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Glancing Moon from Student Perspective: Journey from Intuitive to Scientific

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Abstract: ***The purpose of this study is to provide detailed information about impact of traditional teaching on students understanding of moon in the sky and aspects related to it: shape, pattern of motion, eclipse and phases of moon. The focus is on exploring ideas in the mind of students related to moon that are at foundation for understanding of astronomical concepts. Seventy two students participated in the study. Data is collected quantitatively through pre-test post-test design. Analysis of data revealed that students lack observational experiences about moon and prior knowledge from different sources is insufficient. The more structured instruction is needed to reach full scientific understanding across all aspects of moon. This study has future implications for classroom researches and curriculum designing.***

Keywords: Astronomy, Assessment, Scientific, Synthetic, Non normative

1. INTRODUCTION

There are several reasons why children may benefit from learning about apparent celestial motion in elementary school. First, an accurate understanding of the observable aspects of astronomy, those visible without the aid of camera or telescope, from our own earth-based perspective is one aspect of understanding recommended for a scientifically literate individual. Project 2061, a long-term initiative of the American Academy for the Advancement of Science, This document contains recommendations for the essential areas of understanding in science and technology for all citizens in today's world. One of these essential areas of understanding for the scientifically literate individual is the noticeable effects of the motion of the earth and moon. It was knowledge of the patterns of celestial motion that provided the basis for much of the development of human understanding of more advanced concepts such as rotation, revolution, orbital mechanics, the universal theory of gravity and the speed of light.

The concentrating on an evident celestial movement in middle school education helps in making an association amongst apparent and actual heavenly movement. Finding out about the noticeable parts of celestial movement gives reason to take in the unobserved clarifications for these phenomena. In school, most instruction neglects to make the associations between the watched movements in the sky and the found movement of the planets, sun and moon from a heliocentric point of view (outside of the earth-based

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viewpoint; Nussbaum, 1986). Instruction that basically concentrates on the heliocentric movements is not just improbable to enhance knowledge of geocentric movement; it might

Likewise encourage students in making alternative thoughts regarding celestial object andtheir movement. (Nussbaum, 1986)

If students have a clear knowledge of the patterns of celestial motion, they will have a reason to learn about the heliocentric motions of these celestial objects in a context in which the underlying cause of motion can be explained using evidence from our observations. Once students are familiar with the rising and setting motions of the sun, moon and stars they will have a reason to understand the rotation of the earth. If students have learned that the moon rises later everyday they will have a reason to try to understand the orbit of the moon.

Finding out about the apparent movement of the sun may likewise help students comprehend other critical subjects, for example, the seasons and phases of the moon. The seasons are the result of the earth's tilted axis with respect to its orbit around the earth. This concept is too challenging to expect elementary students to fully master. However, the important effects of the earth's tilt that result in the seasonal change are those that are less abstract: the changing altitude of the sun and the length of the sun's path. If students first learn about how the changes in the sun's path affect the seasons they may find understanding the full explanation of the seasons more accessible, though further research needs to be done to confirm this idea. Similarly, learning the observable pattern of the change in the phases of the moon may help students later learn how to explain these patterns.

Both the National Science Education Standards (NSES; National Research Council, 1996) and the Benchmarks for Science Literacy (Benchmarks; AAAS, 1993) incorporate the examples of celestial movement as a major aspect of the learning objectives for students in early grade school. For the K-4 grade levels, the accompanying space science objectives are recorded in the NSES: 1. The sun, moon, stars, mists, fowls, and planes all have properties, areas, and developments that can be watched and depicted. 2. Objects in the sky have way of movement. The sun, for instance, seems to move over the sky, similarly, consistently, yet its way changes gradually over the seasons. The moon moves over the sky once a day much like the sun. The observable shape of the moon changes from everyday in a cycle that lasts about a month.

Both objectives relate to observations of the sky from an earth-based perspective. These concepts are also recommended for study at this early age in Benchmarks:

1. The sun can be seen just in the daytime, however the moon can be seen at times during the evening and once in a while amid the day.

2. The sun, moon, and stars all seem to move gradually over the sky. (Grades K-2)

3. The moon looks somewhat changed each day however has a striking resemblance again about like four weeks. (Grades K-2) 3. The patterns of stars in the sky remain the same, in spite of the fact that they seem to move over the sky daily and distinctive stars can be seen in various seasons. (Grades 3-5)

These recommendations for early elementary students focus solely on changes in the sky that are observable and not the explanations for these motions.

Sample

The sample consisted of 72 students of 8th class from two Kendriya Vidyalaya in NCT of Delhi. These schools are run by Central Government under the Ministry of Human Resource Development, Government of India. These schools are rated high in hierarchy of government

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school system and are therefore assured good infrastructure, adequate and well qualified staff.

2. METHODOLOGY

Students' idea and knowledge about moon like rising and setting time, place and phases of moon was collected through pre-test post-test design. The simple and open ended items were included in the test and we expected that working through these tests might motivate students to observe and think beyond their textbooks. The students received standard, textbook-based instruction by their regular science teacher on moon related concepts as an intervention.

Results and Analysis - I

The understanding of conceptions related to the moon like phases of the moon, requires one to know the facts related to change in direction, time and position of rising and setting of the moon. Equally important is to access the students' understanding of the pattern of these changes. Based on the responses got from the interview carried out on students, the following aspects of understanding is assessed :

- Direction of Moonrise/set
- Shape of Moon
- Moon at daytime
- Occurrence of Lunar eclipse

- **Direction of Moonrise/set**

The students responses for direction of moon rise and moon set are summarized in Table 1. The percentage of correct responses reported for the direction of moonset is significantly lower than those for sunset. It is possible that the textbook representation and orientation are shaping the understanding of children. Which is also true of the temporal orientation perhaps they have noticed sunrise and sunset as it is more prominent than moonrise and moonset. Besides, the textbooks also mention the former but not the latter. Regarding changes in the timing of sunrise and sunset, the explanation is given in the geography textbook of lower classes, but changes in timings of the moon are not discussed in the textbook. This could be a reason why the percentages of correct responses for the changes in timings of moonset are lower than the percentage of correct responses for changes in timings of sunrise and sunset. The reason behind this can be either the drastic changes in timings of moon-rise and moon-set or more probably the importance of timings of moon-rise in predictions of several religious fasts. The students gave completely different answers: east, west, north or no fixed direction in response to the question on the direction of the moon.

Table 1: Students' responses on spatial and temporal ideas of moon

Direction of Moon sets		Pre Test	Post Test
1	Correct (West)	10%	11%
2	Incorrect	90%	89%
Ca	**you see Moon in sky every night**		
1	Yes	89%	89%
2	No	11%	11%

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	Setting time of moon remains same everyday or change		
1	Changes	15%	20%
2	Does not change	85%	80%

It is obvious that children are better informed about sunset and sunrise than they are about the motion of the moon and the timings thereof. This could be because of the rising and setting of the sun and daylight is critical to human functioning in ways that the motion of the moon is not.

Most of the students (95%) gave non scientific responses as they denied that direction of moon-rise and moon-set don't change. More often one observes the crescent moon on the Western horizon in the evening, when it is actually setting, but because it has become visible only after sunset, it may give an impression that the moon is rising in the West. All these incidents might have confused them in making a generalization on its appearance.

- **Shape of Moon**

Table 2: Students' responses on shape of moon

S.No.	**Elements**	**Pre Test Response**	**Post Test Response**
	Shape of Moon		
1	Sphere (scientific)	35%	40%
2	Circle (synthetic)	20%	18%
4	Plate (non-scientific)	15%	12%
	Does shape of Moon changes every night		
1	Yes	90%	92%
2	No	10%	8%

The following open ended questions is asked:

- What is the shape of the moon?
- Does the shape of the moon change every night?

This is an important prerequisite for the scientific understanding of phases of the moon and is, therefore, important to know if students are able to relate it to the illumination from the Sun. The scientifically correct answer was a solid sphere, 20% of the students gave a response like a ladoo, ball or just sphere. Other synthetic responses like a circle, a plate and ring were also given by students. 5% students drew different shapes like waxing crescent, waning crescent, waning gibbous, full moon. Responses like a plate, ring, circle etc. indicate that the student perceived the moon as two dimensional rather than three dimensional which becomes a major obstacle in their understanding of the moon phases and the concept of seeing the same phase of the moon every time. It might be the result of their daily experiences as they see moon in form of a plate. 90% of students accepted that the shape of the moon changes every night but no other clue got from their responses about sequence in shapes of the moon.

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- **Moon during daytime**

Table 3: Students responses on seeing of moon at daytime

Have you seen Moon in day time		**Pre Test**	**Post Test**
1	Yes	10%	8%
2	No	90%	92%

Students' observations were probed through deeper question on appearance of moon at daytime. 90% of the responses were in "No". Out of these 90%, 30% gave a description like "sometime early morning around 4 am we have seen the moon in the sky" and drawn a crescent shape. Maximum "No" from students depict that perhaps they still believe that the moon can be seen only during the night, while few have observed the moon when the sun is rising and setting. 10 % students clearly knew that the moon is visible during daytime and in response to the observed shape of moon drawn waxing and waning crescent, gibbous. Among these 10% students two students were those who consistently gave scientific responses to questions asked on earth. The above results obtained for the moon shows that students have little clarity on motion of moon in the sky, the only fact they are aware of is related to its shapes.

- **Occurrence of Lunar Eclipse**

Table 4: Students explanation of Lunar Eclipse

S.No.	**Elements**	**Pre Test**	**Post Test**
Figural Responses			
1	Showed Day /Night on Earth	10%	10%
2	Size Earth > Moon	05%	6%
3	Size Earth > Sun	10%	9%
4	No Response	75%	75%

The explanation for the occurrence of the lunar eclipse is asked from students as it is found as the most common explanation given by students for phases of moon cited in the literature. Students gave explanations along with figures. The two components of correct explanations are

- Scientifically correct arrangement: the sun, earth and moon in a straight line.
- The shadow of the earth falling on the moon.

15% of students' gave partially scientific responses like "koi kali cheez chaand ke saamne aa jaati hai", the arrangement was drawn correctly but the comparative sizes of the sun, earth and moon were not proportionate. Amongst the diagrammatic responses, the sun is drawn between earth and the moon, the size of the sun was drawn smaller than earth and in some cases even smaller than the moon. Responses show that students lack the shadow component for the occurrence of the lunar eclipse. Non-scientific responses included wrong

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positioning of sun, earth and the moon, mentioning the coming of the moon near to the sun as one of the cause. The maximum number of students (75%) left this question unattempted. It could be possible that either student were unaware of this term or could not recall the idea related to the phenomena. Even those who gave partially scientific response didn't think through the concept of formation of shadow and its relation to the size of the object.

A close examination of responses of students revealed that students were best able to give scientific and partial description of sun related concepts, followed by earth related concepts. Moon related phenomena showed least sophisticated understanding in the student responses. On the basis of the responses got from the students three categories were made: 1. Scientific 2.Partially Scientific or Synthetic 3.Nonscientific

Table 5: Students overall responses to concepts related to Moon

Concept	**Category**		
	Scientific	**Synthetic**	**Non Scientific**
Moon and its motion			
(a) Shape of moon	**35%**	**30%**	**35%**
(b) Direction of moon set	**10%**	**-**	**90%**
(c) Moon at day time	**10%**	**10%**	**80%**
(d) Occurrence of lunar eclipse	**10%**	**35%**	**55%**

3. CONCLUSION

The minute differences in pre- test and post- test scores of students indicates that solid learning experiences are required to be involved in classroom teaching that are close to their day to day life and interconnected and exhibited within a common setting. Harlen (2010) also characterise such concepts as big ideas. The understanding of this big idea requires the ability to explain the apparent motion of sun, earth, moon and stars without recourse to the personal observation of these phenomena. These abilities help in further explanation of how the motion of earth and moon around the sun is related to the complex concept of phases of the moon. Therefore it seemed important for science teacher to assess a student's initial and spontaneous perception of moon and to explore its relationship to a scientific understanding of astronomical phenomena of phases in moon.

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