SNAP Circuits Program Promoted by Santo Tomás University and the Faculty of Electronic Engineering

Programa de Circuitos SNAP Promovido por la Universidad Santo Tomás y la Facultad de Ingeniería Electrónica

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Abstract

This paper describes how the electronic engineering Faculty carries out the social activities programs, related to teaching and learning process. One of them is the program Snap Circuits, due to easily way to build circuits. The paper presents a new approach of learning process, mixing practices with Snap Circuits kits and written guides for promoting STEM knowledge. For the Faculty is

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important that other disciplines of engineering know the way of increasing educative strengths when it is associated secondary education with the graduate education, in the same way, how the global education must be focused to give real solutions towards social issues. Such as described by the Institute of Electrical and Electronics Engineers IEEE in its program Engineers Demonstrating Science, an Engineer Teacher Connection or EDS-ETC, (Guarín, 2014), in the world year to year there are less students who choose engineering as a professional career, therefore, it is needed to find the strategies to engage students of secondary school with the study of engineering, they should know an easy and practical way of how to learn the engineering concepts.

Key words. *engage, engineering, circuits, learn, and teach.*

El presente artículo presenta una reseña de la forma cómo la Facultad de Ingeniería Electrónica lleva a cabo el programa de Proyección Social, relacionado con procesos de enseñanza aprendizaje. Uno de estos es el programa llamado *Snap Circuits*, debido a que fácilmente se pueden construir circuitos. Este artículo presenta un nuevo enfoque de los procesos de enseñanza, mezclando las prácticas con los Kits de *Snap Circuits* y guías escritas que promueven el conocimiento de STEM. Para la Facultad es importante que otros programas de ingeniería conozcan la forma de reforzar las fortalezas educativas cuando se asocia la educación en secundaria con la educación superior, en el mismo sentido, cómo a nivel global la educación debe estar orientada para dar solución a las problemáticas de la sociedad. Tal como lo describe el Instituto de Ingenieros Eléctricos y Electrónicos IEEE en su programa Engineers Demonstrating

Science, an Engineer Teacher Connection or EDS-ETC, en el mundo cada vez es menor el número de estudiantes que escogen Ingeniería como una de sus elecciones profesionales, por lo tanto, hay que hallar estrategias orientadas a cautivar a los estudiantes de educación media en el estudio de la Ingeniería. Ellos deberían conocer una forma fácil y práctica de cómo aprender los conceptos de ingeniería.

Palabras Clave. *Aprender, Circuitos, Enseñar, Ingeniería, Persuadir.*

Introduction

The Professors of Electronic Engineering Faculty at the Santo Tomas University are members of the IEEE Institute of Electrical and Electronics Engineers, within the activities proposed by this institute is launched the Snap Circuits program, it belongs to the Electron Device Society EDS chapter, (EDS-ETC Program, 2017). The program wants to be known in a practical way the teaching of Sciences, Mathematics, and in general Technology, with the acronym STEM. There are many paradigms that expert people have about the process of teaching and learning, and it is the same way when STEM is taught, the methodology is discussed in different events and by multiple authors. Such as it was mentioned before, the program of *Snap Circuits* is new approach of learning process, mixing practices with *Snap Circuits* kits and written guides for promoting STEM knowledge (Fairweather, 2008), the kits were donated by the IEEE to the Santo Tomás University, the purpose is to use teaching-learning methodologies in which practical evidences allow to acquire knowledge in an easy way, the guides to use the kits were designed by professors of Electronic Engineering Faculty. One feature of these practices is to work with students of different economic

situation levels, but especially those who never have had the opportunity to use this technology as a learning method.

Methods

Figure 1. Students assembling Snap Circuits Kits

It is important to analyse and determines students' competences and abilities at the end of a practice (see Figure 1), therefore, achieve an analysis introduces a clear difference in how the leading teachers of Snap Circuits can focus their didactical strategies in the present or future practice; Anwari (2015) argues that students must share ideas and thinking as a mean to reflect and evaluate their own thinking; besides, STEM education works as an approach for teaching mathematic and scientific applications in the engineering field of study;

it involves the use of technology; besides the combination of scaffold instruction, portfolios, and discussion help improve students' metacognitive skills. To support this teaching-learning process, professors at the Faculty of Electronic designed 50 guides to work with Snap Circuits SC-100 kits, the guides structure is a set of ten guides that covers a complete workshop. The kit's parts have a graphical representation in the guide, thus, the students can do the physical integration, therefore they´ll have enough knowledge and tools to integrate the physical circuit part by part, in this way, the class subjects acquire significance for the student, moreover, the guides have broad information related to each workshop, so the students will be prepared to answer the questions How, Where, Why, What for, How does it work, (Flux, 2011) Therefore, when the student solves these different questions, it can be considered that the competences expected have been achieved, and the guides have fulfilled their objective in the teaching and learning process.

As an example of one workshop developed with students it is shown the circuit in the Figure 2. It corresponds to the Guide No 2, and its objective was to build a circuit that detects the electrical conductivity in different materials, such as iron, wood, plastic.

The task for the students was to assemble the circuit and reach the guide's objectives.

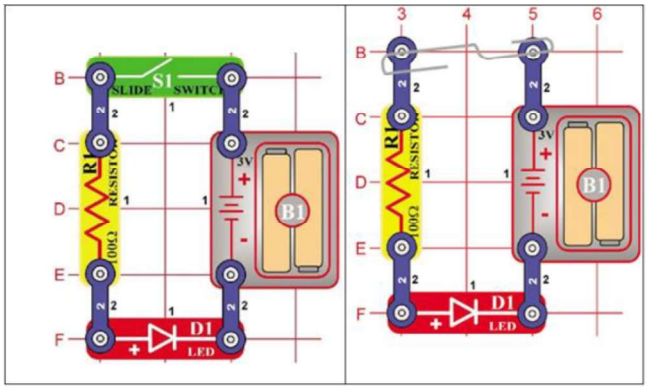

Figure 2. Part of the guide where a circuit was explained graphically

In this point, it can be inferred that the students are prepared to generate new proposals of design or new theoretical approaches on the subject studied, and as a result, this knowledge leads students to have a perspective that conducts to the development of research proposals, with a projection towards real applications in the population environment or daily life.

In addition of this, the Snap Circuits printed guides allowed the students to present their results, not only in physical form, but also in graphic form, through a drawing that describes what they believe about the assembled kit uses or the physical and mathematical principles that surround its operation and performance. As a feedback process the student were questioned about how was developed the practice, taking in a count that each question was focused on small specific and functional projects, which can be compared with some used in daily life (see Figure 3, the ambulance), such as the activities that they see at home

every day, school or city, as some examples, turn on or turn off bulbs, programmable household appliances, also in their city, such as the traffic lights, the siren sound, or at practical events in the country, such as the renewable energy production.

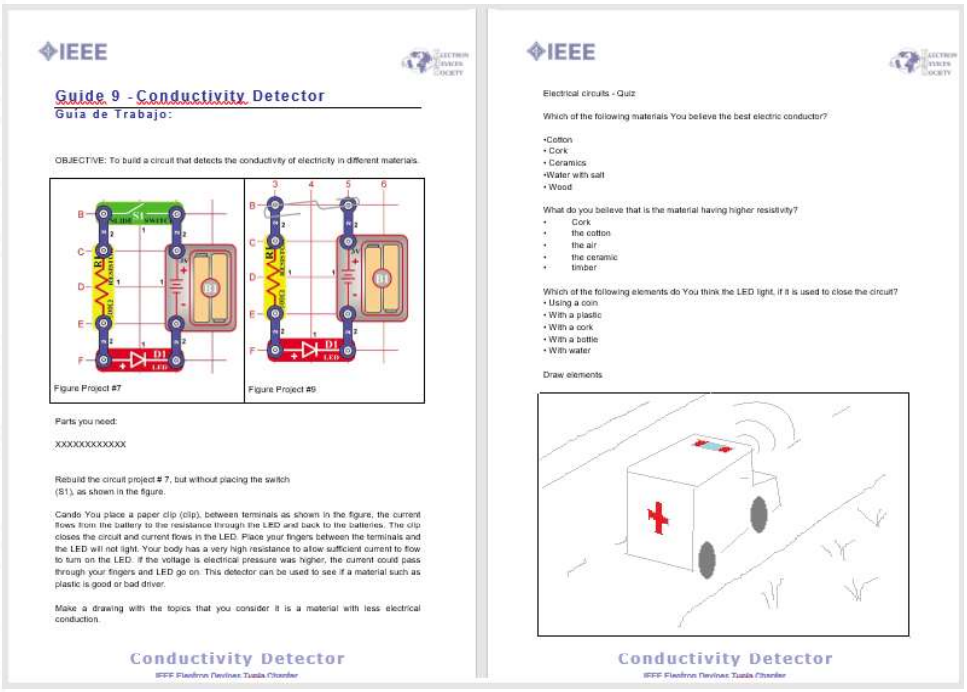

Figure 3. Snap Circuits Guide and its sections

As a complementary part of the guides, the students were interviewed with the objective of concluding about the degree of satisfaction with this workshop and the learning achievement that they have had during the class. To sum up this part, with the practical approach of Snap Circuits, we could measure the student competences and their hardware accomplishments.

Pedagogical Context

Electronic Devices Society EDS, society from the IEEE institute has a program named Engineers Demonstrating Science, an Engineer Teacher Connection or EDS-ETC. One of its objectives is to visit local schools or host events to engage young students in the field of engineering. The Electronic Faculty of Santo Tomás University as a branch of EDS develops this program utilizing the Snap Circuits kits, the population of work are students from eighth to eleventh grades because they define their future professions in this levels, other important parameter is that they belong from different schools in Boyacá (Colombia), place where are located the schools the program work with.

The kits use modular tools to assemble that allow students an approach to the theories related to STEM with a didactical and pedagogical context, (Felicidad, 2002). During the program execution eight institutions were invited, with an average of 20 students per course, the place of these practices was the Santo Tomás University laboratories in Tunja (Boyacá). The work methodology with students and kits will be explained below. There were four stages, in the first (1) stage the student performed a work of sensitization with the elements of the Quick Circuit Kit in which the professor showed how to use the kits and its parts, the second (2) stage included a work with printed guides, starting with the ten most basics with easy concepts to understand, subsequently they applied another ten, rising the complexity up, until to complete forty guides. The period of time used by this work was five or more sessions working in labs or classrooms. In this

stage it was important to ensure that the school teacher accompanies her/his students to explain them the guides and so, they achieve well assembled kits.

Figure 4. The students are proving a circuit.

When the student finished this part, started the third stage, (see Figure 4.), stage in which the students found the possible modifications in the assembly, for each one of them, he or she presented the concepts of STEM that made it possible to learn from their own experience, in the fourth (4) stage, the students evidences the learning process through drawings of what they believed corresponds to their real experiences, as it was shown in the Figure 3, after that, they solved a questionnaire and answered a survey that aimed to measure the competencies covered by each guide. (Labov, 2009).

Results

Through the use of the Snap Circuits kits donated by the IEEE to the Faculty of Electronic Engineering of USTA-Tunja, in the last years the Electronic Faculty has increased the projects with social approaches. This project focuses on the issue of teaching and learning strategies using demonstrative experiences in the topics covered by STEM, (Fairweather, James, 2008), particularly we had experiences in schools in Boyacá such as: Institution Educational Technical San Luis of Garagoa, Technical Educational Institution José Gabriel Carvajal García of Tenza, Silvino Rodríguez School of Tunja, Galileo Galileo School of Tunja, Educational Institution Rafael Bernal Jiménez of Tunja, Normal School of Saboyá, Technical Educational Institution Gonzalo Suárez of Tunja, Boyacá School of Tunja, (see Figure 5). In each institution there was a collaborative work among school teachers, university professors and students, it is usual that the teachers belong to different thematic subjects such as programming, physics or mathematics; regardless they had the desire to collaborate for the execution of the Snap Circuits practices.

Figure 5. Group of work in a session of Snap Circuits

The main scope for teachers was to see that the competences were always evidenced, measured and finally reached, finding that the teaching-learning process was successful in the sense of fulfilling the objectives that were sought. The program of IEEE Snap Circuits has a worldwide coverage, the School of Electronic Engineering of Santo Tomas University is only one branch, it has a great correspondence in the objectives proposed by the sponsors of Snap Circuits, "to allow a large number of students' access to the use of technical tools with high didactic content", especially in electronics or electrical elements themes.

Conclusions

To provide a constant interactivity with the IEEE, the program of Snap Circuits developed by the Electronic Faculty must be fully articulated with the institute activities, therefore, it has been important to show the achievements with

each school by mean of reports, photos and videos, and in the same way it has been relevant to present in these reports the opinion of teachers and students about each activity, this is the way that the members of the IEEE assure that the general objectives are successful.

The guide development is another step for the practical work with Snap Circuits; these allow teachers and students to determine how they will focus the work and which topics will be subject to measure competences, they allow to do reinforcements towards new technologies, mathematical approaches, and to develop new activities.

This program became an opportunity to understand other ways to see the teaching and learning processes, and apply them to students who want to know about science, mathematics, technology and engineering in general STEM (Schwartz, 2015), considering that most children are bored or discouraged when dealing with these issues, but change their attitude by building or assembling practical projects and they find motivational elements to learn STEM when they know actually how these theories work and their applications in everyday life.

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