A COLLECTIVE GAZE AT THE STARS

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Abstract: A planetarium serves its community by leading a vast yet genuine science experiment to quantify how much of the night sky has been lost. Thousands of students, teachers, and parents celebrate the 2009 International Year of Astronomy by conducting citizen-science after astronomical twilight, then build explanatory models out of gelatin and colored blocks. See www.LetThereBeNight.com for details.

I would like to share one way Great Lakes Planetarium Association (GLPA) resources can make your planetarium a vital and valuable element in your community. For some of you, *Let There Be Night* (LTBN) may have simply been two DVDs that arrived in the mail. (See Figure 1.) For the Penn-Harris-Madison School Corporation (PHM) in northern Indiana, Let There Be Night was also a district-wide science experiment that asked the question, "How much of the night sky have we already lost?"

Figure 1. An animated Galileo confronts light pollution in the feature LTBN video.

Launched with the pivotal support of the PHM administration, *Let There Be Night* confronted one unified theme—outdoor lighting issues—and initiated lessons across multiple disciplines in 11 elementary schools and 3 middle schools. Art Klinger and I met twice at each school for 20-minute in-service sessions with the respective teachers, and hosted three optional professional development opportunities in the planetarium.

During the school year, Art presented interactive lessons to over 7,000 students and 300 teachers. With a Maglite demonstration, he tapped into the unique properties of the planetarium to show the impact of unshielded lights and their contribution to glare, light trespass, and sky glow. Each visiting student received a handout with six starfields of Orion, with which they practiced estimating the limiting magnitude as Art varied the level of light pollution in-dome. Afterward, they enjoyed AVI's laser show about the featured constellation Orion.

Each school also selected a handful of students for a combined Student Leadership Team. This was a great group of kids who prepared repeatedly on Saturday mornings essentially to be their in-school experts for the science experiment. We gave each team member and every teacher in grades 3-8 a copy of the 2-DVD set (produced in part with GLPA support) to get background information on light pollution issues. In the dome, the team connected via Skype with an astronomer. Shown is Dr. Connie Walker, chair of the IYA2009 Dark Skies Awareness Committee, answering student questions about astronomy careers. Members of the student team met to discuss outdoor lighting issues with the mayor of Mishawaka, and with the St. Joseph County Council, who later recognized them for their efforts.

Meanwhile, in the schools, teachers designed their own lessons with support from the two DVDs. Several students conducted original experiments for science fairs. Other regular events, such as this overnighter, featured a portable planetarium and more dark-sky lessons.

Perhaps my favorite activity is the Turtle Hatch. The kids simulate sea turtles hatching in the presence of light pollution while parents or teachers act as predators. (See Figure 2.) It's dynamic, lots of fun for everyone, and is well suited for a large group of, say, 50 to 100 kids. As a mini-science experiment, the kids conduct a group hatch; record the turtle survival rate; discuss the outcome; change one variable (the lighting); conduct a second hatch; and compare results from the two trials. See http://www.lettherebenight.com/turtles.html.

Figure 2. *Kids, as sea turtle hatchlings, scramble when predators descend.*

Figure 3. *A team quantifies sky glow with SQMs after astronomical twilight.*

One middle school science teacher had each student do research and a presentation on light pollution. Projects ranged from posters to dioramas, and attracted media attention.

Meanwhile, we continued to communicate regularly with the administration, school principals, and key school leaders. As the two-week observation period approached, we reminded parents and students with large banners outside each school.

The weather team from local TV station WNDU embraced the *Let There Be Night* experiment, and during the last two weeks of March gave daily updates of whether the night skies would be clear with a red-yellow-green color system. The opening night, March 16th, was green for "go."

Across the school district, kids in grades 3-8 voluntarily went outside at 9:30 p.m. (it had to be after astronomical twilight), looked up, and used their Orion star charts to estimate the limiting magnitude. The next day, they reported their results in class and their teachers uploaded the data to an online spreadsheet.

Meanwhile, every night for two weeks—whether clear or not—the Student Leadership Teams met at their schools to quantify sky glow with hand-held Sky Quality Meters (SQMs). They took five readings with each of three meters and averaged the results. (See Figure 3.)

I rotated between the 14 schools, each night visiting a different team. If the sky was clear, I took my telescope. The second night—clear again. In late March we were seeing the ISS and Space Shuttle pass overhead, Iridium flares, Saturn and its moons, and a stunning crescent Venus in the west—all great highlights in the International Year of Astronomy.

Consider this collective gaze. At 9:30 p.m. stargazing kids are in their backyards, fanned out across 140 square miles of school district, estimating limiting magnitude, while student teams are concurrently at the schools quantifying sky glow. The next night, clear again. Notice in these pictures that there are kids, parents, and even teachers who have willingly committed to this late-night group effort. Seven of our first eight nights were stunningly clear.

What were the initial results? Over *3,400* kids went out multiple nights and contributed data. The histogram shows an average limiting magnitude=3.5. (See Figure 4.) Meanwhile, the teams uploaded their SQM readings to a separate spreadsheet.

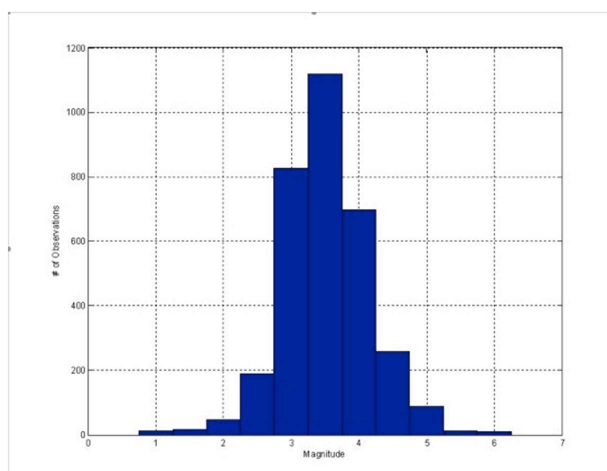

Figure 4. *A well-defined bell curve from over 3,400 observations yields an average limiting magnitude of 3.5.*

At Cerro Tololo in Chile, astronomers had previously conducted a similar experiment, with some of their SQM readings shown here. Astronomer Michael Warner, at right, made a 3D grid over a local map to convey the results. We wanted to do something similar to show both the hot spots with lots of light pollution and the areas with darker skies, but we wanted it to be kid friendly.

We correlated each limiting magnitude to a stack of colored LEGO® blocks, ranging through ROYGBIV for mag=1 to mag=6. (See Figure 5.) If someone had a limiting magnitude of, say, mag=4, then one could place a stack (ROYG) of blocks topped with green on that observer's location. Hopefully, stacks of colored blocks on a school district map would reveal a pattern.

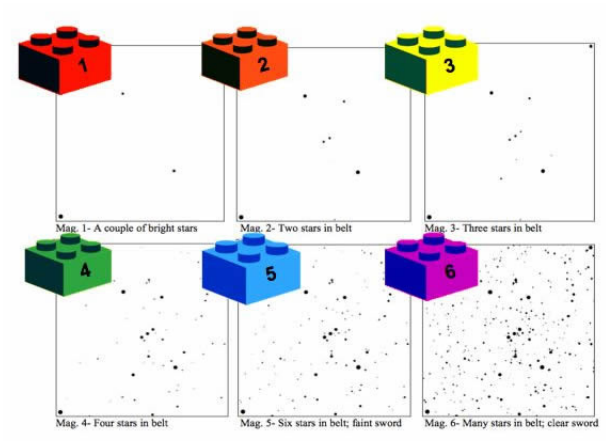

Figure 5. *Colored LEGO® blocks indicate the limiting magnitude or number of visible stars.*

A variation we tried with the Student Leadership Team was to place six layers of colored Jello® atop a school district map. An ideal sky would be a layer of dark gelatin all the way across. Prior to the experiment, the kids estimated what they expected the sky would be by scooping away layers of Jello®. As shown here, they expected one end of the school district to have significantly brighter sky glow than the other.

After the data came in, astronomer Michael Warner helped us plot the results with stacks of colored blocks in Google Earth®—one more learning curve that we admittedly did not use very much with the students.

The signature piece of the experiment was the large 3D model made from LEGO® blocks. On a 4x8 foot table with LEGO® base plates, we drew a map with the district boundaries, roads, and other features. While some kids built stacks of colored blocks, others began organizing them on the table. It was a time consuming exercise as the kids conscientiously placed stacks in their proper locations. (See Figure 6.)

Figure 6. *Team members place colored stacks of blocks at the corresponding observer locations.*

Meanwhile, we made a four-page analysis of the experiment results and distributed it to each student in grades 3-8. The feature diagram with a spectrum correlated limiting magnitudes, colored LEGO® blocks, and a numeric value for increased sky glow. For example, with the students reporting an average limiting mag=3.5, the diagram suggests our community's night sky is now about nine times brighter than an ideal night sky.

Next the team shared their experience and unveiled the 3D model at a PHM School Board meeting. If the skies were ideal, the model would be topped with black LEGO® blocks (black replaced purple because of product availability) all the way across. However, from that ideal model with over 35,000 blocks, the students essentially peeled away over 12,000 upper blocks and put them in a "debris pile" to show visually how much of the night sky has been lost. The 3D model has since gone on tour, displayed over the summer at the local library, at a retail area, and now at each of the 14 participating schools. (See Figure 7.)

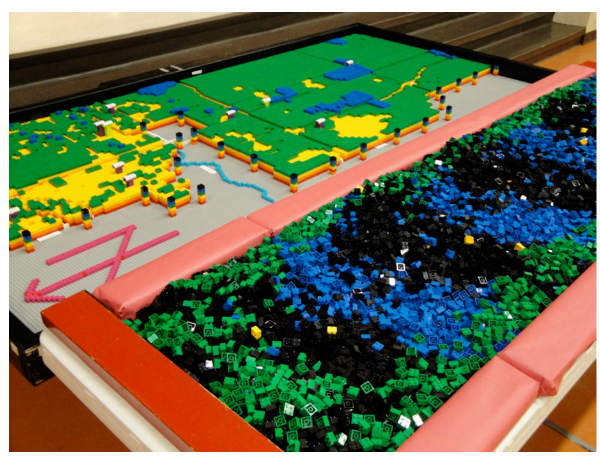

Figure 7. *A 3D model of the experiment results shows varying levels of degraded night sky, with a "debris pile" of lost visibility in the foreground.*

For the *Let There Be Night* experiment, Art Klinger and I created and used resources like the 2-DVD set as we hadn't expected; developed original lesson plans and several interactive activities; created a venue in Second Life which was selected as a finalist for the inaugural Linden Prize; compiled a vast website to share information with planetarians, teachers, and families; and built the framework for a large community experiment that dovetails with Globe at Night.

All of these resources and templates exist for you planetarians to adapt and to use in ways that best serve your facility, your community, your situation. Please feel free to contact me if I can support your advocacy of dark skies. Our school district embraced *Let There Be Night* because the planetarium offered a unique, genuine science experiment that was an educational experience for the entire community. I believe you, too, can lead such a project—as only a planetarium can—and create great value and relevance for your facility. Thank you, and thanks to GLPA for its support of *Let There Be Night*.