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Robotics, Education and Economy

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***Abstract*—**Describes the current situation of educational Robotics "the State of the art" its concept, its evolution their niches of opportunity, academic and business and the importance of education and academic outreach. It shows that the development of high-tech automated educational materials influence the teaching-learning process and that communication between machines and humans is a reality.

***Keywords*—**Education, robotics, robots, technology, innovation, educational constructivism

I. Introduction

CELLULAR, satellites, personal computers, televisions, high definition, robots, telecommunications devices, etc. are just some examples of the current technological progress. The students, from preschool to professional, interacting with this type of applications, paradoxically, with or without the knowledge of the internal function of the apparatus, i.e. for use and handling only enough understanding to level system "I/O", saying more explicitly, learn-making. The starting point that has changed the comfort and quality of life of human beings in just 50 years,itis microelectronics "before" and now with nanotechnology, it is likely that we have applications in only a space of 1 x 10^{-9}; however for the end-user these advances will be transparent.

II. Background

A. Introduction

With the invention of the transistor in 1947 [2] and the further development of the integrated circuit "chip" by Jack S.T Clair Kilby in 1958 [3] home a reduction in the size of the applications process.In the Decade of the 80's the development of integrated circuits known as VLSI "integrated circuits of very large scale integration" [4], who had more than 100,000 transistors embedded in a silicon base, allowed the development of complex electronic systems: coffee vending machines equipment of diagnostics, electronic ignition for cars, cash registers and small missile "weapons" are just one example cars, cash registers and small missile "weapons" are just one example.

In 2002 the microelectronics at its height allowed integrated single-chip technology of 0.12 micrometers (um), 60 million transistors, for the 2012 more of 2000 million transistors on a single circuit integrated, figure that soon may triple with the development of nanoscience. The integration of millions of transistors on a silicon device, not only allowed the reduction of the physical space but also, under the cost of applications.

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- In 1970 a computer PDP9 had a very high cost. In 2002 a computer with processing capacity of 1.7 GHz memory including had a cost of approximately 1000 dolls.
- In 1970 the computers were exclusively used by scientists and technologists. In 2002 the computers are used by children from levels of primary and secondary to the family environment.
- In 1970 the design of integrated circuits is made by people with extensive knowledge in; Physics of semiconductors, materials, manufacturing processes, design of circuits and systems design. In 2002 the VLSI design "computer aided design" can be made through CAD tools and can be done by students of preparatory level or qualified technicians.
- In 2012 the creation of Bio-inspired and nanobots within the human body chips, stopped being science fiction to become a reality with which humans learn to live [5].

B. Robots

Since ancient times the man always wanted how to design intelligent mechanisms which in one way or another can influence the development and behavior of humans. The Egyptians and the Greeks developed manual or hydraulic systems to partially move limbs of their idols "Gods", mechanically controlled to fascinate the worshipers of the temples.Later men sought ways of developing machines responsible for making repetitive and expensive work of humans. The word robot has its antecedent from the Czech word robota, meaning servitude or forced labour established by the dramatist Karl Capek in 1921 in his play "Rossum's Universal robotsR.U.R" [6].

However is due to the famous writer of science fiction Dr. Isaac Asimov at the end of the Decade of the 1930s who establishes the term Robotics [7], as the Science study of robots. Subsequently the term spreads and settles as the field responsible for the study of robotic technology that considers aspects of: design, manufacture and application, combining your development disciplines such as mechanics, mathematics, control, electronics, computing, etc.

Robotics is currently immersed in the concept called "Mechatronics", however the development of machines that they resemble the functions of humans should not be confined only to the physical appearance, but also consider aspects of programming and artificial intelligence.Such is the case of ro-BOTS programmed artificial entities that may develop into a physical or virtual environment e.g. conversational BOTS that can maintain a human logical conversation, progress has been considerable and the limited, controlled by the test of Turing [8], leading the caller to not secure if you maintain a conversation with a human being or with a computer program.

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III. Current problems

A. Robotics

The trend in robotic own technology of highly necessary and industrialized countries in third world Nations, to avoid the technological lag, which limits its growth and its research capacity. He has made multiple universities in Latin America, public and private, to incorporate within its educational offer the careers of Mechatronics, bionics, telematics and even specialties in robotics, in Mexico. Although there have traditionally been topics or some subjects on robotics or advanced control at levels of graduate of the Autonomous National University of Mexico or the National Polytechnic Institute, is not enough, even the home for power; not to compete, but to understand the world of applications that take place worldwide and not only in the academic aspect, but also in the business. Point and separate the technological development of the militia which would seem inspired and influenced by rendering technology not of this world.

However the College vision is not enough, there are two other determining factors for growth: first, second and qualified personnel the cost of equipment. In the first case is very little, perhaps null, considering the amount of people and universities in our country, this shortage as a result of a, not vision, inappropriate governmental policy which does not stimulate, directs or corrected properly, among other aspects: knowledge well paid, low academic professional, the lack of projection and student mobility towards master studies and doctorate, among others.

This first factor covered by merely media expectations and mitigation, take hand of professionals from related fields, to cover a field of study which requires a special care full of opportunities, I seems that we will once again be the eternal spectators.

The second factor is even more tricky, depends on the economy and the purchasing power of the user, because the high cost of highly sophisticated equipment, which also requires the necessary physical space not only for installation but also for its maneuverability, this factor in a third world country is a real problem, universities require an unplanned space for this technological trend.

B. Technology

The developments of technological products of educational nature, mechanisms specifically intelligent, such as robots, have opened a new field of research, which gradually have taken over the market educational, industrial and consumer. It is clear that in the future our children will coexist with increasingly intelligent machines. The interface between human and machine is a reality, it is the inevitable step that is giving and thanks to advances in telecommunications, the magic of special effects, animation technology, video games, artificial intelligence, computing, microelectronics and nanotechnology. There are so many research areas mixed in an application that surprises us what can be done and is done without even knowing really what is happening.

Currently this technology integration incorporated into the classrooms in various applications and forms "internet, multimedia, robotics, ICT" they not only cover the aspects of research, but also promotes the development of new products and lays groundwork for economic development in first world countries.

IV. Educational Robotics

Educational Robotics focuses on a set of pedagogical activities that develop in the student cognitive skills [10], through the construction and programming of robots, manufactured and designed to handle in a didactic way.

But does that mean? Manufactured and designed to handle in a didactic way. The concept is very simple, they are systems or entities pre-assemblies of easy construction with which it can interact, educational robots can be used by students, from primary to postgraduate and in various environments: teaching, research, socialization, etc.

The development of educational robots is based on a novel proposal that takes into account important aspects:

- Programming fully interactive using high level visual interfaces, but easy handling.
- No requires specialized programming, use block illustrated that do not incorporate concepts of engineer.
- Simple and adaptable structures are used for the construction and assembling of robots and mechatronic systems
- Learning based on concept learning-making "constructivism".

Educational robots have a very simple control as opposed to an industrial robot structure; have a microcomputer or microcontroller in a very small space, commonly called "brain of the robot", in analogy with the brain of humans. Communication with the robot is done through a physical or virtual connection from an external computer. I.e. users programmed routine that the robot must be through blocks or instructions simple, observable in the computer monitor and then send the information to the brain of the robot through a cable connection "interface". Or as simple as a local connection "Wi-Fi" technology incorporated in the current computers and the most important aspect, the educational robots are constructed with plastic parts that can be easily manipulated in a classroom.

The exponential growth of these didactic structures strengthened relationship school–industry."companies require the incorporation of new technologies and new ideas within their commercial developments" such is the case of the LEGO Group and the Massachusetts Institute of TechnologyMIT, linked in the first set of educational technology development LEGO Mindstorms, "Robotics InventionSystem" marketed from the month of September 1998. Learning Lab at the MIT Media Laboratory focuses on the development of new learning technologies and the development of new theories about the child's play, learning and creativity[11]. We must remember that MIT is regarded as the best school of engineering worldwide.

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A. Constructivism

Jean William Fritz Piaget the famous philosopher, in one of his several studies argues that logic, based on thought, begins before the language and is acquired through sensory and motor actions of the baby. Through interaction and interrelationship with their socio-cultural environment, this observation introduces the theory of intelligence somatosensory, describing development almost spontaneous one intelligence practice that he is obtained in the action [12].In his study the psychology of intelligence (1947) postulates that logic is the basis of thought and that therefore intelligence is a generic term to refer to the set of logical operations for which the human being is capable. It subsequently develops the theory which establishes that learning occurs through several cycles or stays of development, currently known as cognitive States, where the human being assimilated on the basis of a concept. This idea, based on the studies of James Mark Baldwin, "adaptation by assimilation and accommodation based on feedback".

In essence the constructivism is a current teaching methods based on the need to give the student tools to create own ways to resolve a situation. A problem led to a critical point, may, so that their thinking is not linear but in constant motion which causes that the student has a role active, aware and responsible for their own learning and the results will be the knowledge that the student can build throughout the process of development of solution to the problem. In educational Robotics this point critical occurs in design and challenge of "scenarios". The construction of knowledge based on facts and ideas that the student has obtained and with the integration of some concepts, this manages to create new knowledge, which is the ultimate goal.

V. Education

From our position of adults and educators we criticize and long past, when perhaps the knowledge and the way of teaching should adapt to new discoveries and the era in which living generations. Thus our attention should be focused on how to use the new devices and materials, i.e. search for new teaching methods to meet the conditions for the acquisition of new skills to become more practical and less apathetic and lazy students.

A. Teaching techniques

At the present time the teacher has adding strategies that help the students develop new skills to integrate a general knowledge base. Found that introduce the student in a real environment where the protagonist of the application might be leading to effective learning with greater retention of knowledge. This feature within the robotics education, "a problem in a real environment" makes the didactic technique ABP "problem-based learning is ideal for learning, Assembly, programming and control of robots".

ABP is a teaching technique that uses elements of the real world to describe significant and contextualized situations of everyday life. It relies on the focused learning and experiential (learning-making) organized around research and problem solving of any item in particular.

This technique gives resources, guides and instructs students, while they develop knowledge of content and skills to solve problems. The teacher takes the role of a tutor, forming small groups for the analysis and solution of the problem, aiding in case if necessary. In educational Robotics integration and collaborative work are important parts, build and program requires two related but different areas, mechanics and computing.

In the ABP problem must raise a cognitive conflict and must be somehow motivating and sufficiently complex, to arouse the interest and the collaborative participation of the members of the team. Within the environment of educational robotics challenge is to develop the scenario that wake up the interest, curiosity and creativity to build and program a robot. However and however the real purpose is not to solve the problem, but make it the means to recognize the issues that will require study, i.e. means that the problem is that students meet the learning objectives. The general idea of this technique consists of three steps: confronting the problem; independent study, and return to the problem [16]. The ABP makes emphasis on the acquisition of knowledge and not memorization, students develop their own learning needs analysis and will develop a method to acquire the knowledge, this is part of the process of interaction to understand and solve the problem; while they identify and offer solutions that strengthen critical thinking [17].

VI. Economy

The development and innovation of new materials which introduce cutting-edge technology, is a growing need, structured on the basis of the theory of constructivism, as he was said earlier "holds the idea that the child creates his knowledge actively and that technology and education should provide you with the tools to enable it to carry out activities to promote its development". The South African mathematician Seymour Papert, companion of Jean Piaget, interested in the development of the child mind and the acquisition of knowledge, formed part of the creative group of the educational software Logo (programming language)", tool used to teach programming and is the author of the book Mindstorm: Children, Computers and powerful Ideas, showing the use of computer technology to advance learning. "This publication is the origin of the rapprochement between the President of the LEGO Group and the epistemology and learning group of theMassachusetts Institute of Technology(MIT) directed by Dr. MitchelResnick, creators of the successful ProgrammableBrick, controller of the RoboticsInvention System, known as "RCXprogrammable brick", and on which is based the developments of educational Robotics of the Lego Groups shown in Fig. 1.

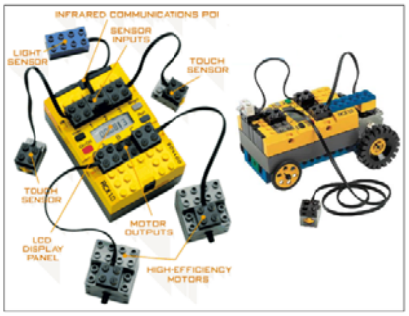


Fig. 1 RCX programmable brick

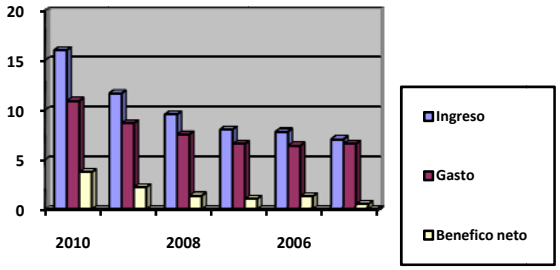
The integration of the Lego Group and the technology of Massachusetts is a sample of the synergy created between a group of companies and academic group, with benefits for both. The development of the programmable brick RXC in 1998 on which develops the educational toy gives rise to a new Division within the group called Lego Mindstorms for Schools, "Lego Mindstorm School" with its own area of opportunity.

Initially Lego financed the epistemology and learning group of MIT on the study of new theories or learning flows. Lego would explore the results to generate ideas on the marketing of new products, without the payment of royalties. Lego Mindstorm for Schools currently is not only it is a development product but a didactic approach to education and that generates team of robotics, pneumatics and solar energy among others. The Lego Group is currently grants and funding for the development of new output 1999 the Group attach funds by $ 5 million to the LearningLab at the MIT Media Laboratory [11].

1. Lego case

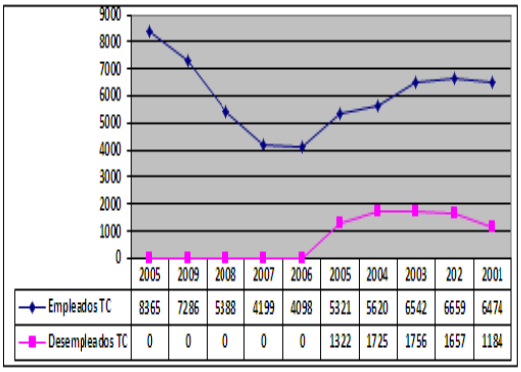
While in 1996, Lego, Danish firm founded in 1932, ranked first in the development of toys, its direct competition MEGABLOKS founded in 1967 in Montreal Canada, expanded during 1997 to Latin America and Europe, achieving between 1999 and 2003 double its sales, the reason, the use of plastics of lowest price. This competitor among other things caused the destabilization in the market of the Lego Group, originated an internal imbalance that could be of dire consequences and that kept the company on the verge of bankruptcy. In the year 2000 to 2004 Lego considerably low their income, between 2003 and 2004 had lost between 1931 and 935 million dollars respectively [19]. This situation of crisis led the group to change of director, appointing Jorgen VigKnudstorp who initiated a restructuring of the company, setting up production plants in Mexico and the Czech Republic and the launch of new lines of toys like Mindstorms, which show positive results in the following years, shown in table 1 and are evidence of the effectiveness of its implementation.The development of educational materials is now an important factor in the generation of employment.

TABLE I
REPORT FINANCIAL GROUP LEGO



Applied technology and innovation is one of the pillars of growth of Lego that keep as one of the leading companies in market, its growth goes hand in hand with its strategic alliances formalized with MIT. An important factor in this economic recovery is the generation of jobs, for 2010 the number of staff of full time in this company of 8,365 jobs situation was totally opposite to the number of people who had lost the work during the crisis, as shown in table 2.

TABLE II
LEGO AND GENERATION OF EMPLOYMENT



A. Technology platforms

Permanent innovation of new strategies of sale in the industry have allowed the creation of competing materials towards a new "Educational Robotics" concept which has given rise to various technological platforms, facilitating research and learning.

1. Meccano

Meccano of France [20], in its infancy, with the legend "Meccano makes it easy" develops a kit of 15 parts metal, patented in 1901 by engineer Frank Hornby and marketed in the second industrial revolution, explodes, an original concept, the creation and Assembly of mechanical systems subject by means of screws and nuts.

This idea that has been adapted to technological changes through several generations to succeeded in assembling structures mechatronic including engines powered manually or by using a wireless remote control. The developments of last generation include the construction of Robots programmed and controlled through a computer in a local Wi-Fi or international way through a "global network", as shown in the fig. 2.

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Fig. 2 Current developments group Meccano

2. NAO

The robot Nao [21] French product of the ALDEBARAN Robotics firm is a robot that can be programmed through blocks through an easy conceptualization graphical interface. It has 25 degrees of freedom, that make the humanoid robot can walk, dance and to play football, feature that allows you to have its own category in the League RoboCup, as shown in the Fig. 3.



Fig. 3Updates for the Nao robot

NAO, socializing and interacts in the educational environment with children of different school levels and in different languages, in addition, can in conjunction with other Nao perform tasks on computer or in a collaborative way. In the University environment can be used for the purpose of research in the fields of: artificial vision, neural networks, fuzzy logic, artificial intelligence, etc.

B. New platforms

The boom in the development of didactic lines has increased in recent years; companies in synergy with universities have developed educational teaching systems: Eitech[21], Fishertecnich[22], Lego [23], VEX Technology [24], Bioloid Robotics [25], Tetrix[26], etc.

However there is a common denominator, the teams are still expensive for developing countries, as shown in table 3, considering the cost which means serving 40 or more students in a classroom, teaching teams are suitable to work in teams of two or three people.

TABLE III
COST OF DEVELOPMENT SYSTEMS "DATA TO 28 MAY 2012"

Technology	**Cost**
Lego NXT	380 dlls
Lego Tetrix	902 dlls
Meccano Wi-Fi	387 dlls
Bioloid Beginner	411 dlls
BioloidComprenhensive	1065 dlls
Bioloid Premium	1341 dlls
Bioloid GP	3278 dlls
VEX Technology	1149 dlls

VII. CONCLUSIONS

The development in robotics education is in its infancy in Latin America so it is important that the universities form paintings of high technological level to achieve impact on the careers and degrees related to the Mechatronics.

They must find the mechanisms to strengthen the link between universities and businesses to develop innovative products aimed at education.

The cost of educational materials of new generation are still high, so it should be thinking on developing virtual and interactive software as teaching method [1][17].

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Within the InstitutoTecnológico y EstudiosSuperiores de Monterrey extended diploma in teaching skills and the graduate diploma in microelectronics. It is currently candidate for the Metropolitan Autonomous University of Mexico city.

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Professor David G Maxinez he has been awarded by the department of science and technology of the federal district in Mexico city, winner of the second place in the development of educational materials digital resources for the DF. Itiscstadviserrobotics of the Universidad Nacional Autónoma de México y de la Universidad Autónoma Metropolitana.

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