

STEAM Program, promoting interest in Cosmic Rays and Neutrinos

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The STEAM program is a joint effort between Universidad de Guanajuato, Universidad de San Carlos de Guatemala and Universidad Galileo with the support of the U.S. Embassy in Guatemala, have developed a broad range of activities to encourage scientific understanding and widespread interest in scientific topics, with a focus on cosmic rays, neutrinos, radiation detection, and other related themes. Technical visits, workshops on cosmic rays and radiation detection, international conferences, mentorships, STEAM clubs, and the Leon Lederman Seminar designed to spark students' interest in science are some of the activities that are included.

It has received numerous national and international honors, including the Falling Walls Foundation Science Engage Finalist Award, the Reimagine Education Awards, the Wharton School Pennsylvania 2018 Latin America Silver Award, and the 2021 Hybrid Education Silver Award.

The mentorships, STEAM conferences, and workshops for K-12 students have attracted over 15,600 students, and over 7,500 teachers since its implementation in 2018. The Leon Lederman Seminar The series, starting in June 2020, includes over 45 internationally recognized institutions and over 96 exceptional speakers that have attracted over 1,300,000 participants.

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1. Introduction

Since the discovery of Cosmic Ray radiation, it became a topic that sparks curiosity and ignites imagination in young students. However, Cosmic Radiation is not part of the regular curricula in High Schools; therefore, the first proper approximation students have to these topics occurs at the Undergraduate level. Astronomy-related topics of all sorts are effective triggers to spark interest in students to pursue further STEM-oriented career pathways and in particular, Physics, Astronomy, and Mathematics. Students often seek resources online, where not all content is appropriate or accurate, and this leads to inaccuracies and misconceptions that often accompany them in their professional development.

For over 15 years, we have conducted educational research to seek improvements in content delivery, pedagogical practices, strategies, and methods. As a result, we concluded that it was needed to support teachers and teachers in training to support positive changes in scientific education, but at the same time, it was needed to spark curiosity and motivate young students, particularly girls, providing positive role models and motivating them to pursue further STEM-oriented career paths.

To help alleviate the situation we started a STEAM Program with STEAM Conferences, where kids took center stage and participated as speakers with over 20 simultaneous workshops in one day to promote participation. During the pandemic, we established online activities, strengthened our mentorship programs and participation in International Conferences and seminars, evolved our STEAM Clubs, and established an Online Seminar Series with high-level researchers from around the world. Some results from the program, oriented to Cosmic Rays and Neutrinos as part of the Scientific Education and Outreach activities are presented. The program evolved to be an international initiative, regionally based in Guatemala and México that has worldwide reach and has been awarded the Hybrid Education Silver Award from Reimagine Education Awards in 2021, and the Latin America Silver Award from Reimagine Education Awards in 2018.

1.1 STEAM Program Cosmic Rays workshops

STEAM Program evolved from the STEAM Conferences held in Guatemala [1] and has had support from the U.S. Embassy in Guatemala via the Fullbright Hayes U.S. State Department funding for Public Affairs. Our goal was to improve Scientific education via Outreach activities that were not part of the regular curricular activities in formal education settings. This will enable students to participate by choice and learn about the Cosmic Rays in the STEAM Clubs, Workshops, and mentoring programs that evolve from said Conferences.

In November 2017, we introduced a small workshop, that will serve as a pilot to establish if it was possible to design, build and construct small cosmic ray detectors with Undergraduate students and with Teachers from the Professional development programs, seeking to determine the differences and similarities between both groups in the Guatemala-Mexico region. The workshop lasted one week, and some disadvantages of the Teacher's program are rooted in the lack of proper training and mathematical backgrounds. A new design developed by J. Felix was

used to test with the participants. The design is based on metals [2] and it was done with accessible materials so that participants could elaborate on several prototypes during the workshop.

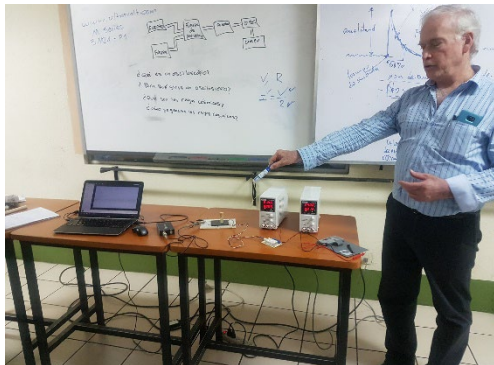


Figure 1 J. Félix showing the Detectors built by students under his supervision.



Figure 2 J. Félix during a Teacher's workshop in Guatemala

However, Teachers were able to perform the tasks and, in the end, build small detectors during the workshop. This also allowed us to establish that it was possible to introduce a new work methodology accompanied by new skills that will properly support the introduction of these topics to students in High School, removing the aversion that usually students acquire to General Physics courses and motivating them to pursue this kind of career path in the future.



Figure 3 J. Félix demonstrates the construction of small cosmic ray detectors to Physics Education students and Engineering Students.

These findings allowed us to promote a Cosmic Ray Workshop during the STEAM Conference 2019, for the group of students representing Guatemala (Chicharrones GT led by MSc. Wendy Miranda) who were training and participating in the Zero Robotics competition [3]. Students inquired about the Cosmic Ray's interaction with the atmosphere and how Primary Cosmic Rays particles can affect satellites and in particular the International Space Station.

Thru the Program, we acquired a mobile planetarium, which allowed us to expand the reach and interest of young students on these topics, it is an inflatable planetarium that has been used in Conferences both in rural and urban areas in Guatemala.



Figure 4 Astronomy talks at the mobile planetarium

The program with the diverse activities it holds (STEAM Clubs, Mentorships, Workshops, Conferences) has reached over 52 countries worldwide including reach from the Leon Lederman Seminar Series.

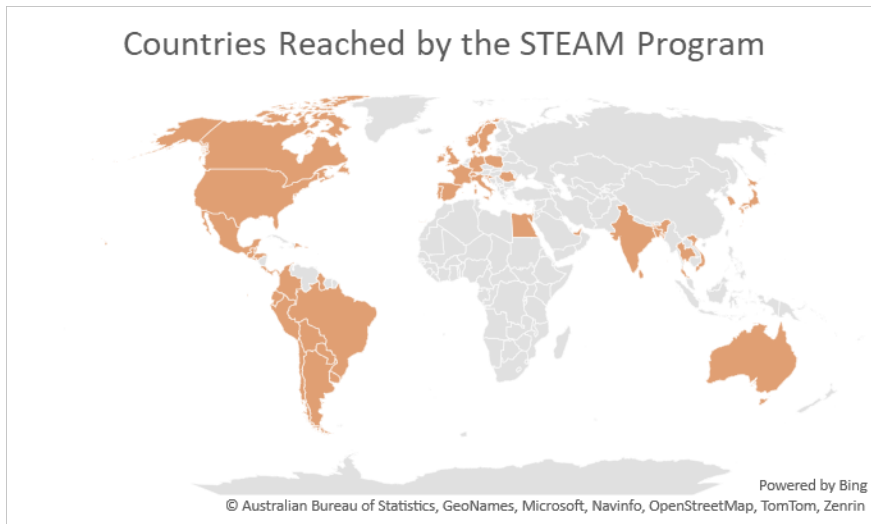


Figure 5 Countries Reached by the Activities of the STEAM Program and Leon Lederman Seminar Series

1.2 Leon Lederman Seminar Series

During the pandemic, to fulfill the void caused by the rapid adaptation to online activities the Leon Lederman Seminar Series arose as an effective strategy to deliver high-quality content with top-level speakers. Interesting results came from this intervention. Students were engaged with the speakers and the series evolved from Seminars and Ask a Scientist series, to a Seminar Series and yearly campaigns that include Real Women Scientists like you (promoting Girls' interest in Science oriented Career paths), Space Week, and Cosmic Month to promote interest in such topics. The design included delivering the Seminars over Social Media to allow students from all economic situations to be able to access the content in particular, from rural areas. We started broadcasting them only on Facebook and moved to other social platforms, we took advantage of the Social Media uses for education. [4] [5] Social media allows us to reach younger audiences and underprivileged participants removing learning barriers such as access, bandwidth, and economic costs.

The use of these Seminars as an outreach strategy was presented at the American Physical Society March and April meetings in 2021, 2022, and 2023, the Virtual Educa International Conferences, and the Academic Days of Science at the Instituto Politécnico Nacional de México. [6] [7] [8]

Since June 2020 over 109 Seminars have been streamed on Social Media (Facebook, Instagram, Twitter, and Youtube). These have been presented by 79 speakers from 62 institutions from 17 countries from 3 continents around the World.

The Seminars with the highest ratings in reach have been related to Cosmic Rays, Neutrinos, and Radiation detection techniques, Julián Félix Seminar on Radiation Detectors reached over 65,000 participants, Juan Maldacena’s Seminar on Hawking’s Radiation and Black Holes reached over 32,000 participants, Fernando Quevedo’s Seminar on The Universe reached 24,000 participants, to mention a few.

Our Real Women Scientist’s like you have reached over 40,000 viewers from all over the Americas, motivating young students, particularly girls, to pursue scientific-oriented careers. To this date, over 1.25 Million participants have accumulated in the Seminars only on the Facebook platform, Instagram reach has accumulated over 150,000 participants in 6 months.

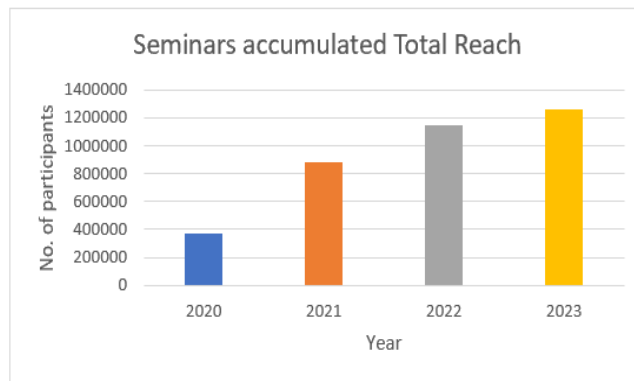


Figure 5 Accumulated total reach

Participants from over 52 countries worldwide have been reached with the seminars and have watched the Seminars according to social media statistics. In the following chart, we present the percentage of followers from the Country of Origin (from the principal countries only).

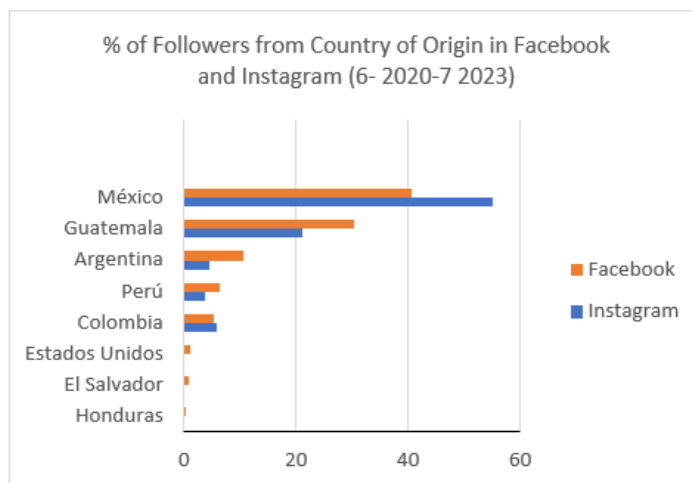


Figure 6 Followers from the country of origin (principal countries)

Distribution of followers and Facebook differs slightly by gender and age, during the pandemic the gender reach was 48% Women, 51% Male, and 1% declared themselves other. After the pandemic the gender reach is 46% Women, 2% declare themselves other, and 52% are Male. We find these results interesting, meaning the Seminars provide a safe environment, also, it shows more interest in the early ages from Women than males, supporting our premise that we need to support women's interest in Science.

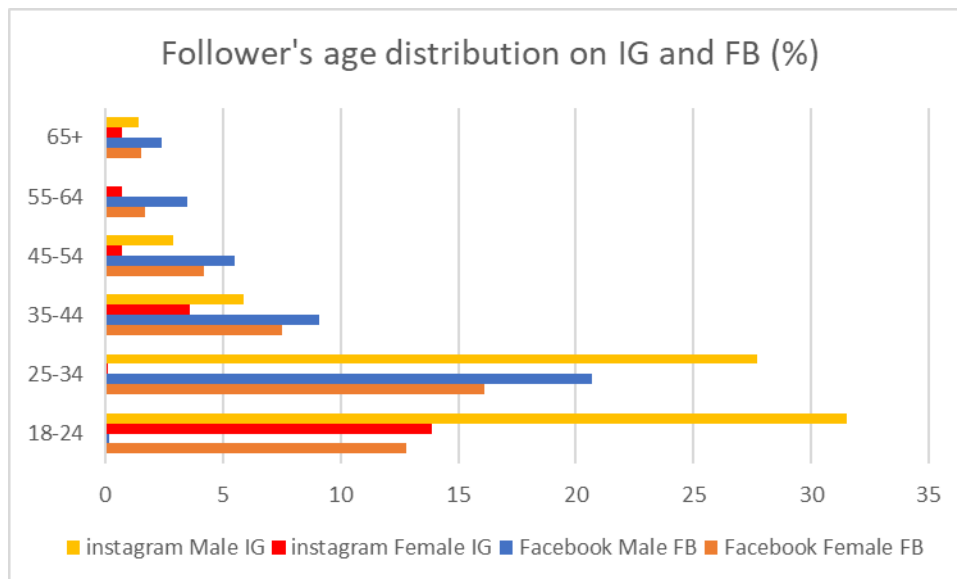


Figure 6 Age distribution of followers on Facebook and Instagram platforms

Different platforms appeal to different public in age and gender. These findings have allowed us to expand our reach, fine-tune our announcements and learn to publish differentiated announcements depending on the platform. Subtle differences in reach could also be explained by the social media policies, Facebook and Instagram currently don't report 18 years of younger participants as of 2021. This means we have an under-registry of participants correlated to registrations on our website.

The seminars can be viewed on our website and our different social media platforms, allowing interested viewers access even after the event.¹ We continue the Seminars in constant review and evolution, this allows us to improve the delivery, and the experience for the participants and to keep our regular viewers engaged. Up to this date, over 400 regular viewers connect to the different seminars, campaigns, and special events they connect from México, Guatemala, Argentina, Colombia, the United States, and Perú. These viewers aside from our worldwide audiences, have remained engaged for the last 3 years.

Acknowledgments

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¹ <http://laboratoriointernacionaldeparticulaselementales.net>,
<https://www.facebook.com/LaboratorioInternacionaldeParticulasElementales>,
<https://www.instagram.com/laboratorioparticulasdciugto/>

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