "dimensions" there are 47 "criteria", 191 "quality indicators" and 263 "items of evidence" (p. 137). The new programs should include a system of supervised student teaching and internships, with common parameters, clear indications of the organization and distribution of academic loads. Along the same lines, it is worth pointing out that the Ministry of Education (MINERD) is offering scholarships to prepare young people who are interested in being a part of the education system as teachers.

4 Continuing Preparation

The MINERD is responsible for Initial, Elementary and Secondary Education as well as continuing preparation of teachers in collaboration with MESCYT's Continuing Preparation Department. These two ministries organize teacher preparation to cover the needs of in-service public school teachers. INAFOCAM is in charge of implementing the preparation.

INAFOCAM has set the following objectives for the continuing preparation of teachers

- Implement preparation processes that develop teacher competencies that permit the practical use of reflexive and participatory methodologies.
- Strengthen teacher capacity and competence so they can demonstrate quality work in the contexts in which they work.
- Use professional development processes that support teachers in developing reflexive and inquiry-based practice that consider the reality of the students and the school.
- Develop school and classroom leadership in the context of the community.
- Promote a preparation that uses quality learning resources, including Information and Communication Technologies (OEI, 2003, p.12).

The institutions of Higher Education are invited to present proposals for continuing preparation, which are evaluated by criteria set by the two ministries. The approved proposals are those that fulfill the structure established by INAFOCAM. Courses and workshops are being offered to in-service teachers all the time. Some

are focused on pedagogical topics such as educational planning and evaluation of learning. Others focus on disciplinary content. The purposes and priorities of continuing preparation respond to curricular changes and innovations that the MINERD would like to implement. The tests administered to students and reports from classroom observations made by district level specialists are also used to detect continuing preparation needs.

INAFOCAM sets the prerequisites needed by teachers to be able to participate in continuing preparation programs. The main prerequisite is to be an active teacher in the public sector who teaches the subject or topic on which the course is based and to work in the region where the course will be offered. Teachers from the private sector are responsible for their own professional development. In some cases, private institutions cover the costs of the continuing preparation of their teachers.

MINERD and MESCYT develop scholarship programs so that as part of their continuing preparation teachers can participate in national and international conferences, as well as in Master's and doctoral programs.

Other professional development activities are carried out in the country by the program called *Support Policy for the Primary Grades*. This program focuses on Spanish and Mathematics. Three institutions collaborate with the MINERD on this program. The Pontifical Catholic University Mother and Teacher (PUCMM) works in the Regional Educational Directorates in Cibao and the north, as well as in the Herrera District 15-05 of Region 15 in west Santo Domingo. The Poveda Cultural Center attends the Regional Directorates of the south and of Santo Domingo. The Organization of Ibero-American States deals with the three Regional Directorates in the eastern part of the country. This program offers professional development to primary teachers (grades 1 to 4), and district technicians specialized in Mathematics, as well as teacher coordinators and assistant principals that work with teachers.

For Mathematics in the zone it attends, PUCMM uses a series of textbooks designed for the program. The books were written to be aligned with the curriculum proposed by MINERD in order to achieve its objectives. Kits of manipulatives that were selected in accordance with purposes of the Mathematics classes (base ten blocks, *Cuisenaire* rods, pattern blocks, tangrams, measurement tools, etc.) have been distributed to all schools. The teachers are also supported by teaching coordinators in their schools. This program originated in another initiative in the PUCMM that has been funded by the U.S. Agency of International Development (USAID) that began in 2006 and will continue until 2014. At least 150 hours of face-to-face professional development have been offered to teachers. The mathematical concepts taught at this level and the corresponding competencies have been emphasized. A profound knowledge of the Mathematics curriculum (topics and strands, knowledge, communication, reasoning, problem solving, connections, valuing Mathematics, decision making) and efficient use of class time have also been emphasized. A teachers' mentoring program was also designed by this program and is being implemented in schools.

Recently the country has dedicated 4% of the gross domestic product (GDP) (Previously, the country dedicated around 2% of GDP.)to provide additional resources for education. With this additional funding it is hoped that initial preparation programs will offer true opportunities for young people interested in becoming educators, as well as for in-service teachers who wish to improve their teaching. For Mathematics the MINERD plans to continue the teacher professional development that has been offered to teachers in grade 1 to 4, and expand it to the rest of the pre-university system. The programs must be restructured to address the standards for those levels and to respond to the curricular changes proposed in 2012.

5 Research in Mathematics Education

In 2008 the *Dominican Institute for Evaluation and Research on the Quality of Education* (IDEICE) was created by the National Council of Education using Ordinance 03-2008 based on the General Law of Education 66'97. IDIECE is a decentralized public institution, affiliated with the MINERD, of a technical nature dedicated to Educational Research.

However, it should be pointed out that given its recent creation the number of published research reports is still small. In reality there are no local doctoral programs that permit research. Currently only three universities have doctoral programs, one public and two private. Only one of them is organizing a Mathematics Education program.

Other research is carried out by INAFOCAM. Its team of researchers continuously monitors the preparation programs that it finances as well as other studies on teacher preparation in the Dominican Republic.

In 2003, the *Evaluation and Educational Research Consortium* (EERC) was created by the Pontifical Catholic University Mother and Teacher (PUCMM), the State University of New York, and the Santo Domingo Institute of Technology. EERC carried out the *Monitoring and Evaluation Study of the Quality of Education in the Dominican Republic*. It followed a population of 26,000 students in grades 3 to 7 for three years to evaluate their performance in Mathematics and Reading comprehension. One of the main objectives was to determine in which grade most of the students have the competencies expected for grade 4.

Beginning in 2006, and continuing until 2014, PUCMM, with support from the U.S Agency of International Development (USAID), provided a program of professional development to more than 4000 public school teachers in the north of the country and in one area of Santo Domingo. This program, mentioned above, included a component of Monitoring and Evaluation in which the knowledge that the teachers needed to teach the Mathematics was tested by having them take the same tests that their students took at the end of each school year. The results were used to determine needed teacher professional development and to study the impact of teacher mathematical knowledge as an explanation of student performance. Also, every year students are evaluated to determine the impact of the program intervention on their achievements.

6 Relation between Initial and Continuing Preparation and the School Mathematics Curriculum

Currently, in the Dominican Republic, both the school curriculum, and programs for initial and continuing teacher preparation, are being revised and modified. This modification proposes a competency model for both curricula. There has been a restructuring of the system. Elementary School is now from grades 1 to 6, with two cycles (from grades 1 to 3 and from grades 4 to 6). Secondary school will include grades 7 to 12.

New programs are being developed for continuing preparation at a national level that will provide professional development for in-service teachers.

For initial teacher preparation, there will be programs for teachers of the first cycle of Elementary Education, certain specializations for teachers of the second cycle, for example teachers for Mathematics and Science, and specialized teachers for each secondary subject.

7 Main Strengths, Weaknesses, Threats and Challenges

Strengthens

- About 92% of students have access to a grades 1 to 8 education, and drop out and grade repeating rates are down.
- Diagnostic studies have determined teacher professional needs and quality standards have been set. The Ministry finances professional development programs that include classroom support to improve in-service teacher performance. Adequate programs for the continuing preparation of Mathematics do exist.
- Initial teacher preparation programs have been revised and are coherent with set standards.
- Training programs for Principals have been created.
- Teachers can now specialize in the level they will be teaching.
- The use of manipulatives for the teaching and learning of Mathematics has been introduced in grades 1 to 8.
- There is a greater consciousness in all sectors of the country of the importance of education in overcoming poverty.
- A teacher evaluation program has been created to admit new teachers into the educational system

Weaknesses

- Access to upper secondary education is barely 37%. Drop out and absentee rates are high in regions where school aged children are in the workforce.

- There are many teachers with official certification, but such certification does not necessarily mean that they are indeed qualified. Many teachers are prepared by the system, but there is often a lack of commitment to the system once they are prepared.
- The majority of teachers work two shifts so there is little time for planning and design of meaningful and challenging teaching-learning strategies. Nor does such a situation facilitate the professional development of in-service teachers. Contracting teachers is sometimes the result of political party affiliations rather than professional competence.
- Special programs do not reach all regions.

Threats

- Preparation programs do not last long given the institutional weakness of the system.
- Teacher compensation policies do not attract the strongest students to the teaching profession.
- There are limited resources for teacher preparation and purchase of adequate materials.
- Some teacher preparation institutions do not have human resources with backgrounds adequate for carrying out their programs nor the resources and infrastructure required to offer good quality programs.
- There is little integration of Information and Communication Technologies into the teaching-learning process. Thus the technological gap between students with higher socio-economic status and those from more deprived sectors is deepening.

Challenges

- Increase Access to upper secondary education.
- Provide opportunities for talented youths to become Mathematics teachers. Structure policies that attract talented youths to the teaching profession, particularly to Mathematics teaching.
- Improve the teacher preparation programs in the Institutions of Higher Education. Provide oversight to ensure that programs fulfill the standards set by the MESCYT and MINERD.
- Improve the quality of those who work in teacher preparation. Create solid Master's and doctoral programs to prepare Mathematics teachers at the highest level.
- Create professional development programs for in-service Mathematics teachers at all levels of the system.
- Make a commitment to have better professors in the Institutions of Higher Education that offer such programs.
- Identify excellent textbooks for Mathematics.
- Improve the teacher compensation system.
- Increase the use of Information and Communications Technologies in the teaching-learning of Mathematics.
- Prepare the needed number of strong Mathematics teachers that will permit learning opportunities to be offered to 95% of Dominican children and youth at all levels.

8 Conclusions

In the last few years the Dominican Republic has made important attempts to provide certified teachers to the system. Various in-service teacher professional development programs have been developed. INAFOCAM has implemented scholarship programs that have helped many teachers. Nevertheless, these efforts have not translated into improvements in student learning.

One of the challenges for Dominican education is to create Master's and doctoral programs to prepare teachers at the highest level, with qualified and experienced professors, especially in the basic sciences. The quality of programs and courses of continuing education must be strengthened to respond to the needs that have been detected. Also, the results of research on curricular design must be linked to teacher preparation programs. There is evidence that teachers at all levels have significant weaknesses in their mathematical knowledge in general and in particular with respect to the Mathematics they teach. They also have

weaknesses with respect to specialized methods and strategies for facilitating and evaluating the learning of Mathematics. Therefore, initial and continuing preparation programs must focus on these detected weaknesses.

The panorama that has been described in this report reflects that the Dominican Republic has much to do to improve education. One of the central aspects in this sense is the preparation of qualified teachers that can successfully confront the challenges demanded by modern society.

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10 Appendix: Meanings of Acronyms

Acronyms	Meanings
CORENOR	Commission for the Restructuring of Normal Schools
EERC	Evaluation and Educational Research Consortium
IDEICE	Dominican Institute for Evaluation and Research on the Quality of Education
IES	Institutions of Higher Education
INAFOCAM	Institute for the Preparation and Development of Teachers
INFOTEP	Institute for Technical Professional Preparation
ISFODOSU	Instituto Superior de Formación Docente Salomé Ureña de Henríquez
MESCYT	Ministry of Higher Education, Science and Technology
MINERD	Ministry of Education
OECD	Organization for Economic Co-operation and Development
OEI	Organization of Ibero-American States
PSSC	Physical Science Study Committee
POMA	Diagnostic Test for Academic Measurement
PRODEP	Program for the Development of Elementary Education
PUCMM	Mother and Teacher Pontifical Catholic University
SEEBAC	State Secretariat for Education, Fine Arts and Culture (previous name of the Ministry of Education)
SMSG	School Mathematics Study Group
UASD	Autonomous University of Santo Domingo
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNPHU	National University Pedro Henríquez Ureña
USAID	United States Agency for International Development

Venezuela: Initial and Continuing Preparation of the Mathematics Teacher

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Summary

The academy and society are interested in teacher preparation because of the implications it has for teaching practice and, consequently, for student learning. Based on this premise, the initial and continuing preparation of teachers was one of the focal points of the *International Workshop on Building Capacity in Mathematics and Mathematics Education*, CANP 2012, that was held in Costa Rica in August of 2012 sponsored by ICMI (International Commission on Mathematical Instruction) and IMU (International Mathematical Union). Each delegation participating in the event prepared a report on the situation in their country. This article is a summary version for the case of Venezuela (León, Beyer, Serres, Iglesias, 2013). Here[24] we begin with a description of the Venezuelan education system to then indicate elements of initial and continuing preparation of the Venezuelan Mathematics teacher that include: a brief historical contextualization; the structure and content of initial preparation, highlighting the relationships among the pedagogical and mathematical preparation and its link with professional practice; continuing preparation and the role of research in the preparation and professional development of both elementary and secondary teachers; and the connection of said preparation with the school curriculum. Finally, the most notable weaknesses and strengths will be indicated, and the main medium term and immediate challenges faced in Mathematics teacher preparation will be enumerated.

Keywords

Teacher preparation: initial and continuing preparation; context; challenges

[24] This document is based on the article: León, N., Beyer, W., Serres, Y., & Iglesias, M. (2013). Informe sobre la formación inicial y continua del docente de Matemática: Venezuela. *Cuadernos de Investigación y Formación en Educación Matemática*, 8 (número especial), 89–129, available at http://revistas.ucr.ac.cr/index.php/cifem/issue/view/1281. This article is a final version of a report presented to the *Workshop on Building Capacity in Mathematics and Mathematics Education,* CANP 2, held in San José, Costa Rica, in August of 2012. This work is part of the Network for Mathematics Education Network in Central America and the Caribbean: www.redumate.org

1 The Venezuelan Education System

According to the current Organic Law of Education (LOE, 2009), the Venezuelan education system is an organic and structured set of levels and modalities according to the stages of human development. It is based on the principles of unity, responsibility and interdependence. Its purpose is that the educational process and permanent preparation of every citizen be assured regardless of differences in age, sex, or ethnic or cultural diversity. It should attend the local, regional and national needs and potentials. The organizational structure is shown in Table 1.

Table 1

Current Organization of the Venezuelan Education System

Subsystems	Levels		Duration
Basic Education Subsystem	Initial Education	Maternal	Boys and girls from 0 to 6 years old
		Preschool	
	Elementary Education	----------	6 years
	Secondary Education	General Secondary Education	5 years
		Technical Secondary Education	6 years
University Education Subsystem	Undergraduate	Short programs	3 years
		Long programs	5 years
	Graduate (leading to a degree)	Specialization	Up to 4 years
		Master's	Up to 4 years
		Doctorate	Set by each university

Sources: LOE (2009) and the National Council of Universities (CNU, 2001 and 2011)

LOE (2009) indicates that the Venezuelan State, through its Ministry of Popular Power for Education (MPPE) and Ministry of Popular Power for University Education (MPPEU), is in charge of the planning, coordination and implementation of educational policies and programs. The National Council of Universities (CNU) in the MPPEU is the link between the MPPEU and the universities. It coordinates admissions to the institutions of Higher Education assigning a percentage of the available quotas. A National Test of Vocational Exploration is given annually to orient upper secondary graduates in choosing careers. For the teaching career there is no specific recruiting mechanism.

According to official data that was provided by the Vice Ministry of Academic Development of the MPPEU for a presentation of the United Nation's Economic and Social Council, during the 2010-2011 school year there was 71% access in Initial Education, 93% in Elementary Education and 73% in Secondary Education. For that same period, a total of approximately 7,739,000 students with 6,074,000 in public schools and 1,665,000 in private were reported. There were 503,240 teachers, 28,908 educational institutions, 297,716 sections of classes and 234,094 classrooms (Reinoso, 2011).

For the subsystem of University Education, the institutions are classified as: Universities and Institutes or University Colleges. In 2003, approximately 74,000 students were enrolled at this level. In the universities there were almost 50,000 students: 39,000 in public and 11,000 in private. There are five public universities that are classified as autonomous and 30 that are classified as experimental. There are also private universities. In 2005, 14 public universities, and four institutes or university colleges offered teacher preparation programs (Peñalver, 2007).

2 Teacher Preparation in Venezuela

2.1 Origins and Historical Evolution

It can be said that education as an obligation of the State in a systematic and organized manner began in 1870 with the Decree on Free and Obligatory Public Instruction. Soon, the first Normal Schools were created to prepare teachers for the elementary schools.

However, it was not until 1936 with the creation of the National Pedagogical Institute (IPN) in Caracas that there was preparation for secondary and Normal School teachers. A pedagogical mission from Chile supported the creation of the IPN and the introduction of the New School into the country. The inauguration of the IPN marked an inflection point in Venezuelan education. It happened at a time of political, economic and social changes that were

the product of the death of the dictator Gómez in 1935, the oil boom, the slow democratization of the country, and the large exodus from rural areas to cities.

With various ups and downs, in both attention to public schools at all levels and to teacher preparation, each government applied dissimilar educational policies. Thus, in 1958 with a fall of a dictatorship there was a return to a populist educational model and the creation of the pedagogical institute in the city of Barquisimeto. In 1965 the Pedagogical Institute in Caracas adopted behaviorism and the Bourbakistic model of Mathematics. In 1969 a general reform of education at the elementary, secondary and Normal school levels brought in Modern Mathematics to elementary and secondary schools, accompanied by behaviorism and the elimination of the old Normal Schools. Teacher education became a new undergraduate program.

In the 1970s the enrollment growth in secondary schools led to the creation of new Pedagogical Institutes: in Maracay and Maturín in 1971, and the "J. M. Siso Martínez" and a one private both in Caracas in 1976. Also, various universities began progressively to offer teacher preparation programs in Mathematics. However, the pedagogical institutes still had the major role in teacher preparation.

In 1980 a new Organic Law of Education was enacted. It moved the elementary and secondary teacher education to a university level. This process culminated in 1983 with the creation of the Liberator Experimental Pedagogical University (UPEL). It absorbed the pedagogical institutes and became the main teacher preparation institution in the country. "Modern Mathematics" was eliminated and "Back to Basics" was adopted.

Finally, in 2009, another new Organic Law of Education (LOE, 2009) was passed. It set out guidelines for the initial and permanent preparation for a teaching career. It also established the current structure of education that is shown in Table 1.

2.2 The Initial Preparation of Mathematics Teachers

Teacher preparation in Venezuela is governed by regulations presented in Resolution N° 1 in force since 1996. There the profile of an educator is conceived in the context of permanent education in which there is a constant search for professional development for personal and academic growth. A four part curricular structure is established to support that search: General, Pedagogical, Specialized and Professional Practice. The contents of these areas must be articulated with an equilibrium between the ethical, conceptual preparation and its projection into practice in the school environment. Also, the percent of coursework dedicated to pedagogical preparation and professional practice is stipulated to be at least 30% of the total.

Moreover, LOE (2009) in Article 15, states that Mathematics will be studied during every school year. Its purpose will be to develop the capacity for abstraction and critical thinking. To do so, innovative methods that promote learning from everyday experience will be used. Now that Mathematics is required every year there is a need for an even greater number of Mathematics teachers at a time when there is already a deficit in the number of secondary Mathematics teachers.

Secondary Mathematics teacher preparation is offered in several public universities: the Liberator Experimental Pedagogical University (UPEL), the Central University of Venezuela (UCV), the University of Carabobo (UC), the University of the Andes (ULA), the University of Zulia (LUZ), the University of the East (UDO), the National Experimental University Simón Rodríguez (UNESR), the National Open Universidad (UNA), National Experimental University of Guayana (UNEG), the University Simón Bolívar (USB) and the National Experimental University Rafael María Baralt (UNERMB); as well as in private universities such as the Catholic University Andrés Bello (UCAB) and the Catholic University of the Táchira (UCT). This all grant degrees such as: Teacher of Mathematics, Bachelor's in Education with an Emphasis in Mathematics or Mathematics and Physics, Mathematics Teaching, Mathematics and Computing. These programs last from between four and five years, usually in a semester system with face-to-face presentation. An exception is the UNA which offers distance programs (CNU, 2011).

In addition to those universities mentioned above there are many institutions that prepare teachers to teach Mathematics in Elementary schools. These include the Bolivarian University of Venezuela (UBV), the National Program for Educator Preparation (PNFE) as well as Institutes and University Colleges. In both the public and private sector they grant equivalent degrees such as Teacher or Bachelor's of Integral Education or Integral Elementary Education. Also, they offer three-year programs that grant the degree of Higher Specialist in Integral Education (CNU, 2011).

UPEL has the largest number of Education students. It offers a wide variety of specializations: Mathematics in the Pedagogical Institutes of Caracas, Barquisimeto, Maracay and Maturín, and Integral Education for Elementary teachers, who must teach Mathematics, in all its institutes.

With respect to the contents of the preparation of secondary Mathematics teachers, it should be pointed out that the majority of the universities follow a traditional model by components that were established in Resolution N° 1. There is an emphasis on the acquisition of knowledge and competencies that, according to regulations, should characterize the graduate of this specialization as a teaching professional with a high level of preparation in fundamental theories, principles and techniques in the teaching of Mathematics as a specific discipline. The graduate should also have the capacity to teach Mathematics according to its processes in a permanent interaction with students. Also, the capacities as a researcher in Mathematics Education, a communicator and motivator of student creativity, and a social outreach activist in the community are emphasized.

According to this theoretical profile, a graduate with a specialization in Mathematics should be a professional with a solid preparation in Mathematics which should be accompanied by a preparation for teaching that permits the design of learning experiences and situations related to the mathematical contents of the educational level. However, in reality the product obtained does not fulfill many of these expectations.

Table 2 summarizes the program of studies for five of the most important universities in the country.

Table 2

Distribution Credits and Number of Courses by the Areas of Preparation in Five Venezuelan Universities

Area of Preparation	UPEL		LUZ		UCV		UC		UNA	
	UCR %	**N° Courses**	**UCR %**	**N° Courses**	**UCR %**	**N° Courses**	**UCR %**	**N° Courses**	**UCR %**	**N° Courses**
Specialization	40	21	47	16	67	15	37	17	35	14
Pedagogy	30	15	22	12	23	8	30	16	34	13
Professional Practice	15	4	16	4	9	1	13	2	7	2

In the administration of this ideal curriculum a separation into disjoint components occurs. This is no more than a reflection of the epistemological perspective that underlines the conception of teacher preparation in Venezuela. According to Parra (2006), teacher preparation has two characteristic features: a parceling of knowledge and a disconnection of theory with reality. Thus, upon graduation and taking a teaching positions, new teachers encounter serious difficulties in trying to adapt what they know with the requirements of the level at which they are teaching and the cognitive development of their students. This is because both their mathematical and pedagogical preparation are inadequate, excessively theoretical and without any points of convergence.

Furthermore, the Mathematics courses are intended to be rigorous, even though there is more of an attempt to cover a lot of content rather than to arrive at a profound understanding. The majority of professors follow a traditional model of teaching based on a conception of Mathematics as a deductive and abstract discipline. They center their teaching on a didactic scheme of definition-theorems-exercises with an emphasis on the formality of mathematical language. Also, much of what future teachers learn will never be what they teach. The topics they will have to teach, and for which they should have both conceptual and pedagogical knowledge, are either not taught or are taught in an inappropriate manner.

Table 3 summarizes the number of Mathematics courses in five universities.

Table 3

Number of Courses in the Area of Specialization in Mathematics

Area	UPEL	LUZ	UCV	UC	UNA
Geometry	2	2	1	3	1
Calculus and Analysis	7	4	6	4	4
Algebra	5	2	2	3	2
Probability and Statistics	1	2	2	1	2
Physics	0	5	2	2	3
Others	5	1	2	4	2

The pedagogical preparation intends to present the key elements of the diverse facets of a teacher's work. Thus, the future teacher will have the theoretical tools to be used with innovative resources and strategies. However, in reality, the study of the teaching and learning processes includes some general knowledge along with techniques and instruments that trivialize educational action without an understanding of its complexity. This is made worse by the very little specific attention to Mathematics teaching as it is reduced to one or two courses. An exception is UNA whose curriculum has four courses on Mathematics teaching methods including a specific course on the Evaluation of Mathematical Learning. UNA also has a course on the integration of Mathematics and Sciences.

Student teaching varies across the universities. The UCV includes a course on administrative-teaching practice at the very end. UNA has student teaching courses in the last two semesters. UC and LUZ have three courses on professional practice beginning in the fifth semester. UPEL has four phases (observation, trial, research project and integration of teaching-research), with the last three at the end of the program of studies.

Student teaching in the last two semesters at UPEL is the moment of professional identity. It is where the participants begin to visualize themselves, and are seen by others, as the teachers they will become. It is their opportunity to share the educational environment, not as mere observers, but as participants in the academic and administrative processes that take place there. It is also the time to confirm their exit profiles. They should demonstrate: A conceptual command of Mathematics; a capacity to design innovative strategies, resources and techniques that support mathematical learning in the contexts in which they will work; leadership which is translated as moral and cognitive authority in cooperative work; respect for others and a disposition to make joint decisions; a professional and personal performance sustained by ethics and values.

Future Elementary teachers who will teach Mathematics are to become integrative educators who teach all subjects in a specific grade and therefore need to know all subjects and be able to integrate them.

The program of studies for Integral (Elementary) Education follows the same structure as that of secondary Mathematics, maintaining the same relationship among the pedagogical, specialized and professional practice components. The Component of Specialized Preparation is distributed across the various areas in which teachers need to be prepared: Language and Communication, Mathematics, Social Sciences, Citizenship and National Identity, Natural Sciences and Education for the Workplace. Teachers need to be able to teach those subjects with an interdisciplinary focus guided by the following integrative strands: health and the environment; interculturality; Information and Communication Technology; and liberating work, language, human rights and culture for peace, sovereignty and defense of the nation (Ministerio del Poder Popular para la Educación, 2007).

The mathematical preparation of this integrative educator is reduced to two Mathematics courses and one in Geometry. In some cases there are also courses in Statistics and Computing. The purpose of the Mathematics courses is to provide a preparation that is theoretical-conceptual as well as methodological. It should be in accordance with the requirements of the Elementary Education curriculum; linked to the educational, social and human context; and include the study of number, polynomials, measurement and proportionality. The Geometry course has the declared purpose of contributing to logical, deductive and spatial reasoning of the future teacher in a problem solving environment that permits the visualization of the connections of Geometry to the physical world and everyday situations. The contents are basic elements of plane and solid geometries. According to the regulations, these courses should be taught in such a way that the future teacher will not only achieve conceptual knowledge, but will also learn how to teach that knowledge and will feel prepared to carry it to the classroom without showing any feelings of rejection or negative attitudes towards Mathematics that could be transferred to students. Nevertheless, in practice this is going to depend on the professors of these courses, many of whom are unfamiliar with the context of Elementary education, know few strategies that are applicable at that level, and know little about how children learn.

The pedagogical and professional practice preparation follows guidelines similar to those described for Secondary Mathematics teachers. The difference being that they take place in elementary schools.

3 The Continuing and Graduate Education of the Mathematics Teacher

If we understand continuing preparation to be all that follows receiving an undergraduate degree, then it can be classified as: preparation that leads to an academic degree (specializations, Master's and doctorates), or preparation that does not lead to an academic degree (extension courses, updating, professional development, post-doctorates) (CNU, 2001).

In Venezuela, the LOE (2009) defines permanent preparation as an integral continuous process that by means of policies, plans, programs and projects, updates and improves the level of knowledge and the performance of the managers and stewards who prepare future citizens. That is, permanent preparation is regulated by the State and proceeds from initial preparation to post-doctorates, including extension courses, updating and professional development. Permanent continuous preparation, understood as the professional development of teachers, intends to provide new visions and prepare teachers for new practices in the exercise of their functions.

The educational authorities charged with such policy development are those in the Ministry of Popular Power for Education and the Ministry of Popular Power for University Education. They have not been able to design a joint policy (nor separate policies) for the continuing preparation of Venezuelan teachers. Nor has there been an assessment of needs and priorities for the education system.

In practice it is basically the universities that have assumed the role of providing continuous preparation. They have developed initiatives such as *Samuel Robinson Goes to School* (UVC), *Academic Extension Programs* (UPEL and other universities) and ULA's *Venezuelan School for the Teaching of Mathematics*. The Venezuelan Association of Mathematics Education (ASOVEMAT) has sponsored regional and national academic events.

3.1 Entities in Charge of Graduate Preparation

The universities that offer graduate programs that lead to degrees in Mathematics Education are:

a) Preparation leading to Specializations: USB, the University of Valle of Momboy (UVM) and the National Experimental University Francisco of Miranda (UNEFM).
b) Preparation leading to a Master's: UPEL[25], LUZ, UDO, UC, UNEG and the National Experimental University Rómulo Gallegos (UNERG).
c) Preparation leading to a Doctorate: in the UPEL, specifically the Pedagogical Institute of Maracay has initiated a doctorate in Mathematics Education in 2013.

3.2 Content, Methodologies and the Populations in Graduate Preparation in Mathematics Education

The graduate programs in Mathematics Education emphasize mathematical contents, disconnected from contents related to teaching. They offer traditional face to face classes, except in the case of the USB which has virtual classes. The teaching is usually done by individuals who have degrees in the Teaching of Mathematics or in Pure Mathematics. An exception is the UPEL where Elementary teachers and other professional who work with Mathematics teach some of the courses.

The Doctorate in Mathematics Education emphasizes the preparation of researchers and the generation of theories concerning Mathematics Education.

4 Research in Mathematics Education and Academic Networks in Relation to Initial and Continuing Teacher Preparation

4.1 Programs and Lines of Research

Research in Mathematics Education in Venezuela is carried out mainly in graduate programs. However, there is no research agenda in Mathematics Education that is a product of those programs. The graduate programs are linked to a certain extent with research units or groups and their respective lines of study that have over time been consolidated in various universities throughout the country. They include the Center for Research in Mathematics Education at UPEL-Maturín, the "Dr. Emilio Medina" Center for Research at UPEL-Maracay, the Basic Research in Mathematics Education Unit at UNEG, the Program Teacher Thinking and Action within the Line of Research on the Teaching of Mathematics at LUZ, the Center for Research in the Teaching of Mathematics Using New Technologies at UPEL-Maracay, the Center for Research in Mathematics and Physics at UPEL-IPC, the "Juan Manuel Cagigal" Center for Research at UPEL-Miranda, the Unit for Research on Elementary Education at UC-Aragua, and the Group for Research and Dissemination in Mathematics Education created in the context of the Line of Research on Mathematics Teaching at UCV.

[25] In the Pedagogical Institutes at Caracas, Maracay, Maturín and Barquisimeto.

However, the impact of research carried out in Work Groups in these graduate programs has been very limited. The results are rarely disseminated and many proposals are not implemented. Work Groups are related to the general Education System. They research topics such as teacher preparation, history of Mathematics in Venezuela, the relationship between Mathematics and other disciplines, and the teaching of specific topics in Elementary or Secondary schools with the use of alternative strategies.

4.2 The Relation Preparation-Research

In the undergraduate teacher preparation programs of study there is no research component. However, Resolution N° 1 expresses foundations and features in the profile of future teachers that makes it necessary to cultivate reflection and action as the starting point for transforming the teaching and learning process and for fostering professional development. That is, the goal is to prepare teachers that base their practice on action research and employ research in their own continuous self-preparation. This is derived from permanent reflection as the catalyzing agent of inquiry and searching.

This preparation for research is carried out in courses in which theoretical-conceptual aspects of educational research are studied. Students design and carry out a research project. It is usually with an action research design to explore problematical situation in a specific educational context.

In theory, the relationship between teacher preparation and research is understood in a dual manner. On the one hand, it is thought of as preparing the future teacher to do research. On the other hand, it is considered that the preparation will be realized through research, intending that the future Mathematics teacher will develop certain research competencies. However, in the initial preparation at both the Elementary and Secondary levels, the emphasis is on the first of the two aspects mentioned above, but the preparation is not developed in a research environment.

5 Initial and Continuing Preparation, and the School Curriculum

In Venezuela it is evident that a disconnection between the State regulatory and planning entities, and the teacher preparation institutions exists. Especially, a marked lack of connections between curricular changes promoted by government entities and implemented at the Elementary and Secondary levels, and curricular changes in the teacher preparation institutions are now a tradition. The implementation of the Bolivarian Curricular Design began in 2007 at the school level and implied a need for the universities to redesign the teacher preparation curriculum, but that process is still incomplete.

It can be said that currently the main link between initial preparation and the school curriculum is the variety of professional practice experiences that are part of the students' program. These experiences have four phases. The first is a scientific observation phase with the purpose of arriving at an understanding of three relationships: teacher-student, teacher-school and teacher-community. There follows a trial phase directed at planning, carrying out and evaluating teaching in simulated situations, attempting to integrate mathematical and pedagogical content. Then the student realizes a research project to improve or transform a problem situation that has been detected in a school. In some universities that research leads to the presentation of a thesis. Finally, the moment of the greatest link between the school and the university arrives, but because it happens in the last semesters, it loses the formative character required in Resolution N° 1.

In the development of the component of specialization in Mathematics there is little reference to the school curriculum. The disciplinary contents are approached from a conceptual and technical point of view with some rigor. However, there are serious limitations in understanding them as objects for teaching at lower educational levels to facilitate student learning; that is, when they are part of school Mathematics (León, Bara y Azócar, 2013).

In the context of continuing preparation, the link between teacher preparation and school curriculum is sporadic. It responds to immediate needs such as the adoption of a new curricular design or the implementation of some national programs. In these cases, obligatory professional development courses are offered.

6 Strengths, Weaknesses, Opportunities and Challenges

Some factors exist in the initial and continuing preparation of Mathematics teachers in Venezuela that have a positive impact (strengths). Among the strengths are:

1. The existence of public policies concerning teacher preparation. As a part of political tradition, the Venezuelan Constitution has established what can be called the "Teaching State" in which the State has the power to establish rules for general action in teacher preparation that are of a compulsory nature. Also, currently the Venezuelan government is implementing projects such as CANAIMA, LEER and LIBRES, that are providing computers and textbooks. These should have repercussions in teacher performance and the teaching of Mathematics.

2. Graduate programs that have led to the development of diverse groups that have carried out and maintain an interest in doing research on the problems associated with Mathematics Education.

3. The existence of organizations for Mathematics teachers, such as ASOVEMAT, that have sustained efforts to improve teacher preparation in the country. Ties and agreements between teacher preparation institutions have been established both nationally and internationally. This has permitted fruitful interchanges and the presence in Venezuela of well-known research from various parts of the world.

Also, factors have been identified that have a negative effect (weaknesses) on the preparation of Mathematics teachers:

1. Much of the curricular structure of teacher preparation programs dates from the 1990s and therefore lags behind current knowledge and results from research in Mathematics Education. They also suffer from a deep fragmentation between content and pedagogy. This is also the case with some graduate programs. Additionally, the Elementary teacher preparation curricula have a weak mathematical component with only two general Mathematics courses and one geometry course.

2. Work conditions: The salary level of teachers obliges them to teach many hours of classes thus leaving little time for continuing preparation. However, the main incentive for taking courses or studying for a graduate degree is that such study leads to changes in professional classification and thus the possibility of a better salary. Also, there is very little follow-up of teachers by their universities or the Ministry once they take teaching positions.

3. There is a large shortage of secondary Mathematics teachers and the situation is getting worse as enrollments in secondary Mathematics teacher preparation programs have been falling.

In this context, the main threat is that current problems will become worse if corrective actions are not taken. Also, since the problems are more than just quantitative, it is possible that the numbers will be improved without improving the quality. It is even possible that quality will worsen if inadequate actions are taken.

Taking into account the strengths, weaknesses and threats that are mentioned above, the main challenges that confront the Mathematics Education community in Venezuela have to do with: Collecting reliable data to accurately quantify the teacher shortage and other parameters; determining with precision the weaknesses in current Venezuelan teacher preparation programs; encouraging more secondary school graduates to study to become teachers, particularly at the secondary level; promoting a profound renovation of the curricula for teacher preparation so that the mathematical component is sufficient and corresponds to the work that graduates will do in classrooms, as well as achieving an internal consistency among the various components; promoting mechanisms for continuing teacher preparation; contributing to a decrease in the gap that exists between educational reforms and the changes necessary in teacher preparation; developing follow-up and support mechanisms for teachers who enter the workforce; producing adequate materials that contribute to the improvement of initial and continuing teacher preparation; and incorporating teachers into projects related to research, innovation and development of teaching materials.

7 Closing Statement

The transformations and curricular changes over the years in Venezuela have resulted in positive changes in quantitative terms, but not necessarily with respect to the quality of education. Reality reflects a sustained deterioration in the mathematical preparation of teachers. This is more noticeable with Elementary teachers as compared to Secondary teachers, but is evident in student achievement at both levels. Also, it has not been possible to repair the dichotomy that exists between preparation in disciplinary content and preparation for teaching that content, and there remains a separation of theory and practice. In fact, these problems may have deepened. Equally, the duality teacher-researcher is not evident in initial teacher preparation where research is dealt with at a mainly theoretical level.

Continuing preparation is presented mainly in graduate programs that can lead either to an academic degree or a certificate, both of which are valid for salary increases. However, there has been little impact on the mathematical and pedagogical knowledge of the teachers. Consequently, there has been little impact in their professional practice, and in improving the teaching and learning of Mathematics. Moreover, no agenda for Mathematics Education research that is the product of those programs exists that could orient the determination of the key elements that currently affect the teaching of Mathematics. Such an agenda, should be oriented to a new conceptualization of continuing Mathematics teacher preparation that overcomes the idea of training and is focused on the creation of a culture of continuous learning.

Nevertheless, the Venezuelan Mathematics Education community has manifested concerns and in the universities there are those who are taking certain actions to improve the prevailing situation. Among those actions the revision of the curricular designs for Mathematics teacher preparation should be highlighted. Here are some of the questions that are being asked. What should be the preparation of Secondary Mathematics teachers and Elementary teachers? What should be the preparation that Secondary Mathematics teachers and Elementary teachers receive in psychopedagogy, sociology, philosophy, etc.? How do you offer an integral preparation, avoiding the fragmentation between Mathematics and the teaching of Mathematics? How can there be a stronger link in teacher preparation between theory and practice? All of these concerns are up for discussion and are concerns of those preparing the future Mathematics teacher educators.

Fortunately, certain favorable conditions do exist, mentioned above in this document, that if handled properly, could lead to actions that tend to overcome flaws and lead the preparation of Mathematics teachers down more promising paths. However, here we want to make it clear that the results of any change that is undertaken, whether it be in the conception that is held concerning initial and continuing preparation, the content of that preparation, the curricular orientations, etc., will depend in good measure on what we, the teachers of Mathematics, think and do.

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9 Appendix: Meanings of Acronyms

Acronyms	Meanings
ASOVEMAT	Venezuelan Association of Mathematics Education
CNU	National Council of Universities
IPN	National Pedagogical Institute
LOE	Organic Law of Education
LUZ	University of Zulia
MPPE	Ministry of Popular Power for Education
MPPEU	Ministry of Popular Power for University Education
PNFE	National Program for Educator Preparation
UBV	Bolivarian University of Venezuela
UC	University de Carabobo
UCAB	Catholic University Andrés Bello
UCT	Catholic University of the Táchira
UCV	Central University of Venezuela
UDO	University of the West
ULA	University of the Andes
UNA	National Open University
UNEFM	National Experimental University Francisco de Miranda
UNEG	National Experimental University of Guayana
UNERG	National Experimental University Rómulo Gallegos
UNERMB	National Experimental University Rafael María Baralt
UNESR	National Experimental University Simón Rodriguez
UPEL	Liberator National Pedagogical University
USB	University Simón Bolívar
UVM	University of Valle of Momboy