CRONE 2018
Conference Proceedings

SENA Tecnoacademia Risaralda and Caldas as a Collaborative Learning Scenario in Robotics

Margarita María Vallejo-Jiménez[1*], John Jairo Martínez-Puerta[2*], Sebastián Bedoya Agudelo[1], Nicole D. Salgado[1]

[1]SENA Tecnoacademia Risalda; [2]SENA Tecnoacademia Caldas

***For correspondence:**
margaritavallejo@misena.edu.co;
johnjmp@misena.edu.co

Abstract: The Research, Technological Development and Innovation System of SENA (SENNOVA) of Colombia, has the purpose of strengthening the standards of quality and relevance, through programs and projects as Tecnoacademias, defined as a STEM learning scenario, equipped with emerging technologies to develop innovation-oriented skills, through project training, to students of basic and secondary education, in courses such as Mathematics, Physics, Chemistry, Biology, applied sciences such as Robotics, Nanotechnology, Biotechnology and Virtual Technologies.

This work presents some of the activities carried out by the apprentices through the Educational Robotics in Tecnoacademia Risaralda and Tecnoacademia Caldas sites, based on Industrial and Mechatronic Design methodologies, using LEGO MINDSTORM EV3 kits and Design Thinking for educators and LEGO , successfully applied in the EducarChile program. It is based on three fundamental pillars, which are empathy, collaboration and experimentation, which are presented in the five (5) phases of the methodology. It should be noted that the tools of innovation and prototyping per se, do not serve much if the team that executes them is not immersed in a culture of tolerance, teamwork, leadership and if there is no feedback and if the capacities are not taken into account and strengths of the work team. All this was achieved through different prototypes of robots of light and robust type originated in a PON scenario (problem, opportunity, needs).

Introducción

In Colombia, the Ministry of National Education MEN (2008) proposes: to train in technology, by encouraging scientific curiosity for the solution of problems and needs of the environment; to propitiate the development of critical thought and reflection, for the control of technology in society; to provide tools for innovation and creativity, in the solution of problems from different points of view.

One of these tools is the Robotics, and since the seventies (Ruiz, 1987), a new area of study called "Pedagogical Robotics" is generated, which uses these artefacts, which have elements of electronics, programming and mechanics for didactic purposes; relying on teaching and learning methodologies, changing the traditional role of the teacher and taking the student to an active role (2010_Pinto-Salamanca). Robots naturally awaken the interests and curiosity of children, excite them to explore their ideas through their inquiries and test their hypotheses, make new discoveries and develop their knowledge through real-world experiences, by using a Technologically and computationally improved tool (Eguchi, 2017).

As a STEM strategy (Science, Technology, Engineering and Mathematics), Educational Robotics allows the generation of learning environments based on the initiative and activity of students, for the solution of problems that arise in the areas previously exposed (Marquez, 2014) and skills in innovation, creativity and real-life problem solving are developed (Ghitis, 2014).

The identification, application and validation of different mechatronic design tools through the use of pedagogical robotics to solve a need, becomes the starting point of an education that truly achieves an impact and a change of mentality, taking advantage of the scenarios and the existing infrastructure in the National Service of Learning SENA (2018), a state entity that provides STEM courses of 140 hours, including that of Robotics Recreation, in its 10 Education Centers called Tecnoacademia.

Methods

The methodologies described are supported in SENA's project-based learning strategy (2007, Carrera, 2011, GIZ), which allows the application of knowledge and the development of thinking skills, knowledge and the development of biophysical skills, in doing and developing basic skills such as ethics, assertive communication, and teamwork.

Methodology for the Domestic Robot Prototype:
The educational robotics workshop at Tecnoacademia Risaralda was conducted face-to-face, in two courses of 20 students each, divided into 5 groups of 4 students. Every session lasted an average of 4 hours, for a total of 10 sessions and 140 hours. The students made a robot prototype, first of low fidelity in cardboard and paper, then using the LEGO Mindstorm EV3 kit and the 5 phases of Design Thinking for Educators (IDEO, 2012):

1. Discovery: Through observation, students discover that some tasks related to housework in their homes generate feelings of discomfort.

2. Interpretation: The students performed technological surveillance on mechanical structures, sensors, displacement of robots, how they can be programmed and what is the cost of their parts in local stores.

3. Ideation: Brainstroming is done to choose the viable ideas for the solution and are valued with a score of 0 to 5 depending on how well it meets the criteria:
   · It should be easy to manipulate.
   · It should be easy to program.
   · Its construction should not be very expensive.
   · It should be able to move easily.
   · It should be beautiful.

   Then, through a process of co-creation, each team joins the winning criteria to realize their idea of robot.

4. Experimentation: Each team was given a set of 20 materials (paper, cardboard, ballons, rope and others) and the students made the mechanical and electronic parts (sensors) initially with sketches, as well as describing the programming (behaviors) of the robot, everything by using a prototyping canvas.

5. Evolution: The tool to share the history of the robot is designed, for the documentation of the process and its validation; Each group presented their work to students of the Chemistry line, who evaluated the robot with the same criteria mentioned in point 3. Then, each team was given a LEGO Mindstorms EV3 kit and an expansion kit to build the functional prototype, choose the mechanical configuration, the type of displacement, the sensors and the sequence of movements of the robot, to then be validated by the above criteria.

Methodology for the Space Robot Prototype:
The previously described methodology was applied, this time with a single group of 5 students aged between 15 and 17 years old, members of the Robotics line of Tecnoacademia Manizales, who were selected for their high performance in the activities of the line .

1. In the Discovery phase, the challenge was to build a robot for exploration and liquid sampling in irregular terrain.

2. Interpretation: The students performed technological surveillance on locomotion systems, stability mechanical structures and, displacement of robots on irregular terrains.

3. The Ideation phase were carried out in the manner already described for the Domestic Robot Prototype.

4. For the Experimentation phase the LEGO Mindstorms EV3 kit was used to design and build the different robot mechanisms: suspension, steering wheels, robot body, probe arm, syringe drive for samples.

5. Regarding the last phase, the prototype is in continuous evolution, with the aim of giving the possibility to new students to depart based on what was learned by their predecessors and from there to give new contributions to the project.

Results

The prototypes of STEM mobile robotics are described, which gave solution to a design challenge in context (training project), made by students of the Robotics Lines of Tecnoacademia Risaralda and Tecnoacademia Caldas, in Colombia. Students developed a variety of lightweight prototypes before developing functional prototypes.

Domestic Robot Prototypes: In Tecnoacademia Risaralda the students designed and built low fidelity prototypes, which they transformed into functional prototypes using the LEGO Mindstorms EV3 kit, as shown in Figure 1.

Figura 1. Domestic Robot Prototypes.

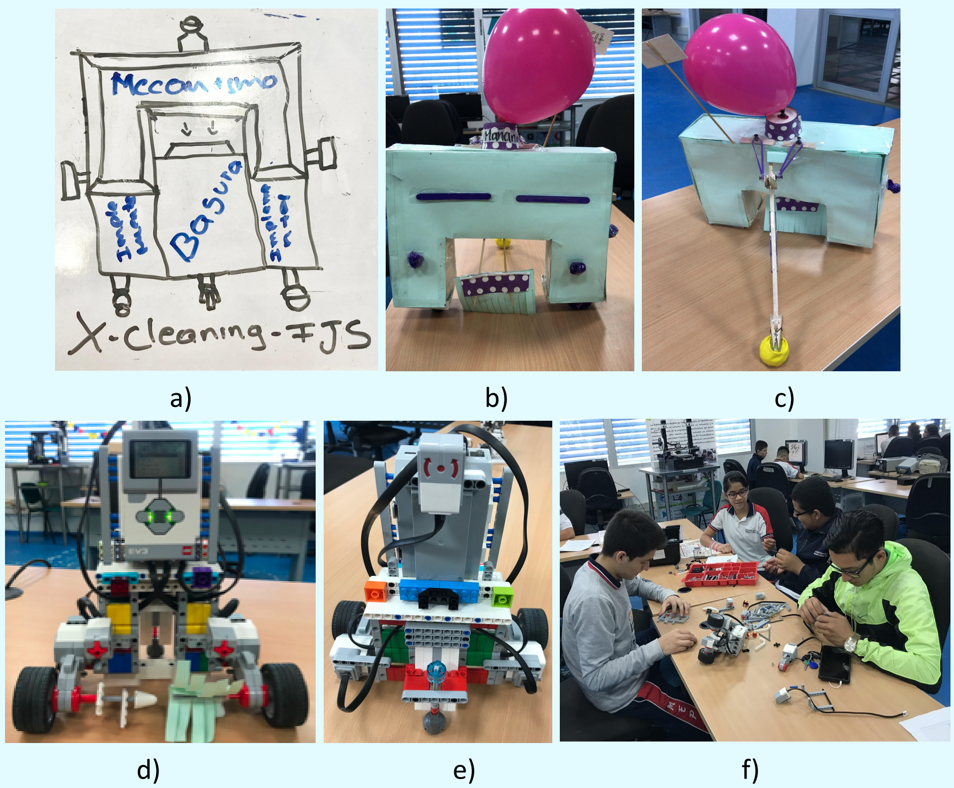

Figura 1. Domestic robot prototypes: a) Sketches. b) Light prototype front part. c) Light prototype rear part. d) Functional prototype front. e) Functional prototype rear. f) Collaborative work.

Space Robot Prototype: Using LEGO Mindstorms EV3 parts, the students built the structures of the wheels based on NASA´s Roker-Bogie system. The best designs were implemented in a prototype that remains in evolution, it is a robot for exploration and taking liquid samples in irregular terrains, as shown in Figure 2. A first prototype was presented at the III International Astrobiology Congress in Manizales (Colombia).

Figura 2. Space Robot Prototype

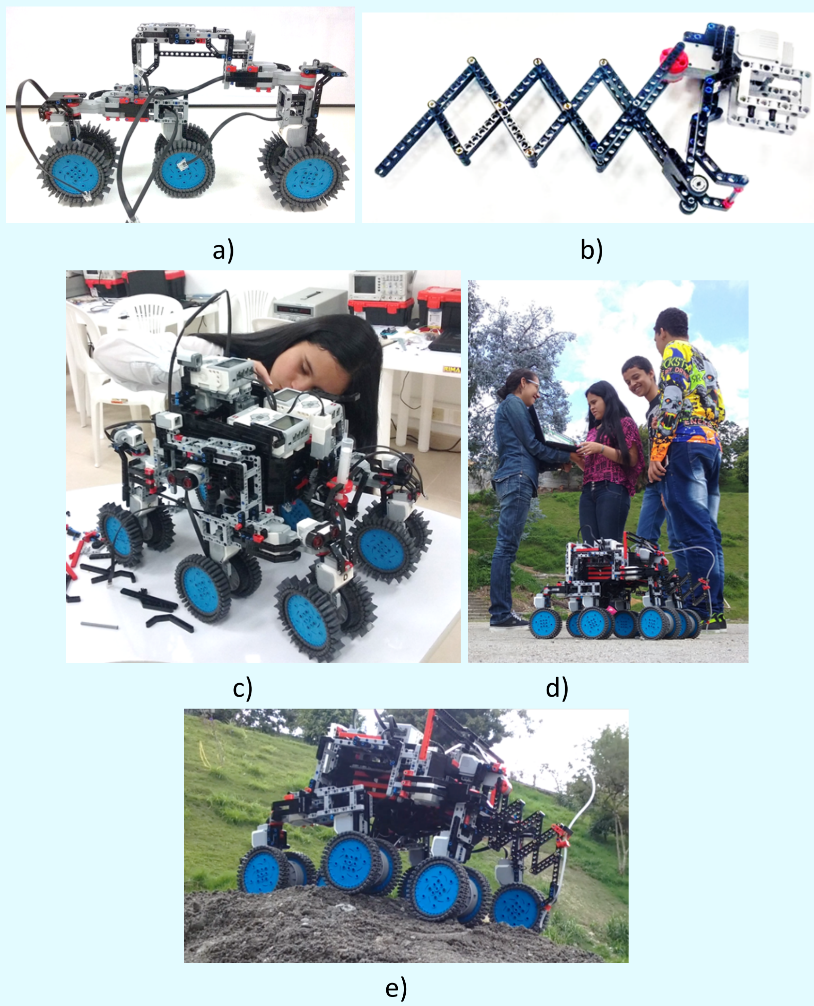

Figura 2. Space robot prototype. a) "Rocker-Bogie" suspension system. b) Arm for taking samples. c) Assembling the systems d) Prototype tests. e) Displacement in irregular terrain.

Discussion

The exercise of carrying out a great variety of prototypes using different phases of a design methodology becomes a challenge for the apprentices, who see how the original idea takes shape step by step, in an orderly, consistent and documented way. The methodology can be applied by using any educational robotics kit; In this case, the Lego Mindstorms EV3 kit was chosen due to its availability in the Tecnoacademias.

The application of the Design Thinking methodology and LEGO Roles allows students to plan their work systematically using different tools for this, to which they are not accustomed; even so, documenting what they do in an orderly manner gives them satisfaction and they feel proud; some of them take photographs of this planning and the first sketches to show to their parents. The validation and exposure of these prototypes in public, although initially it causes them anxiety, allows others to know the activities they do and therefore in the end, they feel proud, understanding that the robot must satisfy the needs of the user. In addition, they identified their strengths, tastes and interests; This is a starting point so that later on they acquire the necessary skills so that they can continue with their training at higher levels or perform jobs related to science and technology that are useful to the community.

In the design phase, despite its abstraction, ideas flow and can sometimes become overwhelming, but with the proposal of the mechatronic approach, to divide the robot into the mechanical, electronic (sensors) and programming sub-systems, they go specifying the options. In the construction, the integration of the mechanics with the sensors allows a coordinated work on the part of the apprentices and the facilitator, giving shape to the abstract. In programming, as the apprentices define it, the robot is given "life", creativity and collaborative work flow again to arrive at a defined programming. Finally, testing, documenting and sharing is a rewarding experience for facilitators and students, as it allows other people to understand the process carried out and realize the importance of applying this knowledge in context.

The SENA evaluation system consists of verifying whether or not students achieve certain learning outcomes, wich are defined in their training program. For this, evaluation instruments are defined that value knowledge, production and product; The prototypes are evaluated by applying such instruments.

There are still more tools to be designed and applied on each of the phases of the methodology, these will be carried out in future courses and will help to improve the experience with the students; For their part they could design the mechanical parts in a software and print them in 3D, and they could even design their own electronic components.

Acknowledgments

We thank the National System of Research, Technological Development and Innovation SENNOVA of the National Service of Learning SENA, who finance the research; the directors of Risaralda Regional and Caldas Regional and, especially the subdirectors sof the centers an the leaders of the Tecnoacademias of Risaralda and Caldas 2018, who believe in the power to transform the lives of young people through science, technology and research.

References

Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding STEM: current perceptions. Technology and Engineering Teacher, 70(6), 5.

Eguchi, A. (2017). Bringing Robotics in Classrooms: Redesigning the Learning Experience. *Robotics in STEM Education* (pp. 3-31). Springer, Cham, Suiza.

Ghitis, T., & Vásquez, J. A. A. (2014). Los robots llegan a las aulas. Infancias imágenes, 13(1), 143-147.

IDEO (2012). Design Thinking para educadores y herramientas. 2ª Edición, version translated by the portal educarchile, of the Ministry of Education and Fundación Chile. Retrieved from: https://designthinkingforeducators.com/. Consulted in February 2018.

Márquez, D., Jairo, E., Ruiz, F., & Javier, H. (2014). Robótica Educativa aplicada a la enseñanza básica secundaria. Didáctica, innovación y multimedia, (30), 1-12.

MEN Ministerio de Educación Nacional (2008). Cartilla No. 30:. Ser competente en tecnología. Una necesidad para el desarrollo y Orientaciones generales para la educación en tecnología. Ministerio de Educación Nacional de Colombia.

Ruiz, E., & Sánchez, V. (1987). La robótica pedagógica. Centro de Estudios sobre la Universidad CESU, Universidad Nacional Autónoma de México.

Salamanca, M. L. P., Lombana, N. B., & Holguín, W. J. P. (2010). Uso de la robótica educativa como herramienta en los procesos de enseñanza. Ingeniería Investigación y Desarrollo: I2+ D, 10(1), 15-23.

Servicio Nacional de Aprendizaje SENA (2018). Página oficial. Retrieved from: http://www.sena.edu.co/es-co/formacion/Paginas/tecnoacademia.aspx. Consulted in April 2018.