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TECHNOLOGICAL ADVANCES TO IMPROVE SOCIAL CHANGES IN BRAZIL

Abstract: Brazil is one of the ten largest economies of the world, characterized by its remarkable dimensions, high population and a substantial diversity of regional differences.

It has among its greatest challenges the facing of how to transform technological advances of its industry, its research institutes and the universities into a process of increasing knowledge in certain regions, thus resulting in the generation of qualified employments and income. Among the numerous actions currently in execution, we can highlight the creation of incubators and technology parks, that interact with industries, and contribute for the increase of competitiveness of enterprises, the identification of new opportunities for installing clusters and supply chains, the stimulation of handicraft production, strong mechanism to support the social changes and, surely the most important, expand the offers of quality education at all levels.

To achieve the objectives mentioned, several organizations are performing a leading role in the Country, specially SEBRAE, the Brazilian Institution of Support for Micro and Small Companies, a nationwide organization that operates in all Brazilian states, that ensures capacity and training to the technology-based entrepreneurs, and sets up the guidelines for the development of business plans and offers several courses to facilitate the operations of the enterprises and to enhance their competitive participation in the Marketplace. Universities and research institutes are largely responsible for the implementation and supervision of incubators and technology parks. In the case of local clusters and chains suppliers, there has been a significant effort carried out to expand its quantitative, and to ensure a more balanced regional distribution. However, the main challenge of all is in the education sector, in that, over 60% of municipalities, have no access to higher education, even in distance learning education programs.

This study aims to analyze the Brazilian initiatives to use innovation as an efficient tool to improve the competitiveness of companies, whilst a mechanism of employment generation, income achievement, and for the reduction of social and regional disparity levels.

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AN OVERVIEW OF HIGHER EDUCATION AND ITS RELATIONSHIP WITH THE ENTREPRENEURIAL CULTURE IN BRAZIL

It could be said that Brazil is a late starter in educational terms, as unlike most of the countries in Latin America whose universities began emerging at the onset of Spanish colonization, such higher education institutions only began to appear towards the end of the 19th century in Brazil with the first university being founded in 1920 as a result of the merger of three independent faculties of Medicine, Engineering and Law, which came together to form the nucleus of the present day's Federal University of Rio De Janeiro — UFRJ, one of the most respected institutions of its kind in our Country.

The development policies adopted and put into practice from the 1950 s were the driving force behind the extraordinary rate of growth witnessed by the country's industrial Park, and contributed greatly to expanding Brazilian higher education, which currently boasts 192 universities and around 2900 other non-university organizations equally dedicated to higher education.

Due to the growing demand for qualified technicians at this time, a professional education policy was put together encompassing three distinct types of institution: government financed, state financed (Brazil is a Federative Republic) and institutions financed by companies from the trade and services, industry, technology and agriculture sectors. This network, which operates through mainstream educational means, offering professional courses and courses for school leavers, in addition to non-mainstream educational means, running courses which offer certificates and additional courses, has been responsible for the increasing competitiveness of Brazilian companies.

Comprehensive and in-depth reforms were necessary at three separate time periods (at the end of the 1930 s, in the 1960 s and in the latter half of the 1990 s) due to the growth witnessed at all educational levels. The first two reforms were never seen through and the current reforms are nearing completion some twenty years after the new National Education Guidelines Law was passed. This process of growth is still in need of organization, and even though it has not led to the decrease and eradication of regional and social inequalities, it has enabled many universities and schools to swiftly consolidate themselves, which has had a positive impact on the generation of an entrepreneurial culture. As a matter-of-fact, legislation from the Brazilian Ministry of Education concerning the compilation of curricula now includes structured curricula contemplating entrepreneurial disciplines in virtually all the professions.

A second important factor for encouraging the deployment of initiatives directed towards an derives from the technological development model adopted by Brazil at the end of the '60 s, whereby universities were identified as the main sources of technological development, in line with Spanish and Portuguese tradition, with exceptions existing in the agricultural sector, due to the presence of the Brazilian Agricultural Research Corporation (**EMBRAPA**), and in the energy sector, due to large state-owned companies like **PETROBRAS and ELETROBRAS** or

EMBRAER, in the aeronautical sector. However, in all of the above cases there is a profound interaction with the universities.

In particular, the technology largely developed by **EMBRAPA**, was the main reason for the growth of agribusiness. It enabled the management of external debt and the accumulation of a significant amount of reserves. Also contributed to supplying the domestic market and boosted exports. Another important advantage from the technology developed by **EMBRAPA** was the great reduction in the cost of the „basic basket" (the main ingredients for meals), whose main beneficiary was the most poor, who spend most of their earnings on food purchases. During the period February 1976 to July 2012, the cost of the basic „basic basket" had accumulated an impressive reduction of 79.42%. This reduction ensured the success of income transfer programs for the poor population. Basically, the modernization of agriculture meant major redistribution of income and very important social changes.

The interaction between universities, Institutes of Research and these important Brazilian companies was one of the main responsible for the increase of graduate studies in Brazil. From the 1970 s public funding intended for Brazilian technological development and innovation was concentrated on providing masters and Ph. D. courses, in programs linked to the public and private universities. Today, are graduates in the country more than 45 000 teachers and 15 000 doctors each year. However, and unfortunately, only a small number of professionals graduating from these masters and Ph. D. courses switched over from scientific activity to other involving innovation and technological development in industry, resulting in

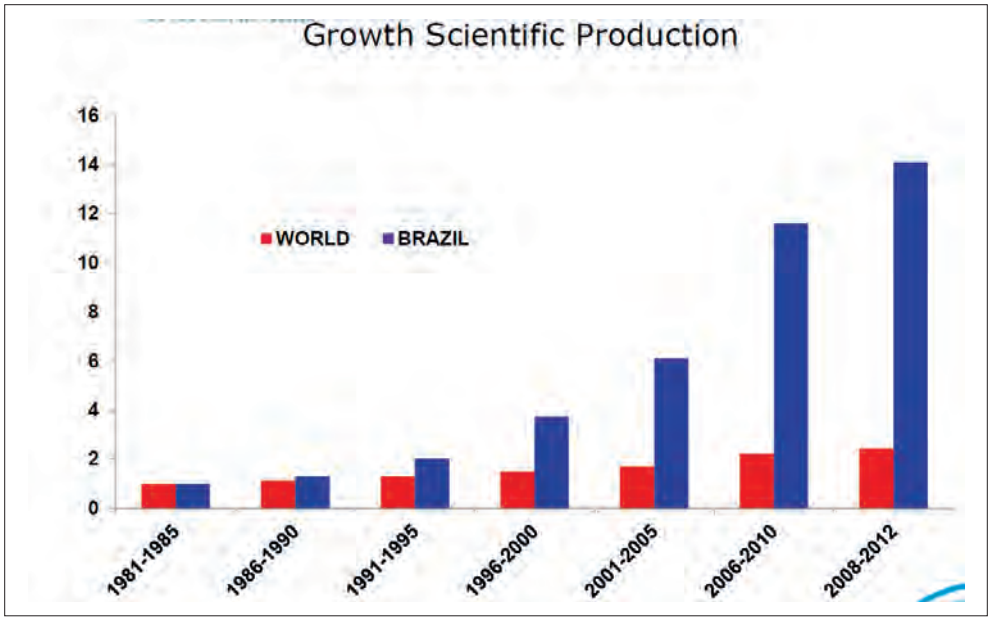

Figure 1

Table 1. Comparative Scientific Prodution, 2008–2013

Rank	Country	Articles	Citation	Impact	% Doc Cited	World %
1	USA	1.761.542	13.434.826	7,6	72,3	28,5
2	CHINA	724.568	3.100.154	4,3	62,4	11,7
3	GERMANY	458.907	3.374.761	7,4	71,9	7,4
4	ENGLAND	416.797	3.233.679	7,8	72,7	6,8
5	JAPAN	383.900	2.070.597	5,4	69,1	6,2
6	FRANCE	328.439	2.237.464	6,8	70,3	5,3
7	CANADA	284.794	1.985.068	7,0	71,6	4,6
8	ITALY	266.606	1.780.950	6,7	71,9	4,3
9	SPAIN	235.228	1.407.728	6,0	68,6	3,8
10	INDIA	215.311	766.141	3,6	59,4	3,5
11	AUSTRALIA	209.489	1.358.739	6,5	71,0	3,4
12	SOUTH KOREA	208.052	897.073	4,3	62,9	3,4
13	**BRAZIL**	**167.292**	**569.540**	**3,4**	**57,8**	**2,7**
14	NETHERLANDS	159.935	1.343.801	8,4	75,8	2,6
15	RUSSIA	140.970	395.494	2,8	48,4	2,3

the number of papers being published in journals growing significantly (Figure 1 and Table 1), but disappointing performance with respect to the registration of patents. It also contributes to the difficulties in the fostering of innovation the differ-

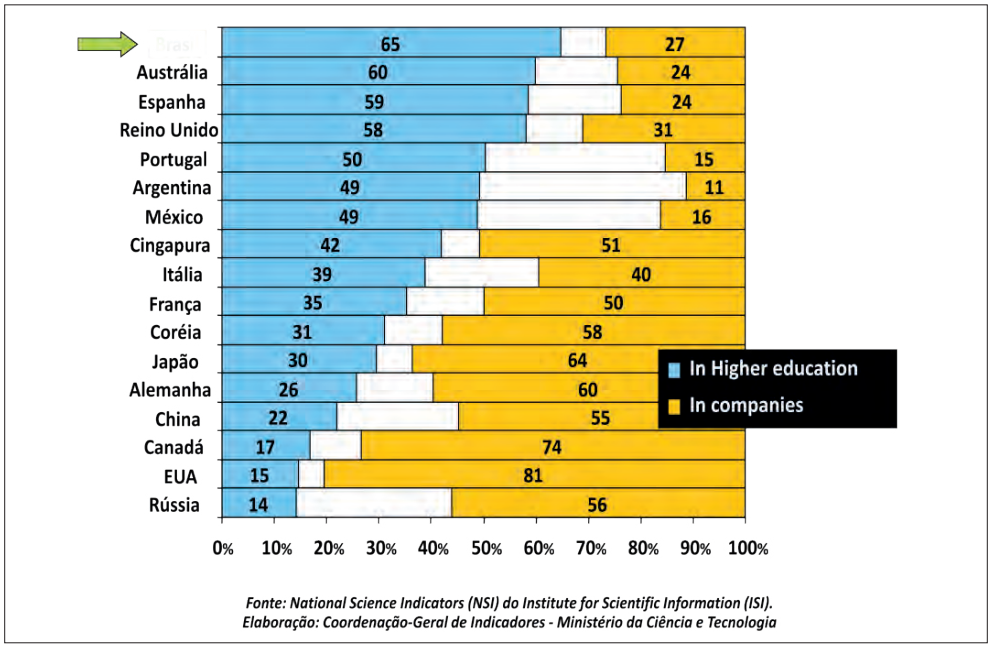

Fig. 3. The intellectual capital in wealth creation

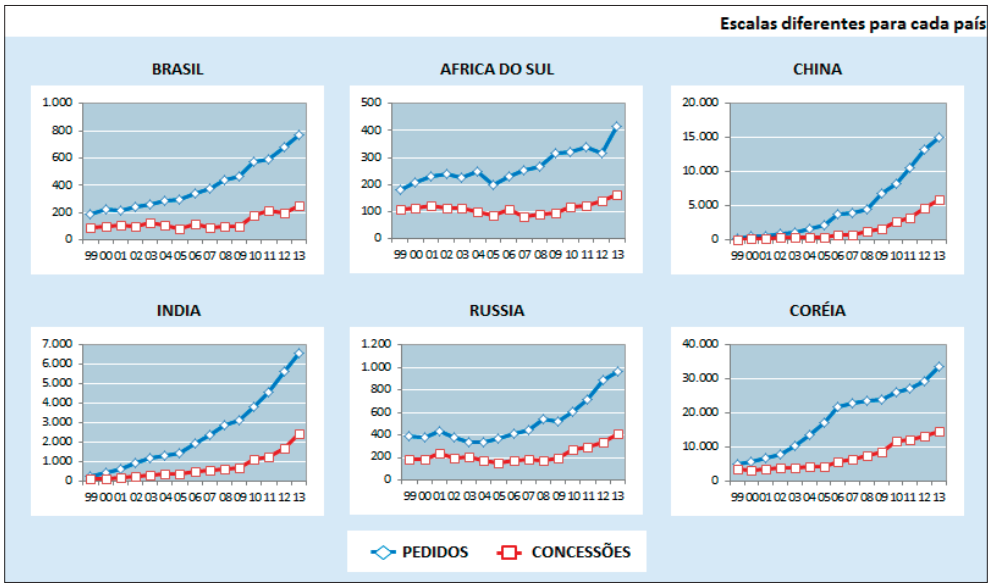

Fig. 4. Patents Requested and Granted (different scales for different countries)

ences in language and in the respective work environments observed in Universities, Research Institutes and Industry and the difficult interpretations, often contradictory in optics from the university and the company, especially on the expectations of industrial property. Thus, few masters and doctors migrated from scien-

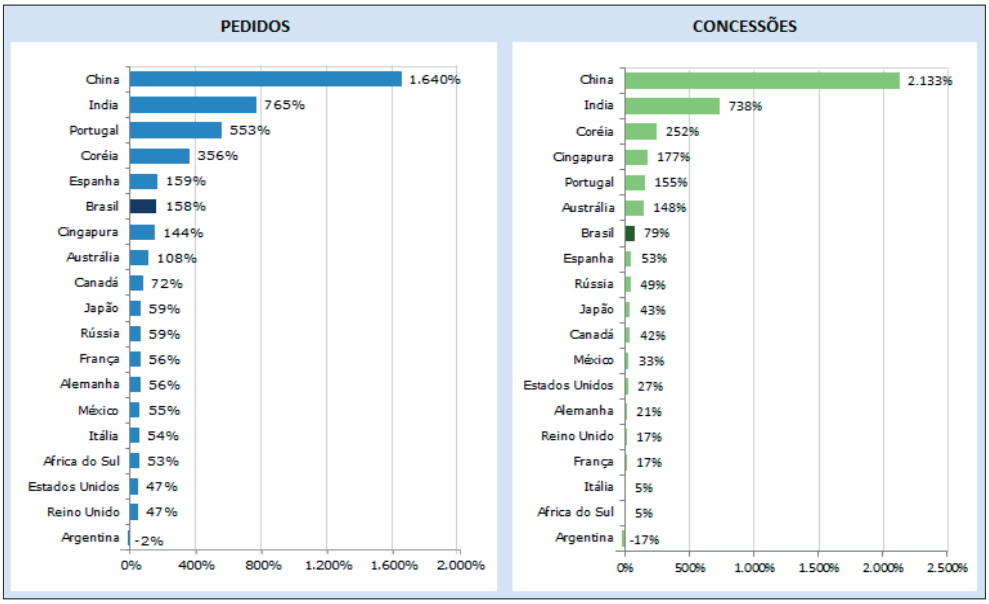

Fig. 5. Variation of Requested and Granted Patents 2000–2011

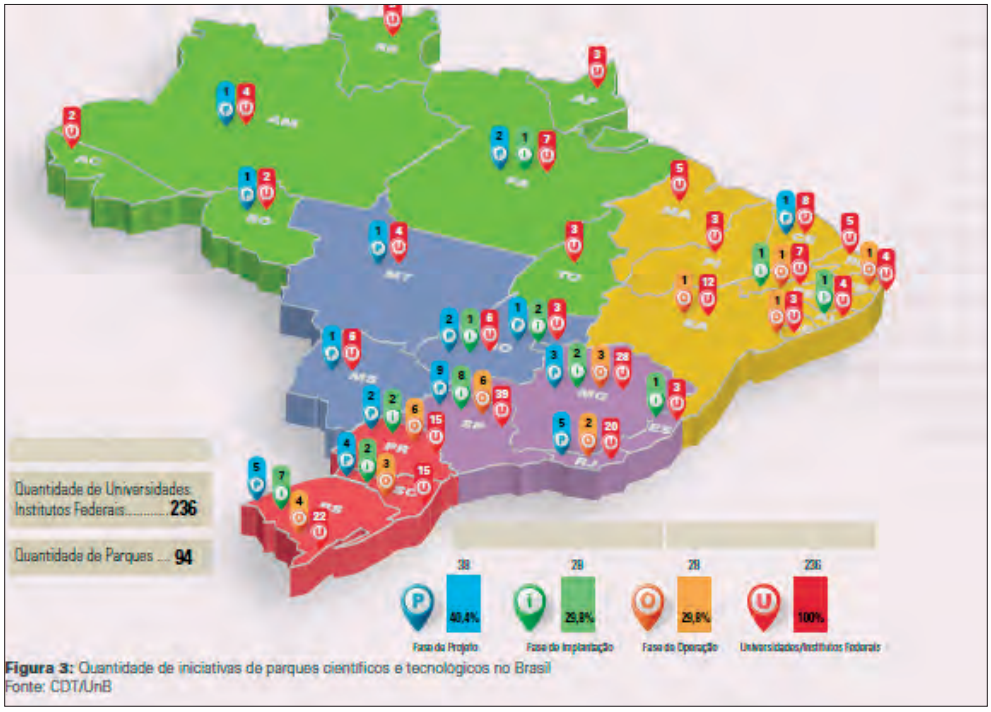

Fig. 6. Distribution of Technological Parks

tific activity to the innovation and technological development in the industry (Figure 3, 4 and 5).

Whilst we have achieved good results in scientific research, as a result of the model adopted we have been unable to meet the requirements of demands of Brazilian companies. This is why South Korea, which at the beginning of the 1980 s invested approximately the same amount of funds in science technology and innovation, which was geared towards companies, registered approximately 26 000 patents in the United States in 2013, whereas Brazil registered a mere 204. Figure 4 denotes the numbers of patents requested and granted by countries belonging to „BRICS". Recent figures gave Brazil a discreet 65nd place in the international competitiveness ranking.

Thus, since early of the 2000 s there has been a pressing need to redirect the University-Company interactive processes, creating mechanisms which increase Company competitiveness and speedup the entry into the international market. Generating an is now essential for the success of initiatives enabling results to be achieved both in local development and for meeting the new requirements thrown down by globalization. Getting academics to work on entrepreneurial initiatives is one of today's priorities for achieving technological and industrial development.

Thus, policies fostering the generation of technological parks and company development agencies and the installation of „" adopted by universities are now re-

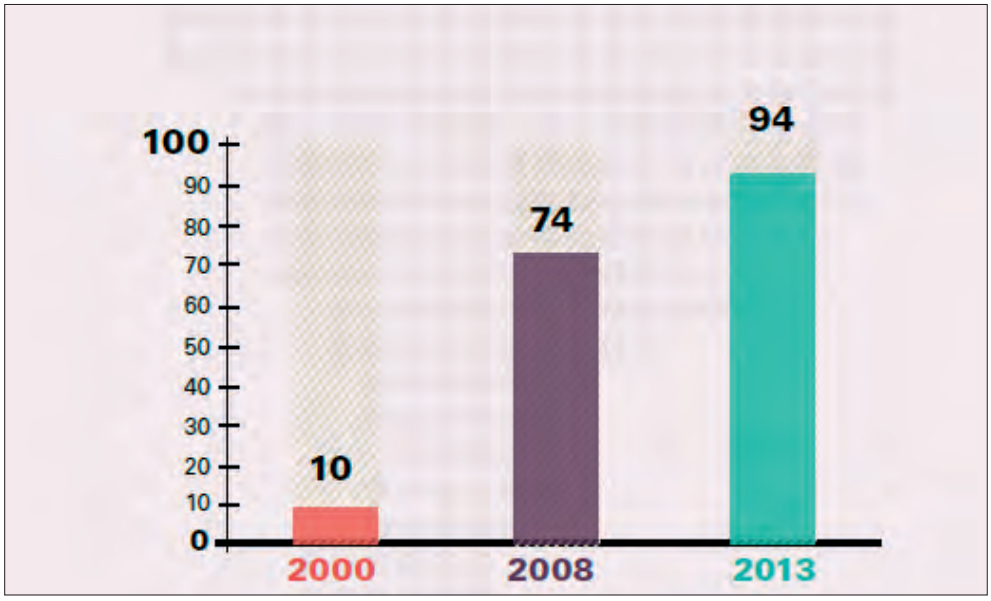

Fig. 7. Evolution of Technological Parks

ceiving substantial support from the agencies that foment science, technology and innovation, as well as and from the SEBRAE System (Brazilian Micro and Small Business Institute).

Brazil has 2,640 companies incubated in 384 incubators. The annual turnover of these incubated companies totaled R$ 933 million and that the jobs generated in incubated firms totaling 16,394 jobs. *Figures 6 and 7* give an indication of the evolution and the regional distribution of technological parks. (remember that Brazil has more than 8,5 million of square kilometers of surface).

The Local Clusters are also very important. The support for the development of productive clusters involves a number of challenges, such as the awareness and cooperation of the participants; the articulation of the various agents; identifying necessary improvements; and development of a „development plan" arrangement and establishing a transfer mechanism of resources.

Experiences in Latin America have shown that micro and small enterprises clusters face unfavorable economic conditions and serious bottlenecks that prevent improving the skills and entrepreneurial dynamism. Its potential competition is limited. In most cases, however, support measures can be taken to improve the survival of these clusters, provided they are important in creating employment opportunities. This effort should be aimed at breaking a vicious cycle of low investment. In a way, more growth and differentiation of mass producers have flourished in the era of import substitution, but the small, medium and even large producers are suffering enormous pressure with the transition to open economies. In clusters of developing countries, the challenge is to create an environment that stimulates

and supports learning, innovation and, in general, to the sustainable economic and social development.

In Brazil, there are 677 local clusters (APLs), in 2,175 Brazilian municipalities, and responsible for more than *3 million direct jobs in 59 sectors of the Brazilian economy.* The data are from the Production Development Secretariat (PDS) Ministry of Development, Industry and Foreign Trade (MDIC).

APLs are intended to assist in the development of the regional economy. Since 2001, the federal government encourages and works for companies in the same industry or part of the same. The process of setting up development bodies has proven to be high important for generating an effective entrepreneurial culture. These organizations came into existence at the end of the 1990 s and have furthered the migration of researchers to the private sector, while simultaneously broadening the activities to help entrepreneurs of very small and small businesses.

Brazil currently has around *9,0 million very small and small businesses, including „MEI" (Individual Micro Entrepreneurship),* which account for:

— 48% of the national production, corresponding to 21% of GDP;

— 98.5% of the total number of companies in Brazil;

— 62% of the existing jobs;

Alongside these companies, some *10 million of the so-called* companies are in activity which, as is the case of those existing in other countries, are also responsible for providing a large amount of jobs. *Generating an entrepreneurial culture* within micro and small companies must be a pursued priority, in view of the following points:

a. Most of these companies carry out *incremental innovations;*

b. The majority of entrepreneurs do not have the experience nor the knowledge carry on the business they have elected or the area which they have chosen to operate in. Thus, more often it is not the issue of contents, but rather to have training capacity to perform entrepreneurial activities;

c. Moreover, entrepreneurs undertake their activities without having well structured business plans. It is quite commonplace (especially in modern-day Brazil) for businesses to be started up due to necessity and not as the result of a clearly defined proposal.

d. Entrepreneurs set up their businesses without the assurance of getting venture capital. Venture capital companies only provide financing to a small number of companies. Most business undertakings in Brazil started-up with family, angel or private capital, whereas venture capital is only obtained later on, when it is necessary to

Recently, FINEP (Brazilian Innovation Agency) started a financing program for innovative technology-based companies and companies operating in the sector of the creative economy In Rio de Janeiro, for example, the network of micro and small companies has been consolidating itself via their clustering with or chain participation with other local larger industries, which already account for a significant part of the State's GDP.

Based upon the above points, the universities and organizations working with Entrepreneurial activities and micro and small companies have been carrying on

actions with the intention of amplifying the offer of „entrepreneurial education", seeking to provide courses to students of all levels of education, businessmen, cooperatives, trade unions and other representative bodies.

CHALLENGES AND ONGOING PROGRAMS- SOME EXAMPLES OF ACTIONS

To meet today's challenges, has been carried out numerous actions that include projects in the area of entrepreneurship, education for citizenship, and construction of curricular bases to ensure a supply of good quality education, to allow better results in international assessments and to ensure the employability of graduates of technical courses and high school.

a) IMPROVING THE QUALITY OF BASIC EDUCATION

In what has been called the „Age of Knowledge", the low quality of education reflects directly on the development of nations, putting in great disadvantage those that present worst performances in this aspect, when compared to others that already offer their citizens more and better educational opportunities.

In the last 20 years Brazil has made an important conquest: democratization of access to Fundamental School. Today 97.2% of the children between 7 and 14 years of age are in school — and in Rio de Janeiro this percentage reaches about 98.1% of the school-age population. Nevertheless, in the age bracket between 15 and 17, close to *15%* have already dropped out of school. As a positive factor, it must be emphasized that according to the Census of 2015, 47% of the economically active population have over 11 years of schooling, against 28% in 2000.

On the other hand, repeating grades and dropping out in Basic Education remain quite significant, resulting in an expressive rate of age-conclusion lag. Also worrisome is the performance of Brazilian students in the evaluation examinations organized by the Ministry of Education and by international organizations such as the *Programme for International Student Assessment* (PISA). These students placed far below the ideal level, principally in public schools: in the subjects Portuguese Language and Mathematics,

In this sense, actions aimed at improving the quality of Basic Education are indispensable and urgent in order to effectively ensure the sustainable development the country. Among such actions, the following deserve special mention:

— Strengthening the initial and continued training of teachers;

— Valorising teachers, especially in the scientific areas and those related to the environment and sustainable development;

— Updating school infrastructure;

— Effectively incorporating new educational technology;

— Developing entrepreneurial culture.

Such programs are being constructed in agreement with the regional development goals, stimulating social innovation and the association with the peculiarities of each region. Thus, for example, they are being created numerous training

centers for crafts and for the training of qualified professionals for demands of local clusters.

SEBRAE recently inaugurated the Reference Center of Brazilian Handicrafts, designed to train craftsmen and to promote craft insertion in international trade flow

b) PROMOTING TECHNICAL AND HIGHER PROFESSIONAL TRAINING CONNECTED WITH THE ECONOMIC POLES.

Professional training is a crucial factor in improving the quality of life and economic development, fulfilling as it does a fundamental role, namely that of transforming knowledge into an asset applicable to productive and technological processes.

The contingent of enrolments in middle-level technical training courses is still small if compared with the number of enrolments in Middle School. With the advance of growth programs, this leads to the sectors of commerce and services, industry, agribusiness and technology suffering from the lack of qualified technical professionals, especially in the municipalities in the interior, where many companies have moved to in the last few years.

With regard to Higher Education, data gathered from the Ministry of Education (MEC) point out that only 14% of young Brazilians between the age of 18 and 24 are enrolled in this level of education, considerably lower than Argentina (32%) and the USA (50%). Besides this, information from the Center of Information and Data (CIDE) reveal that in the last few years about 45% of enrolments were directed to Applied Society Science courses and 16% to Health Science courses, whereas in Engineering and technology-linked areas this figure amounted to a mere 9%.

With this context in mind, the expansion and interiorization of initiatives aimed at technical and higher professional training, in tune with regional potentials and vocations, constitute decisive factors in the socio-economic development of the State. Implementing these measures will potentialize employability as well as technological innovation and higher levels of qualification.

c) USING THE TECHNOLOGICAL ADVANCES TO REDUCE SOCIAL AND REGIONAL DISPARITIES

One of the biggest challenges today is Brazil is the reduction of social and regional disparities. Each year the Brazilian public sector collects a considerable amount of taxes and, despite this does not offer quality services. Comparison with some other countries shows that the inefficient use of the resources collected, rather than any scarcity of same, explains the key disorder that lies at the root of the chronic problems faced in various essential areas such as Health and Labor Justice. Lack of transparency in the use of public resources is one of the main factors that produce the inefficient public management and corrupt practices from which no public instance is exempt. If society has no clear notion of the destiny of the taxes it pays, how can it appeal for results in a more energetic manner.

Ensuring transparency, facilitated access to information concerning budget matters is therefore of vital importance for development. A more involvement of organized civil society in public policies is indispensable in order to strengthen the position of the Brazilian States in the scenario of the Federation, to the extent that the elected representatives do not always have precise information about certain matters so that they can deliberate in a fair and efficacious fashion. The absence of such participation, together with the lack of articulation among our elected representatives, has led to significant losses in terms of State development.

It is imperative to qualify high contingent of the population to the opportunities that are being opened with the generation of employment and income in the environment enterprises, and in the national development programs, comprising housing projects, basic sanitation, infrastructure and logistics, use of wind and solar energies, abundant in the country and health.

Such challenges are demanding training programs, many of them carried out by SEBRAE, technological extension, to add value to products, development of handicrafts, benefit from diversity seen in the country and supporting regional development. Each year the Brazilian public sector collects a considerable amount of taxes and, despite this does not offer quality services.

SOME PROGRAMS IN DEVELOPMENT

a) THE SEBRAE PROGRAMS

SEBRAE has shown itself to be an organization which is dedicated to entrepreneurial education, both with respect to the vision of the entrepreneur as set forth by John Milton Smith and to foster and support the establishment new very small and small companies. In accordance with its strategic planning, which was updated in 2011, SEBRAE has five main objectives:

— To free micro and small companies from the legal and bureaucratic hurdles which hinder and discourage them from legalizing and formalizing their activities;

— Help guarantee the survival of micro and small companies, offering them the appropriate support and assistance, whilst they are establishing themselves. (to get an idea, in 2001, „mortality index" in 2 years was 75% and today is less than 23%);

— Make it possible for companies to increase their competitiveness, both in technical terms and in terms of management practices;

— Ensure greater access for micro and small companies to credit and the other measures for achieving economic- financial feasibility;

— Introduce micro and small companies into the international market;

In addition to these strategies, all of which are appropriate and suitable to the realization of SEBRAE objectives and purposes, other strategies have also been adopted, which can enable companies to participate in the development of Brazil, such as:

— Offer the network of very small and small companies the necessary means for them to access and retrieve relevant information, as well as for the appropriate strategic management of knowledge;

— Foster actions directed towards bringing together relations between the supply and demand of technologies, products and processes, both concerning the government sector, and further cooperation between companies in the same or differing sectors;

— Further relations with municipalities and the state, so as to help to ensure that public policies encourage the consolidation and success of very small and small companies.

The presence of entrepreneurial education is an essential part of all the above items, and is provided by some 30 programs, some of which deserve a mention, as follows:

— *„Projeto Brasil Empreendedor" (Brazil Entrepreneur Project),* with the aim of offering the basics of entrepreneurial activities to potential entrepreneurs by means of short on-site courses

— *Empretec,* which is undertaken in partnership with the United Nation Development Programme (UNDP) and the Brazilian Cooperation Agency — ABC, of the Ministry of Foreign Affairs, which has the objective of identifying and increasing entrepreneurial potential and develop the entrepreneurial characteristics of businessman already working in the entrepreneurial area or who intend to start up a business. Using the concept of workshops, interviews and shared experience, the program aims to encourage changes to the way people conduct themselves, which, in turn, will be reflected in the entrepreneurial field

— *„Líder Cidadão" (Leadership and Citizenship)* — The objective of this program is to train community leaders, with the aim of sustaining local and sector SEBRAE actions in areas with a low human development index.

This project makes it possible for SEBRAE to work in low-income and impoverished areas, in which there are opportunities for economic development and, therefore, the chance to fulfill its mission of proactively participating in the development of Brazil. Potential community leaders are the target public of the course. Literacy is not sine-qua-non requisite for the candidate to take part participating in the course.

The following subjects are addressed:

- Leadership and citizenship
- Communication
- Community meetings
- Planning of community projects
- Negotiation of projects

— „Saber Empreender" (Learn How to Become an Entrepreneur) — The objective of this course is to find out the entrepreneurial skills of people living in areas with a low Human Development Index (HDI), sustaining local and sector action by SEBRAE and disseminating the entrepreneurial culture and contributing for job generation and income. Businessmen, potential businessmen, those doing business in the informal economy, the self-employed and travelling salesmen make up the target public;

— Desafio Sebrae (the Sebrae Challenge) — An Educational solution with the objective of disseminating entrepreneurial culture amongst university students.

This simultaneously employs the methodology of business games, encourages widespread use of the Internet and facilitates face-to-face meetings and business rounds, and is geared towards effective interaction between universities and university students, promoting the importance of understanding cooperative work, how to become flexible in light of adverse or unexpected conditions and stimulating creativity in professional work;

— Jornada de Casos- Knowledge Management — The goals of this project is a development of cases study to show the scenery of very small and small businesses. The methodology used along the project includes the writing of a „case", the discussion about the solutions, with the involvement of students and their teachers, and the build of a data bank, relating experiences.

b) THE BASIC AND TECHNICAL EDUCATION PROGRAMS

— *The FIRJAN Mathematics Program*

Launched in 2012 and aligned with the MEC national curriculum, SESI Mathematics program is an initiative of FIRJAN (Federation of Industries of the State of Rio de Janeiro), through SESI Rio, and aims to improve the teaching of mathematics among students high school across the country, starting with the state of Rio. This is because currently the performance of our young people places Brazil far from the top positions in the world ranking of mathematics (PISA 2012), and the practical consequence of this poor performance is reflected immediately in the labor market. A survey of the FIRJAN System, held in 2011, points out that the lack of mathematical competence and logical reasoning are deficiencies presented by current workers, which results in the lack of qualified professionals to work in companies.

The Mathematics SESI is a methodology that combines modern educational practices to technology, to break the resistance and old prejudices of students and teachers, and thus contribute to the training of young critics and best enhanced logical reasoning. This initiative leads to a radical change in the teaching and learning of mathematics. The approach is to be friendly, exciting and attractive, making it more interesting mathematical and hence facilitating their learning.

SESI Mathematics will be taken to all schools SESI and SENAI of Rio and also to all state public high schools in Rio de Janeiro. Thus hopes to contribute in the formation of young people prepared for the competitive job market.

— *The STEM Methodology*

Both in technical schools and high school public it is important to overcome the weakness of students in the fields of science and technology. For this, the industries Federation system is already applying the STEM (Science, Technology, Engineering and Mathematics) methodology, building programs that combine applied form all disciplines through „workshops" which include planning, writing, study of subjects related to pre-selected themes, activities preparation and implementation, participation in school competitions and drawing conclusions.

— *The Construction of a New National Curriculum for High School*

The Ministry of Education is completing a new curriculum based for all high school students, to ensure mandatory guidelines in part of the subjects, reserving a

percentage for courses that meet local peculiarities and dimensions and vocations of each region.

— *Technical Education Reform Considering the New Needs of the Productive Sector,*

Since 2012, this has been one of the biggest challenges of the Brazilian education, which should seek to bring students to the advances of sciences and technology. For this, a new national program was implemented, the PRONATEC, which is designed to enable students to full use of new technologies, to promote continuing education for technicians already working in industry, trade and services sector, in agribusiness and technology, and modernize laboratories to ensure better training of engineers and technologists.

CONCLUSIONS

The Brazilian effort in order to promote social and economic development has depended much on the participation of micro and small enterprises, that have In SEBRAE, the Brazilian Institute of Support for Very Small and Small Business, a strong partner. It is also important to note the presence of productive sector by their federations and the biggest national companies. It should also be noted that those actions, initiated about 20 years ago, mainly these projects of the Ministries of Science and Technology, and Development, Industry and Commerce, were decisive for such advances. It highlights the incubators companies and technologycal parks, that were born with the academic support of the Universities and the Research Institutes. They allowed the generation of employment and income, and increased the competitiveness of enterprises.