# Entrepreneurship and Technology: Developing 21st century skills

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***Abstract*— The constant change in life requires new skills and competences to achieve success. As science and technology drive new realities and opportunities, it is important to boost and awake the interest in them from a very young age. *Fundación Telefónica Chile* is developing two related innovation programs in this field. On the one hand, the program "Community of Young Entrepreneurs" tries to get together teenagers with innovative ideas. On the other hand, the program "Community of Robotic Developers" has similar features and is centered in teenagers, but now focused in robotic projects. In both these communities, students have taken a course of 100 hours. After the courses, students from the two different communities are joined and grouped by ideas. Each group of young entrepreneurs is developing the business model of the idea while the group of robotic developers is creating its prototype. The aim of this paper is to analyze the impact on the students' STEM skills after the project and to study the relationship between the technical and business competences. At present, the students have finished the courses and they are working on their projects. A competences pre-test was carried out at the beginning of the programs, and when they finish a post-test and a survey will be collected. Preliminary results are very encouraging. Students have shown a high implication in the programs, and they are working on innovative ideas. The combination of the Young Entrepreneurs with the Robotic Developers has created multidisciplinary teams with a high potential and positive results are expected in the STEM skills development.**

**Keywords— Entrepreneurship; STEM skills; Robotic.**

## I. Introduction

Nowadays, the workplace has suffered a deep transformation. Science and technology are present in any sector, and they mean changes and innovations. Developing the new STEM (Science, Technology, Engineering, and Mathematics) skills from childhood will promote better prepared professionals. However, not only technical skills are needed, but also social skills like creativity, teamwork or leadership are keys to manage the technology. These new profiles compose the 21$^{st}$ century skills and cannot be developed with the traditional methodologies [1]. New projects with active methodologies and innovative practices should propose challenges with real problems to students with the aim of boosting the development of these new skills.

The Project Based Learning (PBL) methodologies are getting excellent results in training in STEM areas, as these methodologies increase the motivation and involvement of students. Low-performing students have better results than high-performing students, thus reducing the gap between them [2]. At the same time, more and more experiences show the positive effects of using robotics in the most basic educational levels, raising children's interest in participating in STEM activities, developing greater confidence in the use of robotics and integrating these engineering skills from an early age [3][4].

Recent studies incorporate the arts to the STEM disciplines, traditionally seen as something rigid. The STEAM concept includes skills like creativity, necessary to improve innovation [5]. Besides, in engineering and technology education, some studies demonstrate the effectiveness of adopting pedagogical and delivery methods more usually attributed to liberal arts [6], such as the encouragement of the generation of entrepreneurial ideas [7].

With the goal of developing the 21$^{st}$ century skills, some studies propose new methodologies like gamification [8]. On the other hand, Robotics has great potential for education. The majority of the reviewed studies revealed that the technologies had positive effects on the children's ICT literacy and their social skills [9]. Studies show that robotics increase the students' skills in scientific creativity and science process skills and also change their perceptions of robots, humans and society in a positive direction [10]. Other experiences not only have showed improvement in the motivation, teamwork and social interaction among the students, but also enhancement in the achievement of the related subjects, such as math, physics [11], technology and science [12].

Robotics could be considered a possible solution to integrate the systematic thinking since the youngest levels.

Children program the robot and then observe its movements, so they can "see" their program in action and decide if their plan has worked as expected [13]. In addition, other studies show a significant improvement in the systematic thinking after a robotic workshop [14]. Regarding leadership, some studies show that robotics combined with the PBL methodology develop students' leadership focusing on individual student experiences within team environments [15].

On the other hand, entrepreneurship is a highly demanded competence closely related to the 21st century skills [16] and to teach this competence it is necessary to develop skills like systematic thinking, creativity, teamwork or leadership [17]. Active learning methodologies along with new technologies and innovative resources achieve more effective results in the development of these skills [18].

The relationship that exists between students and science and technology as a function of gender has been studied extensively. Traditionally, boys prefer technology and girl social themes [19]. As regards the academic performance, some studies show better performance in mathematics for the robotics-trained students [20]. Other studies observed benefits in student involvement that increased by learning computer programming, mathematics and engineering concepts [12][21]. Nevertheless, in all of these studies differences in terms of gender were not mentioned.

Entrepreneurship is affected by a variety of social, cultural, environmental, demographic and economic factors [22]. A notable collection of studies shows that the entrepreneurial programs contribute to develop the competencies and intention entrepreneurial [23-25]. These studies show significant results when students become more familiar with basic entrepreneurial knowledge and they remark that innovation, creativity and social skills are key factors for the success of any new entrepreneurial venture. Robotic programs have shown high potential to enhance students and teachers' STEM engagement [26-28], and they relate robotics with innovation and systematic thinking. Other contributions explore how competitive educational robotics programs for youth contribute to the development of future innovative leaders [29]. Recent investigations have found in the mix of entrepreneurship and robotic trends an interesting cross-disciplinary development [30].

The educational plans in Chile evolve including these new competencies. At this point, it is necessary to design experiences for the development of these new skills, which can offer results according to the methodologies followed and the instruments used to measure the student progress. Thereby, the gap between the actual educational plans and the future professional profiles needs could be reduced [31]. This document presents the work in progress of a project, managed by the *Fundación Telefónica Chile* with some encouraging results.

## II. WORK IN PROGRESS

The project has entailed the creation of two young communities: Young Entrepreneurs Community and Robotic Developers Community. Along three months, project was broadcasted in several schools and by social media. To apply for the program students had to send a video and a letter describing their interests and motivations. A total of 57 students joined the communities, 20 students joined the Young Entrepreneurs Community and 37 students joined the Robotic Developers Community. Table I shows the participants' distribution by community.

TABLE I. STUDENTS PARTICIPANTS BY COMMUNITY

| *Community* | *Students* | *Age* | *Gender* |
|---|---|---|---|
| *Young Entrepreneurs* | 20 | 16.15 (0.5) | 9/11 |
| *Robotic Developers* | 37 | 15.55 (1.13) | 26/11 |
| *Total* | 57 | 15.72 (1.03) | 35/22 |

Age showed by Mean (SD) and Gender showed by male/female

The Young Entrepreneurs Community offered to their participants a course named "Emprende-T". The goal of this course was to develop social skills like creativity, teamwork or leadership. At the end of the course, students should work by groups in a business idea. They worked with innovative technologic tools in this project; therefore, they developed systematic thinking and ICT literacy skills too. The course consisted of three different working lines:

- Virtual modules (50 hours). In a Moodle platform, five modules of ten hours were taken along five weeks. These modules ranged from how to boost entrepreneurship to how to develop a business model. Videos, forums and peer to peer evaluation activities were included.
- Face to face workshops (45 hours). Keeping the learning-by-doing model and active methodologies, students worked analyzing business models to know the best practices, applying development tools and interacting among them and with other professionals.
- Consultation. A mentor met students by groups to help them shape their business idea.

The Robotic Developers Community participated in a course of 100 hours. In twenty sessions of five hours on Saturday mornings, students were organized in groups and worked in three different challenges. Systematic thinking and ICT literacy skills were the key of this project. Besides, students worked with PBL methodology, so creativity, teamwork and leadership were also developed everyday. The first challenge was "Programming" and they learned Scratch composing a project. The second one was "Arduino", in which students learnt basic concepts of electronic and developed a prototype called "Spike". This robot had to know how to get out of a maze. The third and last challenge focused on Design. Students must think about an original idea, design a model and print the result in 3D.

At the end of the two courses, developed in parallel, both communities of students joined in a last phase. Students from the Young Entrepreneur community proposed business ideas and the students from the Robotic Developers Community modeled these ideas. Students were grouped by ideas and began to work. Among the projects, it is noticeable an easy-recycling machine, a smart desktop, animatronics simulation of human body and automatic dispensers for greenhouses. In

Figure 1 Animatronic built and programmed by Scratch is showed.

When the experience finished, students presented their projects in a public session, and the best were prized. First place was awarded economically. The rest of winners got robotic kits for the Robotic Developers and smartphones for the Young Entrepreneurs.

Fig. 1. Animatronic built and programmed by Scratch

To analyze the results of this project several questionnaires were collected. At the beginning and at the end pre-test and post-test skills were performed. An experience survey was conducted at the end of the project. Besides, an exam of the knowledge acquired was conducted after the training. The variables of the study were the following:

- Gender and Age. Extracted from inscription form.
- Experience survey. Collected in a multi-item questionnaire when the experience finished in scale 0-3 (0 minimum to 3 maximum). Satisfaction items, self-perception progress items and rating items were included.
- Academic performance. Conducted in an exam with 28 items multiple choice, in scale 0-10 (0 minimum to 10 maximum).
- Pre and Post-test in 21st skills. At the beginning and at the end different tools were used in each skill.

## III. Preliminary Results

The students were asked about the methodology used in the projects and both of the communities answered the maximum values unanimously. The final experience survey included items about different skills. Students in a self-studio assessed their skills progress. Every value showed positive values, in the Robotic Developers Community highlighted Systematic thinking and ICT literacy. And in Young Entrepreneurs Community stood out Teamwork and Leadership. At last, the students totally agreed with the collaboration between the communities. Table II shows the results of the survey.

TABLE II. Students' Experience Evaluation by Community

| *Item* | *Young Entrepreneurs* | *Robotic Developers* |
|---|---|---|
| The methodology used in the project was different and innovative | 3 (0) | 3 (0) |
| The experience has improved my skills: | | |
| ▪ Creativity | 2.61 (0.48) | 2.75 (0.47) |
| ▪ Teamwork | 2.97 (0.16) | 2.85 (0.43) |
| ▪ Systematic thinking | 2.55 (0.69) | 2.87 (0.46) |
| ▪ Leadership | 2.92 (0.32) | 2.74 (0.33) |
| ▪ ICT Literacy | 2.83 (0.45) | 2.88 (0.31) |
| Collaborate with the other community improved the experience | 3 (0) | 3 (0) |

Values showed by Mean (SD)

As regards satisfaction with the project, three items were collected. The first two analysed the motivation and the interest awoke by the project, and the third measured the overall satisfaction after the experience. Table III shows the results in the different items.

TABLE III. Students' Satisfaction by Community

| *Item* | *Young Entrepreneurs* | *Robotic Developers* |
|---|---|---|
| The experience was motivating | 3 (0) | 3 (0) |
| The experience awoke my interest by the topic of the community | 3 (0) | 3 (0) |
| The experience was satisfactory | 2.85 (0.18) | 2.96 (0.16) |

Values showed by Mean (SD)

Three items were collected to analyse the academic performance. The first item asked students if the project helped to improve their academic performance and the entrepreneurs valued more positively than robotic developers. The second item analysed if the project offered students useful concepts for their scholar life. In this item the entrepreneurs valued more positively than robotic developers again. The third item asked students if the project discovered concepts not studied in the school. Finally, a knowledge exam was conducted after the course. Table IV shows the results in the different items and in the exam.

TABLE IV. Students' Academic Performance by Community

| *Item* | *Young Entrepreneurs* | *Robotic Developers* |
|---|---|---|
| The experience boosted my academic performance | 2.55 (0.69) | 2.05 (0.81) |
| In this project I learnt concepts useful for my scholar life | 2.94 (0.25) | 2.42 (0.69) |
| In this project I learnt concepts out of school | 3 (0) | 3 (0) |
| Multiple choice exam results | 9.33 (1.18) | 8.97 (1.11) |

Values showed by Mean (SD)

The pre and post test in 21st skills were collected, however they have not been completely processed. The different tools measured the skills before and after the experience and the results will be related to the rest of variables.

## IV. Discusion

The creation of two communities offered two different working lines to students. They could choose one of them if they were interested and began the experience. In the Young Entrepreneur Community applied more girls than boys, while in the Robotic Developers Community more boys applied. This fact was according to the traditional gender difference [19]. As regard the age, the youngest participants joined in the robotic community, although the mean between communities was near. This effect could be due to the older children are nearest the professional life and consider the entrepreneurship a future option.

Along the course, students kept engaged to the project. It is important to remember that the experience was optional and students could drop out if they considered so. Teachers used active learning and they worked in projects by groups in every session. This methodology has been highly valued by students from both communities according to the previous studies analysed [2][3][4].

Pre and post test skills have not been processed yet, however students in the self-assessment showed high values. The students of the Young Entrepreneurs Community valued teamwork, leadership and ICT literacy as the first skills, and the students of the Robotic Developers Community valued the ICT literacy, systematic thinking and teamwork as the first skills. This difference could be explained due to the different activities carried out in each community. The Robotic Developers worked more with technologies and problem solving, and Young Entrepreneurs worked more with business models and organizational problems. When results of test are available, significant results are expected according to the studies presented [10][14][16][17].

The feature of the project most valued by students was the combination of the communities in the final phase. This is the principal differentiating element of this study compared with other programs focused on the entrepreneurship or robotics. This cross-disciplinary program allowed students perceive the utility of their new knowledge when they created their own projects based on a business idea. Overall satisfaction was positive and the students' interest was motivational for teachers.

Finally, students learnt by doing. Knowledge exams showed that they worked the concepts and understood them. Many of these concepts are not considered in the actual national curriculum [31], therefore previous experience did not contribute in their academic performance. However, this knowledge and the new skills developed will be useful in their future profession.

## V. Conclusion

The two communities project has contributed to train 57 students in the 21$^{st}$ century skills. Preliminary results show that students have developed skills like creativity, teamwork, systematic thinking, leadership and ICT literacy. They kept encouraged to follow the course by the active methodologies, and the interaction between communities let them develop their own ideas. Students worked in new trends out of the school curriculum reducing the gap with the professional needs.

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