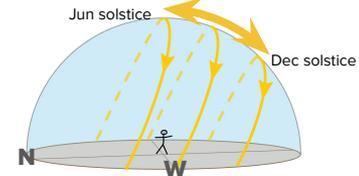


# Understanding geography and astronomy through shadow observations

P. Varuni<sup>a</sup>, Chaitanya Ursekar<sup>b</sup>, Daison Jacob<sup>c</sup>, Mohammed Yunus<sup>d</sup>, Priyanka Shrivastava<sup>a</sup>  
 a. The Institute of Mathematical Sciences b. HBCSE c. Kendriya Vidyalaya Golaghat  
 d. Kendriya Vidyalaya Upper Shillong, e. Kendriya Vidyalaya CRPF Durgapur

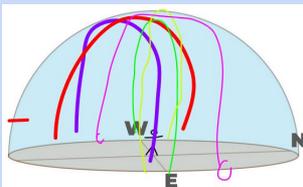
- Misconceptions about the apparent celestial motion of the sun are common among both children<sup>1,2</sup> and adults<sup>3</sup>
- Our proposal: Observing and measuring shadows cast by the sun and their variation with time of day, time of year and location, can help understand the sun's apparent celestial motion
- As part of Vigyan Pratibha (VP)<sup>4</sup>, we conducted professional development seminars for teachers and designed learning units for students
- Here we describe the ongoing development of two such units



## With teachers

### How does shadow length change with time of day?

- Online session for VP teachers 'How does my shadow change?', 2 x 1 hr sessions
- Discussing shadow length and direction change with time of day, longitude, latitude, time of year
- Collaborating with 3 teachers to design unit
- Our only constraint: Must involve observation and measurement
- 10 x 1.5 hr design discussions over 6 weeks



## On our own

### How does shadow length change with time of year?

Development process



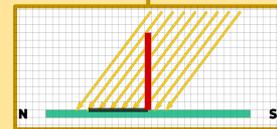
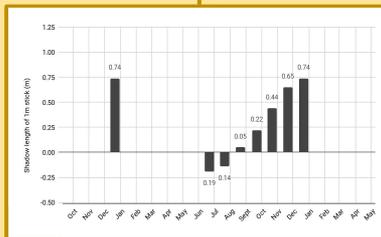
Ratio of shadow length to height is invariant (through a 'story' and secondary data)

Reading graphs: axis crossing, local maxima and minima

Predicting shadow lengths from the graph, verifying predictions

Two-level explanation for change in shadow length:

- Change in angle of sun's rays
- Tilt of the earth and revolution around the sun



Unit plan

Session 1

Students' shadow measurement

Session 2

Shadows: definition, conditions for formation

Ratio of shadow length to height (S:H) is invariant, equals shadow length of 1 m stick (thru observation & measurement)

Ratio of S:H changes over the course of the day

**Application:** Use ratio and 1 m stick to determine height of very tall objects

Enactments

### Priyanka Shrivastava

- Virtual sessions, 2 x session 1, Class 7 students
- Emphasis on shadow definitions, conditions for formation
- Limited student observation and measurements prevented session 2

### Daison Jacob

- Physical classroom, 2 groups, Class 9 students
- All parts of plan carried out
- Adaptations from original plan to compress into one session

Takeaways

Misconceptions about local noon and zero shadow seen among students (PS)

Limited student response after virtual session → may need to revise to address this

Benefit of limited constraints → application task suggested by teachers

Enactment

### P Varuni

- Virtual sessions, private school, class 8 students
- Lengthy discussion on graph reading
- Limited student observation and measurements, session 2 focused on explanation

Takeaways

Too long → Story was shortened

Teacher (observer) feedback → Ratio can be connected to class 8 curriculum

Problems with the explanation of equinox → revising drawing activities

No way to assess understanding of explanation → Added a summary table

### References

1. Plummer, J. D. (2009). *International Journal of Science Education*, 31(12), 1571–1605.
2. Trumper, R. (2001). *International Journal of Science Education*, 23(11), 1111–1123.
3. Trumper, R. (2006). *Journal of Research in Science Teaching*, 43(9), 879–906.
4. <https://vigyanpratibha.in/>