




Global Sky Partners

Report on activities **Aug 2022 - Aug 2023**

A deep space photograph featuring a dense field of stars in various colors, including bright blue and reddish-orange. A prominent nebula with wispy, reddish-orange and blue structures is visible in the lower right quadrant. The background is a dark, starry expanse.

Inspiring students around the world to engage in astronomy and science investigations using robotic telescopes



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Executive Summary

This year we saw the introduction of the new Delta Rho telescopes to replace our 0.4-meter telescopes. These came late in the year for the 2022-2023 cohort of Global Sky Partners and the partners have enthusiastically embraced them. The image quality and the reliability of these new systems is far beyond the original 0.4-meter system. Partners have commented that the images feel like they come from a larger telescope.

This year we have more partners who offer deeper levels of participation and I believe this has given us a stronger program. We are now supporting more partners than ever and over a much wider geographic spread.

The seasoned partners have continued their generous support of more inexperienced partners, with several partners giving tutorials and advice to junior partners over the whole year.

We had an expression of interest in the program from Dr. Alan Hale (discoverer of comet Hale-Bopp). He has become a volunteer advisor for the partners on solar system projects. It is a wonderful bonus to have such an expert available to all partners.

Edward Gomez
Education Director



Global Sky Clubs

In 2022 we started the Global Sky Clubs program. The program aims to provide telescope time and support for school-based investigations. The intent of the program is for astronomy clubs in schools to use LCO without needing to submit a full proposal. Our new program fills a gap in our audience by reaching out to school astronomy clubs.

Every 6 months, Global Sky Clubs accepts new members and clubs can join at any point during that period. They each receive 10 hours of 0.4m time to use for astronomy projects. We ask them for feedback, which is not mandatory. In our first year we have hosted 30 clubs, with a strong mixture of demographics and geographic regions being represented.

Audience

Audience Survey

We ask every cohort of partners to share our audience impact survey with their audiences. In this cohort the survey showed that Global Sky Partners had an overwhelming positive impact. After being involved in a Global Sky Partner program, and particularly using LCO telescopes, data and resources:



96 %

"I can contribute to science"



99 %

"I enjoy working on science projects and would like to be involved in them in the future"



92 %


"I am confident in my ability to do science"



Reach and Demographics

1,500 hours of 0.4-meter telescope time was available. Partner programs used **1,060 hours** during the full year from August 2022 through July 2023, consisting of **3,862 requests** for observations. **74%** of them were completed successfully.


The programs fall into 3 broad categories:



**Curriculum-based
programs**

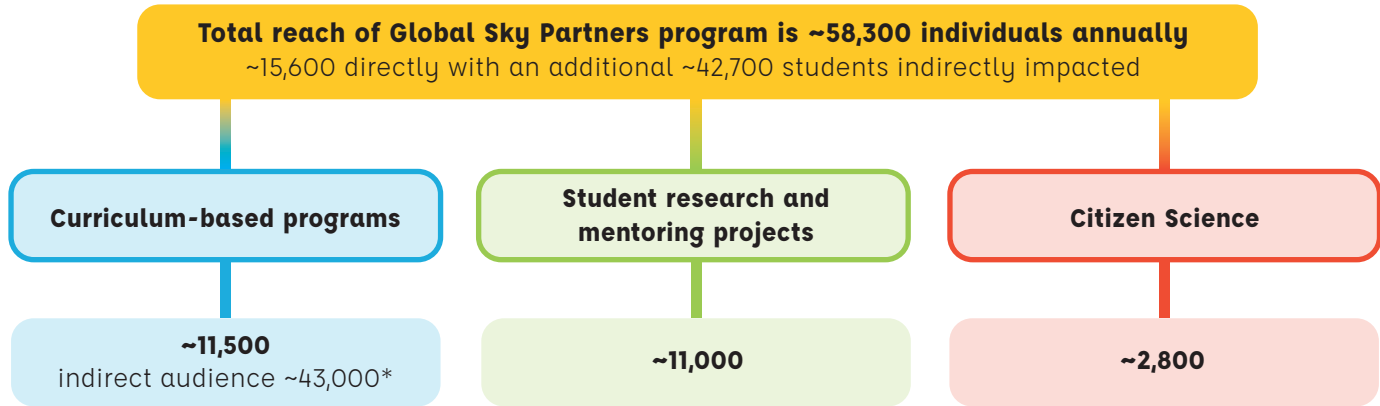


**Student research
and mentoring
projects**



Citizen Science

The reported size of the audience for this cohort is smaller, compared to the previous cohort. This cohort of partners represents a shift from the programs offering presentation-based programs and towards programs with stronger personal connections and a deeper level of impact.



* Out of the total 11,500 in this category 2,135 were teachers who will use LCO with their students. Based on partner feedback we estimate each teacher impacts 20 students, resulting in an indirect audience size of ~43,000.



Audience Demographics

From partners offering mentoring, workshops and training programs, with a total audience size of ~13,000 individuals:



of the audience are from disadvantaged or underrepresented communities or developing world countries



of the audience are from mixed representation



of the audience were high school students



of the audience were teachers.



of the audience were mentored in publication quality research projects



of the audience took part in workshops and teacher training



Audience Region

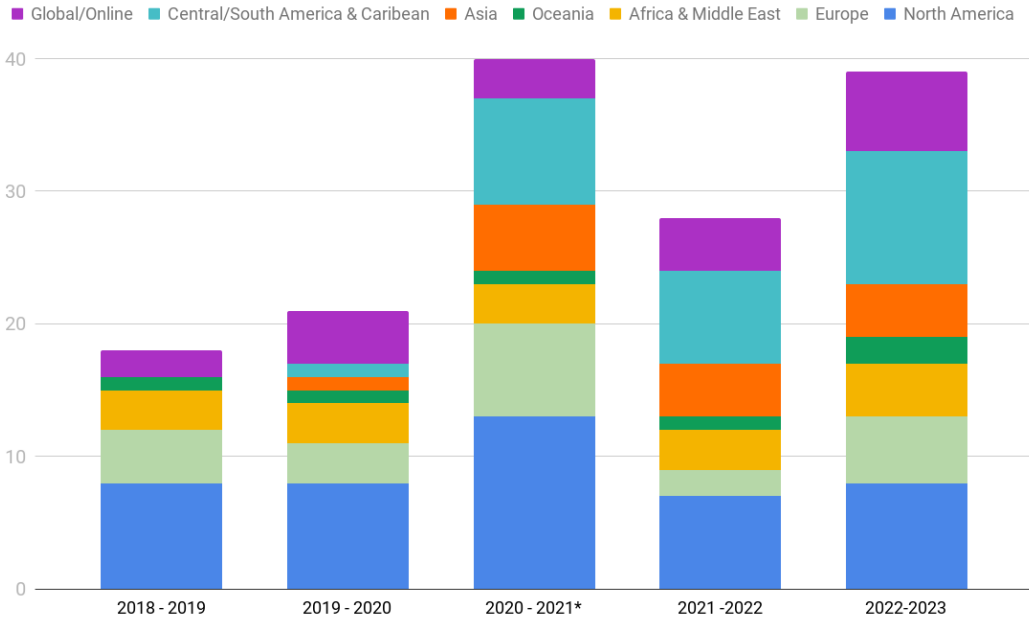


Figure 1. Number of partners with programs in each geographic region (some partners have audiences in multiple regions). The 2022-2023 cohort offered more programs in most regions particularly "Central/South America & Caribbean".

**2020-2021 saw an extended observing period of 20 months due to the pandemic.*

Number of impacts



Figure 2. Geographic spread of partner audiences for 2022-2023 cohort. Global Sky Partners had a presence in 40 countries. The color scale indicates the number of impacts (e.g. events, workshops, conference talks) partners had in each country.

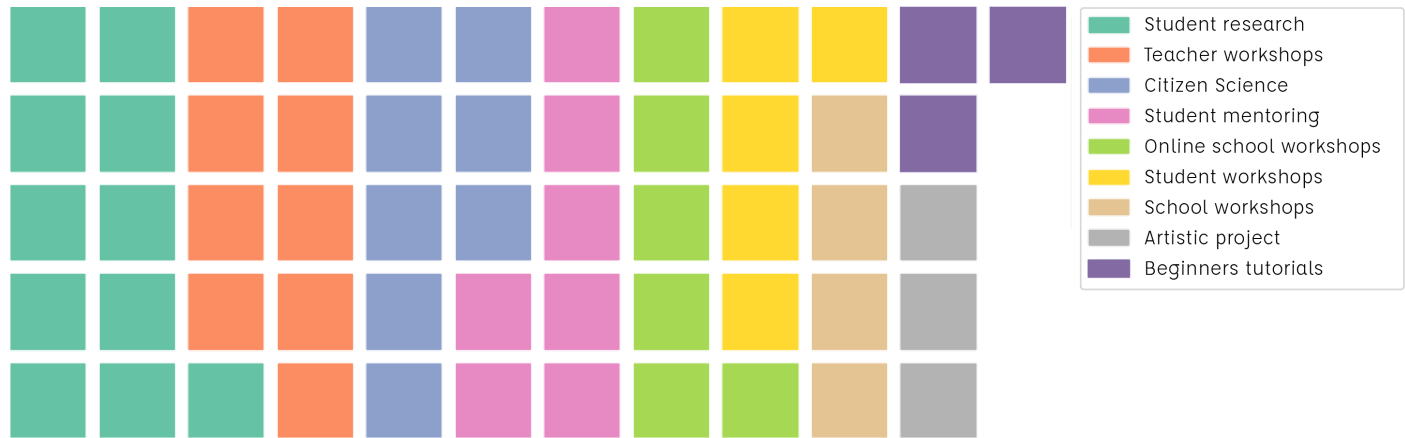


Figure 3. Activity breakdown by partner. The size of each box indicates the number of partners involved in the labeled activity. Some partners are involved in multiple activities.



Figure 4. Audience breakdown by partner. The size of each box indicates the number of partners targeting the labeled audience. Some partners target multiple audiences.

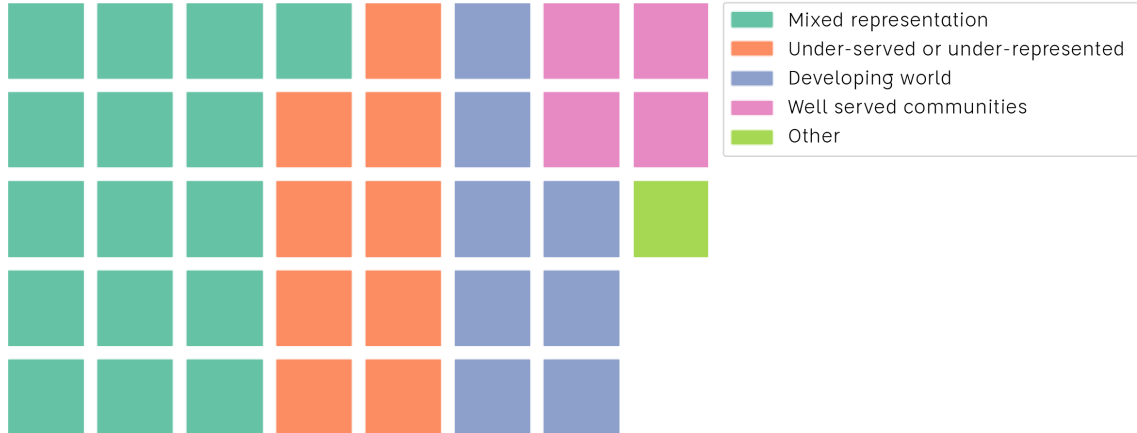


Figure 5. Audience demographic breakdown by partner. The size of each box indicates the number of partners targeting the labeled demographic. Some partners target multiple demographics.



Achievements

The following publications are by high school students in peer-reviewed journals, as a result of investigations through Global Sky Partners in 2022-2023:



20 papers published in **Journal of Double Star Observations**,

1 paper published in **Journal of the American Association of Variable Star Observers**

1 paper published in **Research Notes of the American Astronomical Society**

1 paper published in **The Astrophysical Journal Supplement Series**

1 paper published in **The Astronomical Journal**



18 talks were presented by students at professional conferences

Partner Programs 2022-2023






Astronomy Research Seminars

Institute for Student Astronomical Research (InStAR)

teacher workshops student research

Astronomy Research Seminars provide high school and undergraduate students, and educators with training and mentoring on the whole process of performing science, taking data (using LCO), analyzing that data and ultimately publishing the findings in a peer-reviewed journal.


The impact is larger than the number of educators engaged, as more than half of these were educators who continue to do research projects with their students at the high school and undergraduate levels. Twenty papers have been published in the JDSO as a direct result of [InStAR's](#) participation as a Global Sky Partner, between August 2022-August 2023.

 Location

USA

 Size

28

 Demographic

High school and undergraduate students, and educators


North America

Cosmic Adventures

student research

A program delivered by Orange County Astronomers for their junior members to study exoplanets and eclipsing binaries.


45 weekly meetings were held during the year with professional astronomers in attendance to guide and help the students. At each session, students presented their work and asked their questions. The main focus of their research was studying exoplanets. The students aim to publish their findings.

 Location

USA

 Size

10

 Demographic

Astronomical society members



Astronomy at Stanford Online High School

student research

Stanford Online High School (SOHS) has extremely high achieving students in their program. Most of their student projects will go deeper than those in any other Global Sky Partner program. Their students are spread across an extracurricular Astronomy Club and three Astronomy courses (Astrobiology, Astrophysics, and the Astronomy Research Seminar). All of these groups used LCO to make or examine color images, and Astronomy Club students also imaged exoplanet transits as part of their entry into the IAU exoplanet naming competition. The Astronomy Research Seminar produced eight research projects that used LCO images, two of which have been published and the others of which are in various stages of the preparation and scientific review process. All eight projects were presented at at least one of four different conferences.

SOHS worked with Astronomy Research Seminar and STAR-SD partners to mentor students in Libya on astronomy observing and data analysis using LCO, with a previously unserved community.

Location

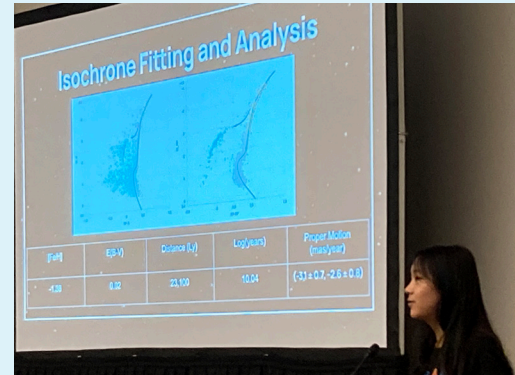
USA

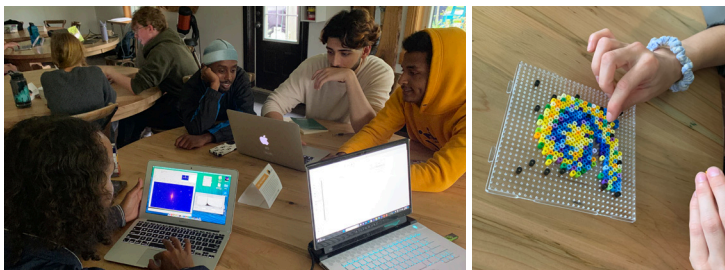
Size

52

Demographic

High school teachers and students








Beyond the Stars

student workshops artistic project

Beyond the Stars explored the feasibility and impact of providing secondary school students located in remote Indigenous communities in Canada with the opportunity to engage in hands-on observing projects and share their own personal connections with the night sky via cultural astronomy discussions.

Each student used LCO to create their own Orion Nebula images for the NASA astrophotography competition. Despite there being significant challenges for these disenfranchised young people, Beyond the Stars attained record attendance and attention.




 Location	 Size	 Demographic
Canada	30	High school students

Exoplanet and Variable Star Search

Glendale Community College (GCC)

student research

Community college student projects for this program were largely to study exoplanet transits and multi-color imaging of extended objects (e.g. galaxies). Time was used by GCC's astronomy club to image objects and instruct students in observation planning, image reduction, and multi-color image composition. Students on the honors program used LCO for research and written communication projects (required components of their curriculum). The classes observed and analyzed the time-series images to determine properties of the stars and their planets. The students perform all of the data analysis, including error analysis, using techniques taught in the class. They wrote up their findings into journal-article format papers for their final assessment.

 Location	 Size	 Demographic
USA	23	Non-science major community college students and high school students



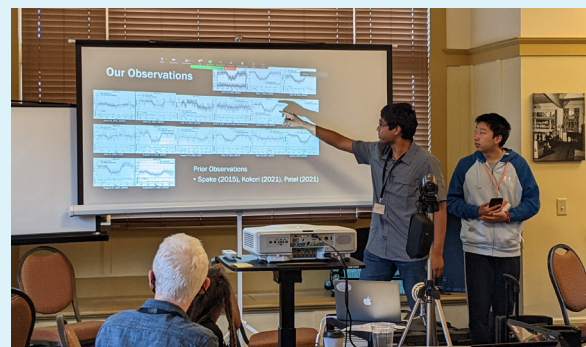
STEM Through Astronomy Research - San Diego (STAR – SD)




Boyce-Astro

student research

STAR-SD is one of the power-houses of the Global Sky Partners program. Since being involved with our program STAR-SD has more than doubled their audience size. They offer a wide ranging curriculum in astronomy investigations, covering exoplanets (where they work with another partner, Exoplanet Watch), double star research, python training and an observational astronomy course, all using LCO. All of their students are fully supported during their projects with many of them publishing their work in peer-reviewed journals.

During the curriculum, the students are mentored online and although they are based in San Diego, an increasing proportion of their students are international. Their demographics are diverse as are the ages of their students, with 50% high school students, 40 % community college students, and 10% adult learners.



 Location	 Size	 Demographic
USA	815	High school students, community college students and adult learners

MicroObservatory Exoplanet Partnership

Harvard Center for Astrophysics




teacher workshops

student workshops

MicroObservatory operates two projects which have been in development during 2022-2023: DIY Planet Search and YouthAstroNet. The Exoplanet Partnership pathway is intended to offer high-school and life-long learners who use our DIY Planet Search website the opportunity to "graduate" from MicroObservatory data to LCO 0.4m telescope data, thereby deepening their analysis skills while learning about the effect of data quality on the scatter of an exoplanet transit light curve. They presented a series of free webinars in the fall of 2022, through a collaboration with NASA's Universe of Learning community. These three thematic sessions were open to all, educators and anyone interested in sharing the exciting world of exoplanet discoveries with learners ages 12 to 100+ in

free-choice learning settings or formal and informal education environments.


Their learning pathway for middle school age students is called YouthAstroNet project - a 5 year research project on the scale-up of innovative technology experiences in astronomy and science imaging. In the summer of 2023, 100 high school science teachers from predominantly rural and urban districts around the U.S. participated in a series of four one-week virtual workshops. They observed with MicroObservatory and LCO as part of these workshops.

 **Location**

USA and
Global

 **Size**

100

 **Demographic**




High school students and
teachers

Central and South America

Atlas-Catalog of Open Clusters

citizen science




This project aims to study open clusters, identify patterns, automate photometry and use artificial intelligence tools in image analysis, with the ultimate aim of creating an open source catalog of Open Clusters (groups of young stars). They run regular training sessions and "data surgeries" for their teams of teachers and amateur astronomers. Over the past 2 years they have performed detailed studies of 20 open clusters.

 Location	 Size	 Demographic
Colombia	183	High school teachers and amateur astronomers

Training Nova Hunters

teacher workshops **student research**

Training Nova Hunters is developing a curriculum for using the analysis of novae as a tool for teaching mathematics in high school. During this year they have led campaigns for observing two nova eruptions (outbursts from stars), Nova Sgr and Nova Sco. As they develop this curriculum they have formed a learning community of teachers and astronomers, which meets monthly, to test out the different aspects.

 Location	 Size	 Demographic
Chile	20	High school teachers and amateur astronomers

Expoastronomy

teacher workshops research projects

Expoastronomy provides training for a wide range of educators, from high school and elementary school teachers through to university level. They host sessions in-person (in Colombia) and online for an audience of Spanish-speaking teachers throughout the whole of South and Central America, in their "Learning Astronomy by Doing Astronomy" course. During 2022-2023 they conducted eight astronomy workshops where university and high school teachers participated in face-to-face, virtual and hybrid workshops. During their research workshops their audiences begin by creating 3-color astrophotography images and progress to studying eclipsing binary systems using analysis (i.e. desktop applications and writing python code).

Location	Size	Demographic
Colombia	577	University, high school and elementary school teachers

Helios

teacher workshops student workshops
research projects

Over the past 3 years as a Global Sky Partner, Helios has developed a strong community which meets regularly. They train this community to analyze astronomical data and organize observing campaigns to study different transient astronomical phenomena. During this year they have studied exoplanets, a new, bright comet C/2022 E3, a recent supernova SN 2023ixf, and Saturn.

Helios ran seven in-person workshops in 2022-2023 which trained their audiences on how to observe and analyze images. Their approach is being applied to a new project in 2023-2024 for hispanic communities in the USA.

Location	Size	Demographic
Colombia	130	High school teachers and students, and amateur astronomers

LCO: Imagens de Céu Profundo (LCO: Deep Sky Images)

teacher workshops




LCO: Deep Sky Images is a 3-year joint project with the International Astronomical Search Collaboration and the Brazilian Ministry of Science, Technology, & Innovations (MCTI). The program currently reaches teachers in all 26 states of Brazil.

Participants are trained by astronomers and image processing specialists to select astronomical targets, plan observations and process raw observational data to create high resolution color images using professional data processing and visualization tools.

After the training students are organized into teams of between 10-20 for observing campaigns. The students initially make observations with LCO and produce color images as part of their curriculum, moving on to advanced topics such as asteroid observing, later in the year. In 2022-2023 there were four project campaigns. The program estimates it has reached 3,000 students during 2022-2023.



The program participants were invited to an award ceremony in Brasília in October 2023. The audience is composed entirely of teachers and students from the program.




 Location	 Size	 Demographic
Brazil	244	Teachers

PETeR (Educational Project with Robotic Telescopes)

teacher workshops student workshops

[Proyecto Educativo con Telescopios Robóticos](#) (PETeR) - An Educational Project with Robotic Telescopes. PETeR is an enquiry-based online lab which aims to familiarize the Spanish educational community with the scientific method and practice, while contributing to the diffusion of astronomy and astrophysics knowledge. This is achieved by dedicating observation time with robotic telescopes to educational activities and e-science projects aimed at students and amateur astronomy associations.

They organized three teacher training sessions and a summer school for teachers, in a hybrid format (with participants from 19 countries). Their curriculum is mature and well supported, including projects to search for and investigate variable stars, supernovae and exoplanets, as well as studying moons in our Solar System. They are working in partnership with the partner ExoClock on exoplanet observing campaigns.

 Location	 Size	 Demographic
Spain and Canary Islands	7,419	Elementary and high school students, and teachers

ORBYTS

student research

ORBYTS (Original Research by Young Twinkle Students) is an educational programme in which secondary school pupils (16-17 y/o) work on scientific research linked to the [Twinkle Space Mission](#) with mentoring from PhD students and other early career scientists.

The goal of every partnership is that students will contribute towards publishable research. They get hands-on experience working closely with scientists and doing scientific research. The program also addresses diversity challenges by dispelling harmful stereotypes and challenging any preconceptions about who can become a scientist.


Working with school groups they obtained several exoplanet light curves.

 Location

UK

 Size

24

 Demographic

High school students



Astrolab (Starlight in the university lab)






student workshops

Astrolab is a curriculum which has been developed primarily for undergraduate science students. It emphasizes the nature of science with the interdisciplinary nature of astronomy, and its natural links with technology and instrumentation. While working on Astrolab, science students plan and schedule observations with the LCO 0.4m network, and transform those observations into a scientific result. It is a learning-by-doing curriculum to acquire research competencies and to understand the complexity of practical work.

Due to the on-going effect of COVID-19 and poor vaccination levels in the developing world,

the team has changed their delivery strategy. Astrolab is now taught in universities in both South Africa and Peru, where it has been taught as an elective course. They have obtained funding to create a website containing all of their resources, so AstroLab can continue to grow into other regions in the developing world.

 Location	 Size	 Demographic
Sub-Saharan Africa	44	Undergraduate and postgraduate students and faculty

Middle East, Asia and Oceania

Moon Over Us

student workshops artistic project

All workshops for this partner program were conducted virtually. The audience was 8-16 year olds, who were provided an introduction to astronomy with a curriculum themed around the Moon. We worked with the organizers to add lunar observing into the LCO simplified observing interface, Kiosk, especially for this program.


Each team posts their results via [Padlet](#) to share with the rest of the community.

 Location

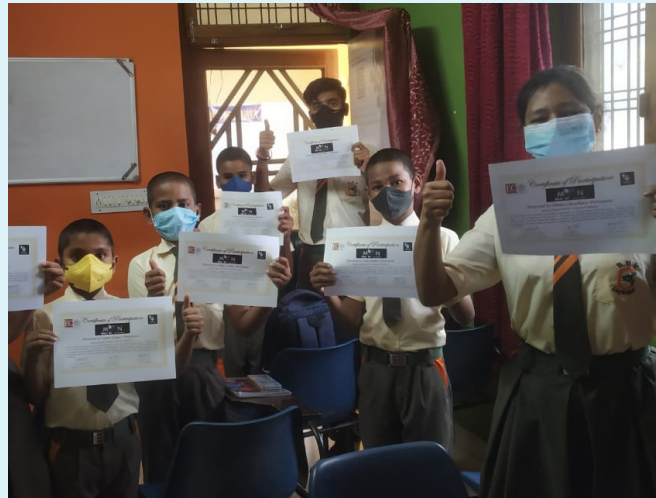
India

 Size

100

 Demographic

Elementary, middle and high school students



100 Global High School Teams

student workshops teacher workshops

Teams of teachers and their students are given workshops by the organizers. They are taught introductory astronomy and also trained on astronomy analysis software. They make observations with LCO and use their skills to produce color images. After this introduction they observed and analyzed exoplanet data sets.

Although the program is conducted entirely online this program has a strong community aspect. Each team posts their results via [Padlet](#) to share with the rest of the community.

Location	Size	Demographic
India	100	Teachers and students

Our Solar Siblings



student workshops teacher workshops

[Our Solar Siblings](#) provides an established teacher training program to enrich the science curriculum with astronomy content. It provides an evidence-based, curriculum-based, project for high school level astronomy. OSS provides teaching and learning support for the participants. The science focus covers the entire life cycle of stars. LCO is used to provide inspirational color images to the teachers and their students.

Australian teachers are still catching up with their professional development since COVID restrictions were lifted. They continue to have an active base of teachers involved in their regular program of workshops, even though they have not added many new teachers.

Location	Size	Demographic
Australia	500	Teachers, high school and middle school students

Sri Lanka Research Initiative (SLARI)

student workshops student research

This is an extension of the previous partner, *Astronomy research in Sri Lanka*, expanding it to multiple universities throughout Sri Lanka, where there is currently no university level research or degrees. SLARI provides an astronomy club for physics undergraduates at University of Ruhuna and University of Jaffna in Sri Lanka. The students take part in two projects. The first introduces astronomical techniques to study double stars. The second part is a research project to investigate exoplanets.

Location	Size	Demographic
Sri Lanka	200	Undergraduate students

Shristi Astronomy

teacher workshops student workshops

Shristi Astronomy organizes in-person and remote learning workshops, specifically in astronomy research skills, including astronomical observation and data analysis. During 2022-2023 Shristi Astronomy organized one in-person workshop and three online workshops. Two of these workshops were open to all audiences and were dominated by teachers and undergraduate students in India.

Data was taken using LCO for use as training sets during the workshops. A smaller number of students were then able to continue using LCO for deeper investigations.

Location	Size	Demographic
India	360	Undergraduate students and teachers




Exoplanet Watch

student research

citizen science

Exoplanet Watch is a citizen science project about observing exoplanet transits and creating light curves from either observed or archived exoplanet observations. LCO enables people who have an interest in astronomy but who do not have their own telescope to actively participate in astronomy research and improve their understanding of planets beyond our own solar system.

In 2022 Exoplanet Watch moved out of its pilot phase, and has seen a huge increase in its membership, and consequently its use of LCO. During 2022-2023 there have been five papers published and one doctoral thesis presented using LCO data. Exoplanet Watch has a global audience from 28 countries.


 Location	 Size	 Demographic
Online and international network	1,884	Amateur astronomers and students



Where's the Flux?

citizen science


This project provides its audience with training on the analysis of real photometric data through the social media platform Reddit. The observation program consists of weekly, multi-band photometric monitoring of a mysterious variable star, KIC 8462852, with the LCO 0.4m network. The program's goal is to measure the extent and chromaticity of its long term variability. Additionally, this program allows for their community to respond and follow the start of any "dip" identified by more frequent measurements from AAVSO observers.

 **Location**

Online network

 **Size**

25

 **Demographic**

General public

Hunting Outbursting Young Stars (HOYS)


artistic project

student research

citizen science

A citizen science project which monitors a small number of star forming nebulae for outbursts from young stars. Their project networks amateur astronomers contributing data from personal telescopes. This partnership allows students and their teachers to be involved in this citizen science project by using LCO. Their teachers and students are located in France, India, Romania, Turkey, United Kingdom, United States of America.


The students undertake mini-research projects using the data they collect, as well as contributing to the overall scientific aims of HOYS. The teachers and their pupils also took part in a picture competition. Two refereed papers with HOYS data were published during the period of the report.

 **Location**

Online and international network

 **Size**

570

 **Demographic**

Teachers and students

ExoClock

student research citizen science

ExoClock is a citizen science project to observe and characterize exoplanets. This partnership provides observing time to their audiences who do not have access to telescopes of their own. For this partnership they held eight observing campaigns for peer-pairs of students.

During the year their teams observed five exoplanet transits and published their results to the ExoClock website.

📍 Location	📊 Size	👥 Demographic
Online and international network	110	Amateur astronomers and students

Gee Whiz Astronomy Modeling (GWAM)

student workshops teacher workshops

Modeling instruction is a teaching model where the teacher demonstrates skills while describing each with a rationale. This partner uses modeling to teach core skills in astronomy data analysis to high school students and teachers. All sessions are remote via Zoom and offered in English and Spanish. The students start by taking a 3-color image and then take more images for data analysis, particularly exoplanets and variable stars.

The sessions happen every week, in both English and Spanish and are offered to teachers and students in both Northern and Southern American countries, particularly Argentina, Bolivia, Chile, Colombia and the United States of America.

📍 Location	📊 Size	👥 Demographic
Online and international network	930	High school students and teachers

Quotes from Global Sky Partner audiences



"It has changed my view of what scientific research truly is. I assumed that new discoveries were very rare, only occurring in a very lucky scenario. However, in this study, we have reassessed, with proof, the type of variable star that our star is, along with its period."

- *Astronomy at SOHS*

"We had fun, learned about the process of writing a real scientific paper, and contributed some useful analysis."

- *Astronomy at SOHS*

"LCO has been a beacon of learning, growth, and passion in my journey as a student and scientist, allowing me to find my happy place in the fascinating world of astronomy."

- ***Atlas-Catalog of Open Clusters***

"LCO Outreach has reached deep into many students' sense of wonder and greatly improved their confidence, and given them a path to understanding and joining one of the greatest scientific enterprises of our time - the understanding of the Universe. This changes kids permanently for the good"

- *Gee Whiz Astronomy Modeling*

"The project provided a golden chance to finally get an exposure towards taking actual observations. The process, right from arranging the observation to analyzing the obtained result, is something which I had never done before and would have not been experiencing if not for the remote observing group of Exoclock."

- *ExoClock*

"Most of the time spent on the project didn't feel like work"

- *Astronomy at SOHS*

"I believed that as a Sri Lankan it was impossible to get access to a pro telescope, work with real data, learn from so many experts around the world. I'm so grateful for the opportunity. It has changed my life and how I see what's possible for my future."

- ***Sri Lanka Research Initiative***

"I absolutely loved the structure of the course, and the semi-self paced structure that really required working together with other team members. I found that it was excellent preparation for more scientific studies when I'm older."

- *Astronomy at SOHS*



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