# Ciencia globalizada y educación: tendencias y marcos interpretativos para su desarrollo

## *Globalization of science and education: trends and interpretative frameworks for its development*

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## Resumen

Las instituciones de educación superior en América Latina enfrentan actualmente una de sus mayores crisis. Pensadas como instituciones sociales encargadas de formar las nuevas generaciones de ciudadanos, bajo enfoques que aseguraban la reproducción y permanencia del modelo de desarrollo (económico, ideológico y cultural), se ven hoy confrontadas en sus principios básicos, consolidados bajo las directrices surgidas de la Ilustración, y sus consecuentes, el Racionalismo, el Positivismo y la Modernidad, mismos que le permitieron mostrar su mejor cara, aquella que proveyó de rumbo y certidumbre a la sociedad, dando lugar al discurso legitimador y a los consensos que construyeron al paso del tiempo el ideario colectivo, las aspiraciones y el sentido de pertenencia que los grandes grupos sociales exigieron.

Palabras Claves: ciencia, educación, desarrollo, globalización.

## Abstract

Institutions of higher education in Latin America currently faced one of its greatest crises. Intended as social institutions to train the new generations of citizens, under the approaches that ensured the reproduction and permanence of the model of development (economic, ideological, and cultural), are today confronted in its basic principles, consolidated under the guidelines that emerged from the Enlightenment, and their consequential, Rationalism, Positivism and Modernity, same that allowed him to show their best face, that provided direction and certainty to the society, giving rise to legitimizing discourse and consensus

that was built over the years the collective ideology, the aspirations and the sense of belonging that large social groups demanded.

Key Words: science, education, development, globalization.

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## Introduction

**PROBLEMATIC CONTEXT: EDUCATION, CRISIS AND IDENTITY**

Under a new environment, loaded with Relativism and subjectivity, the education of the 21st century is disarranged in its axioms and assertions, showing particularly undermined in their daily practice, to the extent of being at a crossroads which puts it at the brink of the abysm.

Such assertion is not risky. You watch how the school itself in the alignment of the educational objectives with social aspirations poses a serious debate about the ontological or teleological sense of education. What is educating nowadays? How to conceive the school under the new economic, political and social paradigms? What goals should it pursue? To this must be added to the unknowns that focus their attention on the formation of a new citizenship, whose cosmogony not just realized as forms made of thinking and acting in democracy; but not one that becomes a distorted Republican vision that is exhausted with the voting citizen, which is continually challenged by the group in power, ignoring it or even annulling it when not paid to the interests of the minority. On the contrary, it is in these times of bet on democracy that legitimately claiming the collectivity, conceiving it from its new interpretive frameworks and the values and ethics that explains and evidence it.

On this basis, we must ask why they still talk of educational modernization << >> of << >> modern democracy or a democratic culture << >>, when in fact what is sought is to recover the context that defines the real as chaotic and uncertain. It is for this reason that Alain Touraine (1999, 2011) speaks to integrate instrumental rationality to cultural institutions, or Zygmunt Bauman (2004, 2005) invites to rethink modernity in its liquid form, accepting

both the onslaught of markets, capital and technology are irremediable. In any case its premises are forged from a late modernity, which gives way to the postmodernism, founded in change and transition, it reflected in contradictions and tensions that the teacher is not free, to move from individual to individual and social actor. Ideal postmodern struggling to beat the germ modernism consciences of emerging companies. In this regard, a predisposition is seen to reject the presence of this new social order, for many single intellectual fashion that will succumb at the hands of their own principles. Henry Giroux (1996: 2) tell you about it:

> If during the last 20 years postmodernism may have been elevated to the top of fashion in American academic journals and popular press, it is clear that a somewhat dark and reactionary provision has some backlash, backlash now emerged. Of course, postmodernism really got to be very fashionable, but these matters are of short duration and rarely taken seriously any topic. However, do not underestimate the power of fashion and commodification in terms of the residue of irrelevance and confusion that such practices imposed on an issue.

Special mention should be forced Touraine destination that seems to condemn humanity, linked to the market economy and technological paraphernalia. On this particular Giroux itself indicate that:

> …in recent debates on postmodernism there is much more at stake than the effects of fashion and commodification; in fact, often essentialized terms that underscore criticism of postmodernism suggest something deeper. In condemning feathers too rhetorical postmodernism as reactionary nihilism, as a hobby or just as a new form of consumerism, anti-intellectualism deeply rooted, which gives credence to the idea that the theory is an academic luxury and has shown little to do with the concrete political practice. Anti-intellectualism aside, the reaction to postmodernism also indicates a crisis in the way the project of modernity attempts to prescribe, fit and appropriate topics of difference and uncertainty or indeterminacy (1996:2).

In the end, if the aforementioned paradigmatic confrontation is accepted, it remains to solve the circumstantial aspects that are involved in the development of an educational project that demands results in terms of efficiency and productivity, which place the same master as the linchpin of any educational innovation, to hold him responsible for implementing and evaluating curriculum and teaching that make it possible, but paradoxically not allowed to intervene in their management processes and administration, so their desired intervention as social actor is bounded. Hence the need to continue making trouble about such a complex phenomenon.

## EDUCATIONAL REFORMS TO BASICS IN SCIENCE

Talking about education reform is necessary to refer to the changes that take place within national education systems as a result of the implementation of State policies, to a greater or lesser extent incorporate education as a development strategy.

To date, international educational trends have been about recovering old worldviews: humanism, psychologism, cognitivism, among others, in addition to shifting models or successful approaches in other disciplinary fields (constructivism, and skills are good examples of it) into the spaces of theorizing and school practice. Particularly because the paradigms that gave life to the old structural reforms have been exhausted. These proposals, innovative at the time, attended a social organization supported by the consolidation of the reproductive system of states, which although still in force, tends to disappear. Cantero et al, (2006) as summarized below.:

> Since the hegemonic political tendencies production and reproduction of a compliant and efficient citizen as worker and client is encouraged. Must be obtained for this new citizen skills necessary to ensure their productive capacity under the parameters of quality and market efficiency. Thus, the project of

> modernity barely citizen initiated in these latitudes try replacing it with the operator, in dimensions of producer and consumer… (p. 17).

The own Cantero et al., (2006) notes that today there is practically who can say I cheated. In His Words, global capitalism has exposed, below the two covers of his tragedy (neoliberal and neoconservative), the tragic consequences for the great majority who make up the contemporary scene. It concerns with particular emphasis on the changes that have exacerbated poverty, marginalization and exclusion of the popular sectors.

Under this scenario had occurred, since the late twentieth century, reform processes in the world, as a response to the chaotic situation facing contemporary societies, who are now need to address the unprecedented events that even question the permanence of the human species on the planet. Several components make up the social-historical background which gives rise to ongoing reforms and the need to address when one is designed: the presence of large volumes of information and knowledge; new media; need to integrate the society on democratic, equitable and holistic models; recover universal values that allow peaceful coexistence. Based on this, it is possible to understand as regards Puelles-Benitez and Martinez-Boom (2003),:

> The concept of reform has two connotations: first, it is expressed as a political program of action, with strategies ranging from the center to the periphery. On the other hand, suggests intentions that exist between different social actors whose relations are almost always asymmetrical, because they are carriers of different traditions, representations and practices, and have different intensity and strength, which creates a much more complex dynamics that a simple movement of action-reaction. The reform is part of the process of social regulation; expresses the strategy through which the power not only delineates and defines social practices, but brings into play order systems, ownership and exclusion. Education reform defines the purpose, possibilities and limitations of the various educational institutions and agents, through the legitimacy of certain models operating in the macro or micro orders of education. That is, define how the many social issues,

> ranging from the organization of institutions to the perception that individuals have of them relate (p. 3).

Special mention must meaning that the quality of education has to justify these reforms and the decentralization of education to which it aspires, leading to enroll education in the field of scientific and technological development as a central factor for the competitiveness, transverse axis models today's society, enshrined in the schemes that combine science with technology (Science & Technology) in all aspects that implies: Science + Technology + Society; Science + Technology + Innovation; Science + Technology + Environment, among others.

Based on this, then the characteristics that distinguish major educational reforms under a scientific approach, both local international and regional level (in this case Latin America) and (referring to Mexico) are described.

**International**

At the entrance of the century, international educational models are confronted with a new reality. According to Cifuentes (2001) the modern university, who was born in the early nineteenth century after the exhaustion of the medieval paradigm, and that supported in three models namely the Napoleonic, the Humboldt and technology, is now in severe crisis . The modern university, created to serve an industrialized society, which more than fulfilled for a century and a half, is in these moments expires.

The new university, own the century, away from the nineteenth century paradigm is thus challenged to transform from new realities that shaped the current post-industrial societies. Globalization, free markets, economic blocks, knowledge economy, information and communications technology are some of the components that determine the definition of objectives for the new century.

Even the neoliberal model, whose ideological and conceptual structure sidestepped the critical sense of society considered alien to their political and commercial interests, is now in decline, despite efforts to maintain its international hegemony, which even observed within university educational spaces.

Under these assumptions, one can say that the current state of the university no longer even respond to the needs of nation-states, much less to the requirements of a demanding society, but naive as not clearly define their future aspirations. In the midst of this social and ideological morass, the university tends to recover its true sense of universality << >>. Nevertheless, the inertia of the century still maintain their presence in the educational areas, seeking to remain dominant. Thus Readings (1996) points out that universities become international corporations in the concept of national culture << >> it changed to excellence << >> to be the latter's international and coined a globalized and globalizing culture, which gives identity to the subjects through advertising slogans that become guidelines for their work in society.

But parallel to this scenario, there is the proposal to recast the university from the pillars of its ontology. Is Delors (1996) himself who makes a way out of this unprecedented social phenomenon, refer to:

> To this end should face to better overcome, the main tensions that, while not new, are at the heart of the problem of the century.
> The tension between the global and the local: gradually become world citizens without losing their roots and actively participating in the life of the nation and grassroots communities. The tension between the universal and the singular: the globalization of culture is steadily but still partially. In fact it is inevitable, with its promises and risks, which is not the least forget the uniqueness of each person, his vocation to choose your destination and realize their full potential within the carefully tended wealth of their traditions and their culture, threatened, if attention is paid by the developments that are occurring… (pp. 10-11).

With all this, and to the recognition of what seems obvious, the appointed tension between the global and the local calls into question the survival of culture as a reference of what is individual to different social groups. Delors (1996) abounds in this regard by stating:

But these desirable and possible improvements not dispense with the need for intellectual innovation and the implementation of a sustainable development model in accordance with the characteristics of each country. We must all be convinced that with the current and expected developments in science and technology and the growing importance of the cognitive and immaterial in the production of goods and services, should reconsider the workplace and their different status in the society of tomorrow . The human imagination, precisely to create this society, must anticipate technological progress if we are to avoid unemployment and social exclusion or inequalities in development ... (p.14) is serious.

It is precisely this technology to anticipate what Delors (1996) refers processes, which encourages thinking about the development of a critical view of the world for the citizen, provided that he claims to say "... a continuous restructuring the human person, his knowledge and skills, but also their faculty of judgment and action ... ". All this points to the constitution of a new citizenship, which recovered from its foundations the premises of a democratic, equitable and inclusive society that becomes "... the isolated individual a social actor involved in the political, economic, cultural affairs, is say in social life "(pineapple and Aguayo, 2012), because without participation there is no democracy (Lozano, 2012).

And in this way and in finding answers to give direction to higher education by the end of the twentieth century, UNESCO promoted various international fora, with the idea of achieving the broad consensus that this task required, from which emanated various governing documents (Millennium Development Goals -ODM-, -EFA- Education for All, the United Nations Decade of Literacy -DNUA- and the United Nations Decade of Education for Sustainable Development -DNUEDD- ). Under this dynamic, it is worth noting that in 1998 was the World Conference on Education, from which emanated the World Declaration on Higher Education in the XXI Century was held: Vision and Action,

which makes clear the role that higher education must be at the entrance of the new century:

Higher education has given ample proof of its viability over the centuries and of its ability to change and to induce change and progress in society. Given the scope and pace of change, society has become increasingly to be based on knowledge, reason that higher education and research now act as essential components of cultural, socio-economic and ecologically sustainable development of individuals, communities and nations. Therefore, and given that it has to face daunting challenges, higher education itself has to undertake transformation and radical renovation that has ever had to go, so that contemporary society, which currently is experiencing a deep crisis of values, can transcend mere economic considerations and take dimensions of morality and spirituality rooted ... "(World Declaration on Higher Education in the XXI Century: Vision and Action, 1998: pp. 1-2)

Likewise, the statement in Article 1. Mission to educate, train and conduct research, subparagraph C, establishes the principle that higher education promote, generate and disseminate knowledge through research and, as part services to be provided to the community, and providing appropriate to contribute to the cultural, social and economic development of societies, promoting and developing turn scientific and technological research, in parallel with research in the field expertise social sciences, humanities and creative arts. All as part of an educational culture that tends to the integral formation of human beings.

On the same side, the OECD (Organization for Economic Cooperation and Development), in its report entitled Measuring Student Knowledge and Skills (measuring knowledge and skills of students) within the << Program for International Student Assessment, 1999> > explicit several questions closely linked to this new challenge:

How well are young adults prepared to meet the challenges of the future? Are they able to analyze, reason and communicate their ideas effectively? Do they have the capacity to continue learning throughout life? (P. 7).

On these lines of action the international community turned to the achievement of educational models based on the commitment to integrate the new archetype of human, society, culture and school. Several trends are being discussed and analyzed today: attention to the cultural diversity, multidisciplinary approach, interculturalism, the pedagogy of leisure and free time, competency-based education and flexible curriculum (Ruiz Iglesias, 2009) .

In the specific case of the upper level and graduate named the World Declaration on Higher Education (1998) in its Article 5 (Advancing knowledge through research in the fields of science, arts, humanities and the dissemination of its results), subparagraph a, he establishes the certainty that "... the advancement of knowledge through research is an essential function of all systems of higher education have a duty to promote graduate studies ..." for what They should be promoted and strengthened innovation, interdisciplinary and transdisciplinary study programs, establishing the guidelines should have long-term objectives and cultural needs. It ends to point out that it should establish the right balance between fundamental research and target-oriented.

Here shown conclusively guidance in general must have programs and graduate (degree), if you want to really put in the level of validity and competence that are currently required, since, as mentioned the World Declaration on Higher Education: "... when higher education and research are conducted at a high level within the same institution a mutual enhancement of quality is achieved ..." (Article 5, Paragraph c).

**In Latin America**

The conditions prevailing in Latin America are of special others. In the words of Cereijido (2001) in Latin America we do not have, nor have we ever had, nor will we have in the process of science. This may seem an extremist so for many; although it is possible to understand the scope of these claims when it is understood that "... science is above all a way of interpreting reality ..." as the Cereijido himself explains. Thus, it is assumed that science depends on what known, or that their statements are true, but how knows. And how

did he do it? apparently very simply: forging a secular space in which every argument must be proved with empirical evidence, and despite that, if accepted, is temporary, pending someone comes to show that there was a mistake; or a person sponsored by their conceptual and methodological brilliance appears, achieves change the conceptual basis on which the initial interpretation was based. This implies a paradigm shift.

But how to explain that the whole region could reach these extremes of inefficiency and delay. The answer is in sight of all: deep intervention in the affairs of educational policy that led to the integration of the different social, cultural and ethnic groups that now prevail, as well as the creation of a national identity and legitimation the power of the State. The result was obvious: economic dependence of Latin American countries for instituted in industrialized countries (the United States and Europe in recent decades) markets, which transformed nations << >> suppliers of raw materials. Nevertheless there were some advantages. In Ossenbach concepts (1993), "... these economic relationships effectively enabled a favorable economic situation that allowed the development and the possibilities for starting modernization ..." But it was never enough to boost the educational and scientific development of the region even not economic, since the existence of this global market in which Latin America is inserted, provided the repetition of their political forms (hegemonic), rather than the spread of productive ways of the giver of wealth and prosperity capitalism.

Arocena (2001) also identifies an important stage in the history of Latin American development, characterized by a serious crisis that appeared in the late twentieth century (80's), which resulted in what became known as << growth >> inward, leading to new strategies based on the substantial reduction of the role of the state as promoter of the sources and forms of production in the ante to the free market and openness to the economy, privatization of public enterprises and encouraging foreign investment.

But with all that Latin America remains mired in a deep abyss of uncertainty, which places him far from the great centers of the global economy, preferably located in North America, Western Europe and Northeast Asia. To watch shows suffice for early XXI century (2001)

more than three quarters of global spending on research and development took place in countries of the so-called triad << >>: 38.5% in America, 26.6% in the Union European and 14.8% in Japan. Latin America contributed only 2% (Arocena, 2001). To date, the conditions have not changed significantly.

As part of the historical and social circumstances, colored by state models that were organized by the phenomena mentioned above (unlike the liberal-national European state), these governments were defined as << >> oligarchic states, ie as forms organization in which political society went away from the channels of a true democracy, which defined them as very limited social representativeness << >> and a precarious footing for education and science, among others.

It is for these reasons that educational institutions of higher education in Latin America are in a serious financial crisis, but also cultural, subject to budgetary constraints that limit their expansion and quality in their educational offer (even in the development of accreditations and certifications They do not guarantee quality in educational terms, acting as official justifying).

On this, Villarruel (2009) clarifies that at the beginning of this century:

... Identifying regional problems in Latin America appear to come from a common denominator: education, and more specifically, of scientific and technological literacy. From this is like the marked deterioration in their economies explains the instability of public policies and the erosion of the social fabric. Thus, we propose to analyze the advantages of a strategy from the daily practice, from the exercise of learning for life as part of a holistic approach to ensure, in the medium term, the consolidation of scientific culture science education It is necessary for the harmonious and equitable coexistence, as a new approach to the inescapable commitment to democracy ... (Villarruel, 2009: p. 1).

In all voices proclaiming a substantial improvement in advancing research and technological development, such as the Center for Studies on Science, Development and Education-NETS (2009), who report that arise in the average investment in Latin America

and the Caribbean (ALC) in R & D (Research and Development), which in 1998 was equivalent to 0.57% of regional GDP, has increased ten years later (2007) to 0.68%. This increase resulted, according to them, an increase in the relative share of LAC countries in all global investment in R & D. In 1998 these countries invested a sum equivalent to 2% of the world total and in 2007 their share had risen to 2.2%.

This shows the slow pace under which educational and scientific policies are moving in the region. But there's more: according to the Center for Studies on Science, Development and Education (2009), globally, and in varying degrees in all disciplines of knowledge production has become a fully collaborative activity. By studying the joint signature of scientific papers, it is possible to reconstruct the collaborative networks that have articulated the development of R & D. These networks exist at multiple levels, from the personal to the institutional or national.

Faced with this new level of demand, universities will have to adjust their plans and curricula >> << aligning with the most advanced countries in this line, so as not to be subjected to a new gap, and even having to endure discrimination on the level and quality of the research conducted. The principle is to create a Latin American knowledge space, as a major circulation area of regional information. Seeking practical effect to this task, there has been a flood of educational reforms initiated in the various institutions of higher education and graduate.

An example that illustrates this dynamic of change and innovation, it represents the so-called Alfa Tuning Latin America (Tuning, 2007), which was conceived as a strategy that "... looking 'tune' the educational structures of Latin America ..." which say the proposal initiated a heated debate looking to identify and exchange information and improve cooperation between institutions of higher education to the development of quality, effectiveness and transparency. Note that talk about information and not knowledge.

Tuning Latin America is a project that takes on independent, driven and coordinated by universities from different countries, both Latin American and European. The objectives of

a project of this magnitude, outlined specifically for Latin America, can be identified in the sense that Europe has interests in this region, under assumed that the integration that they currently need be unavoidable in the near future for these countries, besides allowing peer recognition, not only among professionals but also among students, which should move freely from one continent to another in search of work spaces and personal development (mobility).

It's the classic sense of the global village >> << ideology that is present in this type of proposal, which shared linguistic codes should allow broad consensus on issues and common assumed, as a result of globalization. The idea is that Latin America occupies an important place in the knowledge society. Not only in its use, as it once was, but in the generation and application.

But what educational implications Tuning? Several aspects can be referred to for the purposes of answering satisfactorily. The first involves identifying and exchanging information with the aim of improving cooperation between educational institutions of higher level, which would provide them with the quality, effectiveness and transparency they deserve. The second term, focus educational efforts in achieving professional skills, which are linked to the requirements of a specific disciplinary field, but in turn, with the student learning process throughout life, for which should be structured inclusive curriculum proposals, which are consolidated on four main lines:

1) Competences (generic, specific subject areas).
2) Approaches to teaching, learning and assessment of these competencies.
3) Credits.
4) Quality of programs.(Tuning, 2007: p. 15)

Based on the first point, currently a fierce debate, which of the multiple meanings implied by the term << >> competition, same as it is conceptualized in different ways focuses.

Amid the confusion this is, you should refer to the definition OECD-PISA (2006) proposes, under the regulatory framework of international assessment processes (PISA Program for International Student Assessment).

Although specific knowledge acquisition is important in school learning, the application of such knowledge to adult life depends crucially on the acquisition of a number of concepts and skills of a broader nature. In the case of science, if we think in terms of the issues that are debated in the adult community, knowledge of specific character, as would the names of plants or animals, has less value than the understanding of a range of issues broader, such as energy consumption, biodiversity and human health. For reading, the ability to develop interpretations of written material and to reflect on the content and qualities of a given text would be essential skills. Finally, in the field of mathematics, be able to reason quantitatively and to represent relationships or dependencies have greater value when applying math skills to everyday life than the ability to answer questions that often appear in books text ... (OECD PISA 2006: p.10)

OECD-PISA (2006) determined that a number of general skills of wide character is essential that students develop. Including communication, adaptability, flexibility, the ability to solve problems and use of information technologies they are included. These skills are developed in various curricular areas and therefore must be evaluated with a wide horizontal approach. The fact that under these interpretative frameworks are now speaks not only of knowledge and information stands.

This is where you might think about an education focused on teaching and learning of science, since it is precisely these premises that feed the conceptual and philosophical support of its foundations. As an example, in the OECD, in its Framework for PISA 2006, Table B, relating to the assessment areas concerned:

> Scientific competence. It refers to an individual's scientific knowledge and use that knowledge to identify problems, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues. It

> also involves the understanding of the characteristics of science, understood as a method of knowledge and human research, the perception of how science and technology shape our material, intellectual and cultural environment, and willingness to engage in issues related to science and the ideas of science as a reflective citizen… (p. 13).

It is in this way that the scientific competence and the ability to use knowledge and scientific processes is conceived, not only to understand the natural world, but also to intervene in the decisions that affect it.

On this basis must build educational models in Latin America, if we truly try to advance in the same path of developed countries (industrialized).

**In Mexico**

In Mexico, the first scientific lecture was given by renowned Fray Diego Rodriguez in 1637 at the School of Medicine of the Royal and Pontifical University of Mexico, and was on astrology and mathematics. Although it was Don Carlos de Siguenza the most notorious seventeenth century scientist who in 1672 occupied the chair of astrology and mathematics that left Fray Diego.

With big swings throughout history, science in Mexico would not be significant until 1930, but resumed university education in the early twentieth century, scientific careers would make an appearance later. In this reason, in 1960 the National Institute for Scientific Research, which in 1970 would take the name of National Council for Science and Technology (CONACYT) is established.

By 1984 the National System of Researchers, under the federal government is based (although initially it was thought autonomous). With all universities and institutes begin to receive larger budgets for research and training new researchers, with the disadvantage that

benefit most are those that are located in the Valley of Mexico: UNAM, CINVESTAV, El Colegio de Mexico among others. By 2000, 50.8% of researchers working part of the National System for an institution of higher education and research located in the Federal District (De la Peña, 2004). If to that we add that there are only 383.5 researchers per million inhabitants, compared with the United States that has 4,673 or even Argentina which has 1,091 (see Table 1) then you can scale the size of the problem.

Table 1. Investment in science and technology in the world

| País | % del PIB | Investigadores por cada millón de habitantes | Investigación básica | % de investigación aplicada | % de inversión en investigación experimental | % financiamiento gubernamental |
|---|---|---|---|---|---|---|
| México | 0.39 | 383.5 | 23.89 | 30.99 | 45.11 | 46.92 |
| Estados Unidos | 2.89 | 4,673 | 18.97 | 17.81 | 63.21 | 31.26 |
| Rusia | 1.25 | 3,091 | 20.99 | 20.07 | 58.92 | 66.46 |
| China | 1.70 | 8.63 | 4.65 | 12.59 | 82.74 | 23.40 |
| Argentina | 0.59 | 1,091 | 29.80 | 43.73 | 26.46 | 73.23 |

Fuente: UNESCO-STATISTICS (2009), citada por *Avance y Perspectiva*, CINVESTAV, inversión de Ciencia y Tecnología en el Mundo. Recuperado de: http://ayp.calypso-media.com/infografia/mapapib.html

De la Peña (2004) provides data describing the context more accurately, noting that in scientific journals of international publications, as are an indicator of scientific activity of quality are scarce; of all publications are presented globally, Mexico contributes only 0.64%. This ranks the 22 OECD countries and the second in Latin America. Paradoxically, in the period from 1980 to 2000 public institutions of higher education they doubled and got bigger. Nevertheless scientific careers enrollment declined in relative terms. The situation over the years has not improved significantly.

An objection to be made to these statistics is that the author considered only scientific careers related to the physical and natural sciences, bypassing those related to the fields of economics, management and accounting, among others.

In favor of the scientific development of Latin America, Gómez-Quintero (2013) reports that in this region, including the Caribbean, increased production of articles published in international journals, with a strong presence in Mexico, Colombia, Chile is currently observed and Venezuela, as well as institutions of Ecuador, Peru, Costa Rica, Cuba, Puerto Rico and Uruguay. It emphasizes the role of Brazil as a leader in this line, which based its

dominance in greater investment (60% of total expenditure carried out in the area). Added to this, Mexico and Brazil account for 95% of new doctors who graduate in the region.

In this context, assuming as true that educational institutions must train new cadres of scientific researchers, then plans and curricula should consider that there are three essential factors to be taken into account (Valdez-Ramirez, 2005): 1) direct contact with science; 2) contacting the investigators; and 3) the manner in which science is done. This hardly happens in basic education levels.

Valdez-Ramirez (2005) discloses that students usually have contact with science in graduate programs, mainly in the doctorate, although some do from undergraduate, to make their thesis. In a study reported by him, put into effect in the Autonomous University of Nuevo Leon, Mexico, with undergraduate and graduate students, it was found that participating in an investigation since pursuing graduate studies was a major factor in deciding to continue postgraduate studies. Additionally it was found that the role of the tutor or thesis advisor plays a key role in the formation of the scientist. The evidence showed that the learner is on the advisory model, who also guide you, teach you the theory, how to approach problems, formulate hypotheses, precise techniques, in addition to writing science and communicate with other scientists. Learn how to perform both scientific knowledge and to have a specific attitude towards it (reading the article recommends: Villarruel-Fuentes, M. 2012. Academic tutoring and science curriculum: the relationship between teacher and student-expert-apprentice. Educ Humanism, 14 (23):. 165-178, available online).

With regard to context, the investigation confirmed that the work environment is critical to student development. This is the place where science is valued, quality science is done, it has enough resources and no red tape and excessive administrative burdens, it has updated bibliography and there are research networks that promote contact among scientists.

Referring specifically to the graduate programs, Valdez-Ramirez (2005) notes that there may be in Mexico doctoral programs where the student is not in contact with study plans and programs including these three factors. Which may be true.

Under these circumstances, the idea of consolidating the longstanding relationship between education and science must continue to apply, especially in a country like Mexico, where the lack of effective public policies has led to serious stagnation and elaborate simulations. Asked in a recent interview Olive (2009) on issues affecting Mexico said:

By now it is clear that scientific and technological development is no default way, it can be channeled in different ways and through social agreements must decide what these ways are. To this we must see how decisions are made: authoritatively by political elites or scientific and technological elites, or otherwise, since they affect all of society, it is looking for ways to be a citizen participation with adequate, with a good knowledge of the issues at stake and sense of responsibility (sic). Here is the importance of a society that is increasingly educated from scientifically and technologically, but this does not mean that only knows the contents of science and technological devices you use most without knowing where they come from, but it more aware of the processes under which it is generated and its potential uses, benefits and risks ... (p. 2)

By emphasizing the need for a scientifically literate society, it is necessary to review aspects related to the perception and representation of social science constructs operate as triggers of citizen interest in learning and engage in scientific and technological matters. As an example we can cite the level of information on science and technology people have, which obviously varies from country to country. Table 2 shows a comparative study on this.

Table 2. Level of information on science and technology people have in different countries.

| Nivel | Argentina (Centro Redes, 2012) | Brasil (MTC, 2010) | México (CONACYT, 2011) | Uruguay (ANIL, 2008) | Encuesta Iberoamericana (FECYT, RICYT, OEI, 2009) | Europa (Eurobarómetro, 2010). |
|---|---|---|---|---|---|---|
| | % | | | | | |
| Muy informado | 21.0 | 25.2 | 7.7 | 27.0 | 9.2 | 11.0 |
| Bastante informado | 33.7 | 34.0 | 25.4 | | 39.1 | 50.0 |
| Poco informado | 24.6 | 24.2 | 42.6 | 50.0 | 38.8 | 38.0 |
| Nada informado | 20.8 | 16.5 | 16.9 | 22.0 | 11.8 | - |
| Ns/Nc | - | - | - | - | 1.1 | 1.0 |

* Las categorías de las variables eran: “muy buena”, “buena”, “moderada” y “nula”.
** En la encuesta europea se habla a nivel informativo sobre “nuevos descubrimientos científicos y desarrollos tecnológicos”.

Adaptado de: Polino (2011: p.83)

The results allow to observe different levels of perception in terms of how to approach the study, but above all to perceive and socially experiencing science and technology. With all this, Polino (2011) clarifies that:

... As educational attainment increases, so does the proportion of people who consider themselves more informed about science and technology, or are regular users of scientific content in the media and other industry formats way It may be noted that 20% of people with basic education deemed to be 'all informed'. However, this proportion reaches only 9% in the case of those with higher education "(p. 83).

Olive's own (2006) who explicitly several questions that may well serve as the linchpin of the new proposals for education based on scientific training:

Should the Mexican society to invest more resources in science? What would that mean? To finance a larger number of research projects? EXPAND research infrastructure? Make it easier mobility of researchers between research institutions and higher throughout the national territory education as well as promote the development of research networks? ¿Dramatically expand the template and ensure decent income for researchers? But only

research should be strengthened, and also education and dissemination? Are master's and doctoral programs should be strengthened? -To grant a higher number of scholarships? Aggressively can we promote programs for the development of a scientific culture in the country? But it should not be given equal or greater attention to teachers, from primary school to the upper level, or is it that they have nothing to do with the strengthening of science in Mexico? (P. 1).

The author states that from the point of view of the Mexican scientific community (understood in a broader sense, no disciplinary exclusions), the answer to all these questions is undoubtedly a strict yes. But he asks: Under what justification would have to make these reforms? At this point the matter was already clearly set out in this chapter. In any case it is relevant to note that the scientific, by itself, does not necessarily lead to greater economic and social development, but it must be accompanied to conjunctural reforms in several aspects. One of them, perhaps the most important: the didactic training of teacher who teaches science at the upper level and graduate (degree). This comes to demystify the figure of the teacher-researcher, who they say is a good science teacher just by having a master's or doctorate, or that a good teacher can conduct scientific research from the interpretative frameworks of teaching.

The need to abandon traditional academic comfort zones consolidated within educational institutions can convert to teachers, students and managers in real social actors, builders and owners of the word. Rangers thoughtful participation leading to the construction of the field, educational intervention and continued reflection from research. Without it, no educational reform will have the expected success. It is necessary to give a real opportunity for school science in educational projects, so that actually can show its transforming potential.

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