

Involving local administrations in STEM promotion: how to extend STEM initiatives to a whole region.

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Abstract—This paper describes a novel initiative whose main goal is not only to encourage young students to pursue careers in science, technology, engineering, and mathematics (STEM); Although this is typically seen as the core of any STEM project, we aim at involving local administrations in the project, thus allowing to more easily disseminate and promote STEM areas among students' families and teachers.

The central idea of our approach relies on involving local administrations, and making them allies for the project: they will not only help to disseminate information about the project in their local areas; they will also attract teachers to promote the activities within schools, and more importantly, when convinced of the need of the project, will provide fundings to hire specialized teachers in charge of developing a series of after school learning activities along the academic year. This way, every local administration becomes partner of the project, allowing to hire specific professionals from STEM areas instead of making the project to rely on volunteers.

The methodology developed has allowed to reach 20 small towns in Extremadura, their local governments, teachers and families, with more than 400 students, some of them attending sessions for several years.

I. INTRODUCTION

The importance of STEM education is widely recognized, as a means to fight the general lack of interest among young students over science and engineering. Researchers has already shown that early exposure to STEM initiatives and activities positively impacts elementary students' perceptions [2]. Moreover, the gender gap in some areas, such as computer science, where the presence of women has steadily declined since the eighties, requires specific attention. Developing initiatives at early ages would allow to capture girls interest, allowing in the future to close this gender gap [1].

The main problem with most of available STEM initiatives in the area where our approach is applied, Extremadura, autonomous community of western Spain, is that the workshops offered are developed in a single day model, and typically conducted by volunteers. Two main problems can be observed in this kind of approach, which is similar to those developed by projects like the well known IEEE Teacher in Service Program [3]: (i) activities are developed by volunteers in spare time, which keep them from offering weekly activities to students, and (ii) students do not have thus the opportunity to progressively develop their skills and interest on the topics

they are exposed to in a single workshop. The University of Extremadura, which is the only one in the region where this project is developed, also follows the above described model. Because of funding restrictions, the office in charge can only offer single day workshops to every group of students.

It is not easy, and probably not the best approach, to attract youngsters attention towards STEM areas by allowing them to attend just a sample activity. Instead, we think a more professional approach should be applied to STEM initiatives. Involving government agencies should be one of the main goals to be pursued, so that they can provide funds to hire specialized teachers, and activities could thus be offered every week as extracurricular ones, allowing students to progressively develop their interests and abilities thorough the whole academic year. Although certainly some calls are available for supporting STEM initiatives, such as those offered by the Spanish Foundation for Science and Technology [4], they can only partially fund specific projects to be developed in a single year. No other fundings are available in Extremadura for STEM initiatives, being thus quite difficult to establish a multi-year project.

In this paper we show the approach we followed when establishing the Young Scientists Local Schools (YSLs), which are already developed in 20 cities. The success of the project relies in the involvement of municipalities, whose local governments provides the funding for developing the project along the academic year.

The rest of the paper is organized as follows: Section II introduces the situation of STEM initiatives in Spain. Section III describes our methodology, while section IV presents the results. Finally, we draw our conclusions in section V.

II. THE NEED FOR MORE EFFECTIVE STEM ACTIONS

The European Round Table of industrialists (ERT), similarly as many other international organizations in other geographic areas, has identified increasing young people interest in Mathematics, Science and Technology as essential for sustainable economic growth in Europe [5]. Nevertheless, according to Eurostat, in Europe only 17 in every 1,000 people have completed studies in STEM fields (15 in Spain) [12]. Successful STEM actions are particularly necessary in regions whose gross domestic product is under the average, which is the case

for Extremadura, with one of the smaller regional GDP [8] in Spain.

A number of factors have been analyzed by the European Round Table which pose a challenge to recruitment of STEM professionals in most European countries, whose demand will increase over the next ten years due to economy changes: the low birth rate and the low number of students choosing STEM careers.

But other countries and economic areas in the world are also aware of this situation. For instance, declining interest in engineering has been reported of U.S.-born students [9], as well as lack of gender and ethnic diversity [10].

Not only government agencies, also some of the main private companies in Spain are aware of the problem, and are funding studies to promote best practices. Telefónica, for instance, one of the largest Spanish companies, with presence in many Latin-American countries, recently published a report with 100 innovative educational STEM projects. The report analyze four factors that highly influence young students decisions on degrees to be pursued: (i) educational factors; (ii) psychological factors; (iii) informative factors and (iv) social factors. Although all of them important, we will focus here on the last one: “Improving the social image of STEM careers among the group of students and the general public, with special attention given to families” [6]. We agree with the importance given to families. Moreover, we think the whole students social environment must be addressed if we want to involve a larger number of young students. We thus think that the main goal for a successful STEM project should not only be to involve students and their families; their social environment must be addressed for properly improving social image of STEM perception, which will finally influence students decisions.

Although we can find multiple projects which offer *one-day, hands-on engineering experience* (check for instance [11]) it is not easy to find experiences that try a long term work with young students. Similarly, most of the initiatives involved in STEM promotion in our region, such as those offered by the University of Extremadura, under different project names (see for instance “Breakfast with science” [13]) routinely forgets families and social environment, and only provides fundings for buses which allow students to visit the university campus for a morning. Although any initiative must be always welcome, we think results are not the best when this kind of approach is applied. As we will show below, we think instead that STEM initiatives must be developed near students, were local policies can be successfully developed in long-term projects, and special activities offered at the University campus will only be the perfect complement, instead of the core of the project.

Therefore, the novelty of our proposal relies in the effective involvement of every social group related to young students: (i) families, (ii) teachers, and (iii) local government. While the first two will provide required encouragement to young students to enroll on STEM activities developed in every town, the last one, when convinced of the need for the actions

developed, will collaborate funding the project. Yet, an specific methodology must be developed to reach the involvement degree required for every group.

III. METHODOLOGY

As described above, the main goal for YSLS is to get the students environment involved in the STEM project, so that each of them will take a different role within the project: teachers disseminating information among students, families encouraging them to participate and local administration funding the project and coordinating activities within the town. But given that fundings are the key component for being able to establishing the series of workshops in a given town, our methodology for getting involved every social group is based on a strategy that includes actions developed in a well established order. We describe below, sequentially, the meetings we organize to deploy the STEM initiative in every new town.

A. Meeting the Mayors

Before beginning the process of establishing a new YSLS, we arrange a meeting with the town mayor. The goal is first to make him aware of the importance of STEM initiatives, showing data about the job market as well as results already available in other towns in Extremadura. We first try a phone call so that initial information is presented and then a meeting with the mayor is arranged. Usually somebody else in charge of culture or education within the town will also take part in the meeting.

Complete information about the project is then provided, and usually a positive feedback is retrieved from the meeting, although many factors will influence the final decision taken by the local government: economic situation of the town hall, strategic policies, etc. Therefore, some weeks are typically required after the meeting for the mayor to decide whether the project will be launched or not. A positive decision usually leads to the next step: information diffusion within the town. We provide flyers and posters that are disseminated. Also social networks are a key element for providing information to families. Once this dissemination process ends, we ask for a new meeting with parents interested in the project for their children, and simultaneously, we send an agreement form that must be signed by the mayor, which includes specific commitment for funding the project in the town. In any case, the project is usually co-funded, and the amount required from the town hall is is not the key factor for avoiding a positive decision.

B. Meeting the families

Once the local government has decided to launch YSLS, a meeting with families is arranged. This meeting aims at providing useful information to parents, describing the job market situation in STEM areas, so that parents notice the interest of the project. We also describe the kind of activities that every week the students will face, and display videos where parents can see children working. Finally, we describe

special activities that are also organized along the year, such as the Science Fair, where all young students from every town come to meet, share and enjoy a whole day of activities, contests, lunch and workshops.

Usually, when parents come to the meeting, they always understand the interest of the project, and the students enrollment process automatically begins. Unfortunately, we may also refer to towns, where all previous steps were performed, and no parents came to the meeting. The main conclusion is that if a proper dissemination of the information is done, and parents come to the meeting, the project will be run in the town.

C. How to get teachers involved

Although in these first steps, teachers are not the main goal of the meetings, sometimes they are invited by the local government to come together with parents, or instead, specific meetings are arranged in towns where several schools or high schools are present. Similarly as with parents meeting, we describe the initiative and the situation of YSLS in other towns. We pay special attention to Science Fair, and show them some of the projects students have developed in previous editions, so that they can evaluate the interest of the project for students. Appropriate teachers involvement, typically means that they will encourage students to attend YSLS, making it easier to reach the minimum number of students required to work. Yet, the opposite situation sometimes happens: Despite interest displayed by families and local government, when the number of students is below a certain number, the project cannot begin.

Summarizing, the appropriate involvement of every group is the guarantee of success when YSLS is launched in a new town.

In the following section we provide specific data collected along several academic years that allows us to evaluate the approach previously described.

IV. RESULTS

As described before, several steps were required for a new town to enter the project: (i) visiting the mayor in every town and making him aware of the importance of STEM initiatives and YSLS project; (ii) meeting the parents to explain them the initiative so that they can encourage students to enroll YSLS; (iii) and finally offering workshops every week to interested students in the town.

YSLS were officially launched in academic year 2014/2015. Initially seven cities were visited, five of them being finally involved in the project. Therefore, five YSLS were launched with a total number of 100 students participating the first year. Along this first academic year three more towns entered the project, so that a total of 8 towns were working YSLS during the first year.

A. Meeting the Mayors

Table I shows the evolution experimented along the three last years, including total number of meetings with mayors, number of towns which finally launched the project, as well as

the total number of students participating. Although the growth is reasonably positive along the years documented, several conclusions can be drawn from the data: Usually a large number of cities must be visited, typically double the number of final ones running the project. This means that on average only one new town will run the project out of two visited and invited. In any case, we could say that although YSLS is a brand new project, we do not find particular opposition to it; on the contrary, a general interest is present in every meeting with mayors, and the reasons for not launching the project are typically associated to lack of financial resources in small towns, although other reasons can also be found. We must take into account the average size of towns visited: 2000 inhabitants. This means that not a large number of young students is available for the project. This reason, together with the fact that other activities are typically preferred by students, such as sports, soccer, basketball... makes YSLS sometimes difficult to begin in a town. Yet, we can also refer to three of the towns included in the project that were added when they call us to express their interest. We did not have in this case to convince local government; they received information from media, decided to run YSLS in their towns, and then, once the decision was taken, contacted us to launch the project. This is the preferred model for us, and we hope it will grow progressively.

We must point out that the financial resources for hiring teachers is completely provided by the town halls. The larger the number of workshops developed on a specific town, the larger the amount they must provide to YSLS, so that the specialized teachers can be hired. Although some mayors declined the offer, the interest displayed is usually larger than the number of YSLS that can be finally set up, and the reason behind it can be found on the second layer of the social environment: the families.

B. Meeting the families

As described in previous sections, once the local government agrees to promote the project, they organize a meeting with parents, which is crucial to arise families interest on the project.

Therefore, once the information about the project is spread, we meet the parents, describe the project and our vision. Usually parents attending are interested in the project, so it is not a big deal to convince them about the interest. They are only concerned about their children attitude towards this new extra-curricular activity. But we explain that students can come and try, and then decide whether to continue or not. Usually students who come remain for at least a year, as we will show below. Therefore, we can say that the results of these meetings are usually positive, and after the meeting, the enrollment of students begins.

Nevertheless, the meeting does not always produce the results we look for: when the number of students enrolled is small, sometimes the mayor decides not to launch the project, because of financial restrictions. As stated above, we may also refer to some meetings with parents, where nobody attended

TABLE I
EVOLUTION OF YSLS ALONG THREE YEARS

Year	Towns invited	New YSLS	Number of YSLS	Students
2014	10	8	8	150
2015	25	11	15	200
2016	21	9	19	270
2017	15	3	21	402

TABLE II
WORKSHOPS FOR FAMILIES

Year	Workshops	Parents participating
2015	12	170
2016	40	400

the meeting. Several reasons can explain it: an unsuccessful distribution of information in the town; general lack of information and interest about science and technology among families, which keep them from understanding the interest of the meeting; schedule time wrongly chosen, etc. In any case, these negative experiences makes us aware of the difficulties for reaching families, and show us the path to be pursued: trying to devise better ways for involving families.

We would like to also point out the specific meetings we held with head teachers in a couple of towns. These meetings, organized by the local government, were an intermediate step before parents meeting. It allowed us to provide specific information to teachers so that they helped to pass information to both students and families, thus making it easier to find the appropriate public.

1) *Parents workshop*: Although the parents meeting is of primary importance for the project, we have seen along the years, that parents want to get somehow involved in the project in the long term. Therefore, as part of our interest to involve families, we organize semester meetings where parents receive information from the teachers about the activities developed. Yet, parents typically ask us to organize specific workshops for them, similar to those we offer to students. We thus decided from the very beginning to organize special activities for parents. Thus, at least twice a year, parents have the opportunity to come and experiment: during Science Fair, that is described below, we offer workshop for parents. Table II provides the number of workshops offered to parents in the last three years.

Figure 1 shows a group of parents trying to find their own DNA. This workshop was developed in a small town of Extremadura, Lobón, 2500 inhabitants, during the *Local Science Fair* developed in June 2016. We may notice the teacher in the center of the group explaining parents what to do. This specific workshop is developed every year with students enrolled in *Navigators* level (see levels description below) as part of the science group of activities.

We have also organized special events when invited by other institutions different than those supporting the project. We may refer, for instance, to a workshop organized by a well known



Fig. 1. Parents workshop: Looking for the DNA.

spanish company where not only parents with children, but also grandparents came.

Summarizing, we think that one of the best ways of promoting fidelity of students to YSLS is working with parents: this is one of the key elements for making society aware of the need for STEM projects.

C. Building the challenges

Once every social agent has been involved, every town launch its YSLS. In order to make it easier for them to run the activity, the project is run under supervision of the University of Extremadura and its Foundation, so that they are in charge of hiring specialized teachers. We have tried to make up a multidisciplinary team, with larger presence of women, so that we can simultaneously support the role of women in science and technology. The professional team of teachers features a plethora of degrees associated with science and technology: industrial designers engineer, electric engineer, computer scientists, master in education, etc. The idea is to develop challenges for students that allows them to know every area of science and technology: biology, chemistry, physics, maths, electric engineering, computer science, etc. The teachers are thus developing activities which are then included in a book that is used by students. Every week, the teacher will thus select one of the activities of the book and the students will face the challenge for two hours. The methodology developed within the classroom allows both collaboration among students, they are organized in a number of teams, but also competition among the teams when they try to find the best solution for the problem. Anyway, activities are adapted to ages, and we have thus established a number of stages in the project, with activities students will face along the years.

Table III describe the stages we designed according students ages. Each of our YLSL levels encompasses two years of activities. The names of the levels paraphrase the stages human beings have followed along history when discovering the world they live in. On the other hand table IV shows the total number

TABLE III
STAGES THAT STUDENTS FOLLOW ALONG THE YEARS

School Level	YSLs Level
Primary 3-4	Dreamers 1-2
Primary 5-6	Navigators 1-2
Secondary 1-2	Explorers 1-2
Secondary 3-4	Discoverers 1-2
Secondary 5-6	Researchers 1-2

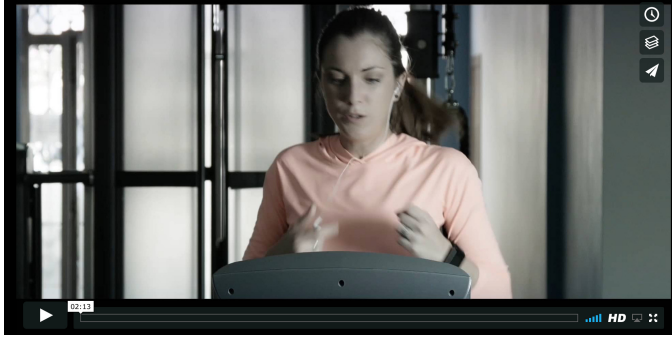


Fig. 2. Short film "Robotic challenge" (spanish). Available at: <http://vimeo.com/channels/emjc>

of students participating in the activity since 2014, and the students today attending the workshops. Almost all of the students are participating as *navigators*, given that this was our first level designed. Only in 2017, we have offered *dreamers* level, and some students have began at this level. We hope to be able to design all of the activities for every level in the next couple of years.

We must point out that classrooms are provided by Town halls, equipped with computers and internet connection. It is very important for the project to clearly show students that what we do is something different from the standard activities developed at schools. This is the reason why we select places out of their standard school environment. As described before, we offer activities related to computer science (such as programming with scratch, or robot programming), maths (building and using an abacus), biology (evolution, looking for DNA), engineering (aeronautics, building bridges), etc.

1) *Girls and computer science*: A specific attention is paid to computer science activities, which is essential for the project. We are particularly interested in promoting it among girls. As we may see in table IV YSLs attracts girls on a percentage well above the number of women in computer science degrees at Spanish universities. This shows how the project will be useful to attract future computer science students.

2) *Short films*: Although our specialized teachers are in charge of motivating students when workshops are developed, in 2016 we decided to prepare a couple of short films useful to more graphically display a challenge to be faced by the students. Similarly as in amusement parks every entertainment attraction and ride projects a video trying to involve visitors,

TABLE IV
TOTAL NUMBER OF STUDENTS: ALONG HISTORY AND ENROLLED EN 2017

Year	Total number of students	Boys	Girls
2014-2017	720	386	334
2017	387	186	201

we have followed this idea trying to create a series of short films, each of them encouraging students to face the challenge proposed every week. We have thus prepared the first two videos in the series. Figure 2 shows a link to one of the film, which is publicly available and can be used by anybody interested in promoting STEM activities among youngsters. This way the project collaborates with other international initiatives in charge of producing useful materials.

D. Science Fair

We must point out another way of developing students competences. Although we provide every week the activities to be faced, we allow students to choose a science-technology project once per year. We thus organize every year a Science Fair that allows them to present their project in a competition organized in two stages. The first one takes place in every town at the end of the academic year. Students have the opportunity to present their projects to the whole community: friends, teachers and families. Moreover, a competition is organized so that the best project is selected to compete with the best project of the other towns in a second stage, developed at the beginning of the next academic year. The first stage thus allows students to develop communication abilities and simultaneously promote YSLs in their own towns.

The second stage of the Science Fair takes place in October. A whole day of activities is programmed for all of the students and their families. More than 300 people attended the event in 2016, in the Faculty of Economics, University of Extremadura (see figure 3). The schedule included conferences, competitions, lunch, etc. We thus organized it as a single day scientific conference. The competition allows not only best projects from every town to be displayed, but also specific competitions allow all of the students to test the knowledges acquire along the year; in 2016 they faced robotic challenges, abacus operations, cryptography, etc.

Given that YSLs is run by the University of Extremadura, the presence of researchers in the team behind the project allows to interact with colleagues from other countries so that it may benefit our students. We are planning to offer a visit to an international research center in Europe as part of the the best project award in 2017.

E. Evolution of YSLs

Although YSLs is growing satisfactorily, we consider YSLs must be a project in evolution. It is thus important for us, as well as for any education project, to be aware of the needs of the students involved while also considering other approaches that are being developed by other institutions around the world.



Fig. 3. Science Fair. Faculty of Economics, University of Extremadura. Badajoz.

We have thus identified a number of areas where special attention must be paid to:

- Students communication abilities.
- Girls in Computer Science.

1) Communication abilities - Canal Extremadura Radio:

As part of our everyday classroom activities, we noticed the need for allowing students to tell their community what they were learning, which would be useful to develop students communication abilities. We have thus reached an agreement with Canal Extremadura Radio, to allow students to talk about their experiences once per month. Thus, they have the opportunity to share what YSLS is, and the kind of challenges they face every week. Figure 4 shows one of the students, together with their teachers, participating in "Los Sábados al sol" radio program. During the last 5 months, 5 students from different towns have thus had the opportunity to visit the radio studios, to know how journalists work and finally to talk about their work. The program is broadcasted to every town in our region, thus helping us to promote YSLS more easily.

2) *Girls in Computer Science*: The University of Extremadura, as well as almost any other university offering computer science degrees, features the gender gap that has frequently been described for computer science. We considered that YSLS could be a nice platform to promote computer science among girls. Therefore, we have organized additional workshops for girls, that are offered to primary school along the region. The first ones have already been developed on the *Womens day on science and technology*. What we did was to ask every student at YSLS to invite a girl to come and try a computer science activity. The success of the workshop made us to consider it as a priority for 2017 to continue with this idea, and we have already received fundings to run 200 specific workshops for girls in 2017.

Summarizing, we can say that YSLS is a well established project in the regions, that promotes STEM initiatives using a profesional approach, with specialized teachers that are



Fig. 4. Los Sábados al sol, radio program. At the right, M. Teresa García, winner of 2016 Science Fair in Extremadura. More info at: <http://www.uexfundacion.es/jovenescientificos/category/noticias/>

hired using funding resources provided by towns where it is working. More than 400 students are attending YSLS every week in 20 different towns, with a total of more than 1000 workshops in 2016. We hope to continue growing and hope to reach 1000 students in the next couple of years.

V. CONCLUSION

This paper has described the Young Students Local Schools, an initiative developed by the University of Extremadura and its foundation to involve not only students, but also their families and social environment in STEM initiatives. The methodology developed allows to directly work first with municipal government and parents, to make them aware of the need of the project in every town. A proper understanding of the project allows local government to provide funding resources required to launch YSLS.

The project is nowadays working with more than 400 students in 20 towns every week. A series of workbooks are being edited and used within the YSLS to provide the challenges to be faced from any science-technology related area. Moreover, a series of short films have been produced and are available on-line, that allows to more easily motivate students.

Finally, a series of areas have been identified where we must pay special attention to: gender gap and communication abilities. An agreement has been reached with the main regional radio station, Canal Extremadura radio, so that students can visit it and broadcast their experience. We plan to develop a series of specific workshops along 2017, so that we can promote computer science among girls.

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