

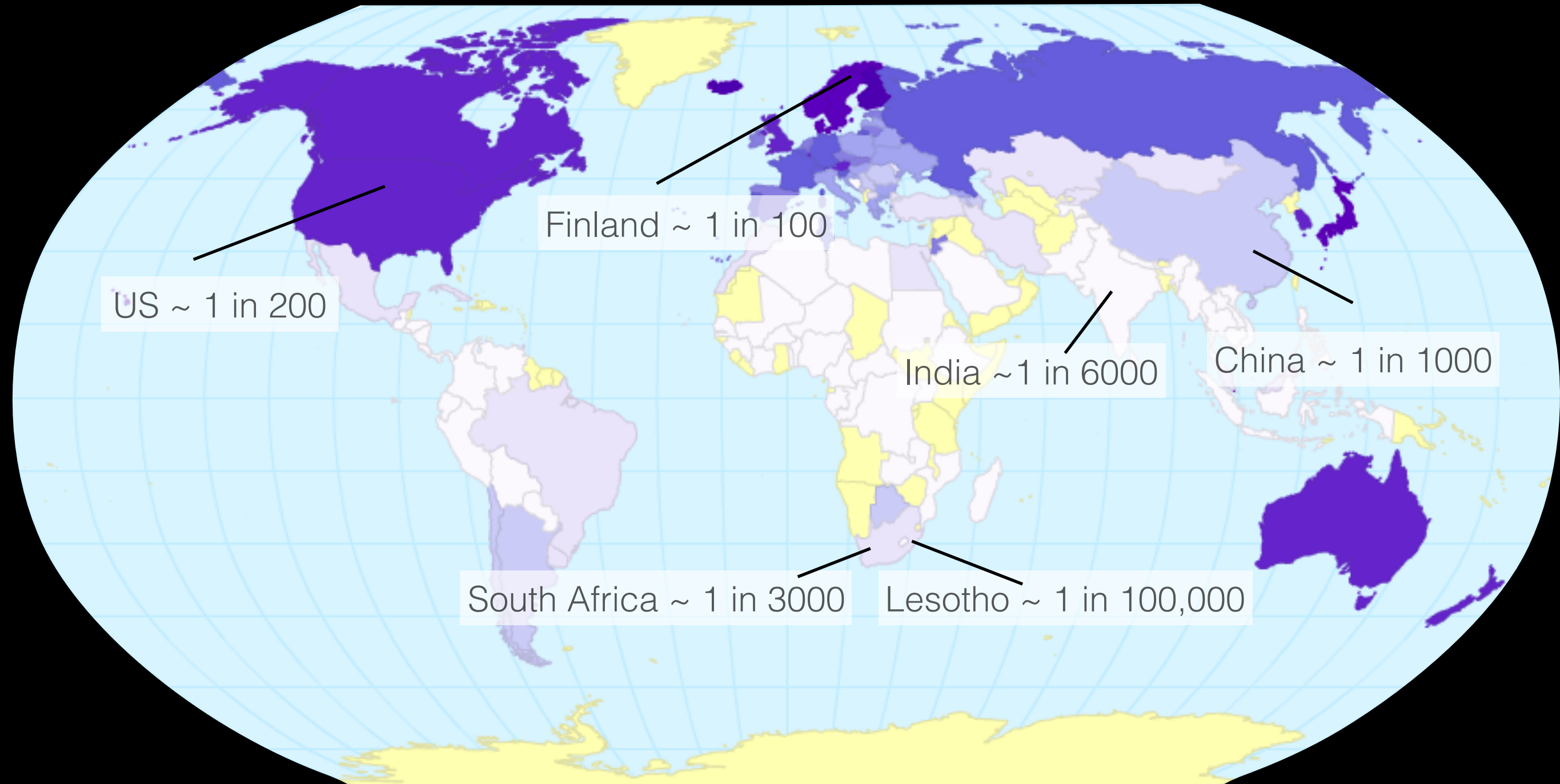
One Sky: Eight Years of Astronomy Outreach In the Developing World

**Henry Throop
Senior Scientist, Planetary Science Institute
Mumbai, India**

**Brigham Young University
October 17, 2017**

Carl Sagan Medal Award Talk

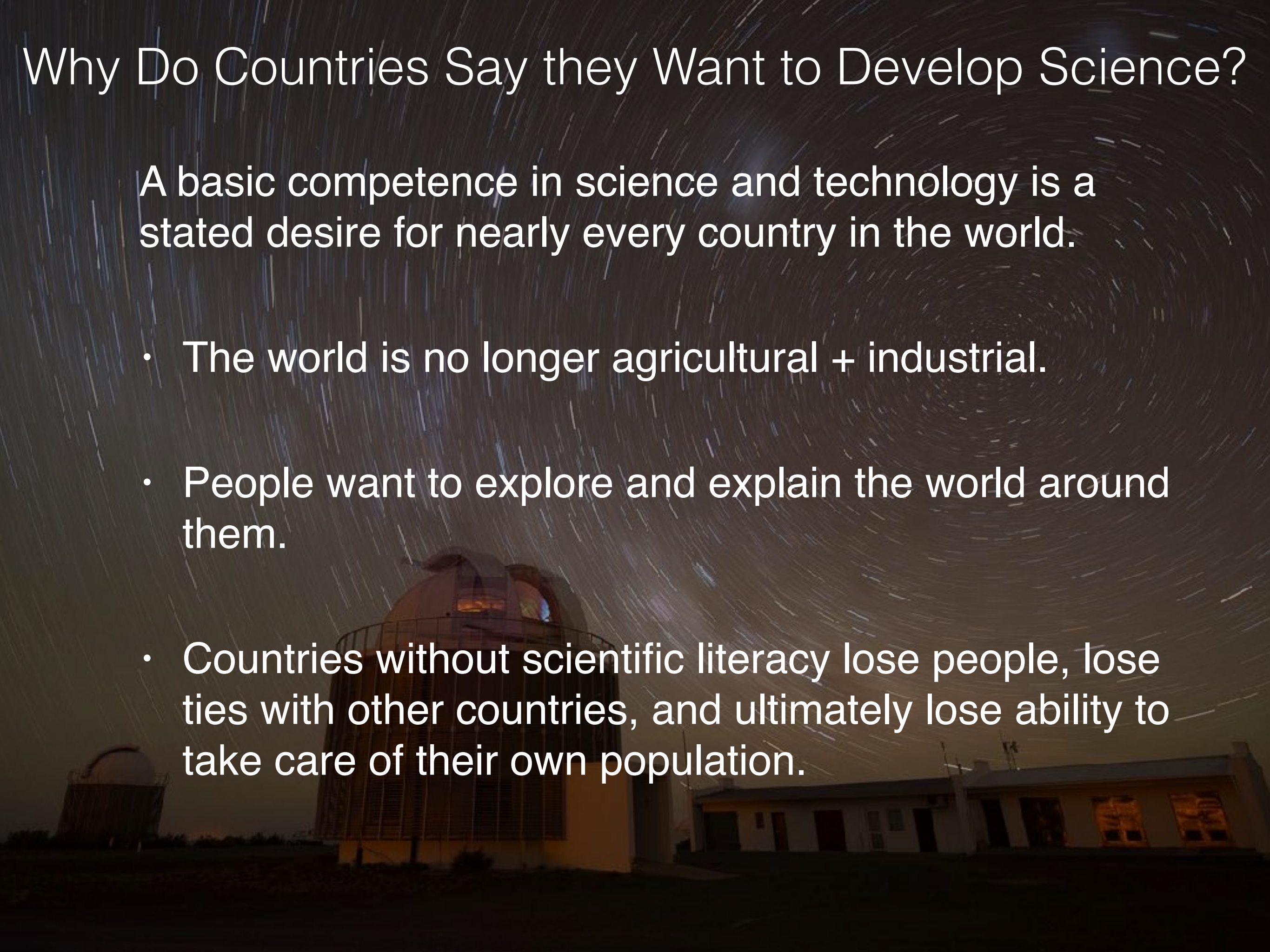
Number of Researchers per Capita



Why Do Countries Say they Want to Develop Science?

A basic competence in science and technology is a stated desire for nearly every country in the world.

- The world is no longer agricultural + industrial.
- People want to explore and explain the world around them.
- Countries without scientific literacy lose people, lose ties with other countries, and ultimately lose ability to take care of their own population.



In the last 8 years, I've given hundreds of talks to schools and public groups across the developing world.



Outreach — Teaching — Research

South Africa

South Africa remains very segregated despite the official end of apartheid in 1994.

- Personal income
- Unemployment
- Townships
- Education
- School quality
- Teacher quality
- Educated black middle class remains very small

Three Years in South Africa

- 50+ school visits, public talks, museum lectures, science festivals
- Many visits to rural schools and township schools.
- Started astronomy program at formerly all-white university
- Taught first university course in Astrobiology in Africa



A chance meeting with some great teachers...



... led to a trip to visit their school in rural
Limpopo, South Africa





Madikweng Senior Secondary,
Limpopo Province, South Africa





Largest building in the village









EBENEZER





Talking about New Horizons









Making dry ice comets







Preparing lunch for students



Astrobiology talk in the
school's new science lab.





No toilets*, no phone, no computers, one water tap...



A bit of soccer while waiting for sunset.



Students stay at school until 10 PM



200+ students, parents, and villagers line up for Saturn and the Moon.





Principal Joseph, with awards from 100% graduation rate. Many students go on to college, and some to the top universities in the country.

Governmental support is not enough. Some teachers are paid directly by the parents, and corporate donations to the school have helped.



Teacher Charles Wasswa has inspired hundreds of South African students with science and math.

He stays late, he works hard, he demands a lot, and he loves his students.

Dendron Secondary School



1200 students, rural village, Limpopo, SA.
Public boarding school, science-focused



Astronomy Club presidents welcome me.







Talking about Pluto and New Horizons



Q&A runs for longer than the talk!



Presenting a new telescope



Astronomy Club at Dendron

Astronomy Club
learning to observe
sunspots, so they
can host their own
star parties for other
local schools.





As of 2015, students don't have access to smartphones, YouTube, DSL. Most students have never used a computer. Without online educational resources, printed material has a lot of value.

Feedback from teachers...

and students.

“Genuinely speaking, in 30 years I doubt that this school has had an event bigger than yesterday's. There is clear indication in the school that immense interest in astronomy has been aroused. We can never thank you enough for the inspiration you have given us.”



Nimrod Manyelo

September 21 via BlackBerry Smartphones App

As Madikweng we a proud of being visited by one of the greatest scientists on dis planet earth "HENRY THROOP" — with Henry Throop.



Unlike · Comment · Unfollow Post · Share

You, Jim Adams, Kathleen Kelleghan, Rowdy Webb and 27 others like this.



Trudy Kgodu Dikgale eh ke bo phala na

September 21 at 10:15am · Like



Nimrod Manyelo Ja ke bona mmata

September 21 at 10:17am · Like · 1



Moloko
Engineering,
U. Pretoria

Tshegofatso
Leadership Training
program in US



Ananias
Economics,
U. Johannesburg

Nimrod
Science Education,
U. Witwatersrand,
Johannesburg



India

- 1.3 billion people: 20x the population of South Africa, in 2x the area.
- Population density: lack of sanitation, food, clean water, housing, medical care, education...
- GDP ~ \$10/day/person
- Many good schools and universities, but not enough for the population! Admission rates can be $< 1\%$.
- But...

India is only the fourth country to successfully send a spacecraft to Mars!



Mars Orbiter Mission, arrived September 2014



Three years in India

- Gave ~50 talks for public groups and schools, at science festivals, observing nights...
- Astronomy research workshop for Indian students
- Taught university-level solar system course

'Pragyan' Engineering Festival



Tiruchirappalli, Tamil Nadu, India

Guest Lectures

PADMA SHRI DR. SANKAR KUMAR PAL

FORMER DIRECTOR,
INDIAN STATISTICAL INSTITUTE

MARCH 3 | 11:00 AM | EEE AUDI



KISHORE JAYARAMAN

PRESIDENT OF
ROLLS-ROYCE, SOUTH ASIA

MARCH 3 | 1:30 PM | EEE AUDI



DAVID J PETERSON

LINGUIST, LANGUAGE CREATOR –
GAME OF THRONES

MARCH 3 | 6:30 PM | BARN HALL



PADMA BHUSHAN A. SIVATHANU PILLAI

FOUNDER CEO AND MD - BRAHMOS

MARCH 4 | 11:00 AM | EEE AUDI



DR. HENRY THROOP

PLANETARY SCIENTIST AND SENIOR ADVISOR –
NEW HORIZONS

MARCH 4 | 2:00 PM | EEE AUDI



DR. RICHARD A MULLER

PHYSICIST, COFOUNDER OF
BERKELEY EARTH

MARCH 4 | 8:00 PM | BARN HALL



RAJSHEKHAR MURTHY

FOUNDER OF INTERNATIONAL MALWARE
CONFERENCE - MALCON

MARCH 5 | 11:00 AM | EEE AUDI



NANDINI HARINATH

DEPUTY OPERATIONS DIRECTOR,
MANGALYAAN

MARCH 5 | 1:30 PM | EEE AUDI



DR. ADA YONATH

NOBEL PRIZE IN CHEMISTRY, 2009,
PROF. WEIZMANN INSTITUTE OF SCIENCE

MARCH 5 | 3:30 PM | EEE AUDI



‘Pragyan’ Engineering Festival

National Institute of Technology, Trichy, Tamil Nadu





Talking about New Horizons



Student Engineering Competitions





Engineering Speed Tests



‘Robot Wars’

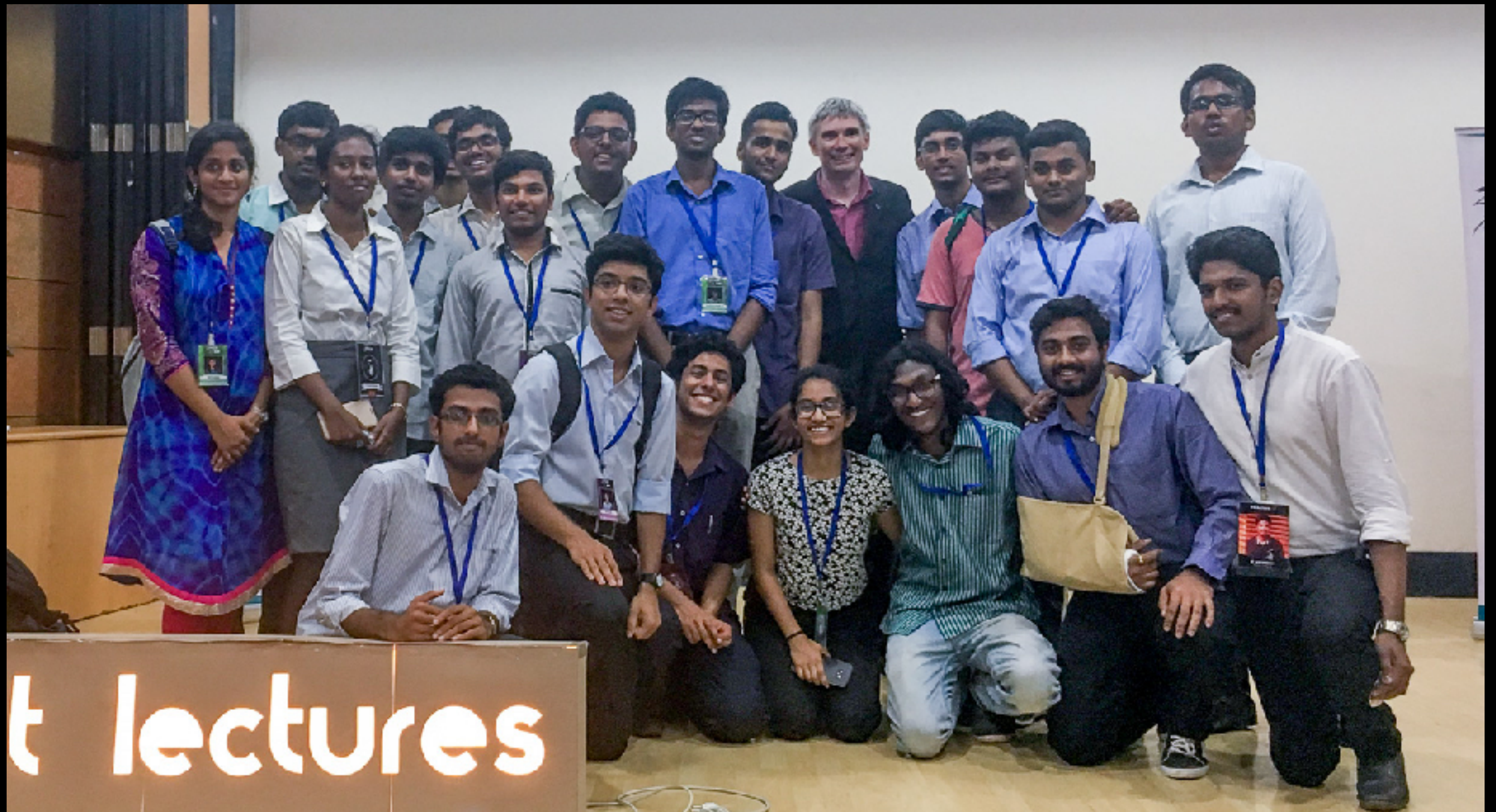


Students are equally proud of their heritage,
and of moving their country forward



Innovators at any age

The student organizers who have done *everything*:



Planning, Recruiting, Arm-Twisting, Fundraising, Production,
Finding Sponsors, Grant Writing, Budgeting, Publicity...

Similar student-run science and engineering festivals are held at hundreds of colleges across India...

Pragyan	National Institute of Technology, Trichy
Footprints	MS University, Baroda
TechFest	Indian Institute of Technology Bombay
Quark	MP Birla Institute of Science, Goa
Conscientia	Indian Institute of Space Science and Technology, Thiruvananthapuram
Paradigm	St Xavier's College, Mumbai

...

These students get more real-world experience than many do in the US!

Khagol Mandal: Observing the Night Sky from an Indian Megacity...

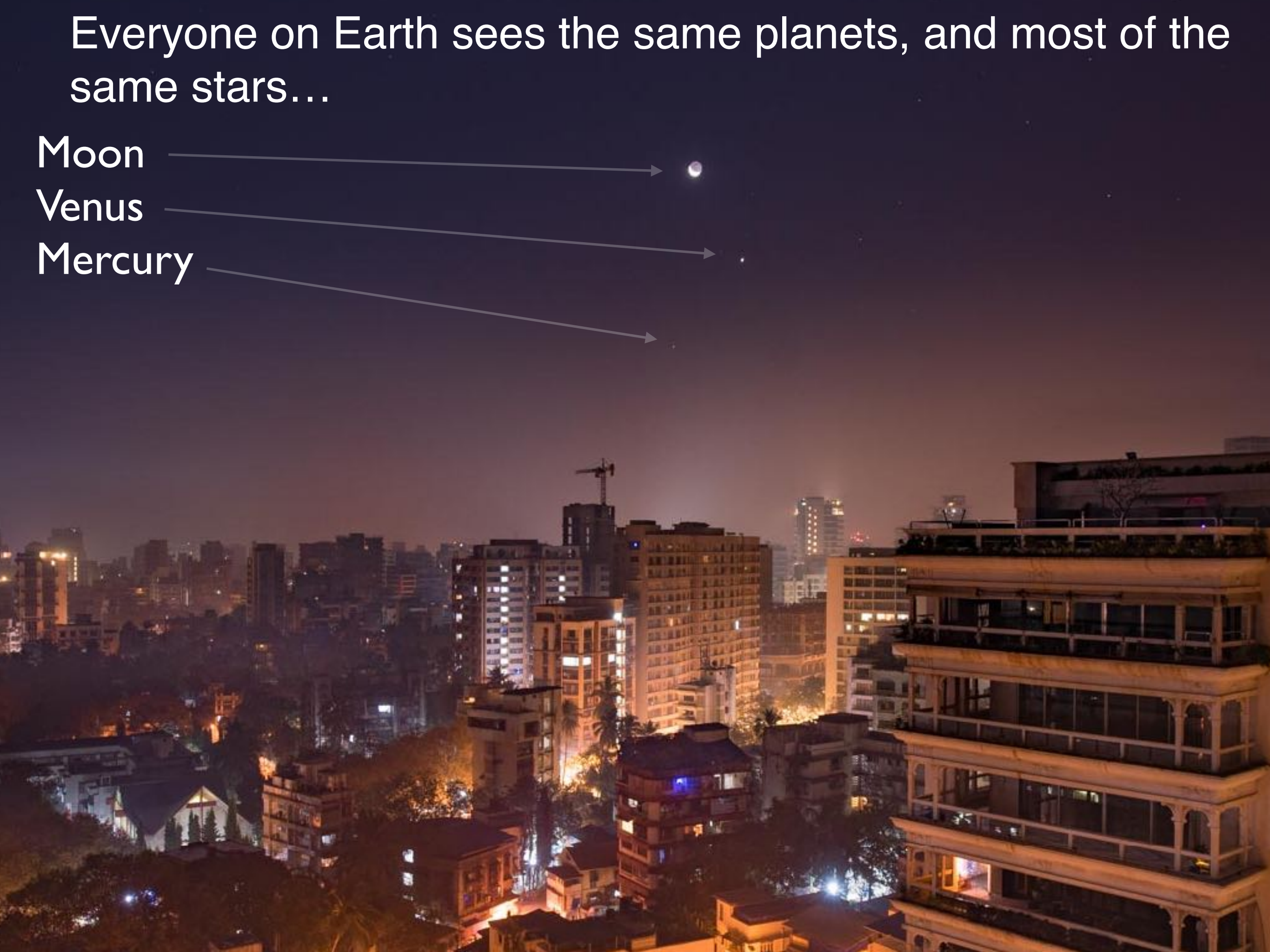


Everyone on Earth sees the same planets, and most of the same stars...

Moon

Venus

Mercury

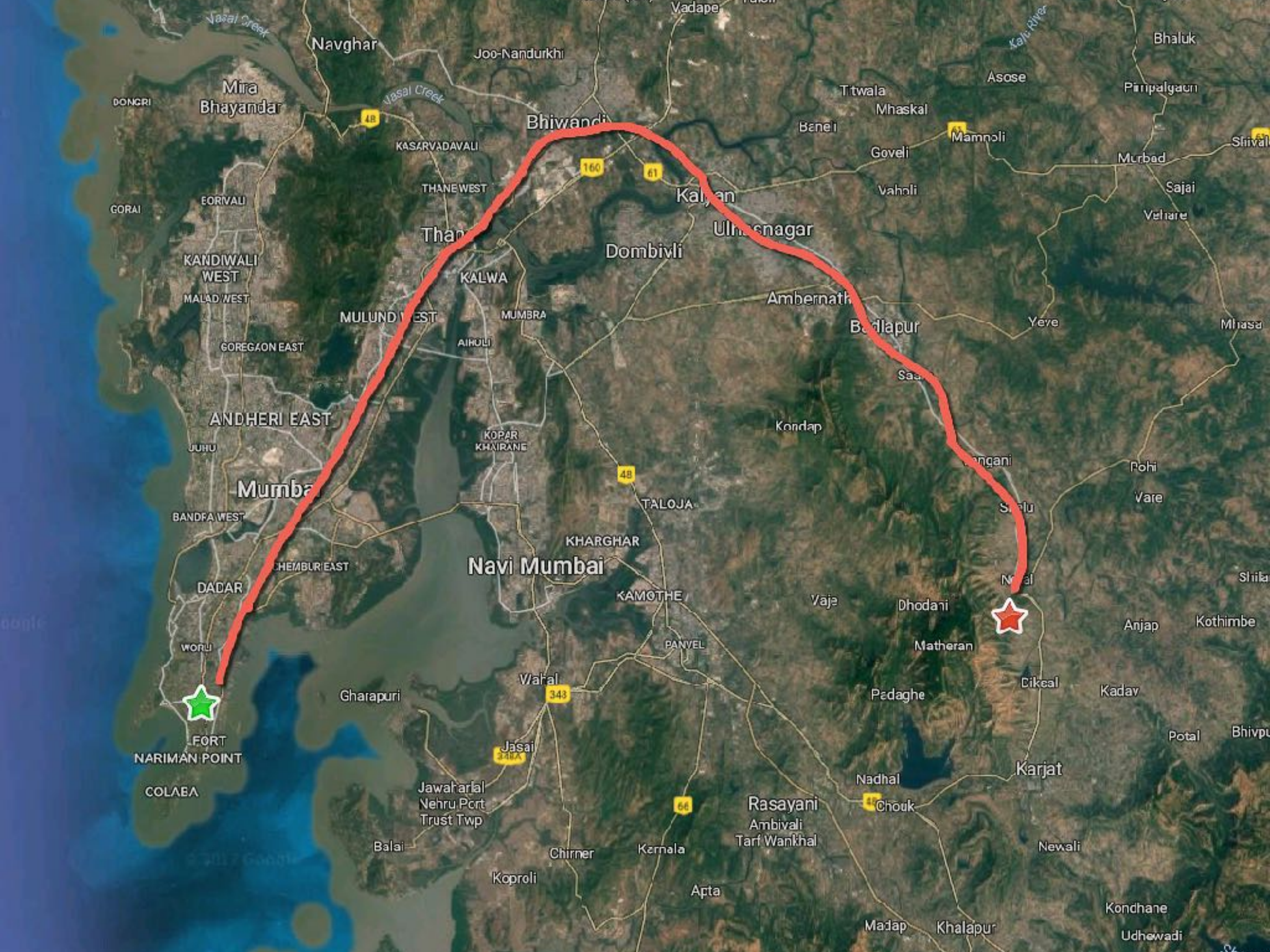




On the Mumbai local train, heading to observe



On the Mumbai local train, heading to observe





Students checking in to observe



Amateurs setting up telescopes for the night





Star tour for 200 people under the sky



Thali platter while observing!



12:30 AM: Giving a talk about New Horizons and Pluto



4:30 AM: Time for a final chai break before packing up for the night.

200 students and public have braved trains, pollution, dust, and more... in order to connect to the sky. We are lucky to have this world, and so many people who are curious to explore it with us.

Larger International Programs

An aerial photograph of a large radio telescope dish, likely part of the Square Kilometer Array project. The dish is a massive, circular structure with a complex internal support system of struts and cables. It is situated on a steep, rocky hillside. The surrounding landscape is rugged and mountainous. In the foreground, there are some smaller structures and infrastructure related to the telescope's operation.

South Africa and India are major partners in the consortia of countries building the largest telescopes in the world.

But with all the poverty and social issues, why are countries in the developing world spending money on cutting-edge science?

Larger International Programs

- **Human Capital Development** — *i.e.*, because it will develop the country's science and engineering skills, needed in order to grow and evolve.
- **Because science is worth doing.**

"Scientific endeavour is not purely utilitarian in its objectives and has important cultural and social values. It is also important to maintain a basic competence in "flagship" sciences such as physics and astronomy for cultural reasons. **Not to offer them would be to take a negative view of our future - the view that we are a second class nation, chained forever to the treadmill of feeding and clothing ourselves.**"

*South African White Paper on Science & Technology,
Department of Arts, Culture, Science and Technology, 1996*

A Few Universal Truths

- People ask the same questions everywhere.
- Direct engagement with people is fun.
- People connect to the sky, anywhere. It's shared, and it's both mysterious and tangible, and it's always there.
- Even in a large country, the influence that one person can have on others can be huge: principals, teachers, etc.

And some advice for anyone interested in giving talks...

- Sit down next to people you don't know.
- Do what's easy! For me, it's talking about astronomy.
- You don't have to be an expert. You already are.
- Consider offering to give a talk with a local US Embassy if you are traveling or living abroad. Or call local schools, universities, science centers, and offer to visit.
- Students everywhere love interest from other parts of the world. You are a huge inspiration to them.

Thanks to...

- All of the teachers and students
- NASA for enabling us to explore the universe
- US State Department
- My family for always encouraging and supporting me
- The thousands of people who have inspired me with their outreach, teaching, writing, and support.

throop@psi.edu

Backup Slides



Principal Matsopola M.K. One amazing founder and leader has made a difference in thousands of students' lives.

State Department

- Fulbright programs — international visitors
- US-run Libraries, science centers, reading rooms abroad
 - Free and open access to local students, citizens
- Sponsoring and arranging speaker visits
- Many ‘public diplomacy’ projects that build ties between countries: economic, scientific, cultural, etc.

Larger International Programs

- South Africa and India are major partners in the consortium of countries building the largest telescopes in the world: the Square Kilometer Array (SKA) and 30 Meter Telescope (TMT).
- Both South Africa and India are actively developing their research programs. Why, when they have so many social issues?

"Scientific endeavour is not purely utilitarian in its objectives and has important cultural and social values. It is also important to maintain a basic competence in "flagship" sciences such as physics and astronomy for cultural reasons. **Not to offer them would be to take a negative view of our future - the view that we are a second class nation, chained forever to the treadmill of feeding and clothing ourselves.**"

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