

# Session 21.7 – Education Programs Promoting Light Pollution Awareness and IYL2015

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**Abstract.** By proclaiming the IYL2015, the United Nations recognized the importance of light and light based technology in the lives of the citizens of the world and for the development of global society on many levels. Light and application of light science and technology are vital for existing and future advances in many scientific areas and culture. Light is a key element in astronomy: as astronomers, it is what we study and makes our science possible, but it is also what threatens our observations when it is set-off from the ground (light pollution). The UN-designated year 2015 represented a magnificent and unique opportunity for the global astronomical community to disseminate these messages and raise the awareness of the importance and preservation of dark skies for heritage and the natural environment.

As such, the International Year of Light served as a launching pad for several projects during 2015. Two other projects with equally as impressive programs are highlighted and begin the narrative for this section on public education and outreach programs on light pollution issues and solutions.

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## 1. Network for Light Pollution Education at Secondary Level

Beatriz García (ITeDA - UTN FRM, Godoy Cruz, Mendoza), Rosa Ros (Universidad Politécnica de Cataluña, Barcelona, Spain) and their colleagues at the Network for Astronomy School Education (NASE) offer a set of simple, low-cost and fun activities for secondary school educators and students. The activities focus around the three main types of light pollution (sky glow, light trespass and glare), the problems associated with over-consumption of energy and the effects on the astronomical observation (both visible and radio) and on human health. The activities include pin-point boxes (for use without a light, with an unshielded light, and then with a shielded light) (Figures 1 and 2), boxes to let students feel the difference in heat between incandescent lights, CFLs and LED lights and other simple instruments that you can make out of pieces of paper or use with cell phones. More details are at <http://www.naseprogram.org>.

## 2. Astronomy Education Under Dark Skies

Johanna Molenda-Zakowic and her colleagues at the Department of Physics and Astronomy at the University of Wroclaw in Poland have been providing professional support for the high school students and the astronomy teachers since 2007. Among their events and projects, like ‘School Workshops on Astronomy’ (SWA) and ‘Wygasz’, are dark skies awareness programs that count stars and measure the night sky brightness, familiarizing

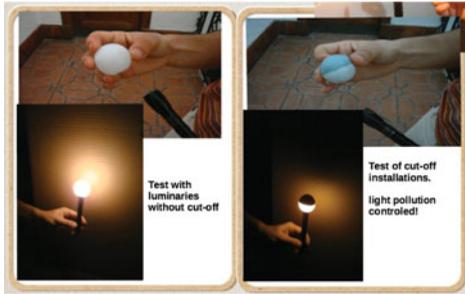


Figure 1: An activity on Sky Glow using a cardboard box with holes punched for a constellation, two 7" maglights with removable reflectors and two ping pong balls (one half painted) each with a small hole for the maglight bulb.



Figure 2: The Sky Glow activity in action. Which light fixture works better? With or without the top of the globe light blocked (e.g., the half-painted ping pong ball)?

teachers and students with the idea and the necessity of protecting the dark sky. All those activities are organized either in the Izera Dark-Sky Park in Poland or in other carefully selected locations in which the beauty of the dark night sky can be appreciated. Understanding dark skies awareness allows for enjoyment of other astronomy activities. Students work in groups on particular assignments such as learning about astrophotography, lenses, star maps, spectroscopy and even how to build a cloud chamber.

### 3. Dark Skies Rangers

Creating awareness about the importance of protecting our dark skies is the main goal of the Dark Skies Rangers project, a joint effort of the Galileo Teacher Training Program (Rosa Doran, Nucleo Interativo de Astronomia) and the National Optical Astronomy Observatory (Connie Walker). Hundreds of schools and thousands of students have been reached by this program. In particular, students in several municipalities in Portugal have conducted street light audits and produced suggestions on how to enhance (illumination) energy efficiency in specific urban areas. During the International Year of Light, efforts to export the successful Portuguese experience to other countries are being undertaken. The recipe is simple: train teachers, engage students, foster the participation of the local community and involve local authorities in the process.

Dark Skies Rangers activities focus on inquiry-based learning. The students are involved in making observations – when did the lights go on, when did they go off, what is the measure of light pollution, etc. Highlights of the program over the last two years involved an invitation to 1500 schools in Portugal to participate in a contest to create a student-designed calendar (Figure 5). Students have also designed special projects (Figures 3 and 4) and written letters to mayors with ideas for reducing light pollution (i.e. have sports games during the day to reduce need for lights at night). Students have designed three games: one for elementary schools, one for middle schools, and one for high school. The games take place on an imaginary island known for its biodiversity, but tourism wants to move in (Figure 6). The students deal with protecting biodiversity versus promoting commercialization. Between the IAU General Assembly and June 2016, there will be 120 workshops in more than 40 countries using Cosmic Light EDU kits that include 50 free light-based activities. The website has hangouts, resources, and



Figure 3: Student-made model of lighting and its effect on sea turtles.



Figure 4: Student-made model of good and bad lighting.



Figure 5: One of the winning, student-designed games from the Dark Skies Rangers Contest. The objective was to create awareness for the growing problem of light pollution and its effects on our lives.



Figure 6: Another student-designed game winner from the Dark Skies Rangers Contest.

activities: <http://nuclio.org/cosmiclightedukit/>. As a final comment, education isn't always from the top down. This project shows the power of using the energy of children bottom-up.

#### 4. IYL2015 and “Cosmic Light” Message: Awareness and Dissemination in the UK

Global and National initiatives for the International Year of Light have been taking place during 2015 (and will beyond). As an IYL National Committee and Gold Sponsor of IYL2015, the Department of Physical Sciences at The Open University in London has been carrying out IYL2015 activities in the UK. Lucia Marchetti from that department has provided an overview here of what the activities are, how they developed their National Programme and how a long-lasting “Cosmic Light” communication strategy can be constructed to exploit the lessons learnt carrying out the IYL2015 UK year plan.

IYL2015 is cross-disciplinary educational and outreach program with more than 100 partners in 85 countries. The Institute of Physics is the coordinating body in the UK. Prince Andrew is the patron and has helped to promote its visibility. A special page on Cosmic Light has been created on the UK IYL webpage: [www.light2015.org.uk](http://www.light2015.org.uk). The

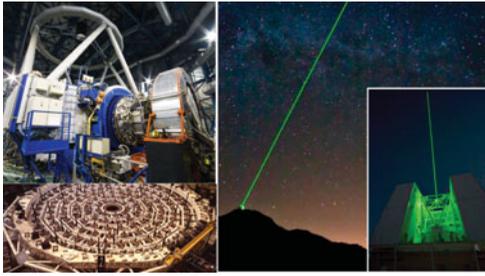


Figure 7: IYL2015 Global Open Lab Day promoted by CIE, May 9-25, any date, anytime, anywhere



Figure 8: The Skyglow Citizen-Science Campaign: Light Pollution and the UK's Changing Skies



Figure 9: The Skylight Opera: Students in 28 countries are creating a Science Opera about Cosmic Light, basing it on creative science learning and cross-border cooperation.

webpage provides a national calendar, but also is a way for people to participate in global projects, like Global Open Lab Days (Figure 7). One of the special projects is Skyglow, which compares the light at night from 1992 to the present (Figure 8). The website is building a page of education resources in 5 areas of the spectrum, delineated by age groups. Materials are being promoted through the Open University. There are Open University experiments online. An event has been organized for Parliament during British Science Week. Various exhibits have been organized including a traveling photography exhibit and a special event at a museum. A soapboxscience.org event is to be held. (Soapbox Science is a novel public outreach platform for promoting women scientists and the science they do.) A citizen science project is to measure the speed of light ([www.speedoflight2015.co.uk](http://www.speedoflight2015.co.uk)). The solar eclipse in March 2015 was used engage the public. Many countries are involved in the Skylight opera (Figure 9). The Skylight opera web platform has been used to communicate with schools all around the world. The UK IYL team is also partnering with Lunar Mission One, which has a presence at the British Science Festival in September, and is doing projects with museums.



Figure 10: Countries worldwide registered for the Cosmic Light EDU kit and training.

## 5. Cosmic Light EDU Kit

The main aim of this project is to involve schools around the globe in awareness campaigns in the framework of the International Year of Light. The project is a joint collaboration between Rosa Doran (lead) and Thilina Heenatigala at Nucleo Interativo de Astronomia (NUCLIO), Lina Canas at the IAU Office of Astronomy Outreach (IAU OAD), Pedro Russo at the University of Leiden, and Connie Walker at the National Optical Astronomy Observatory (NOAO). The project features a tool kit, the Cosmic Light Educational Kit, with simple tools to address the proposed thematic of the ephemeris, in particular, those related to the nature of light, the impact of light on our knowledge of the Universe, and its importance for our existence. The richness of the networks involved in this project will also allow for a rich cultural interchange of experiences. The outlined campaign is reaching teachers and students all over the world. The kit contains components in material format and several digital tools and resources. Tutorials for its use and training is foreseen in the framework of this project. These will take diverse formats: face-to-face in some countries, asynchronous and synchronous formats, according to the possibilities and needs of each partner. Thematic hangouts, related to the main cornerstones of IYL2015 as well as to the components foreseen in this program, will be promoted into 2016. Accompanying training efforts will be implemented in order to empower teachers to the full exploitation of the kit and its different components.

The project aims to target diverse social and cultural audiences and has topics related to light in its rich variety and impact. Light as a source of life, light as a source of knowledge, light from the past, light from the future, light for inclusion. Colours we see and colours we don't see. A special component designed for children with visual impairment will be incorporated in the kit.

Over 120 workshops taking place from July 2015 through June 2016 are registered in the Cosmic Light EDU page coming from over 42 different countries (Figure 10). With the support of the Office of Astronomy Outreach, all workshop promoters registered until end of September will receive a package with a few resources donated by different institutions and resources in digital format of the kit on a pen drive. For more information on the Cosmic Light EDU kit, see <http://nuclio.org/cosmiclightedukit>.

## **6. The Quality Lighting Teaching Kit: Educating the Public about the Dark Side of IYL2015**

Poor quality lighting not only impedes astronomy research and our right to see a starry night sky, but creates safety issues, affects human circadian sensitivities, disrupts ecosystems, and wastes billions of dollars/year in energy consumption. It also leads to excess carbon emissions. How do you change the mindset of society that is used to turning night into day? You educate the next generation on quality lighting.

The United Nations-sanctioned International Year of Light in 2015 (IYL2015) provided an opportunity to increase public awareness of dark skies preservation, quality lighting, and energy conservation. The Education and Public Outreach (EPO) group, namely Constance E. Walker (Connie), Stephen M. Pompea and Rebecca Levy, at the U.S. National Optical Astronomy Observatory (NOAO) received a grant through the International Astronomical Union (IAU) and the Optical Society of America (OSA) to produce official “Quality Lighting Teaching Kits” (QLT Kits) for the IYL2015 cornerstone theme, “Cosmic Light”. The QLT kit allows students to do creative problem solving using quality lighting. The files for the QLT kit (Figure 11) can be found at [www.noao.edu/education/qltkit.php](http://www.noao.edu/education/qltkit.php).)

The concepts and practices of quality lighting are explored through problem-based learning, hands-on/minds-on activities, as well as formative assessment probes. The six activities use quality lighting to solve realistic cases on how light pollution affects wildlife, the night sky, our eyes, energy consumption, safety, and light trespass into buildings. The impact of the kits is amplified by providing professional development using a tutorial video created at NOAO and conducting question and answer sessions via Google+ Hangouts for program instructors. The Quality Lighting Teaching Kit program leverages NOAO EPO’s work over the last ten years in lighting and optics education (e.g., “Hands on Optics”, the International Year of Astronomy’s “Dark Skies Rangers”, the IAU “Dark Skies Africa”, and Arizona Public Service’s “Dark Skies Yuma” programs).

The premise of the activities is that the instructor is the mayor of a fictitious city in which the students live (inspired by the City of the Future Poster). The mayor has been receiving complaints from citizens of the city, which all have to do with the lights in the city (stated on the Issues Poster). The students have been assembled into 6 different task forces, to determine the underlying problems expressed in each of the 6 complaint categories, as well as to come up with feasible solutions to those problems.

The students start by reading the information presented in their group’s poster. The “Now Try This!” section gives instructions for an experiment, game, or activity to complete in order to gain more understanding of the problems they face. They use the materials in their box and/or envelope to complete the activity. Using what they know along with help from the Problem Solving Poster, the students brainstorm solutions to their problem. The students then carefully consider the implications (both positive and negative) of their solutions as well as any exceptions where their solutions may not work. They determine if there is any other information they need to better understand the problem or have better solutions. This may involve using the links provided or key ideas from the poster to research more about their problem and possible solutions.

### *6.1. Example: Glare Poster and Activity*

As one of the three main types of light pollution, glare is caused by an exposed light bulb. An overly bright bulb can severely impair vision, especially while driving at night. Glare is worse for older adults due to the presence of cataracts and loss of pupil control. In this activity, the students will explore glare from a “headlight” (a capless Mini-Maglite) at





Figure 12: Earth Hour on March 28, 2015 kicked off an intensive year of astronomy outreach in Pittsburgh. This is before lights were turned off at 8:30pm.



Figure 13: Lights during Earth hour on March 28, 2015 went out from 8:30 to 9:30 pm in over fifty buildings downtown.

and discussion have concluded, the post-assessment is given, mainly to assess student understanding and growth during the project.

#### 6.4. Project Partners

NOAO's partners are International Commission on Illumination (CIE), the International Dark-Sky Association (IDA), International Society for Optics and Photonics (SPIE), the Optical Society (OSA) and the IAU Office of Astronomy for Development, with sponsorship from IAU and OSA. This is the first time that all six stakeholders have partnered in educating the public on the importance of quality lighting and its effects on society. Starting in December 2015, the partners are disseminating the kits to audiences worldwide.

## 7. Our Pittsburgh Constellation

Riding on the Pittsburgh mayor's keen interest in astronomy and the ongoing change of 40,000 city lights from mercury and sodium vapor to shielded LEDs, Diane Turnshek from the Physics Department of Carnegie Mellon University in Pittsburgh, Pennsylvania, USA and her colleagues organized a series of city-wide celestial art projects to bring attention to the skies over Pittsburgh. Light pollution public talks were held at the University of Pittsburgh's Allegheny Observatory and other colleges. Earth Hour celebrations kicked off an intensive year of astronomy outreach in the city. Lights went out on March 28, 2015 from 8:30 to 9:30 pm in over fifty buildings downtown and in Oakland. Their art contest was announced at the De-Light Pittsburgh celebration at the Carnegie Science Center during Astronomy Weekend. "Our Pittsburgh Constellation" was an interactive Google map of all things astronomical in the city. Different colored stars marked locations of planetariums, star parties, classes, observatories, lecture series, museums, telescope manufacturers and participating art galleries. Contest entrants submitted artwork depicting their vision of the constellation figure that incorporated and connected all the "stars" in their custom city map. Throughout the year, over a dozen artists ran workshops on painting star clusters, galaxies, nebulae, comets, planets and aurorae with discussions of light pollution solutions and scientific explanations of what the patrons were painting, including demonstrations with emission tubes and diffraction



Figure 14: More than 23,000 Globe at Night campaign observations were measured from participants in 104 countries in 2016! A new world's record!)

grating glasses. The celestial art created in this International Year of Light was displayed at an art gallery as part of the City's Department of Innovation and Performance March 2016 Earth Hour gala. The organizers are thankful for the Astronomical Footprint grant from the Heinz Endowments, which allowed them to bring the worlds of science and art together to enact social change.

## 8. Globe at Night: From IYA2009 to the International Year of Light 2015 and Beyond

Celebrating its tenth year, Globe at Night ([www.globeatnight.org](http://www.globeatnight.org)), directed by Constance E. Walker with Stephen M. Pompea at the U.S. National Optical Astronomy Observatory, is an international citizen-science campaign to raise public awareness of the impact of light pollution by inviting citizen-scientists to measure and submit their night sky brightness observations via a "web app" on any smart device or computer. Globe at Night was invited to be an official citizen-science program for the International Year of Light in 2015. By the end of 2015, Globe at Night exceeded all records for the number of observations in a year, topping at 23,000 observations from 104 countries and all 50 US states (Figure 13). 56% of the observations were taken with mobile devices (smart phones and tablets) versus desktops; nearly three-quarters of the mobile device measurements were made by iOS devices versus Android devices; 3 out of 5 mobile device measurements were with the Dark Sky Meter app and 1 out of 5 mobile device measurements were with the Loss of the Night app. (The data from both apps feed into the Globe at Night data base.) Nearly 9000 measurements included readings from the handheld Sky Quality Meters devices.

The overall results for limiting magnitudes were distributed as follows: 2030 measurements at Limiting Magnitude 1, 3285 measurements at Limiting Magnitude 2, 4827 measurements at Limiting Magnitude 3, 4290 measurements at Limiting Magnitude 4, 3410 measurements at Limiting Magnitude 5, 2759 measurements at Limiting Magnitude 6 and 248 measurements at Limiting Magnitude 7.

Twenty-two countries qualified for the "Over 100" Club for Globe at Night. Five countries got over 1000 measurements: United States (8216), Croatia (2276), South Korea (1568), Uruguay (1455) and Germany (1363). The other "Over 100" Club countries are: Poland (987), Japan (808), Chile (739), United Kingdom (669), Spain (477), Macedonia

(FYROM) (423), France (404), Canada (368), Australia (324), Italy (232), Austria (179), Switzerland (159), Puerto Rico (156), Mexico (156), the Netherlands (133). Costa Rica (113) and Belgium (111).

Citizen-science is a rewardingly inclusive way to bring awareness to the public on important issues like the disappearing starry night sky, its cause and solutions. Citizen-science can also provide meaningful, hands-on “science process” experiences for students. Globe at Night will continue to do both for at least another ten years.

## **9. Summary**

The ambitious projects launched during the International Year of Light have potential as legacy projects in the years to come. We urge you to use the projects in doing outreach to bring awareness to the public on issues and solutions surrounding light pollution. Many hands make light work.