

The first experiences of the UNA STEM network

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Abstract

The UNA STEM Network is a proposal of several academics from the Faculties of Exact and Natural Sciences, and Earth and Sea of the National University, which aims to generate appreciation for science in Costa Rican primary and high school students and to generate and publicize learning opportunities in the scientific area, as well as to promote STEM in the students and faculty of the National University. In this work, we present the experiences of this network during the first year of its creation, to publicize the activities and motivate the creation of these spaces aimed at the public from the academy.

Keywords

Network, STEM, experience, activities, knowledge

1. Introduction

During the 1990s, the National Science Foundation (NSF) forged the acronym "STEM" to group the terms Science, Technology, Engineering and Mathematics.[1] Consequently, STEM education [1, 2] corresponds to a grouping of subject areas that form a framework of reference for knowledge construction. The construction of knowledge is integrated and coordinated among different disciplines to solve real-life problems, transdisciplinary, within an active process.

Motivating the study of STEM will make it possible to increase and improve the dissemination of scientific knowledge. For this, it is important to make changes in the structures of scientific work: train scientists in the academy and university students to value science communication and outreach efforts, support the initiatives of multidisciplinary groups and incorporate different populations in science and technology activities where they can interact directly with researchers, among others. [3].

The development of activities that promote communication and dissemination of scientific work and knowledge have a direct effect on the population, increasing interest in STEM topics, generating a greater impact on the most disadvantaged populations, helping to make better decisions in the choice of STEM careers, offering professional references in the STEM field that allow perceiving the social utility of science, among others [4,5]. Through their participation in STEM activities, children and youth receive benefits, such as those listed below [6].

- Feeling confident to express innovative and creative ideas.
- Feel comfortable doing practical learning
- Take ownership of your learning

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- Working collaboratively with others
- Understand the ways in which science, mathematics, the arts and technology work together.
- Become increasingly curious about the world around them and feel empowered to change it for the better.

To reach a wider audience, scientists nowadays resort to different resources to disseminate scientific knowledge, for example: blogs, vlogs, social networks such as Twitter [7], podcasts and even other non-traditional forms, such as Telegram [8], and more artistic ones such as plays [9], stand up comedies [10,11] or scientific comics. [12,13]. The Government of Costa Rica, through the Ministry of Science, Technology and Telecommunications (MICITT), has promoted the inclusion of issues such as women's economic autonomy and vocational support for women in science and technology careers in the development of gender equality and equity policies in national plans and in the National Science and Technology Plan 2015-2021 [14]. To achieve results, it is important to approach the female population from an early age, since it has been shown that girls begin to feel less identified with science as early as age 6 [15], The stereotypes that portray men as having greater math and science skills are beginning to take their toll on their perceptions of themselves and their abilities.

The above inputs motivated the formulation of the Network for the Strengthening and Dissemination of STEM Competencies of Youth and Teachers (UNA STEM Network), which began in 2020 and is proposed as a multidisciplinary proposal of the National University.

This paper presents the following sections: STEM in the world, description of the UNA STEM Network, UNA STEM Network volunteer group, STEM and the female gender, activities performed, scientific posters, future activities and finally the conclusions of the paper.

2. STEM around the world

Latin America

W-STEM is a project that aims to improve strategies and mechanisms to attract, access and orient Latin American women in STEM higher education programs. The European project, funded through the Erasmus + program, is coordinated by the GRIAL research group of the University of Salamanca (Spain) [16].

In Latin America there are different chapters, also called «pods», of the U.S. initiative 500 Women Scientists. This has the mission to «... serve society by making science open, inclusive and accessible and to transform society by fighting racism, patriarchy and oppressive social norms » [17]. In Costa Rica there are two pods of, 500 women scientists Costa Rica [18], one in San José and the other in Heredia, which was co-founded by one of the members of the UNA STEM Network, M.Sc. Carolina Esquivel Dobles.

Other initiatives at the Latin American level are GeoLatinas which aims to "empower and inspire Latinas to pursue and thrive in careers in geosciences and planetary sciences." [19] and STEAMED Latam which focuses on developing competencies in teachers and working with families to provide them with guidelines for parenting focused on the development of STEAM competencies. [20].

Ecuador

In Ecuador, initiatives focused on gender equality have been implemented that consider the continuous social changes, such as HeForShe, which aims to provide cross-cutting strategies for the equitable and inclusive professional development of future leaders [21]. Other initiatives include the WISE Program (Women in Science and Engineering), Latin America in Ecuador [22],

Ecuadorian Network of Women Scientists [23], WIE (Women in Engineering) of the IEEE Ecuador Section , and the IEEE Ecuador Section [24].

Argentina

In Argentina, the Argentina Gender, Science and Technology Network, a civil organization registered with the OEA, has the following objectives «... *to generate a space for exchange among women scientists and researchers interested in the situation of women in the scientific and technological sector, to make a diagnosis of the situation of women in science and technology and its evolution in recent years, to develop strategies for recording, promoting and valuing the contribution of women in science and technology, and to strengthen gender awareness in the sector..* » [25].

Costa Rica

In Costa Rica, several initiatives have been developed, such as Engineering For Kids Costa Rica, which seeks to teach STEM to children in a fun way and with practical experiments [26], Rocket Girls, which aims to generate opportunities for girls in the STEM world through the development of various programs. [27], Data Scientists, which aims to «*inspire and educate Costa Rican women in the areas of data science, supporting them in the educational and professional fields...*» [28]The Society of Women in Space Exploration Costa Rica (SWISE Costa Rica) seeks to promote and encourage more women, diversity and inclusion in multidisciplinary fields of space exploration [29]. Chapters of this initiative have also been founded in Mexico and Honduras. Another initiative is Society Women Engineers, «*dedicated to raising awareness of the need to support women engineers in their careers and encouraging young women into the profession*» [30].

Rest of the world

Worldwide, there are initiatives such as Ellas Lideran, which seek to «*to inform and raise awareness about the climate crisis, promote and make visible the key role of gender equality in science and climate action, and inspire with our experience and commitment leading initiatives for a more equitable and sustainable planet*» [31]. At the UNESCO level there is the Organization for Women in Science for the Developing World, which among some of its objectives is to «*increasing the participation of women in developing countries in scientific and technological research, education and leadership* », *as well as to increase «access of women in developing countries to the socio-economic benefits of science and technology* » [32].

Other initiatives in STEM include Inspiring Girls International [33], Women in Aerospace [34], Women in AI [35], Women in HPC [36], Women in Nuclear [37], R-Ladies [38], Women Who Code [39], +Women in UX [40], Pyladies [41], Stemettes [42], as well as LATINITY[43], is an international conference to bring together women students, researchers, professors and professionals in the fields of Science, Technology, Engineering and Mathematics (STEM) and ANITA B. ORG[44], created in 1994 and inspired by the legacy of Admiral Grace Murray Hopper (she was a pioneering computer scientist and naval officer. She earned a master's degree (1930) and Ph. (1934) in mathematics from Yale. Hopper is best known for her pioneering contributions to computer programming, software development, and the design and implementation of programming languages. A maverick and innovator, she enjoyed long and influential careers in the U.S. Navy and the computer industry.), AnitaB.org's flagship event, Grace Hopper Celebration, brings the research and professional interests of women in computing to the forefront.

3. Description of the UNA STEM Network

This network aims to generate appreciation for science in Costa Rican elementary and high school students in scientific progress and to generate and publicize learning opportunities in the scientific area. It is formed by academics from the Faculty of Earth and Sea and the Faculty of Exact and Natural Sciences. With this objective we seek to promote the most valuable resource that our institution has: the students and academics, and in this way disseminate in an attractive way the scientific and technological knowledge generated in the UNA. The motivation for this network is framed in the Universal Declaration of Human Rights, which establishes the right of all people to participate in scientific progress. Furthermore, it is considered within the framework of the Sustainable Development Goals which are: « ensure inclusive, equitable and quality education" and "promote lifelong learning opportunities for all and achieve gender equality and empower all women and girls.» The UNA STEM Network seeks to actively incorporate members of academia and students in STEM areas in direct exchange activities with society, particularly children and adolescents. The Network has the dual purpose of disseminating in an interactive way the knowledge in STEM areas produced by academics and students of the Universidad Nacional de Costa Rica, while at the same time fostering the appreciation of this knowledge in children and adolescents.

It also seeks to encourage knowledge in STEM as tools for the development of a peaceful, inclusive, and environmentally friendly society. Within the initiative, specific actions will be implemented to strengthen efforts to bring STEM areas closer to children and adolescents.

Finally, the proposed activities provide a space for the target population, as well as our students and academics, to develop soft skills, such as the ability to understand others, know their motivations and develop commitment in the execution of projects. These skills will form an integral part of the humanistic formation that students receive at UNA and are reflected in the substantive activity of the participating academics.



Figure 1: UNA STEM NETWORK logo

The network is present in the following social networks: Twitter, Instagram and Facebook, and can be identified by its logo (Figure 1) For December 2020 the following statistics of the presence in social networks are presented.:

Table 1
Statistics of the UNA STEM NETWORK in social networks

Social Network	Number of followers	Number of Likes to the Page	Number of publications
Facebook	600	554	129
Instagram	375	Not applicable	42
Twitter	86	Not applicable	246

4. UNA STEM Network volunteer group

One of the main motivations of the UNA STEM Network is to promote the active incorporation of members of academia and students in STEM areas in activities of direct exchange of knowledge with society. Since the beginning of the creation of the Network we have achieved the incorporation of students and academics in the formulation and development of activities (Figure 2). The situation of the COVID-19 pandemic, and the confinement condition, made that the activities during 2020 will be performed virtually.



Figure 2: UNA STEM NETWORK group of volunteers.

5. STEM and the female gender

Another specific objective of the UNA STEM Network is to promote scientific vocations among girls and young women. This is since Costa Rica [45]: faces many challenges in terms of women's rights and the labor market reflects this. This was revealed by the diagnosis and workshops on lines of work to promote STEM in girls and young women in Costa Rica 2018 prepared by the Instituto Ciudadano. The diagnosis pointed out that, in Costa Rica, the promotion of STEM aimed at the female population, especially girls and young women, began approximately in 2014. However, these initiatives were not articulated, and it was not until 2017, when the Ministry of Science Technology and Telecommunications (MICITT) launched the Policy for equality between women and men in science.

In December 2020, the MICITT conducted a survey [46] on the social perception of science and technology, with the objective of generating awareness for institutional decision making and the construction of public policies in science and technology. This study revealed that the vast majority of those interviewed do not know any Costa Rican female scientist (89%), and of those who said they did know one (6%), only 13% mentioned the name of a female scientist correctly.

On the other hand, there is evidence of some important prejudices such as: the belief that women have more skills for careers such as education, nursing, or social sciences (53%), that science and technology-based companies prefer to hire men (54%), and that women are encouraged from childhood to study careers related to family care (51%).

6. Activities performed

Among the activities carried out in the network, the following are included:

- Presentation of the Network and invitation of volunteers. Figure 2 shows this activity, the objectives of the network were presented, and the student community was invited to participate as volunteers, either in the judging of the school or high school science fairs or in the preparation of materials with scientific content aimed at children, young people or primary and secondary school teachers.
- FOCAES activity, it was possible to support a student from the School of Computer Science to participate in a Fund for the Strengthening of Student Capacities (FOCAES). This encourages the development of skills and student academic production, through financial support to students, with which they cover expenses related to their graduation work or those

required for active participation with an extension component in an academic project, as long as they are developed in communities outside the Greater Metropolitan Area (GAM) [48]. The work developed was called "Support for the scientific-technological training of children and adolescents during the Covid19 pandemic". This project and other selected projects will aim at the creation of digital communication products that allow the link between student action and the target population, from remote presence to face the challenges presented by the Costa Rican society, aggravated by the COVID-19.

- Conference: My experience at CERN with Eng. Francini Corrales Garro the objective of this activity was for the student of the School of Computer Science of the Universidad Nacional to share her experience in order to motivate more young people to participate in scholarship activities in this type of institutions. This activity was developed in agreement with the MICITT of Costa Rica. In this way we strengthen ties with this ministry to carry out activities in the future.
- Conference: Afro-descendants in STEM. This activity had the objective of sharing the experience of two Afro-descendant researchers in their careers in science and technology, as well as the barriers and challenges they have had for being Afro-descendants. This within the framework of the #BlackLivesMatter movement.
- The General Studies Center activity: In this activity, two members of the UNA STEM Network were invited to give a talk to 40 students from the Center for General Studies about the role of STEM with the theme of General Studies and the role of women in science.
- Children's Day Activity: For this activity, a programming workshop was held using the Scratch tool for programming by graphic blocks, for boys and girls of the Marcelino García Flamenco public school, with the participation of 28 students of which 14 were boys and 14 girls with an average age of 8 years old. September 8. This workshop was conducted virtually through TEAMS.
- Open Doors Activity: Admission 2021. A video was made to inform the new admission population for the year 2021 about the STEM careers that the National University offers. For this activity, the university held a virtual fair with stands in Figure 3 shows this activity, in which the network was presented with a stand on STEM careers at the National University, which can be seen in Figure 4.



Figure 3: Illustration of participation in the Open Doors activity



Figure 4: Illustration of the STEM careers offered by the National University.

- Ada Lovelace Day Costa Rica 2020 activity. This activity was co-organized in conjunction with the Applied Physics Research Program (IFA) of the Physics Department; the Network of Women Researchers (MIREN) and the ACS Student Chapter UNA. It also had the support of UNA Science Hour, a student science outreach group. The activity counted with the participation of 9 university students from UNA, the Universidad Estatal a Distancia (UNED) and the Instituto Tecnológico de Costa Rica (TEC); and 6 Costa Rican women experts in different STEM areas. This activity took place on October 28th.



Figura 5: Cartel del Ada Lovelace Day Costa Rica 2020

- Conference: J.A.R.V.I.S and Robotifest: Students tell us about their experience. This activity was conducted with the aim of motivating students from different careers to participate in programming and robotics competitions, among others. As a success story, four students from the School of Informatics of the National University won the first place in the NAO GreenBelt challenge [46], an activity held on November 9.
- Conference: GreenBytes: student solution for waste transformation. Lecture organized in conjunction with the "Women in Science and Technology" activity of the IFA Program. The objective of this talk was to present the experience of two students of Management Engineering in the Environmental from the UNA who participated with the interdisciplinary group GreenBytes, winner of 3rd place in the hackathon

#TRANSFORMAResiduosenRecursos. This activity was held on November 25 in Figure 6 shows the poster of the activity.



Figure 6: GreenBytes activity poster

- Participation of the Network in the STEM Forum in Costa Rica, this activity was an opportunity to make visible research work, actions, and policies at national and international level, related to the state of the art of the gender gap in STEM. To this end, the network produced a video to publicize the activities it has conducted and to motivate more women students to study STEM-related careers. The activity took place from December 2 to 4.

7. Scientific Posters

Twelve science outreach posters were made, with the aim of publicizing different media with STEM content that can be found on the Internet. These were disseminated by means of posters such as the one shown in Figure 7, where a brief description of YouTube channels in Biology is presented. In this way, the followers of the Network can learn more about websites with reliable and accessible scientific information for all audiences. These publications were made periodically on Fridays, called "Science Fridays". In this way, a culture is also being generated in the population to expect this type of publications.



Figure 6: Science Friday poster

8. Future Work

For the year 2021, the UNA STEM Network is working on the formulation of a Training Program for young people in STEM.

Although the activities that the network has conducted this year have been open and directed to all students at the National University and the public, it is intended for 2021 to bring more

activities to the regional university campuses, and thus directly invite students from these campuses.

Also, conduct more activities jointly with the National Academy of Sciences (ANC), as well as schools and colleges in Costa Rica.

Continue making posters for scientific dissemination to provide new reference pages for the public.

Bring to the community workshops using ECO software, which is a multiplayer online world where students must solve global challenges or risk virtual destruction. It was created to build a prosperous society and prevent catastrophes, for which they will need to apply STEM skills, using their knowledge of science, statistics, civics, economics, ecology and more.

9. Conclusions

Activities have been conducted jointly with other programs such as the IFA, as well as with the MICITT. On the other hand, we participated in a national event, which allowed us to get closer to other higher education institutions in Costa Rica and work together on the topic of women in Costa Rica.

The UNA STEM Network is consolidated as a space for the promotion and dissemination of science generated at the National University, in Costa Rica or abroad, bringing this knowledge to the general public, especially to children and youth, including a gender perspective in its activities.

10. Acknowledgment

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