SUNDERSTANDING: THE SUN AS A LEARNING RESOURCE FOR UNIVERSALIZING SCIENCE

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The Sun is an unparalleled resource for learning science, math, and technology. It has been described as a wonderful sky laboratory that all the affluent nations in the world together could not afford to build. Yet it is available in the most remote village, anywhere in the world. Sunderstanding is a program, being developed by Navnirmiti for universalizing understanding of the sun with low cost, no cost tools, and using the sun as a universal tool for understanding SMT. Sun study can be made part of every school curriculum from primary school onwards, with wonderfully simple, and simply wonderful experiments for learning SMT at every grade level. This paper describes a few such activities.

A Clock Calendar

Observing how the sun moves in the sky is a good place to begin. It teaches about time, angle, seasons…This can be made quantitative by conceptualising, designing and constructing sun dials. Many sun dials have been constructed and yet many more new designs are within the reach of schoolroom discovery. At no two times of the year is the sun in the same position in the sky. A good sun dial is not only a clock, but also a calendar. Constructing such a clock calendar is a wonderful schoolroom exercise in science, math and technology that can be done anywhere with everyday materials at low cost.

Collecting the Sun Knowledge of Each Culture

Every culture in history has had to study the sun. The sun studies of each culture are not only wonderful epochs in the history of science, but also a powerful and effective statement of the truth that every human being has his/her history of science and that science is not an imported commodity. Whether Asia, Africa, the Americas, or the Island cultures, the sun knowledge of each region is both unique and universal. Collecting and validating such traditions, and making them available to all (just as sunshine is), would be an important collective exercise for international SMT education.

Imaging the Sun

Imaging the sun is a highly instructive exercise. With the simple pinhole projector one can discover a number of things, including learning about angle, area, intensity, the inverse square law, and that the sun is about 100 times as far, as it is big. The Navnirmiti Surya Sandesh card is an exercise in science as well as in combating religious and communal bigotry. The pinhole projector was developed into a solar telescope in the cathedrals of 16th century Italy. Today, the Chhatrapati Shivaji Terminus railway station at Mumbai is one such solar observatory.

The Magic Mirror

The magic mirror experiment is a simple but non trivial toy based on the same principle. When developed as a tool for projecting the sun, a simple five-rupee pocket mirror can be converted into a powerful solar telescope which can be set up in every school. Long distance (30 m and beyond) projection with the pinhole mirror projector delivers large (30-50 cm diameter) images of the sun which can show sunspots with considerable clarity.

Discovering non trivial concepts with simple equipments

Long distance projection throws up technical problems which the students need to solve with ingenuity. From cheap plastic balls, or even watermelons, stable ball mounts can be made by the students with their own hands. Portable darkrooms can be constructed from used cartons. Improving resolution can take the students into the realm of discovering the problems of high precision. With the self constructed pocket mirror and ball mount projector an accuracy of one part in ten thousand and the discovery of optical diffraction is possible.

Measuring Local Latitude

The ball mount offers some interesting simple but non trivial applications. Mounting a hollow tube through which one can take a fix on the stars, shows that the north star is fixed, while all other stars move. With an angle dangle meter, local latitude can thus be measured.

The Geosynchron

The same principle is used to construct the ‘geosynchron’, which is a model of the earth which is always parallel to the real earth with its motions in space of rotation and revolution. Solar time on the geosynchron is the same as the solar time on earth as can be seen by placing a miniature sun dial on the geosynchron next to a real earth sundial. As if one were observing the earth from a geosynchronous satellite, one can see the line of sunrise and sunset move across the earth. Every school globe can be easily converted into a geosynchron with the ball mount. The children can learn about geography, time, seasons in a new way.

Imaging the Sun by Telescope Projection

Imaging the sun can also be done by telescope projection. Telescope making workshops can be held for 50 children where each makes his/her own telescope with a low cost lens kit and mountboard. The ball mounting combined with this simple telescope makes an easy to use projector for sun imaging which gives crisp and clear images of the sun.

Very Long Focal Length Lens

The ball and mirror projector, combined with a Very Long Focal Length (VLFL) convex lens gives yet another way to construct a solar telescope in every school. With the above low cost tools, which no school cannot afford to construct, the students can begin to do a number of non trivial experiments.

Discovering the Sun’s Rotation

Studying sunspots students can discover about the sun’s rotation about its own axis.

Measuring the radius of the earth and the distance of the sun from the earth

The image of the sun at around 50 m is seen to creep across the screen as we watch. Measuring the amount of creep at different distances is easy and makes tangible the angular motion of the sun due to rotation of the earth. Two of the ten most important measurements in physics made by humankind are the measurement the radius of the earth and the distance of the sun from the earth. With their low cost observatory both these measurements can be made by each child in every school. Only simple school geometry is necessary for this, and learning geometry is an important by- product of this exercise.

Earth's radius can be measured by school students in different ways, the simplest being to measure the latitude at two different points north-south of each other separated by a few hundred kilometers. With the Indian railways, this is not difficult to plan and organize during a school tour trip.

The measurement of the sun's distance is such a non trivial problem that even Galileo and Newton did not know this number. Horrocks attempted to measure this during the 1639 Transit of Venus. He made a wrong assumption, else he would surely have gone down in history as the first person to measure the solar distance correctly. With a simple assumption (which is correct to within 10 %), that Venus and Earth are approximately the same size, every child can measure the distance of the sun by himself/herself. This can be easily done from the photographs taken from the 2004 Transit of Venus. For every child to measure the sun's distance first hand will be possible during the next transit of Venus which will occur in 2012, six years from now.

Building a Mass Campaign

This is sufficient time for building an international education campaign which will reach every school in every country around this event. A dress rehearsal of such a campaign took place in India through All India Peoples' Science Network in 2004 in which thousands of students from urban, rural and tribal schools successfully participated. The www.sunderstanding.net website attempts to provide access to all the tools needed for such a campaign.

Every solar eclipse gives an exciting opportunity to schools to do experiments. The simple low cost tools outlined earlier provide the experimental apparatus necessary for many such experiments. Solar energy is another treasure house which we do not discuss here.

First Class Science Resources

The Sun is a first class science resource which is available everywhere at no cost. Water, Soil, Rock, seed, leaf, worms and bugs, the animal and human body, the human mind and senses… the list of first class science resources which are available everywhere at no cost is long.

Universalising high quality science education without compromise is therefore a real possibility, as is universalising high quality math learning.