The Development of the Concepts related to the Earth, the Moon and the Sun among Children in Elementary Schools: A multi-Cross-Sectional Study

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Abstract

This project report is based on a study done to understand the " The development of the concepts related to the Earth, the Moon and the Sun among Children in Elementary Schools: A multi-Cross-Sectional Study ". This study shows primary level children's understanding of the size, implementation and comparative characteristics of the Sun, the Earth and the Moon. Children's brain development is a complex process. Children's conceptual development occurs through daily life experiences and society. In this study, we found the answers based on the life of children about the size of the Earth. This indicates that the Earth is round. While some children said that the 'earth is flat', 'the number of earths is two'. One of the Earths is round, which we see and the other is the plane on which we live. The concept is quite different from the concept of science. The impact of this result can be seen in the future. In order to realize a better vision, it is necessary to strengthen the foundation of the country, it is necessary that positive steps should be taken by the education system of India to give the right direction to the children.

Keywords- Science Education; Concepts Learning; Learning by Experience

Introduction

Science is learning of nature and, its cause and effect on it. Science is a great step towards investigation, observation, finding, interpretation, conclusion, and generalization related to the body of knowledge in a systematic and logical way. Human is always, curious about its process

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and product, try to discover the truth, which remained hidden, till yet. But it is not easier to understand by simple reading and writing. We need to elaborate it's in the systematic, logical and sequential way in the term of facts, concepts, principle, theory, and law. Our thinking processes construct this information in the form of knowledge. These terms are used in an educational institution in the form of formal education. These formal educations are far away from some people; still, they have knowledge about it. The learning starts in the children as they go and learn science in their own mindset, beyond the textbook. In starting, children have their own "world of science". where their concept is built on the foundation of prior knowledge, attitude, the goal of learner, family, society, rituals, custom, poem and story taught by elders as well as self-life experiences. Children view scientific information based on their own paradigm of mysterious, imaginary or real thinking. After the continuous educational development with intellectual, psychological, psychic, social, spiritual, and physical children learn science beside less misconception. In earlier, understanding of nature and its phenomena are mysterious for the human being. They try to solve the problem arises in them around about the inside and outside the earth. People collect the information by observation, discussion, experimentation, and their own experiences. The collected information makes some pseudo concepts among the people. This pseudo concept leads to the development of scientific query among philosophers. Society governs by leading philosophers of that ancient time. The scientific discovery and globalization help in the development and nourishment of young children to creative thinking beyond the race, caste, religion, region, gender, etc. However, there are still many questions, which help in the understanding of how the concepts are structure in the mind of young children.

The objectives of the study

The aim of the field-based study in this project report was as given below:

1. To investigate the development of the concepts related to the Earth, the Moon and the Sun among Children in Elementary Schools.
2. To investigate the relative shape and size related to the Earth, the Moon and the Sun among Children in Elementary Schools.
3. To investigate the relative orientation related to the Earth, the Moon and the Sun among Children in Elementary Schools.
4. To understand how the children locate people or things on the Earth, the Moon and the Sun.

Review of Literature

Nussbaum and Novak (1976) in this study found that the children held five concepts about the Earth. These are a) earth is round, b) earth is round like ball, c) objects at the bottom of the earth would fall down into the space, d) the object at the bottom of the earth do not fall in space, e) the object at the bottom of the earth do not fall in space due to gravity. Nussbaum's (1979) study states that earth was like a huge ball consisting of two hemispheres; an upper hemisphere made up of "air" or "sky" and a lower hemisphere consisting of the ground where people live. Seider and Pulos (1983) conclude that most of the children in their sample who were 10 years of age held concept a), b) and, c) that most of the children 13 and over held notions d) and e). Mali Hawe (1979) conclude that Nepali children showed earth concepts similar to the American children but that they tended to occur at a later age.

Vosniadou and Brewer (1989) found that in their research that children have tremendous surface inconsistency related to concepts of the Earth's shape. In terms of children's responses, 99 % of the children said that the shape of the earth is either a circle or round, but only 63% of those said that the Earth does not have and end. Finally, they argue that children form a naïve concept of the earth, according to which the earth is flat. Vosniadou and Brewer (1990) conclude that American children and (85% and 90% for third and fifth grade) and Greek (60% for the kindergarten and 86.6% for third and fifth grade) understand that the earth shape is round. The Greek sixth-graders chosen the word "sphere" (43.3%), which was not used much by the American fifth-grade children (only 5%), they said that earth shape is a circle (70%). In this research, children concept related to earth's rotation around axis and revolves around the sun. the Greek children say that the sun is behind the mountains, the clouds, or the sea, while the American children were more likely to say that Sun is "west" of down underneath the earth. In both, the Greek and American samples, the younger children understand that the earth to be flat rather than spherical.

Research Methodology

Sample

In this field-based study, the researcher takes three group students. The participant for this project report were 35 students, 2nd, 4th, and 6th class. The sample of the study came from CIE Experimental Basic School, Department of Education, Delhi and Virendra Public School, Delhi,

India. The sample students came from the middle-class and lower-middle-class background, in which 17 were girls and 18 boys. The participants were range in age from 4 years to 12 years (Mean-8.83, Median- 9, Mode-9, SD-2.12 year)

Research Design

The research was of descriptive survey design. The questionnaire and drawing activity was used to check the thinking and mental image of the children. Participant's responses were in both the qualitative and the quantitative manner. The children are free to show their conceptual understanding of the Earth, the Moon, and the Sun.

Measures

The researcher examined the development of the concepts related to the Earth, the Moon and the Sun. The questionnaire was developed through an extensive pilot study. The questionnaire contained factual and mental construction-based questions. The questions provide proper chance to the children for exploration of knowledge on the answer sheet and drawing sheet (A4).

Procedure

The researcher took an interview in the library room in the school premises. The interview duration approximately 30 to 35 minutes with each child. The researcher made detailed notes of the participant's responses, which were also recorded using audio-recorder. At the beginning of each interview, the researcher explained that this was not a test and that he/she was only interested in what they understand about the same things he/she wanted to ask. The researcher encourages the participants by saying "Haa Haa", "you were saying something" when children did not know the answer. In the rapport-building stage, the researcher started with a general question related to day and night "What is the difference between day and night?" The follow-up questions were used during the children's responses, which we could not see the same as children.

Data presentation and analysis

The student responses to the question “Where does the sun go at night?”

Table 4.1.1 percentage of the student responses

Sl. No.	Responses	Classes			Total	%
		2	4	6		
1	Do not know.	0	2	0	2	5.71
2	The sun hides behind the moon.	0	1	1	2	5.71
3	They drown in the river or sea.	0	1	1	2	5.71
4	Go to the sky in their house.	1	0	0	1	2.86
5	Going into the cloud (inside / back / up) is hidden.	**6**	**5**	**2**	**13**	37.1
6	The Sun remains constant in one place (goes to London/Another side of the earth due to rotation).	0	2	8	10	28.6
7	The sun hides behind the mountains.	4	0	0	4	11.4
8	At night the sun changes to the moon.	1	0	0	1	2.86
	Total	12	11	12	35	100

Table 4.1.2 percentage of the student responses

Sl. No.	Responses (No. of students)	2nd Class		4th Class		6th Class		Total	%
		12	%	11	%	12	%	35	
1	Do not know.	0	0	2	18	0	0	2	5.71
2	They go somewhere	0	0	1	9.1	1	8.33	2	5.71
3	They drown in the river or sea.	0	0	1	9.1	1	8.33	2	5.71
4	Go to the sky in their house.	1	8.33	0	0	0	0	1	2.86
5	Going into the cloud (inside / back / up) is hidden.	6	50	5	45	2	16.7	13	37.1
6	The Sun remains constant in one place (goes to London/ Another side of the earth).	**0**	**0**	**2**	**18**	**8**	**66.7**	**10**	**28.6**
7	The sun hides behind the mountains.	4	33.3	0	0	0	0	4	11.4
8	At night the sun changes to the moon.	1	8.33	0	0	0	0	1	2.86
	Total	12	12.5	11	13	12	12.5	35	12.5

Table 4.1. A total of 32 responses were received from the students of class 2, 4 and 6 in response to question number 1, in which many students gave similar answers. Serial number 6 shows that students understanding "Where does the Sun go at night?" is developing. This fact is confirmed by the fact that 0% of class 2, 18% of class 4, and 66.7% of class 4 students believed that the Earth is stationary at a certain place. Because of the rotation of the Earth, the Sun Does not appear at night.

Table 4.2.

The student responses to the question “Why do not the moon and stars appear in the day?”

Sl. No.	Responses	Classes			Total	%
		2	4	6		
1	They go and hide somewhere.	1	2	0	3	8.57
2	Looks a little bit.	0	1	0	1	2.86
3	Go to the sky in their house.	2	0	0	2	5.71
4	Going into the cloud (inside / back / up) is hidden.	4	0	0	4	11.4
5	**The moon and stars are not visible due to the high sunlight.**	**2**	**4**	**8**	**14**	**40**
6	Goes to another world (in London).	0	2	0	2	5.71
7	Not seen because of the rotation of the earth.	1	1	3	5	14.3
8	They hide in space.	0	0	1	1	2.86
9	The Moon and stars hide behind the Sun	1	1	0	2	5.71
10	The moon and the stars hide behind the black hills.	1	0	0	1	2.86
	Total	12	11	12	35	100

Table 4.2. Shows the students' initial concept about the question "Why don't the moon and the stars appear in the day?" Is based on the imaginings of rhymes and stories. Most of the class 2 students responded that the moon and stars do not appear due to "being hidden (inside / behind / above) in the cloud". Students are taught in the early times through stories and poems at home by parents and teachers in school. These stories and poems give a glimpse of the culture and civilization of the society. According to a class 2 student, "old Amma lives on the moon, cleansing, we see that she is sitting with a broom". Similarly, according to a student of class 4, "The full moon is seen only on the night of the festival and fast, half-moon is seen on the night when festival and fast is not". According to a class 2 student, "The moon and stars go to sleep in their house behind the change in the day". A student of class 4 said that "The moon and stars are in the sky, but the

light does not cause trouble to the people". It is clear that school, home, and the surrounding environment have an effect on the student's learning. It has been proved in research that learning not only depends on heredity but also on the economic, social, cultural, spiritual, and scientific environment. Serial number 5 shows how the exact concept is developing in the students. Serial number 4 indicates that students' misconceptions are decreasing as the level of academic development increases.

Table 4.3

The student responses to the question “the Sun, the Moon, the stars and the Earth are shown in decreasing order (made)?”

Sl. No.	Responses	Classes			Total	%
		2	4	6		
1	S, E, St, M,	2	0	0	2	5.71
2	S, M, E, St,	1	1	3	5	14.3
3	S, M, St, E	2	0	0	2	5.71
4	E, S, M, St	5	8	1	14	40
5	E, M, S, St	2	0	1	3	8.57
6	S, E, M, St	0	2	2	4	11.4
7	St, S, M, E	0	0	2	2	5.71
8	E, St, S, M	0	0	1	1	2.86
9	**St, S, E, M**	**0**	**0**	**2**	**2**	**5.71**
	Total	12	11	12	35	100

S-Sun, E-Earth, M-Moon, St-Star

Table 4.3. Shows the answer to question number 4 by the students. Astronomical bodies look quite small due to their distance from the Earth. On the response sheet, the students drew pictures of the sun, moon, earth, and stars. The size of the stars and moon in these paintings were smaller than that of the Sun and Earth. Serial number 6 shows that the students of classes 2 and 4 have described the earth as larger than the sun. With the mental structure and physical development and growth of students, their thinking gets expanded. However, at this academic level, students' conceptual

understanding of the sun, moon, earth, and star is still in a dilemma. Only two students of class 4 have given the correct response.

Table 4.4.

The student responses to the follow-up question No.10, "which one of them rotates?"

Sl. No.	Responses (No. of students)	2nd Class		4th Class		6th Class		Total	%
		12	%	11	%	12	%	35	
1	The Sun	3	25	5	45	2	16.7	10	28.6
2	The Moon	2	16.7	6	55	10	83.3	18	51.4
3	**The Earth**	**8**	**66.7**	**10**	**91**	**12**	**100**	**30**	**85.7**
4	Stars	4	33.3	2	18	4	33.3	10	28.6
	Total (28)	17	35.4	23	52	28	58.3	68	60.7

Table 4.4. Children observe natural phenomena in normal life. It is very interesting and wonderful for children to see the sun moving from one direction to another. It seems true for the children to move around the Earth, that the Earth is stable and the Sun is revolving around it. The authenticity of this is based on interview-based data that 25% of the students of class 2 believe that the sun revolves around the earth. Conceptual understanding of students increases with educational development, 66.7% of class 2, 91% of class 4, and 100% of class 6 students believe that the Earth rotates. Serial numbers 2 and 3 show how the conceptual understanding of the Sun, Earth, Moon, and stars developing. The increase in the percentage of students 'reactions to the Moon and Earth means that it exhibits a positive relationship between students' conceptual understanding and educational level.

Table 4.5

The student responses to the follow-up question No.10, "Who among the following has his own light?"

Sl. No.	Responses (No. of students)	2nd Class		4th Class		6th Class		Total	%
		12	%	11	%	12	%	35	
1	The Sun	12	100	11	100	12	100	35	100
2	**The Moon**	**7**	**58.3**	**10**	**91**	**5**	**41.7**	**22**	**62.9**
3	The Earth	4	33.3	2	18	3	25	9	25.7
4	Stars	11	91.7	9	82	8	66.7	28	80

Table 4. 5. The Sun is the main source of heat and light on Earth. The moon shines with the light of the sun. Students develop the basic concept of light based on their own experience and knowledge gained from other sources. Every shining thing that emits light makes it known to the students to be the sources of light. Normally students from class 2 to 4 are not able to evaluate with deep thinking thoughts in bright and non-luminous things. 91% of the students of class 4 believed that the moon has its own light, while only 41.7 % of the students of class 6 believed that the moon has its own light.

Table 4.6

The student responses to the question No.12, "What is the shape of the Earth?"

Sl. No.	Responses (No. of students)	2nd Class		4th Class		6th Class		Total	%
		12	%	11	%	12	%	35	
1	Round (like ball)	6	50	4	36	4	33.3	14	40
2	Plane	1	8.33	0	0	0	0	1	2.86
3	Hemispherical	3	25	6	55	4	33.3	13	37.1
4	wheel	1	8.33	0	0	1	8.33	2	5.71
5	oval	0	0	0	0	0	0	0	0
6	Dual (plane and round)	1	8.33	1	9.1	3	25	5	14.3
	Total	12	16.7	11	17	12	16.7	35	16.7

Table 4. 6. It shows in table that 50% of the class 2 students believe that the shape of the earth is round, based on the knowledge of elementary education. However, they have no clear explanation of "why the earth is round?" If the Earth is round, why do we see it flat? Whereas in-class 6 students, it was found that they are able to think comparatively in the flat surface and round shape of the earth. 25% of the students of class 6 believed that the Earth has two shapes, one that looks round and the other is the surface on which we live.

Table 4.7

The student responses to the question No.16, "Demonstrating plants and animals on the Earth"

Sl. No.	Responses (No. of students)	2nd Class		4th Class		6th Class		Total	%
		12	%	11	%	12	%	35	
1	Out of the earth.	1	8.33	0	0	0	0	1	2.86
2	**On the periphery of the Earth.**	**0**	**0**	**4**	**36**	**4**	**33.3**	**8**	**22.9**
3	Everywhere in the earth.	5	41.7	6	55	6	50	17	48.6
4	On the hemispherical surface inside the Earth.	4	33.3	1	9.1	2	16.7	7	20
5	Both inside and outside the Earth.	2	16.7	0	0	0	0	2	5.71
	Total	12	20	11	20	12	20	35	20

Table 4. 7. This shows how the students responded to question number 15 "Where do plants and animals live?" According to the data given above, 41.7% of class 2 students believe that tree-cloud and animals live everywhere inside the earth. Zero percentage of class 2 students believe that trees and plants live on the periphery of the earth. Whereas 33.3% of Class 6 students believe that trees plants and animals live on the periphery of the earth

Table 4.8.

The student responses to the question No.17, "Where are the stars, the Moon, and the Sun? (Inside or out of the Earth)"

Sl. No.	Responses (No. of students)	2nd Class		4th Class		6th Class		Total	%
		12	%	11	%	12	%	35	
1	**Out of the earth.**	**7**	**58.3**	**8**	**73**	**7**	**58.3**	**22**	**62.9**
2	On the periphery of the Earth.	1	8.33	0	0	1	8.33	2	5.71
3	Inside the earth.	3	25	2	18	2	16.7	7	20
4	Both inside and outside of the Earth	1	8.33	1	9.1	2	16.7	4	11.4
	Total	12	25	11	25	12	25	35	25

Table 4. 8 Earth is the habitat for humans, plants, and animals. The sun, moon, stars and other celestial bodies are seen away from the surface of the Earth when viewed in the open sky. According to recorded data, 25% of the students of class 2 have all these sun, moon, stars and other celestial bodies inside the earth. Whereas after passing continuous educational development, only 16.7% of the students of class 6 believe that the sun, moon, stars and other celestial bodies are inside the earth. Some students believe that those who look big and bright are outside the earth and those who look small are inside the earth. That is why a student made the sun and the earth outside the earth, while the star made the earth inside.

Table 4.9

The student responses to the follow-up question No.10, "how many the Sun, the Earth, the Moon, and stars around us?"

Sl. No.	The solar particle	Responses (No. of student)	2nd Class		4th Class		6th Class		Total	%
			12	%	11	%	12	%	35	
1	Number of the Sun	one	11	91.67	10	90.9	11	91.7	32	91.4
		more than one (E/W)	1	8.333	1	9.09	1	8.33	3	8.57
2	Number of the Earth	one	12	100	9	81.8	12	100	33	94.3
		more than one(4EWNS)	0	0	2	18.2	0	0	2	5.71
3	**Number of the Moon**	**one**	**2**	**16.67**	**7**	**63.6**	**11**	**91.7**	**20**	**57.1**
		more than one (2FH, 4)	**10**	**83.33**	**4**	**36.4**	**1**	**8.33**	**15**	**42.9**
4	Number of Stars	one		0		0	0	0	0	0
		Many	12	100	11	100	12	100	35	100

Table 4.9. Refers to the response given by the students to the follow-up question of question number 10. Students observe their surroundings. They think that the Earth is very big, Mumbai, Patna, America, London, Kashmiri Gate, it is all Earth. In this way, there will be a lot of earth; there will be around 60 while looking at the other side, the moon, the earth, and the sun look only one. There are some interesting answers to the question asked by the researcher in the interview, which shows the stage of that educational development -

About the Sun

Siva class 2, "Sun is two, one in the evening which looks like orange color and the other which looks yellow in other times"

Niharika class 4, "The sun is four, it rises in the east, west, north, and south".

Komal class 4, "The sun is visible in Delhi, Jaipur, Mumbai, Patna, Kolkata, Kashmiri Gate, along with it, so there will be at least 60 sun which gives light to all these places"

About the Earth

Rukshana class 4, "There is a lot of Earth in the world, one is in India, one is the Earth of the Sun, the Earth of the Alien, etc.".

About the moon

Sadhna class 4, "The moon is two, the night the women fast, the full moon is seen that night, and the night when it is not, the half-moon is seen."

Fabi class 2, "The moon is two, one half and the other full. They remain separate, one after the other."

Aadil class 2, "The moon is two, the half-moon is seen in the poems and the full moon is actually there."

Christina Class 4, "The moon is two, the full moon is visible at night and a half-moon is seen in the evening."

Avantika class 4, "The moon is two when the night begins it is round, at the end of the night it looks half".

Utkarsh class 4, "The full moon is visible on the full moon night and half the moon on other days."

Divya class 2, "The moon is two, the whole moon is seen when everyone works in the world, and half the moon is seen when we do no work in the middle of the night."

Rudra class 2, "The moon is two, the full moon is on the full moon night, and the half-moon is always visible, but the two do not appear together."

Kartikey class 4, "The moon is the same, half a moon is seen when there is a cloud in the sky, and when the cloud is removed, on a particular day, the full moon is seen."

Conclusion and Recommendation

Based on the data collected and interpreted by the researcher, it can be confirmed that students have information about the Sun, Earth, and Moon. Children get information about these celestial bodies from many sources such as mutual interaction among students, school, family, electronic media and film, newspapers, magazines, scientific articles and self-observation of events happening in the surrounding environment or their own by staying in the company of more knowledgeable people. Society, social customs, cultural beliefs, family environment, etc. affect this received information as external factors. Whereas the level of intelligence of the children, will power, reasoning ability, memory capacity, etc. are the internal factors that affect the information received.

A variety of curiosity and interest in the Sun, the Earth, Moon, Stars were found among children. From the data obtained, it can be said that the students of classes 2 and 4 think about the Sun's hypothesis that "the sun goes silent behind the clouds", "drowns in the sea", "falls asleep, in our home, in the sky". In the children's mind, there is a fantasy of an object about the Sun, which rotates from one place to another. While most of the students of class 4 after continuous academic development understand that the Sun is stable, the Sun does not appear at night due to the rotation of the Earth.

Similarly, it was found in the children about the understanding of the moon and the stars that most students of class 2 and 4 understand that "the moon and the stars hide behind the clouds in the day". Students of class 4 believe that the moon and stars are not visible due to the rotation of the earth. Therefore, it can be said that with continuous educational development, the process of developing a complete understanding of the moon and star in children is going on.

According to this received information, most of the students of class 2 and 4 consider the earth to be the largest. Students need to develop a rational understanding of the changes in distance and object shape. As students reach Class 4, the understanding of students is developing. Students are able to make connections between the distance and object shape. Planets and satellites revolve around the Sun, depending on which they are telling the Sun to be larger. But some understanding still needs to be developed in the shape of the planet (Earth) and satellite (moon).

The Earth rotates; students begin to understand it from the primary level. However, due to the sunrise in the east and sunset in the west, some misconception also arises in the students. Students say, "The sun revolves around the earth". Students are uncertain about the rotation of the star.

According to the data received, 28.6% of the students believe that both the Sun and the stars are orbiting the Earth.

All students from class 2 understand that the sun has its own light. There is light on the earth during the day, so some students believe that the earth has its own light. The moon reflects light from the sun towards the earth. In this way, the moon illuminates the earth. Children consider these lights as "the light of the moon". Students are taught in poems since childhood and are shown in textbooks that the moon shines. Due to this, misconceptions about moonlight develop in children.

It is reported, in children about the shape of the Earth that the Earth is round. But after this, when children are asked "How is the Earth round?", "Explain round", the children change their answer. Now children start explaining the earth as flat or hemispherical by not calling the earth as round. "Earth is like orange, half of which is land and half is sky" "We look round, we live in a circle".

Students represent creatures, animals, humans, trees and plants inside the Earth. Some students also built their school on the periphery of the Earth, in a response sheet. The Sun, the Earth, and the Moon were created by most students (62.9 %) outside of the "drawing of the Earth" on the paper. Some students (11.4 %) made it both inside and outside the Earth. Understanding the number of the Sun (91.4 %), the Earth (94.3%) and stars (100%) is satisfactory among the students. However, students have not developed an understanding of the actual number of the Moon due to the changing nature of the Moon.

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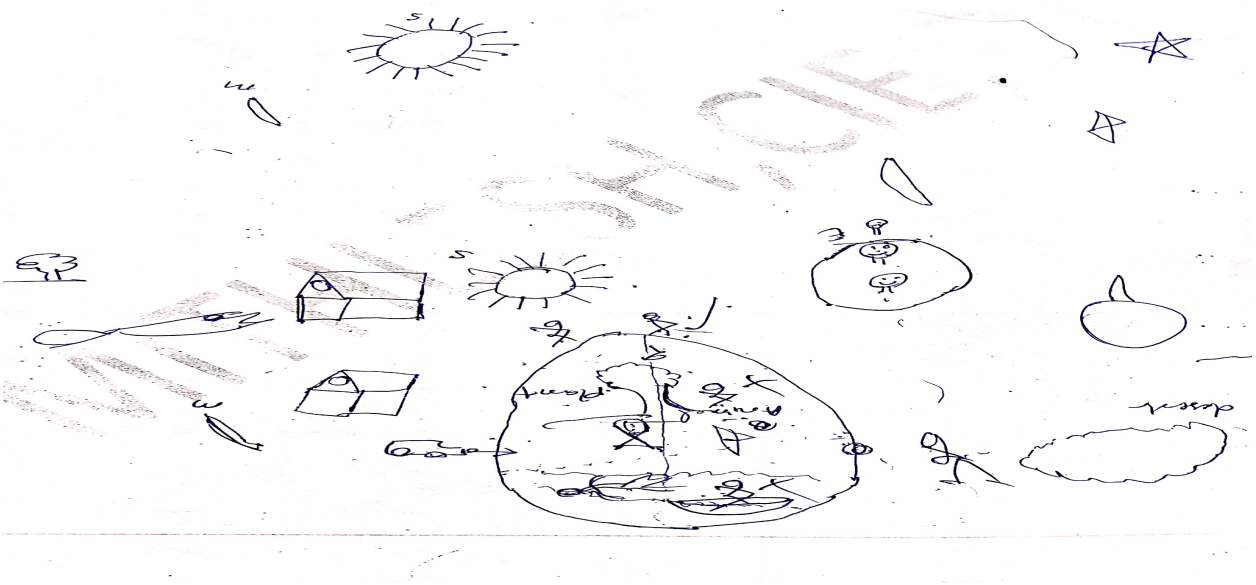
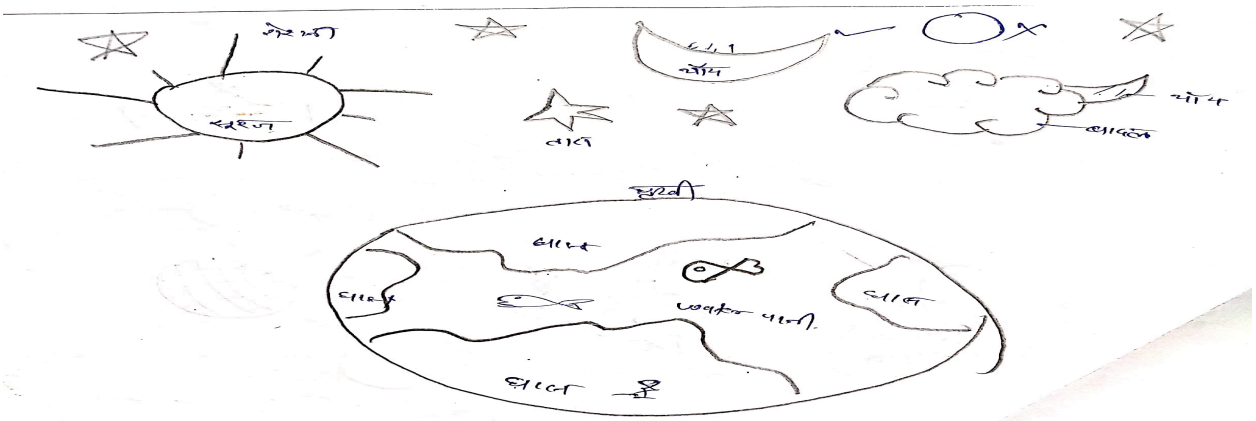
Appendix Students: Response Sheet

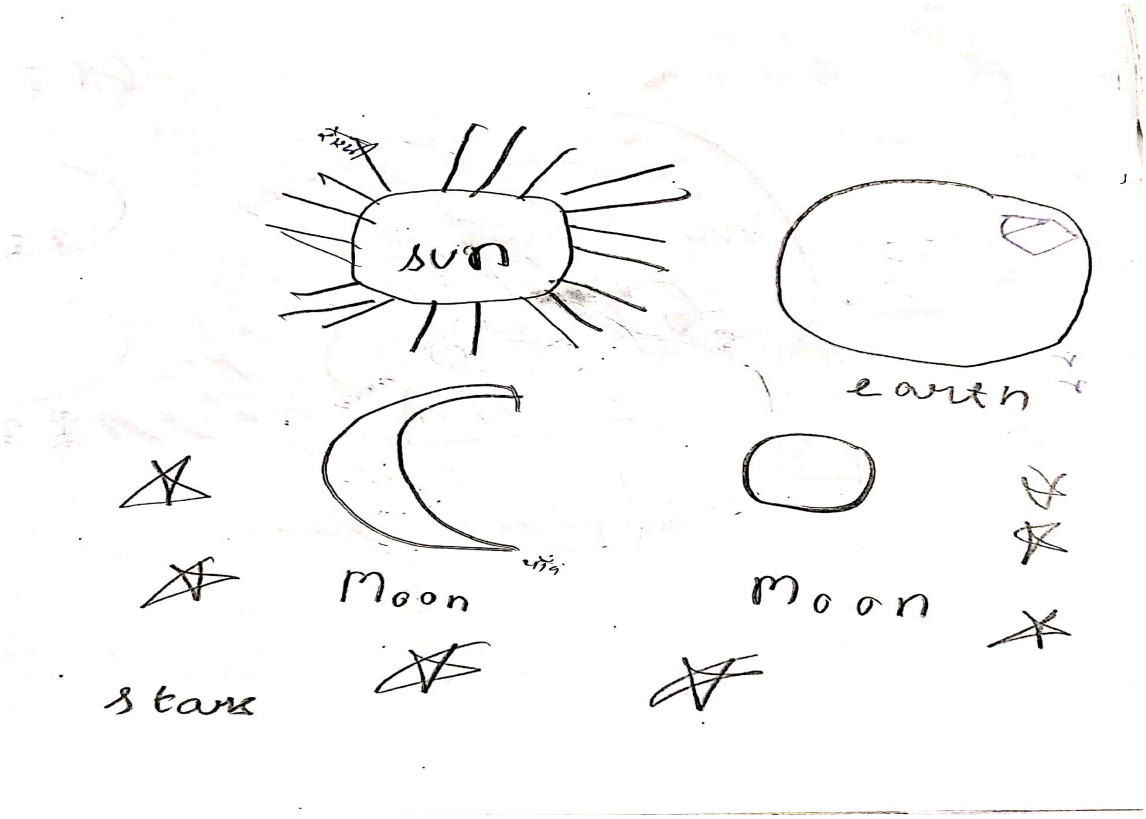
Student 1: response



Student 2: response

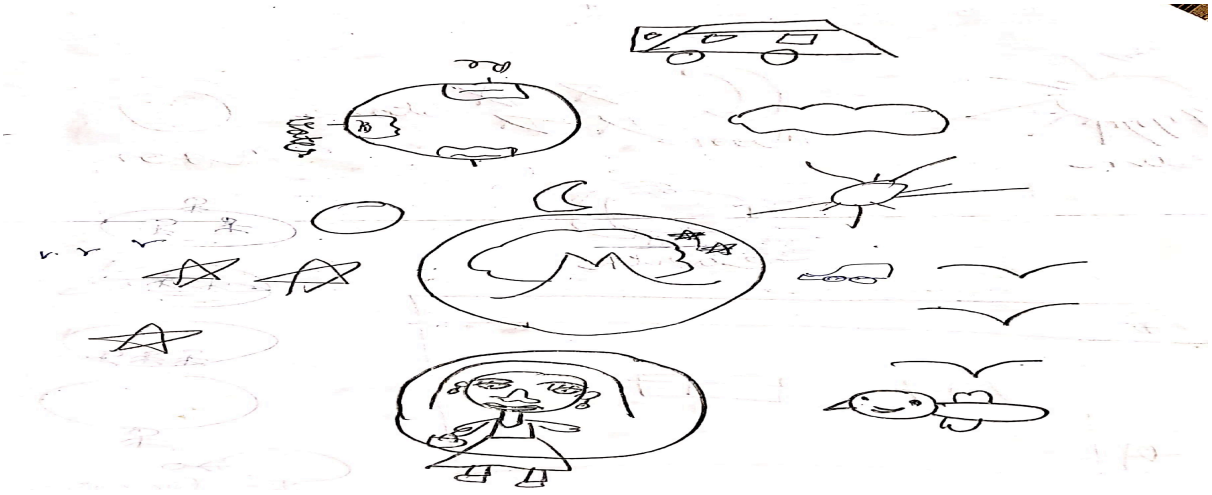


Student 3: response

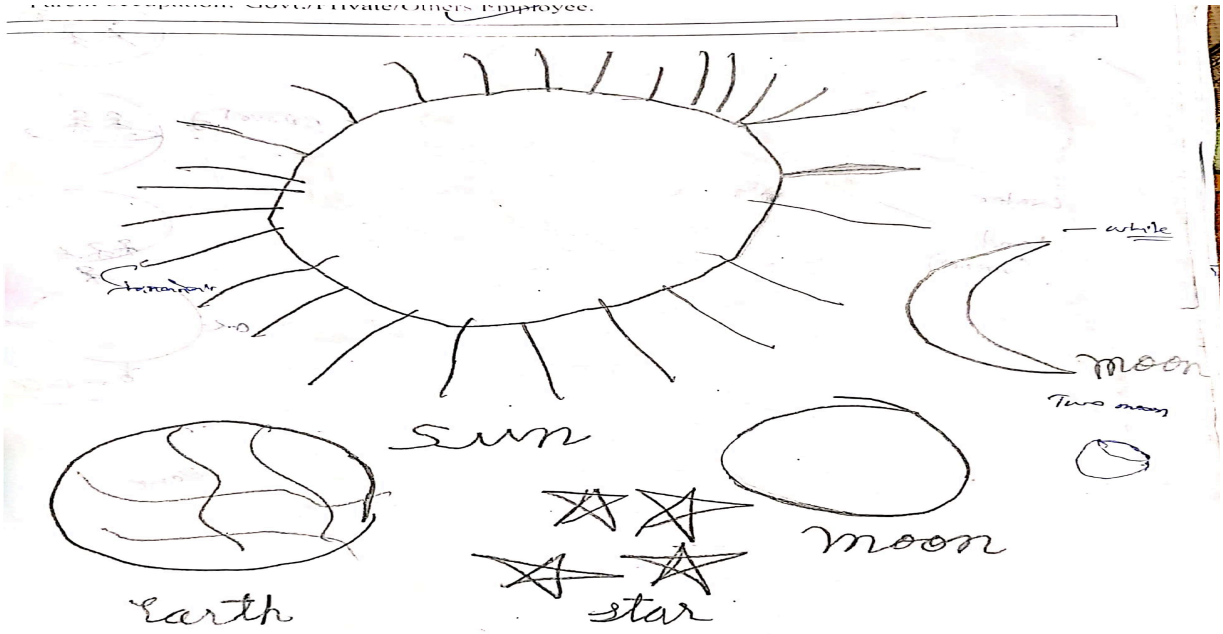


Student 4: response

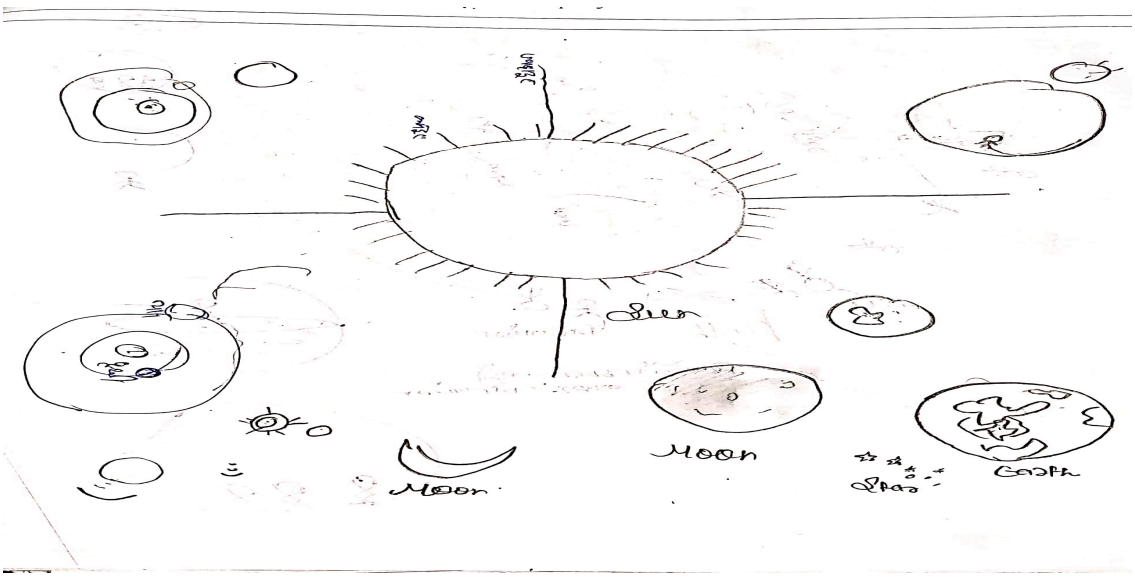
Student 5: response



Student 6: response



Student 7: response



Student 8: response