Electronic Didactic Toy, as element for programming teaching to boys and girls from 4 to 7 years

Cartagena, Edgar Eduardo.
eecartagenao@utn.edu.ec
Technical University of North

Abstract — The project consists of the development of a prototype of Educational Electronic Toy which aims in the teaching of basic programming for children between the ages of 4 to 7; the same that relates to learning with fun simplifying the programming so that children through the game that is an innate activity, to adopt programming knowledge and at the same time go by involving them with the world of technology.

Educational electronic toy designed in this work involves children basically with three concepts of programming which are: instruction, sequence and structures (cycles and conditions); which are the key concepts to time to directly learn the programming logic. The purpose of the game is to program sequences of instructions in a tangible programming interface to guide a robot toward a destination or goal proposed by way of challenge, so that children develop their creativity, imagination and at the same time be involved in programming in a playful way.

This prototype is based on the Arduino platform and contains a tangible program logic; the same one that allows children to program the robot wirelessly via Bluetooth technology and without the need of a computer or smart device, only by inserting small pieces of wood, which gives you simplicity at the time of the action of play and learn how to program.

Keywords— Children, Programming, Toy, Technology.

I. Introduction

Nowadays with the great technological advances, production of electronic systems for daily use of people and the internet; Ecuadorian children and youth should have a positive attitude to change, where they are not limited to be simple consumers, otherwise they become the producers of new technologies, helping with the educational process in which are immersed and their improvement.

Free platforms give us the opportunity of free knowledge and with the appropriate guidelines Ecuador can be a potential in education, technology and investigation, if it offers low-cost technologies to every child who wants to learn, without forgetting the fun and creativity that involves be child. Educational toy proposed in this paper is designed with the intention of providing free access tools to educate children of the country and encourage them to innovation and technological development from the early stages of life.

This work contains a research of the theories of learning and basics of programming for children; the same one that allows to understand the behavior of children in the learning process and the advantages of teaching programming from an early age. Later outlined the elements of software and hardware used for prototype design and each one of the steps in your deployment. An analysis of the costs and benefits that leads the development of educational toy and the teaching of programming to children and ends with conclusions and recommendations obtained in the implementation of the project is then performed.

II. Basics

A. Behavioral Theory

The behaviorist theory defends fully compliance with the procedures in the teaching process, Behaviorism focuses on the practice and behavior observable completely discarding all of the individual thought processes, basis is to learn what is shown or displayed.

B. Cognitivist Theory

The cognitivism is based on mental processes and the representation of knowledge, beyond the change in observable behavior of an individual exposed to a stimulus-response, proposed Behaviorism. This theory emphasizes knowledge rather than the response, on the mental structure and sees the individual as active, constructive, and as that able to solve problems and not as a passive recipient who reacts to stimulation.

1) *Pre-Conceptual stage:* at this stage are children between the ages of 2 to 4 years, children in this age begin to develop their symbolic representation demonstrating it graphically or through imitations, are able to imitate words and understand its meaning; however they still think that all things have life and feel.

2) *Stage of intuitive thinking:* children corresponding to this stage has between 4 and 7 years, in this age already can

solve problems intuitively through games, activities and experiences that allow them to develop their mental activity, however still are limited by their lack of experience.

C. Constructivist Theory

Children in the constructivist model must be sharers of knowledge forming part of the learning activity and not to remain only passively observing what is explained. Basically, children learn more easily when they can control an object or activity, without the need for a rigorous literacy only with basic guidelines the child will build their own knowledge.

D. Developmental characteristics of children 4 to 7 years

The boys and girls between the ages of 4 to 7 according to the cognitivist theory of Piaget are in the stage of intuitive thinking, at this stage developed a motor coordination that enables them to manipulate tools and accessories in a way more accurate and precise, in this age children are much interested in acquiring knowledge and become very curious by what you are interested in activities that allow them to discover, reflect and create, this is why strategies that take advantage of this stage taking into account that children should develop activities in accordance with its possibilities since if it's easy or otherwise is very difficult children could lose interest should be developed..

Constantly the thinking of children is becoming more analytical, logical, are able to understand more complicated situations, draw conclusions and make classifications. At the same time it will evolve their emotional maturity that allows them to be more sociable and have the ability to work in group with greater ease, being participatory and collaborators, also develop their cognitive curiosity and try to acquire knowledge of everything which for them is unknown.

E. Incidence of the didactic toys in children

Educational toys are educational tools that can be used as a teaching strategy in any age, these toys in children's learning process are very important since with a suitable methodology can allow infants to develop and strengthen their skills, expectations, conceptualization and socialization.

Educational toys are made in an effort to contribute to the development of children in aspects related to thought, oral and written language, imagination, socialization, better knowledge of himself and others. These have been increasing its importance since the teaching processes have changed, avoiding forced memorization and physical threats by methods of stimulation of the senses and the imagination.

F. Objectives of the educational toys

Educational toys should have a number of objectives that meet the purposes of the game and the goals that you want to achieve. Among the main objectives of a game or educational toy this first establishment of a problem, which should be resolved with a level of analysis and appropriate difficulty to arouse the interest and the child mental compression.

1) *Educational purpose:* refers to the educational intention which has toy, for example in this case is an educational electronic toy that aims to didactic teaching of programming logic to children.

2) *Playful action:* refers to the activity of playing, since if there is no game is not a didactic toy but would be a teaching tool that is something different. Play action stimulates the child and awakens their interest which causes that the child voluntarily see the need to learn.

3) *Game rules:* constitute the organizational part of the game, the rules are that set as it must be played, which actions are allowed and what not; the rules of the game are very important since they will determine fair shares in the game.

G. Children and technology

Recently it has been seen to children aged three or younger locate a program on a phone or computer from their parents, relax with a video game interactive or turn on a technological appliance in the home, this is because children by be continually exposed to technology, the technology tends to be very easy to use for them. Children as well as have to need to learn to read, write, add, subtract, and calculate do they well at school and then at work, the children will also have to know how to operate computers and other technological devices.

H. Programming for children

An increasing number of countries has begun to teach their students to write code with the objective of training to digital creators and not just mere consumers of content, enhancing your creativity and your logical mind. Programming is a word that may sound boring, but things change when you ask a child if you'd like to learn how to create your own toys, apps and games.

Programming is give a series of instructions and see the effect in real time. I.e., what is indicated by the instruction moved to action, and this action has consequences. The programmer is responsible for the action that took place from the statement given by. Programming involves structured thinking, ideas, turn them into a construction project to generate something new, not only to manipulate what already exists.

1) *Program:* is a set of instructions that guide the computer to perform some activity or solve a problem; in the program run different actions according to the data being processed.

2) *Programming language:* is the medium through which we communicate you to the computer or to the driver the sequence of instructions to be executed to carry out activities, tasks, or troubleshooting. If is the language through which we can have communication with programmable device.

3) *Algorithm:* is a tidy and chronological sequence of steps that lead to the solution of a problem or the execution of a task. The steps of the algorithm must have the following

characteristics: be clear, simple, precise, and accurate, have a logical order and have a beginning and an end.

4) *Sequence:* it is a set of instructions that are executed in the order they were written one after the other.

5) *Control structures:* are a fundamental part of any programming language. Without them the instructions of a single program could run in the order in which they were written. Control structures allow you to modify this order.

I. Tools to teach program

Worldwide teaching programming to children already is a much validated idea in the effort to improve education and the use of technology. In recent years, a debate which has as its central topic if the subject of programming in the curriculum of primary education must incorporate or not has been created. Currently some European cities already have incorporated these subjects however beyond that is incorporated or not several tools have been created to help children to learn how to program.

1) *CODE.ORG* learn to program with the Angry Birds: Code.org is an organization of the United States, which has the support of large companies such as Google. Microsoft, Facebook and Twitter; This organization is focused on the teaching of programming to all people of different ages in particular children, its last proposal tries to teach children to be programmed to create his own game called Angry Birds this tool is intended to guide a bird at a target programmatically block.

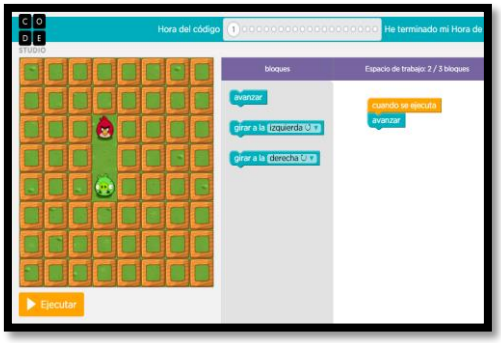

Fig. 1 Angry Birds of Code.org

2) *Scratch:* Scratch is a widespread tool around the world created by the Massachusetts Institute of technology, this is a tool focused on children and young people between 8 and 16 years so they will understand how the code works using a programming through graphics with a very clean interface. In Scratch kids can program their own interactive stories, games, and animations and so learn to think creatively, reason systematically, and work collaboratively.

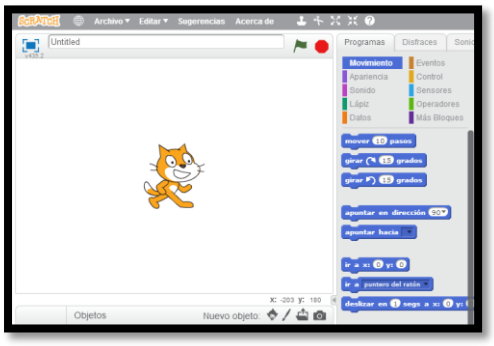

Fig. 2 GUI from Scratch

3) *LEGO MindStorms*: Lego MindStorms is a line of robotic toys for children manufactured by the company LEGO, which has basic elements of the theories of Robotics as the union of parts and programming interactive actions. LEGO MindStorms may be used to construct a model of integrated system with computer-controlled electromechanical parts.

Fig. 3 Programmable LEGO Mindstorms robot

III. PLATFORM ARDUINO

Arduino is an electronic platform of hardware and software free, consisting of a plate with a microcontroller and a development environment and designed to facilitate the use of electronics in multidisciplinary projects. "Arduino can take information from the environment through their PIN input of a wide range of sensors and can affect that surrounds you by controlling lights, motors and other actuators", which has allowed to motivate students and developers to use this platform.

Arduino is an electronic that adjoins a microcontroller input and/or output ports, has an own programming language and an EEPROM memory that acts as a small hard drive, here are stored programs will be run. This memory is non-volatile, i.e. that so goes out the Arduino data remain there, also specify that he supports such as communication interfaces: Wireless, Bluetooth and Ethernet, among others.

A. Arduino Mini-Pro

The Arduino Pro Mini is an circuit board based on the ATmega328 microcontroller. It has 14 digital pins for input and output, 6 analog inputs, a reset button and the Mount of pin

holes. The Arduino Pro Mini plate is designed for permanent or semi-permanent installation in objects or exhibitions. The Board comes without Sockets pre-installed, allowing the use of various types of direct welding cables or connectors.

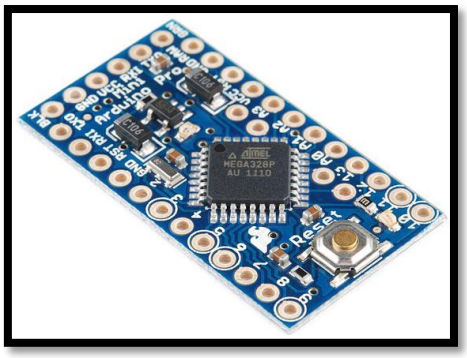

Fig. 4 Arduino Mini-Pro

B. IDE

Arduino has an environment of development of programming known as IDE that can be obtained for different operating systems such as: Windows, Mac and Linux, which is transferred via USB cable. This interface allows you to introduce the program to run on the Arduino board and is where it is defined that make both entries and outlets offering plate.

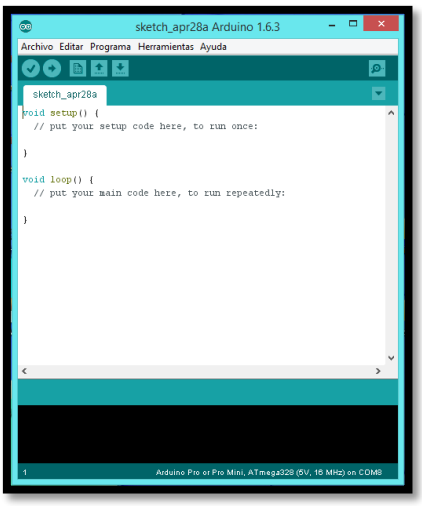

Fig. 5 Arduino IDE interface

C. Digital inputs/outputs

Arduino is formed basically by input, a microcontroller in the Middle pins and output pins. Input pins are used to preview and capture information from outside, for example pushbuttons, sensors and readers, among others. The microcontroller is used to process the loaded program and finally the output pins are used to send information from the Arduino card abroad.

D. Analog inputs

The Arduino boards have analog inputs which can receive voltages between 0 and 5 volts. Although Electronics's microcontrollers can only work with digital data, incorporate a circuit that converts the analog value received to a digital value the approximate possible..

E. PWM outputs

PWM or pulse width modulation, is a technique to obtain similar results from digital media. This technique is used with the need to send analog signals to the environment, for example, to vary the speed of a motor, the frequency of a sound emitted by a buzzer or change the intensity of a LED.

F. Communication Serial

Serial communication is used for the exchange of information between the Arduino board and a computer or other devices. All Arduino boards have at least one serial port that allows you to communicate in a direct way or also gives the possibility of connecting wireless Bluetooth, ZigBee, WiFly among others communication modules.

1) *Serial synchronous communication:* synchronous communication is one that undergoes a rigid timing clock that allows the receiving device to be able to know in that instant the signal that arrives has full validity.

2) *Asynchronous Serial communication:* asynchronous communication is not subject to any timing, in this type of communication data in ASCII characters can be transmitted at any instant. The clock is synchronized at the beginning of every character received.

G. Compatible wireless technologies

Serial communication can incorporate different wireless technologies depending on the project requirements to implement. Among the aspects that must be taken into account to choose the type of technology is the speed of data transmission, distance of the link, required safety, energy consumption, frequencies, capabilities and resources; all this trying to not waste the capabilities of the technology chosen.

Wireless technologies used in the development of embedded systems are Wi-Fi, ZigBee, and Bluetooth..

1) *Wi-Fi:* WI-FI is one of the technologies of wireless communication by means of waves most currently used, also called WLAN (Wireless Lan, wireless network) or standard IEEE 802.11. WI-FI is short for Wireless Fidelity, simply a trade name is.

2) *Zig-Bee:* ZigBee is an open standard for low-power radio known under the IEEE 802.15.4 standard for wireless personal area networks. It includes a robust and reliable protocol network, low consumption and cost, with security services and application layer that ensures interoperability between devices. ZigBee operates at a data rate of 250 Kbps

on the free 2.4 Ghz band, although it also supports 868 & 900 MHz bands.

3) *Bluetooth:* Bluetooth is a technology that defines the IEEE 802.15.1 standard for the transmission of voice and data between different devices using an omni-directional radio link. Is specially designed for devices with low consumption with a range of coverage low especially for personal networks.

IV. Sensors and Actuators

En la actualidad la mayoría de sistemas electrónicos requieren medir, controlar y monitorear información de su entorno físico, para esto se necesita de elementos de entrada y salida llamados Transductores. Los Transductores son elementos que son capaces de trasformar o convertir cualquier tipo de energía a señales eléctricas para que puedan ser procesadas o controladas.

A. Sensors

Sensors are devices that capture and convert a type of physical, chemical and biological energy to another type of energy that usually is electric. These devices enable communication between the physical world and measurement or control systems both electrical and electronic, used extensively in all kinds of industrial and non-industrial processes for purposes of monitoring, measurement, control, and processing.

1) *Analog sensors:* analog sensors are those who get as output a value of voltage or current variable continuously over time within the field of measurement. Normally in electronic sensors provides analog outputs between 0 and 5 volts.

2) *Digital sensors:* digital sensors are those who give as a result an output encoded in the form of pulses or in the form of a digital Word encoded in binary, BCD33 or any other system. Two logical values 1 or 0 is a digital sensor you can only get, these sensors are based on a threshold or limit to throw any of the two results depending on the function and configuration of the sensor. In electronics is usually known to 5 volts as a logical 1 and 0 as a 0 Volt logic.

3) *Ultrasonic distance sensor:* ultrasound or Ultrasonic sensors as they are also known are proximity sensors that perceive objects at distances of up to 8 meters without the need for physical contact direct. The sensor emits a sound signal that arriving at an object is reflected and returns to the sensor, the elapsed time from the moment when the signal is emitted until the reflected signal allows the distance to the detected object is located.

The HC-SR04 Sensor is a module compatible with Arduino platform and the majority of microcontrollers. HC-SR04 is an ultrasonic distance sensor capable of detecting objects and calculate the distance to that found in a range from 2 to 450 cm. The sensor works by ultrasonic and contains all the electronics that are responsible for making the measurement. Its use is as easy as sending the start pulse and measure the return pulse width.

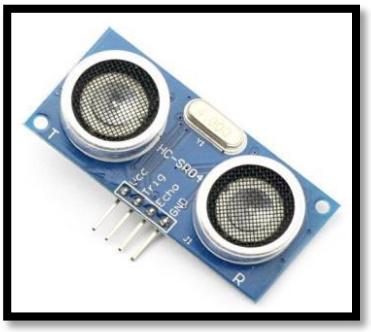

Fig. 6 Sensor ultrasonic HC-SR04

4) *Sensor Encoder:* the encoder are Rotary sensors that transform an angle into digital impulses movement. These generated pulses can be used to control the displacement type angular or linear type using microcontrollers, programmable logical counters, systems of control among others.

The reader module encoder FZ0888 is a sensor of incremental type that AIDS in creating prototypes of robotic and automation, which allows on the basis of digital pulses know the speed of an engine or the exact position of the same. This module is especially compatible with any microcontroller with Arduino.

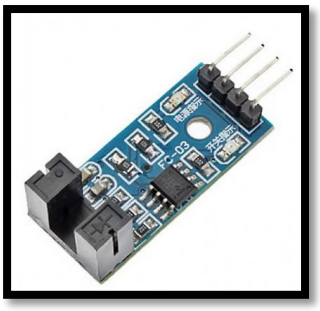

Fig. 7 Reader encoder module

B) Actuators

Actuators in electronic systems are elements that usually act as interfaces to convert physical quantities usually electrical to another type of magnitude allowing to act on the environment or process control, for example a motor converts electrical pulses moving, an LED turns the electrical pulses into light and so we have other examples; in other words the actuators allow interact or exercise before the electrical signals.

1) *Direct-current motor*: are Rotary devices that transform electrical energy into mechanical energy on the basis of the action of an electric field which rotates in both directions (clockwise or counterclockwise). They are

composed of two main elements, which are the stator and rotor. The stator is the mechanical part of the engine where are the poles of the magnet. The rotor is the mobile part of the motor winding and a core, which becomes the current through the brushes.

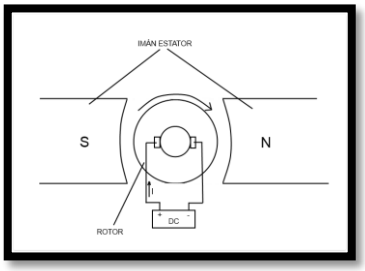

Fig. 8 Elements of direct current motor

2) *LED (light emitting diode):* is a special type of semiconductor, whose main characteristic is to convert into light electric current of low voltage flowing through your chip. From the physical point of view a common LED presents itself as a miniaturized, bulb filament or any other element or hazardous material, with an advantage over other technologies that do not pollute the environment.

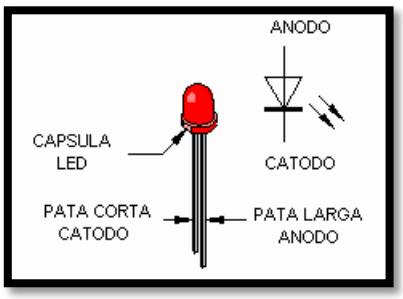

Fig. 9 Parts of a LED

C) Electronic components

Electronic components are devices or elements that make up an electronic circuit. These elements tend to be encapsulated usually ceramic, metal or plastic material. They are designed to be connected between them usually by welding.

1) *Resistance:* resistors are electrical elements whose mission is to hinder the passage of electric current through them. Its main feature is its ohmic resistance but it has another no less important which is the maximum power that can be dissipated. The latter depends on physical construction of the element.

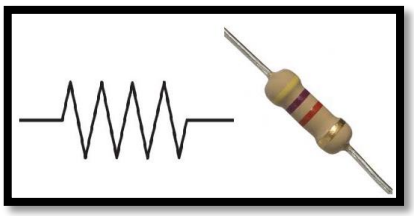

Fig. 10 Symbol and common resistance appearance

2) *Multiplexers:* combinational circuit with multiple inputs and output of data, they are equipped with control inputs to select one and only one, entries of data to allow its transmission from the selected input to the output that is unique.

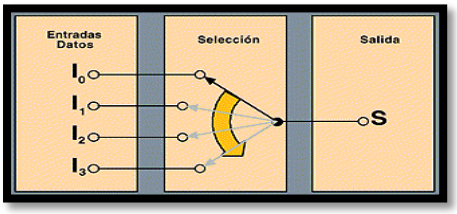

Fig. 11 Operation of the multiplexer

3) *Rechargeable batteries:* today there is a large number of electronic devices that make use of different types of batteries so there are many different types that can be differentiated by its size, capacity, weight, duration. A battery is basically a storage bin of the electricity you need a specific tool, this electricity is stored in a way chemistry then becomes electrical energy.

Fig. 12 Rechargeable batteries

V. SOFTWARE TOOLS

A. ISIS Proteus

Proteus ISIS is a program of electronic design created by Labcenter Electronics which allows design circuits with a variety of components, ranging from simple resistors to sophisticated microcontrollers, including power supplies, signal generators, and many other benefits. Electronic circuits designed in this software can be simulated in real time thanks to enter numerous families of microcontrollers and add compiled programs who wish to carry out. This tool allows to simulate microcontrollers also allows you to combine different devices such as LCD or message, engines, logical Gates screens, integrated circuits, displays, among others.

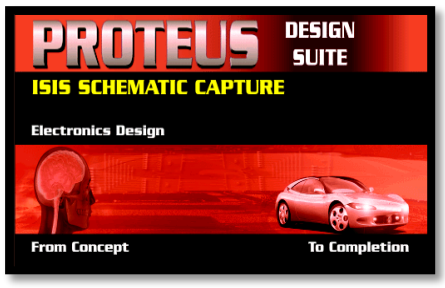

Fig. 13 Interface of Proteus

B. *Eagle*

EAGLE is a software design diagrams and printed circuit boards with router auto. This software is well known around the world since it has many free versions and with a large number of libraries that allow to design plates for plenty of electronic devices. EAGLE contains an electronic diagram editor which components can be placed with one click and easily routed them with the other components of both manual and automatic.

Fig. 14 Entrance to Eagle interface

VI. JED-PRO

A. *General description of prototype*

The present prototype which will be called JED-Pro (programmable educational electronic toy) has as main feature the logic of tangible programming for children. This programming logic is based on small parts of instructions with different resistance value, which are inserted into an electronic form of sequence Panel to be able to be read via analog pins of the microcontroller which in this case will be the Arduino platform.

The logic of tangible programming designed in this project consists of 8 blocks of different instructions, this leads to the need to use 8 resistive values allowing to differentiate each of the functions or instructions of the tabs inserted without any problem, so that these values must be quite distant each other.

Instruction cards are inserted into the programming interface, which consists of 16 inputs and a circuit of control based on the Arduino platform, this control circuit is responsible for reading the resistive value of each inserted instructions and is relating the value read with the previously assigned value of the instructions. After identifying you are storing instructions temporarily in a vector based flash memory while it finishes reading the instructions. Once the reading instructions proceeds to send string one instructions through the port serial connected to a wireless module into the robot represented by a cart which proceeds to execute the instructions one after another to finish the sequence. All this is done in milliseconds once the child press the home button also located the Board.

The robot receives the instructions and the store into a vector in the order in which they were received for running them, instructions that can run the robot include: advance forward, turn right and left turn; these are the basic instructions which can be accompanied with repetitive or conditionals such as IF and FOR control structures.

B. *First prototype*

The first prototype of JED-Pro was built as an element for testing of operation and to have clear the final requirements of system hardware and software. This first prototype was developed using one and Arduino Arduino MEGA plates for the Robot and programming interface respectively.

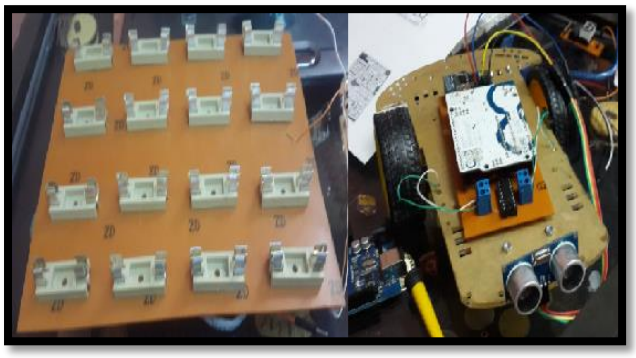

Fig. 15 First prototype of JED-Pro

C. *Second prototype of JED-Pro*

Once both software and hardware performance tests proceeded to design the visual appearance of the toy through the elaboration of covers or housings for the robot as the interface that resulted in the second prototype of JED-Pro. As main material of the housings are used cleaning, this material a part of give an attractive appearance is also an insulating material that helps to protect electronic devices.

Fig. 16 Second prototype of JED-Pro

D. *Prototype end of JED-Pro*

1) *Programming interface:* programming interface consists of a rectangular Board in which the children inserted sheets instructions enabling you to program a sequence of up to 16 instructions. The interface must only be supplied with a 5V power supply and will be ready to keep children entertained programming.

Control circuit consists of two integrated circuits that allow multiplex entries to get 16 analog inputs required by the system, in refers to the plate microcontroller programming Arduino Mini-Pro the functions of analog digital conversion

for the reading of the values used analog to that they will deliver the instructions sheets, also will use a digital pin configured as input for the Start button and a digital pin as output for an led power indicator, also initialize the function of serial communication through which it will send the data to the module bluetooth HC-05, which will be configured as a master for the module containing the robot can be linked and receive the data.

Fig. 17 Final design of the JED-Pro programming interface

2) *Robot JED-Pro:* JED-Pro robot is the element that executes instructions programmed by children in real time. This robot is composed basically of a chassis kit, which consists of two motors DC, a plastic base and an omni-directional wheel; an ultrasonic sensor and Arduino-based control circuit.

For the design of the robot accepted characteristics of the first prototype due to the great acceptance that had its appearance; the only thing that changes in relation to the first prototype is in the control circuit, which uses Arduino Mini-Pro instead of the Arduino platform one, this change was only made an effort to optimize the cost of the prototype since the two plates have similar characteristics.

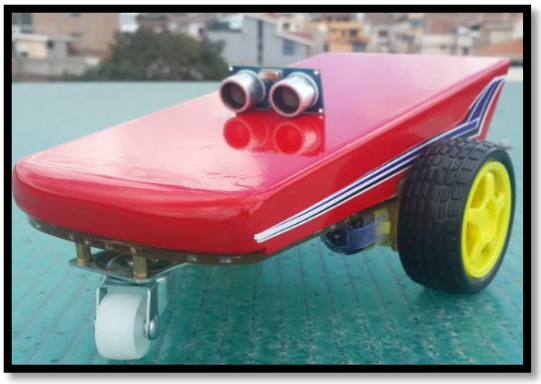

Fig. 18 Design end of Robot JED-Pro

3) *Tangible programming:* tangible programming is oriented to learning and consists of make instructions physical is to say that they can touch or directly manipulate with our hands. The purpose of tangible programming is to hide the several lines of code that may frighten or intimidate users under physical chips that have certain functions to facilitate the assignment of instructions, in this case is to use tangible programming to guide a small robot that complies with the following instructions: advance forward, turn to the right and left turn.

The block of instructions is composed of a total of 27 of chips. Each tab represents a statement or a structure of programming control and so the interface can identify the function of the tab inserted each one has a different resistance value.

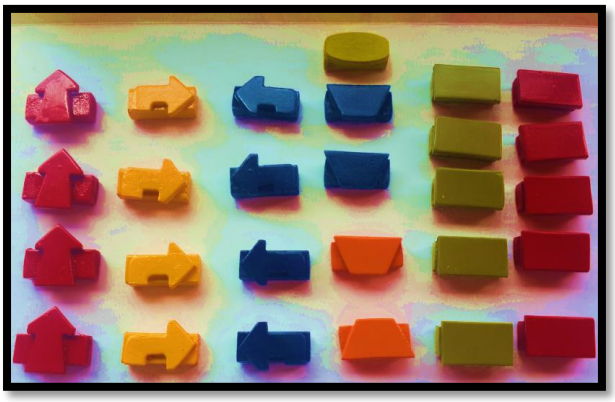

Fig. 19 Block of the tangible programming instructions

VII. Analysis of Jed-Pro

JED-Pro is an educational toy based on software and hardware that serves as support for teaching programming logic and promote a culture of creating technology from an early age in a playful way. The objective of the game is to program a robot using tangible programming to guide you through a journey or proposed route.

In the design and construction of the prototype of JED-Pro the following aspects were taken into account:

1) *Draw up the design the covers of the toy with colors and shapes that attract the attention of children and at the same time protect the electronic circuits.*

2) *Develop a program on the Arduino platform, enabling children to program the robot in a tangible way.*

3) *Use Arduino Mini-Pro plate to optimize the economic cost of the toy.*

4) *Choose the elements and electronic devices according to the operation of the prototype.*

5) *Ensure the link between modules bluetooth using the MAC address authentication.*

6) *Use a Lithium Ion battery to power the electronic circuit of the Robot to work completely wirelessly.*

VIII. Conclusions

- To learn about the learning capacity of children was carried out an investigation of the theories of learning and evolutionary characteristics of children aged 4 to 7, which allowed to understand that children between these ages are in a stage of intuitive thinking, in which develop learning skills therefore if it is possible that children acquire knowledge, including programming, taking into account that some children can learn more easily than others.

- The main element of this work is a toy, which was investigated which is the incidence of educational toys in children's learning process and came to the conclusion that are of vital importance since the game is something innate in children and is the most appropriate way to teach children.

- Developed a logic of tangible programming based on the Arduino platform, which was introduced into the toy in an effort to familiarize children with basic concepts such as instruction, sequence and control structures in a playful way and without the need for smart devices.

- It managed to design an educational electronic toy as element of support for the teaching of programming and new trends in education, which seeks to instill technological development from an early age; Based on previous knowledge of electronic and wireless technologies acquired during the career of engineering in electronics and communications networks and at the same time contributing with a grain of sand to the change of the country's productive grid.

- To potentiate the use of JED-Pro was a user manual that tells how must be submitted each of the elements of the toy to children, also contains the explanation of the features and potential challenges that help primarily in the initialization and familiarization of tangible programming of toy.

- JED-Pro testing conducted with children between the ages of 4 to 7 years where you could see great acceptance by the parents and mainly of the same children, where you could see his great willingness to play and learn; Initially noted the difficulty of understanding the use of control structures mainly in younger children, however they were gradually incorporating them in their programs.

IX. References

[1] L. L. Román, Programación estructurada y orientada a objetos: un enfoque algorítmico (3a. ed.), Mexico: Alfaomega Grupo Editor, 2011.

[2] J. Letrán, «Corto Circuito,» Diciembre 2011. [En línea]. Available: http://www.cortoc.com/2011/12/introduccion-arduino.html.

[3] Valeria de Elia, Paula de Elia, «Niños creadores de tecnología,» 12 Noviembre 2014. [En línea]. Available: http://www.oei.es/congreso2014/memoriactei/469.pdf.

[4] I. Almeida y J. Ochoa, «Repositorio UPS,» 2013. [En línea]. Available: http://dspace.ups.edu.ec/bitstream/123456789/4498/1/UPS-GT000403.pdf.

[5] I. I. C. Arcega, «Conductismo, Cognitivismo y Diseño Instruccional,» Buenos Aires, 2009.

[6] O. Arduino, «Arduino Oficial,» 21 Abril 2015. [En línea]. Available: http://www.arduino.cc/.

[7] ARDUINO, «Pagina Oficial Arduino Uno,» 16 Noviembre 2014. [En línea]. Available: http://arduino.cc/en/Main/arduinoBoardUno.

[8] L. Arroyo, «Repositorio ESPOCH,» 2014. [En línea]. Available: http://dspace.espoch.edu.ec/bitstream/123456789/3139/1/65T00104.pdf.

[9] Ó. T. Artero, Arduino : curso práctico de formación, Madrid: RC Libros, 2013.

[10] M. Bers, «educ.ar,» 10 Diciembre 2008. [En línea]. Available: http://portal.educ.ar/debates/educacionytic/inclusion-digital/ensenar-a-programar-a-los-nino.php.

[11] I. Zamora, «ABC Tecnología,» 4 Febrero 2015. [En línea]. Available: http://www.abc.es/tecnologia/informatica/20140915/abci-programacion-201409111713_2.html.

[12] E. Urgiles y D. Colcha, «Diseño e implementación de un sistema de comunicación Omron – Celular para medir la presión arterial,» 2015. [En línea]. Available: http://dspace.espoch.edu.ec/bitstream/123456789/3794/1/98T00063l.pdf.

[13] R. TABERNER, «ENCODERS ÓPTICOS,» 2015. [En línea]. Available: http://www.infoplc.net/files/documentacion/instrumentacion_deteccion/infoPLC_net_ENCODERS_OPTICOS.pdf.

[14] A. M. Salsa, Desarrollo simbólico en niños pequeños: el rol de la instrucción en la comprensión y el uso de símbolos, Red Interdisciplinaria, 2005.

[15] J. Montesinos, «Red de sensores auto-configurable mediante tecnologías ZigBee y Arduino con monitorización por aplicación Android,» Septiembre 2013. [En línea]. Available:

http://repositorio.bib.upct.es/dspace/bitstream/10317/3678/1/tfg176.pdf.

[16] L. V. Montes, «La importancia de los juguetes,» 15 Abril 2012. [En línea]. Available: http://www.nuestrosninos.com/PDFs/130-importanciadejuguetes.pdf.

[17] N. Monsalve, «Robótica I,» 24 Febrero 2015. [En línea]. Available: http://www.nelsonmonsalveo.com/2015_02_01_archive.html.

[18] MinisteriodeEducación, «Curriculo de Educación,» 2014. [En línea]. Available: http://educacion.gob.ec/wp-content/uploads/downloads/2014/06/curriculo-educacion-inicial-lowres.pdf.

[19] M. M. G. Michay, «"Diseño de Material Didáctico,» 2012. [En línea]. Available: http://memorias.utpl.edu.ec/sites/default/files/documentacion/arte2013/utpl-diseno-material-didactico-matematico.pdf.

[20] C. Martín Biezma, Didáctica de la educación infantil, Macmillan Iberia, S.A., Diciembre 2013.

[21] O. Guzman, «HetPRO,» 25 Abril 2014. [En línea]. Available: http://hetpro-store.com/TUTORIALES/arduino/comunicacion/modulo-lector-rfid-rc522-rf-con-arduino/.

[22] M. Cisneros Estupiñán, Cómo elaborar trabajos de grado (2a. ed.), Ecoe Ediciones, 2012.

[23] P. Chacón, «El Juego Didáctico como estrategia de enseñanza y aprendizaje,» *Nueva Aula Abierta* , p. 16, 2008.

[24] J. P. Casares, «AMIVA,» Julio 1999. [En línea]. Available: http://usablehack.com/amiva/AMIVA.pdf.

[25] F. J. Casares, «ELECTROTECNIA,» 2012. [En línea]. Available: http://www.uco.es/electrotecnia-etsiam/pdf-master/05-Comunicacion_Serie-paralelo.pdf.

[26] A. A. M. d. Carmen, «Diseño de un Manual de Estrategias Metodológicas para la Integración de la Informática en el Desarrollo Integral de los niños/as de 4 – 5 años, en el Centro de Desarrollo Infantil UTE,» 4 Abril 2007. [En línea]. Available: http://repositorio.ute.edu.ec/bitstream/123456789/11444/1/32589_1.pdf.

[27] P. Cabrera y E. Nato, «Repositorio ESPE,» Diciembre 2012. [En línea]. Available: http://repositorio.espe.edu.ec/bitstream/21000/6395/1/T-ESPEL-CDT-0991.pdf.

[28] A. Cabrera y G. Delgado, «Repositorio UAzuay,» 2014. [En línea]. Available: http://dspace.uazuay.edu.ec/bitstream/datos/3610/1/10292.pdf.

[29] BricoGeek, «BricoGeek,» 15 Noviembre 2014. [En línea]. Available: http://tienda.bricogeek.com/home/562-tarjeta-rfid-mifare-blanca-1356mhz.html.

Autor

EDGAR EDUARDO CARTAGENA, nació en Ibarra, Ecuador el 18 de Enero de 1991. Sus estudios primarios los realizo en la Escuela Gral. Luis Leoro Franco, Se graduó de bachiller en la especialidad de Físico Matemático en la Unidad Educativa Experimental Teodoro Gómez de la Torre, en Ibarra. Actualmente es egresado de la Universidad Técnica del Norte en la Carrera de Ingeniería en Electrónica y Redes de Comunicación.