DRAFT

IMPACT OF CURRICULUM ON GEOGRAPHY LEARNING

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CHAPTER 1

THE DESIGN

BACKGROUND

During the course of our work at evolving an alternative curricular frame for social science at middle school level, we experimented with a number of geography chapters. One way of establishing meaningful links for children was to discuss geography concepts in a regional context. However, the other problem was to grapple with the comprehensibility of some of the geography chapters such as those dealing with earth's movement, latitude and longitude, air pressure belts, ocean currents, distribution of temperature etc.

In our own experience of trial and error, we modified the traditional chapters by elaborating on conceptual areas and tried this with both students and teachers. The torch and globe method could not be done very appropriately because of practical problems of a darkroom. Even then, the simultaneous movements of both rotation and revolution and the concept of 'tilt' posed as problems. The experience with teachers was not any better either. Visualisation of the process appeared to be rather weak. When senior geographers faced serious issues of communication and incomprehension, we could empathise with the teacher's situation.

We encountered similar problems with some draft chapters made on pressure belts. Physical geography concepts kept posing problems and challenges. The Science group had faced similar problems with 'atom' and 'molecule', solar system and chemical formulae. Issues of complexities, appropriate age of introduction of teachers' competence, were some of the issues which had been raised earlier. With this background, we decided to explore through a survey the impact of teaching some of these concept areas across a section of students.

PILOT SURVEY

We began our enquiry with a large set of geography concepts covered in middle school such as movement of earth, latitude and longitude, air pressure belts, ocean currents and tides, etc. We soon realised that the list was too long a fruit enterprise for investigation. Moreover, children were not seen to respond much to questions on pressure belts and ocean currents. Therefore in the second round we tried to focus on movements of earth and latitude and longitude as representative chapters of middle school where we could expect some response from children. We also decided to introduce two kinds of questions. The direct question was meant largely to test the recall of definitions and the other was an application kind where one could get an idea of children's understanding. To test out the questionnaire we conducted three tests -one in a rural government school, one in an urban public school and another at the college level. Many popular misconcepts were spotted during these rounds. In order to probe such situations, discussion with children was also introduced.

The major modification brought about in the questionnaire through pilot rounds were a) sensitivity of communication through language; b) diagrams and maps made more suitable c)

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multiple choice format of questionnaire. We also realised that the final survey should cut across a cross section of areas and schools. With such large coverage of students multiple-choice questionnaire was suitable for systematic mapping of the patterns. This multiple choice paper, a descriptive paper and discussion were decide as the final modes of enquiry.

SAMPLE DESIGN

There was a certain rationale by which the sample was chosen. There are many arguments generally put forward as to why concepts like earth's movements should be an important part of the school curriculum. The main arguments circle around the following assumptions: a) such concepts form the 'basis' of geography and hence they need to be introduced early in the school curriculum so that the understanding matures over time; b) teaching-learning problem has little to do with the nature of concepts but it is more a matter of lack of an atmosphere of diligent teaching; c) nowadays many students (specially urban) have a lot of outside exposure and hence they are able to grapple with these concepts. While designing the sample, we had such arguments in mind. The sample was cut out in a way that could enable us to check out such assumptions regarding status of teaching-learning. Hence it was necessary that our sample contain children of different age groups of different types of schools and of different areas.

Choice of schools

Classification of schools as good, average and poor were done on the basis of local reputation. Examination results could not be taken as a criterion for categorising school. Discussion with teachers revealed that reputation of schools at local levels is formed on the basis of teacher attention and regularity of teachers and students at schools, rather than on the basis of examination results. The latter, they feel can be a bad indicator because of prevalent cheating in examinations. Hence, we are not attributing any other factor other than diligence, in the selection of these schools. Therefore, good schools in any situation would be those with a local reputation of diligent functioning. In urban areas, some of the 'public' schools were part of the sample. Teacher's seemed the most reliable and convenient way of segregating a sample of schools in a local area.

Choice of area

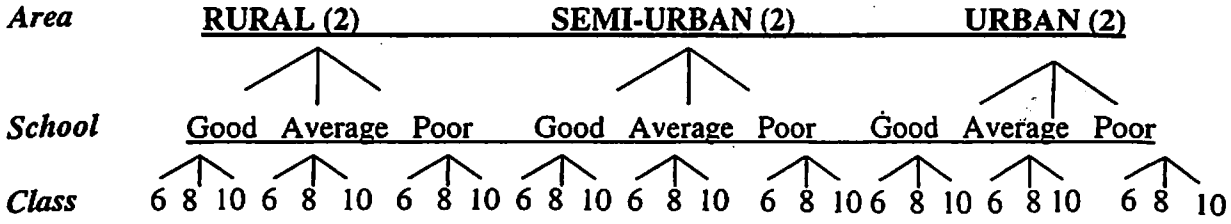
The choice of areas was based on our field area in M.P. But the criteria of urban, rural and semi-urban were followed as per the definitions of Census of India. We chose two rural clusters two semi-urban centres and two urban centres.

Choice of class

Within each school, we chose three classes, namely 6, 8 & 10. We kept to a minimum size of 30 students in each class and where that was not possible two classes had to be taken together so that for each class a minimum of 30 could be acquired, which is statistically considered a minimum size for analysis.

Selection process

The sample was designed in the following manner. We first chose two rural clusters, two semi-urban centres and two large urban centres. Within each area, we chose three different types of schools. Hence all together we had six areas and (6X3) 18 schools. In each school, we chose three sections i.e. classes 6, 8 and 10. Therefore, the entire sample consisted of (18X3) 54 sections. The entire structure could be visualised as follows:



College sample: For the purpose of reference and as point of contrast with the school students we had one sample each from the graduate and post-graduate levels. These two samples were from Indore city.

Limitaions

Using the method described above obtained a stratified sample so that the contrast between strata could be studied. However, the choice of schools in each cluster was purposive. That is within a shortlist of suggested schools we chose those that were most convenient. Since this is different from a random sampling procedure these results should be seen only as indicative of what we would expect to find in the over all population. It is more of a judgement sample than a strictly representative one.

QUESTIONNAIRE

Multiple choice

In the multiple-choice questionnaire we gave four options for each question. Children were asked to tick their choice. The options were formulated by picking up children's responses from the pilot rounds. The most popular responses were generally picked up and the apt answer was also included among the four options.

Since children are not familiar with the multiple-choice method of questionnaire, we provided a familiarisation sheet to start with. This contained pictures of some common themes along with four options. They had to identify the object depicted in the picture and tick the apt description. Entire class of children did this familiarisation exercise along with us. Then they proceeded to do the questionnaire. To make the situation as tension free as possible we always told the children that they were not to think of his exercise as an examination and that our objective was not to evaluate them. We believe that such communications helped to let children relax at least to a certain extent.

For each topic, we provided two or more questions. One was essentially a direct enquiry like

'what are latitudes and longitudes?' This demands only a response of definition. But others questions were more of an exploratory nature, for example, the uses of latitudes and longitudes.

Descriptive questionnaire

The enquiries of the descriptive paper were the same as that in the earlier paper. But instead of giving options to choose from, children were given space to draw and write. This questionnaire was given to only about one fifth of the children of each class. This exercise had the advantage provision for children's expression and at the same time, its evaluation in a qualitative framework could provide us with further explanations to the findings from the previous paper.

This questionnaire also followed the pattern of direct questions and exploratory questions (see appendix 2)

Discussions with Children

In all average schools we held a group discussion with children these children were essentially those who had attempted both the questionnaire. The discussions were audio recorded.

The multiple-choice questionnaire was answered by all students of each selected class - a total of 2033 students. A sub sample from this (nearby 1/5) answered the descriptive paper - i.e. 376 students. A smaller sub sample of students i.e. who had attempted both Paper 1 & 2, were called for the group discussion. Due to the large number of sections by the survey, we restricted this exercise to the average schools. In each discussion round, there were around 15 children. There were 9 groups in all.

CHAPTER 2

POPULAR NOTIONS

MAPPING THE CONFUSION

Right from the beginning of our survey, the prevalence of wrong notions among students on the movements of the earth (and associated processes) was seen. With a significant number of children having responded to our queries, the popularity of wrong notions is getting firmly established. What are the characteristics of the earth's movements and how do these cause processes like day and night and seasons on earth? What are the functions of graticules of latitudes and longitudes? These define the conceptual arena of our survey. At every juncture we find explanations of processes that stand quite apart from those that the school tries to impart. In this chapter, we map out these popular notions.

There are two main areas of focus that we try to call attention to. One is of wrong arguments that are extended in explanations of earth's movements (and of their consequences). The other is that crucial conceptual areas simply get lost and are not seen to be recorded in children's responses. These are actually two sides of the same coin. In this chapter we map out this scenario and also the strategies the system perpetuates in coping with achievements. Perhaps this is one of the most outstanding features brought out by the survey that requires an open perusal and dialogue on curricular impacts .

Our questionnaire was structured to have both direct and application queries. The former refers to simple questions such as what a concept means. Children had to select the most appropriate of four given options. The options were chosen from responses of children received through pilot surveys. These responses contained a number of common confusions. The application questions probed a higher ability to use the concept in a given situation. The distinction between two types of enquiry was maintained in the descriptive question paper too. While analysing the results, we would be using this distinction, wherever appropriate.

While looking at children's responses, we search for existence of patterns. If there is a general pattern and is this widespread i.e. is the pattern obtained at disaggregate levels also? In other words, do the various subgroups of the sample confirm to or go against the general pattern? Further, we look into what the patterns imply in terms of conceptual understanding.

POPULAR ERRORS

We first chalk out the most outstanding wrong notions students hold. One such popular notion deals with the way seasons are caused. It is largely believed that hot and cold seasons are fallouts of the earth being sometimes near the sun and of being sometimes away from it. Hence it is clearly an association made with the physical phenomenon of being placed near a hot body. Other two prominent notions are construed in the context of functions of latitude and longitude. These lines are believed to play the roles of representing temperature of places and also of finding out distances between places. These popular misconcepts are examined here.

DISTANCE FROM THE SUN

We had a direct kind of question on why seasons are caused. Whereas in one paper (multiple choice) children had to choose appropriately from given options, in another (descriptive) they were asked to explain the reasons too.

Q3 In December and January it is winter season here, but in April and May it is the summer season. This change of seasons takes place because:

Table 1: Responses to Q3

	OPTIONS	% STUDENTS
A	The earth revolves around the sun	20
B	The earth is tilted and it revolves around the sun. (Correct)	14
C	When the earth is near the sun, it is summer and when it is away from the sun, it is winter	46
D	The earth rotates on its axis	10
	Not attempted	10

It is seen that, 46% of students attribute the cause of seasons to varying distances of earth from the sun i.e. "when the earth is near the sun, it is summer and when it is away from the sun, it is winter" (see table 1).

Examining the situation at the subgroup levels, the pattern seems to get firmly established (see table 2). The most favoured option of every subgroup is C, implying a common-sense notion that when a body is close to a source of heat it will be warmer than when it is away from it.

Table 2 : Subgroup scenario of options B and C

SUBGROUP	% CHOOSING B	% CHOOSING C
Class 6	13	39
Class 8	11	54
Class 10	18	48
Good school	16	43
Urban school	23	45
Urban good school	26	38

Even at graduate level[1], students depict a similar pattern where 44% opted for this explanation and only 19% stated the correct reason. At postgraduation level we see a dramatic improvement with 60% of students choosing the correct option (B). This implies that the concept introduced at class 6 had to wait for a period of 10 years before bearing fruit!

The poor performance of a direct question, such as the above, even in the best of school situation is somewhat surprising. This suggests that even in the best of schools, the cause of seasons is at best learnt by rote. The most popular option (C) resembles a text book formula (though it is meaningless). This must have encouraged students to opt for it at first glance.

[1] The comparisons with college students is made on the basis of a small sample only. This includes 36 graduate and 30 postgraduate students.

The written responses too confirm this state of affairs. In some cases (elaborated below) there are references to the oval shape of the earth's orbit (as given in the text) which seem to assist a visualisation of varying distances of the earth from the sun. (We will come to this in the next chapter.)

Some responses of children are as follows:

"When the earth comes near the sun it is summer and when it goes away from the sun it is winter."

"पृथ्वी अपनी धुरी पर झुकी होकर सूर्य का चक्कर लगाती है। वह अण्डाकार रुप में चक्कर लगाती है। जब पृथ्वी पास आती है तो गर्मी , दूर जाती है तो ठण्ड होती है।" (The earth is tilted on its axis and goes around the sun. It makes circles in an oval form. When the earth comes close then it is hot, when it goes away then it is cold)

During discussions, some children gave an explanation as follows:

यहां की और यहां की दूरी सूर्य से नज़दीक है और इस साईड की लंबी और अधिक है। (see figure)

One child put it very explicitly as –

"हम सिगड़ी के पास बैठते है तो गर्मी होती है और दूर जाते हैं तो गर्मी कम हो जाती है।" (When we sit near a fire it feels hot and when we go further away from it then it feels less hot.)

Some other explanations are as:

"दिसंबर जनवरी में हमारे यहां ठण्ड, अप्रैल मई में गर्मी रहती है, क्योंकि पृथ्वी दिसंबर तथा जनवरी में थोड़ा नीचे जाती है तथा अप्रैल मई में ऊपर चली जाती है।" (It is cold here in December-January and hot in April-May because in December and January it goes a little lower and in April-May it goes a little up.)

"जब पृथ्वी सूर्य के मध्य में आती है तो गर्मी पड़ती है और जब मध्य से हट जाती है तब ठण्ड पडती है।" When the earth comes to the centre of the sun it becomes hot and when it goes away from the centre it becomes cold.)

This probably indicates visualisation of the earth as travelling to hotter and cooler areas marked out by the sun.

In explanation of the two seasons in different hemispheres, explanation follows a similar pattern i.e. of distance from sun:

"क्योंकि भारत सूर्य के सामने आता है तो आश्ट्रेलिया दूर रहता है। जब आश्ट्रेलिया सामने आता है तब भारत सूर्य से दूर रहता है। जब पृथ्वी सूर्य की परिकमा करती है तब एक तरफ से दूसरी तरफ होती है। जब आश्ट्रेलिया वाला भाग सूर्य के निकट होता है तो गर्मी होती है जब भारत सूर्य के निकट होता है तो गर्मी होती है।"

REPRESENTATION OF TEMPERATURE

Latitudes and longitudes are grids and as a combined grid system it helps in location of places on the globe. But individually too these sets of lines have some functions. Thus we have an association of longitudes with time and of latitudes with heat zones of the earth. We tried to explore children's understanding of these associations. Their responses reveal that a very prominent notion held is that these lines (both latitude and longitude) are used in calculation of temperature.

The use of longitudes is explored in Q8. Children's responses are presented below:

Table 3 : Responses to Q8

The north-south lines seen in the above map are used to	Responses (%)
Calculate temperature	43
Calculate time	20
Show roads and railway lines	15
Calculate the amount of rainfall	12
Not attempted	10

As can be seen (from table 3) the most favoured option is that these lines are used to calculate temperature.

Similarly for Q 9 which explores uses of latitudes, we find that temperature calculation is again the most favoured choice (see table 4). It is also to be noticed that in both the questions the percentage of correct answers does not exceed 30.

Table 4: Responses to Q9

Options	The east-west lines seen in the given map are used to	Responses (%)
A	Show roads and railway lines	14
B	Calculate time	13
C	Calculate exact temperature of places	30
D	To get an idea of the climate in various parts of the world	29
	Not attempted	14

Is the confusion with temperature widespread i.e. do various subgroups show the same trend? By examining the various subgroups, we see the following patterns (see table 5):

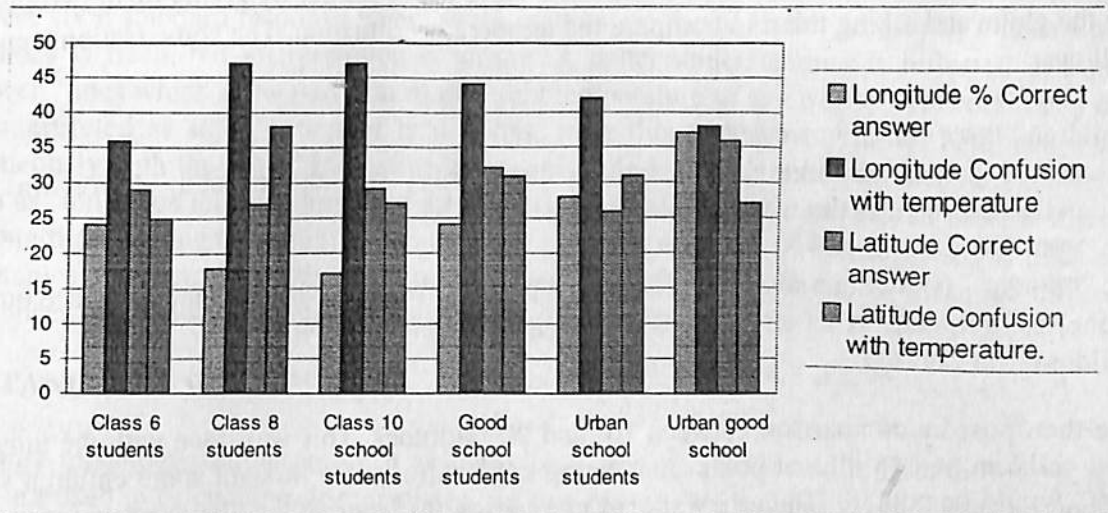
1.All subgroups record the popular notion of association with temperature. Hence this appears to be a deep area of wrong notions.

2. The status of correct answers (%) for most subgroups is similar to that of the overall sample. Some improvement is found in urban-good school where 37% have answered correctly. But even here a substantial proportion of children (65%) record the wrong notion. Thus, even in best situations students are largely unable to understand this concept.

3. It is only at the postgraduate level that we find a positive move towards right conceptualisation.

Table 5: Subgroup scenario of correct option and of popular confusion

subgroup	Longitude		Latitude	
	% Correct answer	% Conf. with temperature	% Correct answer	% Confusion with temperature
Class 6 students	24	36	29	25
Class 8 students	18	47	27	38
Class 10 school students	17	47	29	27
Good school students	24	44	32	31
Urban school students	28	42	26	31
Urban good school	37	38	36	27



Subgroup breakup of confused and correct answers

Even though postgraduation marks a positive departure, even here 23 to 40% students still linger in the area of confusion (see table 6). This is intriguing because this concept is relatively simple and the students we are referring to are of postgraduate levels.

Table 6 : Postgraduate scenario (% responses)

Concept	Correct Answer	Confusion with Temperature
Longitude	57	40
Latitude	67	23

The descriptive answers and discussion with children further confirm that the most prominent misunderstanding on use of latitude and longitude is of an association with temperature. It also reveals to us some of the root causes of such a notion. For instance there seems to be a fair amount of confusion with "degrees" of latitude and longitude and "degrees" of temperature measurement. Typical statements go as: "रेखाएं अलग–अलग तापमान बताती है" "imaginary lines used to calculate temperature in different regions", "artificial line used by scientist to indicate temperature and climate in certain area". Many children have explicitly stated this as"If Amritsar falls on 82° line, then it will have 82° temperature".

There are statements like" वैज्ञानिक इन रेखाओं से देश का तापमान ज्ञात करते हैं, मशीनों और अपनी समझ से।", "देशांतर रेखाओं से तापक्रम देखते हैं। हमें यह भी पता चलता है कि किसी गॉव या शहर का तापक्रम क्या है।" , "Show temperature by location of sun". Some guesswork goes as " यह भी मालुम करते हैं कि तापमान में गड़बड़ी तो नहीं है।"

In discussions with children, we tried to probe into the perceived of association with temperature. Some statement came out as "उत्तरी ध्रुव में गर्मी सबसे कम और दक्षिणी ध्रुव में सबसे ज़्यादा पड़ती है।"

In one case, latitude and longitude were shown to children on the globe. A place was pointed out to them as being 10^{O} latitude. Children responded that it meant that the temperature would be 10^{o} Celsius. In some such cases we tried to probe deeper by giving them two places on the globe and asking them to compare the temperature situation. The conversation went as follows:

Children " भूमध्य रेखा के पास कम ठंड है।"
(As noted earlier children had a certain familiarity with the equator. There was an understanding the it is the warmest place on earth.)
we "भूमध्य रेखा 0 अक्षांश पर है।"
we "यह जगह" (showing a place on globe) 10 डिग्री अक्षांश पर है और यह जगह (another place on the globe) 80 डिग्री अक्षांश पर है। इन दोनों में से कौन सी जगह पर ज्यादा ठंड होगी?"
children : 10 डिग्री पर।"

We then posed a comparison between 10^{o} and 90^{o} latitudes. This was done with the thought that children had an idea of polar areas being cold. After some thought some children said, "90^{O} would be colder". Then they started comparing 90^{O} with 80^{O}. Whereas some said that 80^{O} is colder, others insisted that 90^{O} is colder. The reason for the former was a textbook memorisation of " सूर्य की किरणें तिरछी हैं।"

It is true that slanting rays of the sun is a phenomenon that is more applicable to the higher latitudes. But in this case, the implication is different. Because children singled out 80o latitude as receiving slanting rays. The logic is not applied to 90^{o} latitude. Therefore we tried to focus on the coldness of polar areas.

we: पृथ्वी का ज्यादा ठंडा इलाका कहाँ है?
children: उत्तरी ध्रुव और दक्षिणी ध्रुव
we: और सबसे गर्म इलाका?
children: भूमध्य रेखा और आसपास
we: फिर 10 डिग्री पर ज्यादा ठंड होगी या 80 डिग्री अक्षांश पर?
Here they were forced to make equator (as warm area) and poles (as cold area) as points of reference).
children: 80 डिग्री अक्षांश पर"

It is to be noted that discussions like the one mentioned above were not feasible amongst sixth standard students. Such possibilities of dialogue were found at eighth and tenth standard levels. This was the nature of maturity that we could trace as we moved from smaller to bigger classes. The concepts were not clear but possibilities of exploration were definitely lying untapped or rather lying dormant (without normally receiving any opening for exposure and learning).

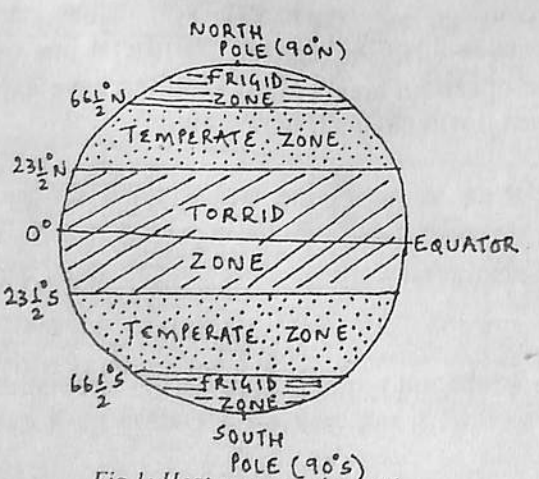


Fig 1: Heat zones on the earth

Longitude and latitude lines do not indicate temperature of different places as envisaged by children. Latitudes can definitely give us a broad indication of warmth across the earth. It is on this basis that we have heat zones.

It is interesting to note that this zonation has sometimes led children to give answers like "latitudes give us torrid and temperate zones. So they tell us temperature of places." This is a typical sixth standard response where these matters are found in the geography chapters and memory is fresh, but interpretation is wrong. A better understanding is reflected in a rare answer "lines which show partition of different temperature of the world". This definitely can be interpreted as some notion of heat zones, even though the association has been made erroneously with the 'lines' indicative of both latitude and longitude. Another rare answer is seen as 'longitude tells us climate of all countries". Here, it should have been latitude instead of longitude. Giving the benefit of doubt within the dim scenario of identification of lines and the names etc, and sieving through the responses to find some reflections, these are the only responses that show *some* interpretation in the right direction.

DISTANCE BETWEEN PLACES

Another misunderstanding amongst children on usage of latitude and longitude lines is that they are used in calculating distance between two places. We had not given this as an option in our multiple-choice question. But it has emerged as a popular notion through the descriptive papers and discussion with children. In most cases, the reasons given for such an association are quite vague and reach nowhere. E.g.: "Distance in degree can be found out" Sometimes responses were a jumble of terms. "जिस प्रकार पूर्व की दूरी 72 होती है। कर्क रेखा की सहायता से पता लगा सकते हैं।" This is a typical senior student's response (10th standard). Other expressions followed patterns like "जहाँ से रेखाएँ प्रारम्भ होती हैं वहाँ से दूरी लिखी जाती है अर्थात पता लगाया जाता है।" "रेखा पर किलो मीटर दर्शाता है। इससे हमें दूरी का पता चलता है।"

Within the notion of association with distance, there is a popular trend linking latitude and longitude with map scale. Children have a general idea that map is a source of indication of distances between places. Some children also have an idea that this function is performed by scale of a map. Its typical reflection is found in answers like "latitude and longitude are a type of scale". In explaining how latitude and longitude it used to find distance between places some responses are as : "from the scale given below, e.g. 1 cm = 100 km" "किसी भी स्थानों के बीच की दूरी का पता लगा सकते हैं क्योंकि ये रेखाएँ निकश्चत पैमाने के द्वारा नापी जाती हैं।"

Some persons held on to the fact that there is a distance of 111 km between any two latitudes. This key information seems to induce visualisation of calculation of distances between any two places. Of course the information on distance between latitude lines is factually correct. But it does not apply in this context. It was a case of children's search for some credible answer to the query.

Children do not seem to be aware that latitude and longitude lines have functions that are quite distinct and different from that of indicating distances between places. At the same time, responses to queries do not indicate any explanation on what exactly is the linkage between these lines and the map scale. Though it is not our main focus here, this is also indicative of lack of sufficient clarity amongst children on concepts like map-scale. Discussions with children have only drawn a blank. We do not find children going beyond levels of trends mentioned above. Further attempts at discussion had resulted in silence.

LOST CONCEPTS

With wrong notions being so widespread and well established, the major indication is that real and concepts of earth's movements are not being analysed or understood by learners.

Parallel paths are seen, i.e. one where the system (school) tries to impart knowledge on these topics and the other where a visualisation is built in quite fertile ways using logic of commonsense. Since the latter finds very few ways to hold hands with the former, the overlap between the two are very scarce. Moreover the overlaps seem to develop only in places where the commonsense notions can possibly be strengthened. Thus we find that very crucial conceptual areas like nature of earth's movements, earth's tilt and functions of latitude and longitude lines constantly remain out of children's range of visualisation. Here we examine this status.

MOVEMENTS OF THE EARTH

At any point of time, the earth is simultaneously performing a spinning and an orbital movement. The former describes a west to east movement on its axis i.e. what is generally called earth's "rotation". Its other movement is around the sun along an orbital plane and this is generally called earth's "revolution". Whereas a single spin takes 24 hours, a single movement around the sun takes a year. Broadly speaking, it is through the nature of the movements that we experience day and night on a 24-hour basis and seasonal cycles on an annual basis.

Our questionnaire enquired into causes of day and night and of seasons. A more exploratory query tried to look into direction of rotation. All these enquiries and discussion show that children overwhelmingly confuse the two movements of the earth. They are not able to differentiate between the two and the movement around the sun is the more prominent visualisation.

In the direct question on why day and night are caused (Q 1), half the entire sample have opted for the earth's movement around the sun (see table 7)

Table 7: Responses to Q1.

OPTIONS	OPTIONS	% STUDENTS
A	The earth circles the sun	50
B	The moon circles the earth	11
C	The earth rotates round its axis (Correct)	30
D	None of the above	4
	Not attempted	4

Only 30% of students have opted for earth's rotation on its axis, the correct option. This suggests that half the students are unable to distinguish between these two movements. The confusion appears to be quite pronounced.

When we check this trend with the data of the sub-groups, the pattern is sustained in most cases. It does not change as we move from class 6 to class 10. (Table 8) However the urban good school group indicates a somewhat different picture as the best subgroup.

Table 8 : Subgroup scenario

SUBGROUP	% CHOOSING A The earth circles the sun	% CHOOSING C The earth rotates round its axis
Class 6	46	25
Class 8	50	35
Class 10	56	30
Good school	47	33
Urban school	39	47
Urban good school	29	65

The Postgraduate sample is also different, however even there 23% of students have opted for 'revolution' as the cause for day and night. Hence we could say that at least 30 to 50 % of the students are clearly confusing the two movements.

The descriptive papers and the oral rounds gave us a chance to probe the visualisation of this entire process. The confusion appears to be deeper, since the earth's rotation nowhere emerges as a common realisation.

Some explanations are given below:
"पृथ्वी चक्कर लगाती है इसलिए दिन ओर रात हाते है" (Earth goes around. So day and night are caused.)
"सूर्य के परिकमा करने से दिन और रात होते हैं। जिस हिस्से में सूर्य की किरणें पड़ती हैं वहाँ पर दिन और जिस हिस्से में सूर्य की किरणें नहीं पड़ती वहाँ रात होती है।" (Day and night occur because of making a circuit around the sun. Where the sun's rays fall there is day and where they do not fall it is night.)
"जिस समय पृथ्वी सूर्य का चक्कर लगाती है तब दिन होता है। जब चक्कर लगाकर आगे बढ़ जाती है तब रात होती है।" (When the earth is making a round of the sun then it is day. When it moves on after making this round then night falls.)

This visualisation does not hold space for part of earth having day and part of it might. Moreover it appears as though earth moves over areas of "light" and "darkness" Even more intriguing is the visualisation that the earth has day when it is moving around the sin. It is at other times (when it is not moving around the sun) that night falls. Other responses like the one given below also has similar implications:

"रात होती है जब पृथ्वी सूर्य के सामने से हट जाती है।" (It is night when the earth moves away from the front of the sun.)
In another response, the role of a moving sun is also visualised which comes near the earth to provide light and hence the occurrence of day, that is,
"पृथ्वी अपनी जगह पर धूमती है और वह आधा चक्कर लगा लेती है तो रात होती हे। सूर्य घूमती हुई पृथ्वी की ओर आता है तब दिन होता है।" Here the revolution of the earth around the sun seems to have no existence. It is an earth-centric imagery.

Just as was seen in the context of seasons (elaborated earlier), some children held a notion that the distance between earth and sun causes day and night, e.g.:

"जब पृथ्वी धूमकर सूर्य के सामने आती है तब दिन होता है; और जब सूर्य से दूर हो जाती है तब रात होती है।" (When the earth circles and comes in front of the sun then it is day and when it goes away from the sun it is night.)

Here again parts of earth having of earth having day and parts having night cannot be explained.

In extreme rare cases we came across answers like:

"पृथ्वी सूर्य की परिकमा करते समय अपनी धुरी पर धूमती है एवं जब पृथ्वी का एक हिस्सा सूर्य के सामने होता है तो वहां दिन होता है।" (The earth rotates on its axis while circling the sun and when one part of the earth faces the sun then it is day there.) The above indicates the best obtained response where simultaneous movements are mentioned.

"पृथ्वी धूमती है इसलिए एक हिस्से पर दिन होता है तथा दूसरे हिस्से पर रात। यदि नहीं घूमती तो एक हिस्से पर दिन ही दिन रहता तथा दूसरे पर रात ही रात।" (The earth turns and that is why one part has day and the other night. If it did not turn then one part would only have day and the other part would only have night.)

Where the rotation is mentioned more explicit responses go like:

"पृथ्वी अपनी धूरी पर धूमती है। तब पृथ्वी के उपर वाले भाग मे दिन और नीचे वाले भाग में रात" (Earth rotates on its axis. Then the top part of the earth has day, the bottom part has night). Here instead of an east- west demarcation of day and night, a north- south one is visualised. This wrong notion gets examined in Q2:

Q2. This is Sheela's explanation of how day and night are caused - "When it is day in the northern part of the earth, all places in the southern part have night. Then the earth's position changes and all places in the northern part of the earth will then have night and all places in the southern part will have day". Sheela's statement is:

Table 9 : Responses to Q2

	Options	% Students
A	Correct	49
B	Incorrect (Correct Answer)	13
C	Partly correct	21
D	Correct for summer season	7
	Not attempted	10

The correct option (B) which rejects a north-south rotation of earth has been chosen by only 13% of all students (see table 9). Nearly half (49%) of the students agree with the wrong statement made by Sheila. This status becomes even more prominent if we add to this the responses to option A and C. All put together 70% of students wholly or partly support Shiela's statement.

Leaving apart the 13% who have correctly answered the large majority are unable to identify the direction of rotation of the earth, i.e. 87% of students are not aware that the earth rotates on a west to east direction.

Some of the descriptive answers reveal similar north south variations of day and night:

"जब पृथ्वी सूर्य की परिक्रमा करती है तो उत्तरी हिस्से में दिन होता है और दक्षिणी हिस्से में रात। जिस हिस्से पर सूर्य का प्रकाश पड़ेगा वहाँ ग्रीश्म ऋतु और जहाँ सूर्य का प्रकाश नहीं पड़ेगा वहाँ शीत ऋतु। यही कारण है।"

This is a classic case where both day and night and seasons are explained using earth's revolution. Here day and summer coincides like night and winter does.

Rotation and revolution is very much mixed up. Some such responses explain seasonal change as being due to:

"Revolution of earth from east to west."
"Revolution of earth's axis round the sun"

Children possibly remember some stated link between seasonal change and the revolution of the earth. These answers are not really true to what the text mentions but in trying to conjure up the movements of the earth such responses have resulted.

A similar response goes as "सूरज रहता है उसके चारों ओर रास्ते में पृथ्वी उसकी परिक्रमा करती है। चारों ओर घूमने से दिन रात होते हैं।"

It is surprising that even at college levels, similar confusions on earth's movements are seen. It is noted in the descriptive papers that large number of students do not explain rotation. References are made to axis and revolution with typical explanations like "those parts that face the sun will have day and those parts..."
….. "अपने अक्ष पर परिक्रमा करती है"
" अपनी धुरी पर परिक्रमा करती है और परिक्रमा करते समय जब ....."
"परिक्रमा 24 घंटे में पूरी कर लेती है।"
'जब घूमती हुई पीछे चली जाती है... ।"

EARTH'S TILT

The tilted nature of earth is one of the key factors that contribute to seasonal changes. For a tilted earth moving around the sun in the course of an year, any particular place on it receives varying amount of heat at different times of the annual journey. At some time of its journey, the northern part is tilted towards the sun and at other times, the southern part. In yet other times, it is the middle portions that face the sun more. Hence the quantum of heat received at those portions of the earth determines the season on *those parts* at that particular time of the year. Thus those months of the year when the northern hemisphere receives more heat, it is the northern summer (at that time it is the southern winter because of the less quantum of heat received there). As the earth moves ahead and its tilted position causes the southern hemisphere to receive greater quantum of heat, those months define the southern summer (and the northern winter).

Spring and autumn seasons are transition periods before the onset of summer and winter respectively. These coincide with that part of the earth's journey when the middle portions receive greatest quantum of heat.

As the earth moves around the sun in a year, it keeps simultaneously spinning around (on its axis) taking 24 hours for a single spin, i.e. we have day changing to night and night to day in a 24 hour cycle. Suppose the earth was not tilted, we would have had a standard 12-hour span of day and of night. But the tilt causes days to be longer at some time of the year and nights

to be longer at others. The summer months have longer days and the winter months have longer nights. Such varying lengths of day and night are not marked in areas around the equator, but in areas away from it. The situation becomes dramatic as one moves towards the poles culminating in six months of day (during summer) and six months of night (during winter) in the arctic and antarctic circles (see figure 2).

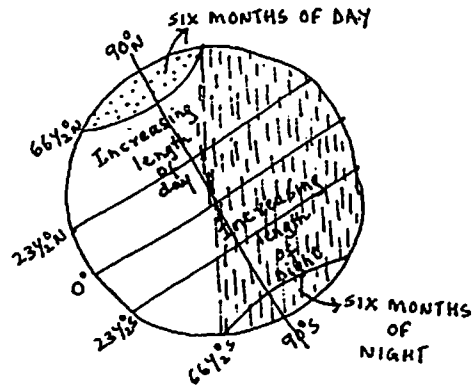


Fig. 2 Effect of tilt of earth on duration of days and nights

We had three queries that tested the concept of tilt of the earth. One was a direct question on how seasons are caused (Q 3) and the other two of the application variety (Q4 & 5). In the direct question (see table 1) only 14% of students think of a combination of revolution and the tilt of the earth as the cause for seasons. Hence notion of tilt, even in the form of rote, is rather low.

Looking at the subgroups (see table 2), tilt seems to identified by very few students, i.e. only 11% to 26% in any subgroup. The notion of tilt and its consequence is the least understood factor in the explanation of seasons. As explained earlier, only postgraduate sample shows some positive growth. But even here 23% still mention only revolution and tilt is not taken into count.

Secondly we examine the results of Q4 where a diagram of the tilted earth was given and students asked to demarcate that half of the earth which had night A person with an awareness of the tilt would opt for the choice of shade as shown in options B. The vertical line given indicates the line of illumination which does not coincide with the line of the axis. This recognition indicates an identification of the tilt factor.

Q4 Given below are four diagrams of earth and the sun. The shaded area shows night and the unshaded part show day. Which is the correct diagram that shows the occurrence of day and night?) We could summarise the results of the above as follows:

Table.10 : Demarcation of day and night areas

OPTION	INTERPRETATION	% STUDENTS
A, C & Not attempted	Clueless	38
B	Correct Answer	33
D	Confused as to which half is the correct representation	29

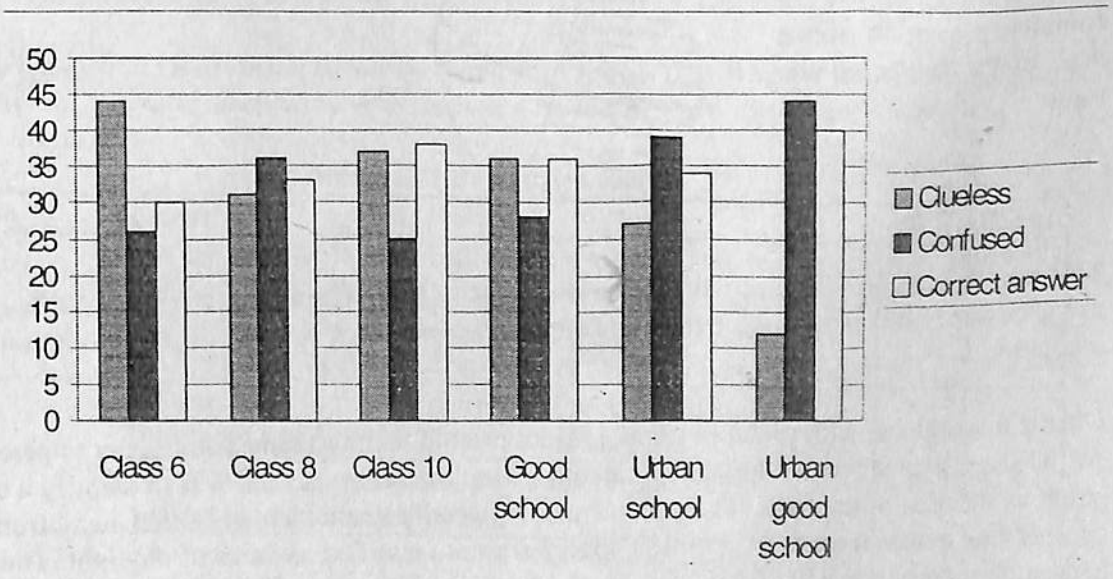
It is seen that 38% of students were either clueless or had not attempted this question (see table 10). The rest of students are equally divided between options B and D. Obviously, for anyone with bare subject familiarity, the choice trickles down to option B and D. There could be an element of guesswork involved because from these answers we cannot say that those who chose B have confidently ruled out D. In any case at least 67% of the students are unable to apply the concept of tilt. It is also to be noted that 20% of the students have not attempted this question. This marks a high level of non-attendance, i.e. in no other query is the percentage seen to move above 15.

Among the subgroups, almost one-third of the students are either clueless or have not attempted the question. The remaining students are divided between option B and D. Even in the better performing pockets such as class 10 or urban good school, not more than 40% have answered correctly (see table 11).

Table 11: subgroup scenario of day and night demarcation

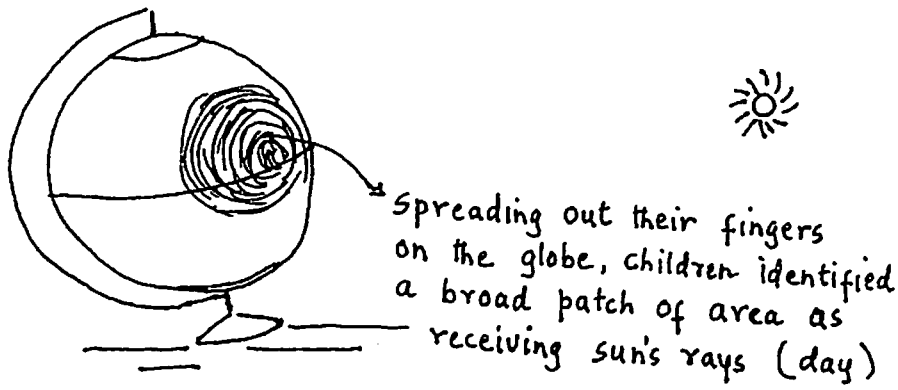
SUBGROUP	% CHOOSING A & C & NOT ATTEMPTED (Clueless)	% CHOOSING D (Confused as to which half)	% CHOOSING B (Correct answer)
Class 6	44	26	30
Class 8	31	36	33
Class 10	37	25	38
Good school	36	28	36
Urban school	27	39	34
Urban good school	12	44	40

The general picture therefore emerges that at least 2/3 of the students do not seem to think that tilt of the earth has a determining role in determining the day-night demarcation. Even at postgraduation only 56% of students are able to shade correctly.



In the descriptive paper, children were commonly found to demarcate a patch of darkness in areas away from the sun and daylight in areas facing the sun. These patches popularly followed an east-west pattern (See figure 3)

Fig. 3



Thus concept of a tilted earth do not seem to be understood. While shading the night areas on the diagram, the tilt was rightly identified only by few children from senior levels (10^{th}) as given to the left.

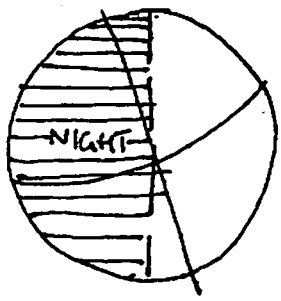


Fig. 4

When children were asked to express freely without the aid of four given options, they were commonly seen to shade it as in the figure on the right:

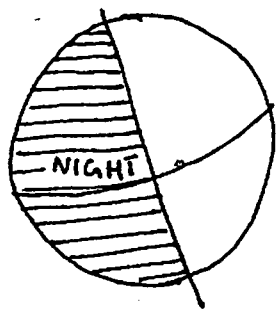


Fig. 5

This implies that all students who chose option B in the multiple choice (30 to 40 %) need not necessarily be conscious of the tilt factor. They may not be clear as to why option D is incorrect.

During discussions, with globe in hand, children found the third dimension easier to perceive. At the same time it became more realistically complex. What they did was to identify a broad patch as the area of daylight. The polar areas, especially that which was tilted away from the sun became constant areas of doubt. Those were not identified as areas of daylight. Thus we had patches on either side of the 'day area' on which children could not make up their minds of the possibility of daylight falling at any time.

Here is a typical conversation:
Q कहाँ–कहाँ दिन है? हाथ फैलाकर ग्लोब पर दिखाओ।
A: यहाँ दक्षिण अमेरिका में दिन।
Q: यहाँ पर क्या है, दिन या रात? (See figure 7)
A: रात।
Q: अब ग्लोब को घुमाते हुए वह भाग यहाँ आ गया है। अब यहाँ दिन है या रात? (See in fig 8)
A: रात।

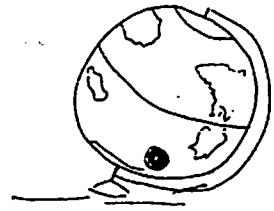


Fig.7

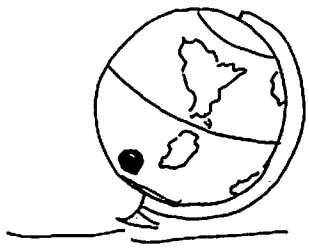


Fig. 8

Thus even after rotating the globe fully children could not visualise any change in day/night situations. Does the area always have night? They could not say much more. When the globe is placed in front of them, the tilt factor as well as the earth's curvature becomes very self –evident. It was only their simple observation from the globe that they were immediately expressing. The shaded polar areas (figure7) were a point of confusion. In which position will these areas get light? Question remained unanswered. They were totally unprepared for such concepts. No one anywhere even at 10th std showed any notion of six monthly day and night situations in polar areas. In the entire question posed to them (written and diagrammatic) such a factor could easily be kept on the background. But that could not be so here.

Another application question (Q 5) gave a statement on the different seasons in India and Australia along with picture of a globe indicating location of the two places. The reasons for both the places not having same season at any time of the year was probed into. The right option (of the multiple choices) was that these are in different hemispheres (north and south). The conceptual identification sought was of the difference in seasons in southern and northern hemispheres (the fallout of the tilt).

Q5 : Look at India and Australia on the picture of the globe. When it is winter in India, it is summer in Australia and when it is summer in India, it is winter in Australia. This happens because:

Table 12 : Responses to Q5

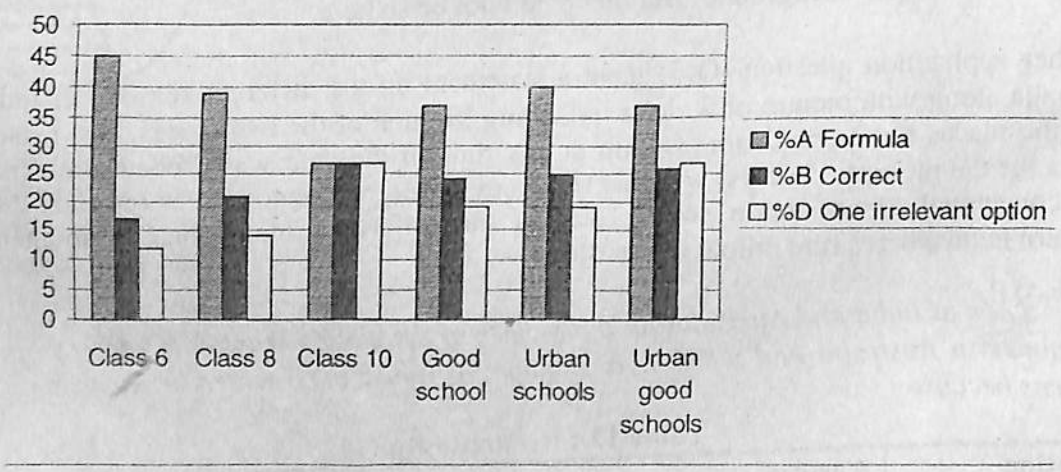
Option	Answer	% Students
A	When the sun's rays fall on that part of the earth on which India is located, it will have summer. Sun's rays do not fall on the other part of the earth on which Australia is located and hence that part will have winter.	38%
B	Australia is in the southern hemisphere and India in the northern hemisphere (Correct Answer).	21%
C	Australia is surrounded by oceans on all sides, but that is not the condition with India.	12%
D	India is near the equator and Australia is away from the equator.	15%
	Not attempted.	14%

Even one fourth of the students do not identify the correct reason. Examining the scenario in the subgroups, marginal progress is seen in the 10th std. (see table 13). At postgraduation, the situation is much improved (56% have opted for the correct answer). But the prominence of an irrelevant option (D) accounting for 23% of responses of these students makes the overall situation unclear.

Table13 : Subgroup scenario of responses to Q5

Options	%A	%B	%D
Subgroup	Formula	Correct	One irrelevant option
Class 6	45	17	12
Class 8	39	21	14
Class 10	27	27	27
Good school	37	24	19
Urban good schools	40	25	19
Urban schools	37	26	27

The written responses further confirm the unfamiliarity of the concept among children. Even those who may have got it correct in the multiple- choice paper are probably unable to reason out their choices.



A number of children have mentioned some terms or phrases (tilt, earth's revolution, different hemisphere etc) without elaborating. Where the responses are a little elaborate we tried to make out the pattern of their visualisation. This is seen more at class 10 than in class 6.

Some inkling of reasons for seasonal change is brought out only by two students:

"भारत में सूर्य की किरणें दिसंबर में कम से कम कोण बनाती हैं। जिस कारण भूस्थल अधिक देर से गरम होता है और मई जून में सूर्य की किरणें सीधी पड़ती हैं।"

"– भारत उत्तरी ध्रुव पर होने के कारण सूर्य की किरणें अधिक पड़ती हैं। इसलिए अप्रैल मई में गर्मी की श्रतु होती है। आश्ट्रेलिया दक्षिणी ध्रुव पर होने के कारण वहाँ सूर्य की किरणें कम पड़ती हैं।"

But we get no explanations as to why this sort of a change occurs in these two time periods of the year. The impact of tilt isn't explained.

Some other responses are given below :

"पृथ्वी अपनी धुरी पर घूमती है। अप्रैल मई में पृथ्वी सूर्य के सामने रहती है जिससे आधी पृथ्वी पर गर्मी पड़ती है। दिसंबर और जनवरी में पृथ्वी का आधा हिस्सा पीछे रहता है जिससे वहाँ ठंड पड़ती है।" "When the earth rotates on its axis. then when the northern part is in front of the sun it is summer and then it is winter in the southern part".

In these responses half of the statement actually corresponds to the right situation of the tilted earth going around the sun. This is important to note because it is only in rare cases that children have used northern and southern hemispheres to explain differences of seasons.

One child gave the explanation of seasons with the help of a globe during discussion: "पृथ्वी ऐसे घूम रही है जिसके कारण वह अपनी धुरी पर थोड़ी झुकी हुई है। जिसके कारण सूर्य की किरणें सीधी पड़ती हैं तो गर्मी होती है। जब वो धीरे–धीरे वापस अपनी स्थिति पर आ जाती है तो सर्दी होती है।"

The tilted position of the earth was seen to be the cause of summer. The child tried to straighten up the globe to explain that at certain times the earth was not tilted and that was the winter position. Here 'वापस अपनी स्थिति पर' referred to an earth which was not tilted.

Other responses mix revolution and tilt in odd ways such as-

"पृथ्वी घूमती रहती है जिस जगह पर झुकी हुई है ठण्ड की श्रतु होती है। जब वह घूमकर आती है ऊपरी हिस्से पर गर्मी होती है।"
"दिसंबर जनवरी में पृथ्वी घूमती है और अप्रैल मई में झुकी रहती है।"
भपृथ्वी अपनी धुरी पर घूमते हुए दिसंबर जनवरी में अपने स्थान से हट जाने के कारण उत्तरी ध्रुव की ओर झुक जाती है। जिसके फलस्वरूप सूर्य की किरणें सीधे पृथ्वी पर नहीं पड़ती तथा अप्रैल मई में पृथ्वी वापस अपनी धुरी पर आ जाती है जिससे सूर्य की किरणें पृथ्वी पर पड़ती हैं। इस कारण दिसंबर में ठंड पड़ती है और अप्रैल में गर्मी।"

This indicates a notion of earth sometimes being on it's axis and sometimes not. Moreover it also points to a notion of the whole world having similar season at different times of the year. Hence even those who have revolution and tilt in mind have a visual concept which is quite different from the text explanations.

One of the very few answers that come close to explaining the concept is as follows:
"सूर्य स्थिर है। पृथ्वी अपनी धुरी पर और सूर्य के चारों ओर घूमती है। सीधी किरणें जब भूमध्य रेखा पर पड़ती है तब भारत में ग्रीश्म श्रतु होती है। जब किरणें तिरछी पड़ती हैं तब श्रतुएँ बदलती हैं।"

This is the response that has come nearest to the causes of seasonal change. But this too is a partial explanation. For instance why do we get direct rays sometimes and inclined rays at other times – Such linkages associated with tilt are not explained.

Apart from the questionnaire given to school students, some conceptual questions of a higher level were posed to college students. Two of these were concerned with the tilt of the earth. In one case four positions of the earth in relation to the sun were given and students asked to identify the position of our (northern) summer. This demanded an identification of the tilt. No clarity is seen to emerge from the students. Responses seem to be divided amongst winter, summer and spring positions.

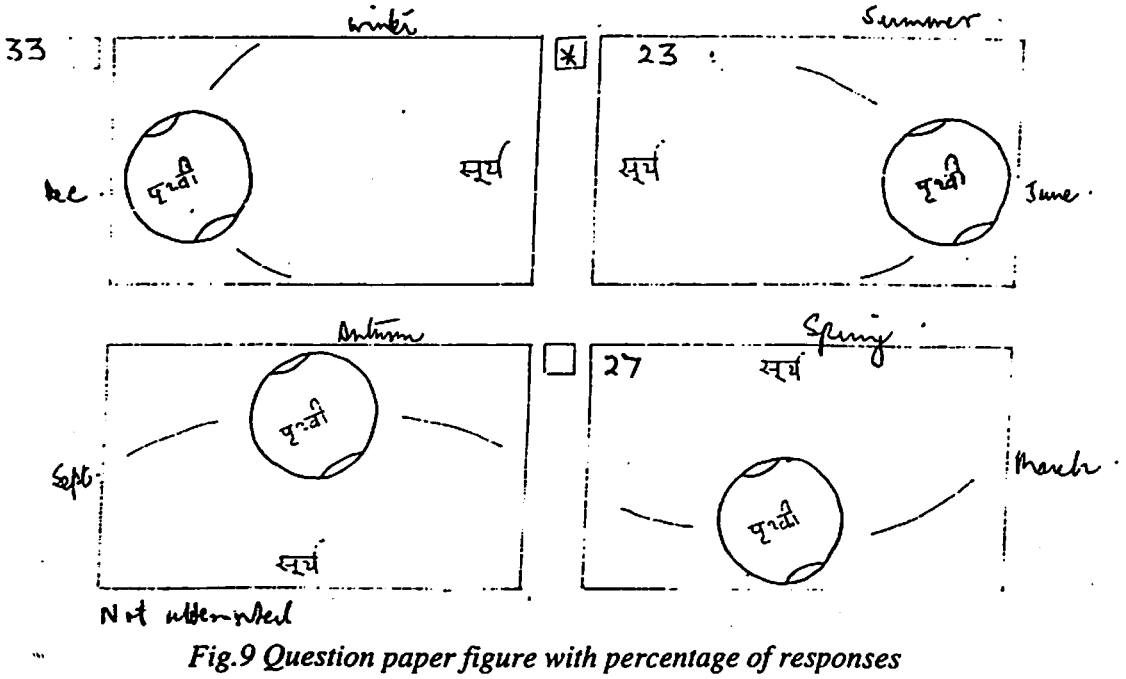


Fig.9 Question paper figure with percentage of responses

Another question sought to find out the implications of angular measurements of 23 and half degree indicating earth's tilt.

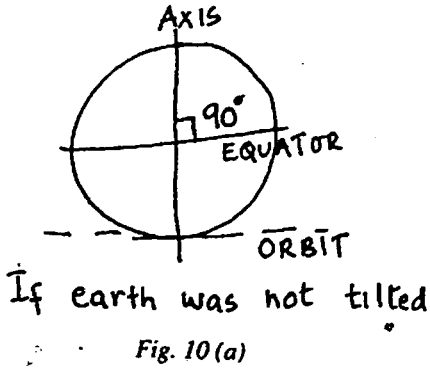


Fig. 10 (a)

Only 13% of students have opted for the correct answer. Strangely almost half of the responses are registered "angle between the axis and the equator". This is an angle which always remains constant (90 degree). Whether the earth is tilted or not, this angle would be 90^{O}(see fig 10). Since a large number of students of postgraduate level failed to note this fact, it throws light on the serious of spherical geometry which is taken for granted at 6^{th} std. The condition seems to undergo only marginal changes. Another point to be noted is that in the midst of emphasis on spherical geometry (though inadequately done) certain desirable elementary concepts fail to get built.

For instance, it is conceptually important that students understand that earth is tilted. If the earth was not tilted (as in fig 10 a), the equator would have been parallel to the orbit and the axis would have made 90^{O} to the orbit. Since the earth is tilted (as in fig 10 b) the axis and the equator makes different angles with the orbit, simply by virtue of its tilt. This is the conceptual requirement to remember that the me4asurement of these angles is 23 ½ ^{O} or 66 ½^{O} is a matter of detail (see table 11) even after so many years of

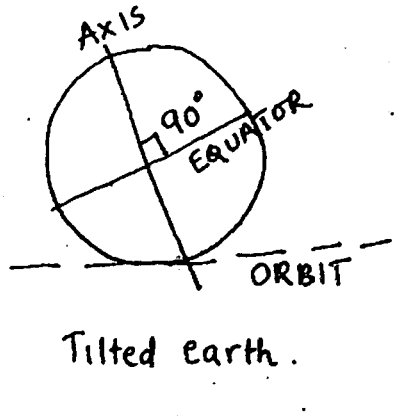


Fig. 10 (b)

geography learning.

FUNCTIONS OF LATITUDES AND LONGITUDES

Children's understanding of latitude and longitude lines are confined to the premises of recognition of these lines on maps and to their imaginary nature. It is seen that even though recognition of these lines on maps is very much done by children often their names are confused; their identities as separate sets of lines are simply lost. Moreover the co-ordinate functions and the association of longitudes with time figure nowhere in children's understanding.

SEPARATE IDENTITIES

Though latitudes and longitudes are generally identified by children, clarity on their separate identities is very much lacking (see table 14).

Table 14:Identification of latitudes and longitudes (% students)

Lines	Identification as Latitude	Identification as Longitude	Not Attempted
East to West	31	29	38
North to South	27	35	40

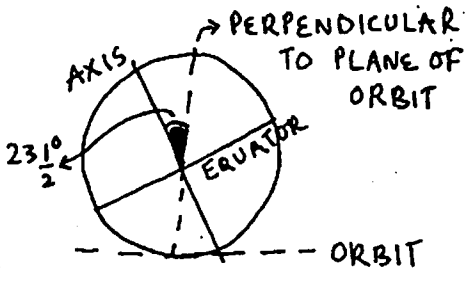


Fig. 11 (a)

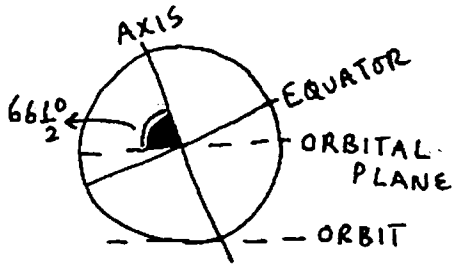


Fig. 11 (b)

Definitely the correct identification exceeds the wrong one, but only by 2 to 8%.ie.. almost an equal proportion of students opted for the wrong option. This implies that the confusion is quite prevalent. Added to this is the fact that 38 to 40% students have opted not to answer the question. The subgroup scenario confirms the widespread nature of this situation (see table 15)

Table 15 :Correct identification of latitudes and longitudes in subgroups

Subgroups	Longitudes(%)	Latitude(%)
Class 6 students	36	32
Class 8 students	39	31
Class 10 students	30	30
Good school students	48	41
Urban school students	44	43
Urban good school students	64	64

They also generally mark right recognition of latitudes and longitudes only within a range of 30% to 40% recognition. Moreover there is no marked growth in ability and can be traced from class 6 to 8 to 10.

Perceptible difference is seen amongst the better-off subgroups. The good school and urban school attain 10% points above the general average. The urban good school group is twice the general average. This indicates that exposure appears to make a difference in this context. However, nearly 35% of the students are still unable to recognise correctly even in the best of situations.

The postgraduate student subgroup shows a distinct improvement over the rest with 80 to 83% identifying the lines correctly.

The written responses also indicate that identification of latitude and longitude as a set of lines do not necessarily mean that names of the lines are correctly noted. Some times they are identified as those running from north to south and from east to west and otherwise as आड़ी and सीधी or खड़ी lines. Often lots of confusion emerge like "अक्षांश दक्षिण की ओर जाता है और देशांतर उत्तर की ओर।" At times children have simply made wild guesses like "अक्षांश अंश का पता करती है। जबकि देशांतर देश का or सात महाद्वीपों का दो सतह है, अक्षांश और देशांतर".

As we go towards the higher classes, answers seem to have more chunks of memorised terms used almost like some defense mechanism against condition of conceptual non-familiarity. Monsoon, climate, direction, distance and earth's movements etc are some such terms used to explain latitude and longitude. Some such responses go as
भपृथ्वी के बीचोंबीच से होकर गुजरने वाली रेखा जिस बिंदु से होकर गुजरती है। जहाँ खतम होती है वहाँ का उत्तरी भाग अक्षांश कहलाता है। और दक्षिणी भाग देशांतर कहलाता है। दक अक्षांश और देशांतर रेखाएँ इसलिए हैं कि उनका उपयोग है। पृथ्वी धुरी पर जुकी है और सूर्य का पहला भाग अक्षांश और देशांतर रेखा होता है।

LACK OF DIFFERENTIATION IN FUNCTIONS

Children have expressed latitude and longitude lines as having similar functions. We do not see them visualise these lines separately. Combined function of these lines is actually seen in location of places through intersection of the lines. Otherwise they have specific and different functions. E.g.: Time demarcations across the globe are linked with longitudes, whereas heat zones and seasonal demarcations are linked with latitudes. But our children do not seem to even hint at such differences. Wherever they have, it only seems like guess work and even then it holds no water. An example where difference is mentioned is given below "360 latitudes and 180 longitudes"(it has obviously got reversed).

By and large the two sets of lines have been treated together like "अक्षांश और देशान्तर रेखायें तापमान और दूरी बनाती हैं।" or "अक्षांश और देशांन्तर काल्पनिक रेखा है जो ध्रुव से ध्रुव तक खींची गयी हैं और पठार, नदी, पहाड़ ... दिखाने के लिये हैं।"

More explicit expressions like "अक्षांश और देशान्तर एक ही रेखायें होते हैं। उनका उपयोग तापमान का पता करने के लिये हैं।" are also seen.

CO-ORDINATES OF LOCATION

Latitudes and longitudes together define a grid system over the globe. Since latitudes run in an east- west direction and longitudes from north to south, their points of intersection are

used to pinpoint the location of places on the earth's surface. Thus they function on the globe in a fashion somewhat like graph co-ordinates on flat paper. Since maps are the flat representations of earth's surface, they have networks of latitude and longitude lines. We perceived that the location of places could easily be handled by children at least in the context of usage of maps and atlases (given sufficient exposure).

Q11 of our questionnaire explored this aspect. A point was marked out on a map and children were asked to state its right location in terms of latitude and longitude.

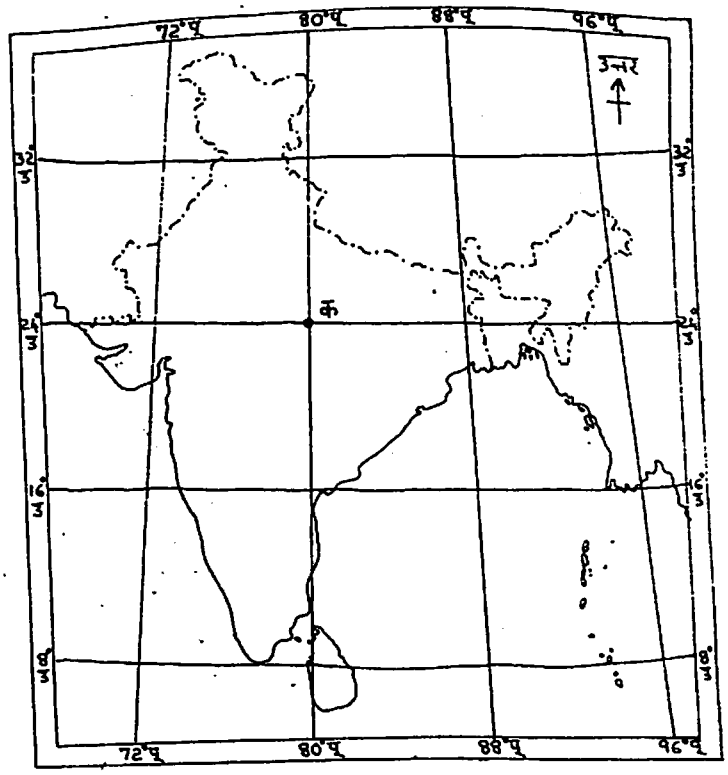


Table 16: Responses to Q11

Question Options	Look at place A given on the map. The location of this place can be indicated as	% Students
A	80 degree E	19
B	80 degree E16 degree N	14
C	24 degree N (Correct Answer)	25
D	None of the above answers are right	27
	Not attempted	15

The results show that 73% of students are unable to use these lines for location (see table 16) Those students who are able to use these lines for locating a place form only 27% of total. Earlier we found that some subgroups of students are were distinctly better off in recognising the lines. Let us see if those subgroups perform better in location of places as well.

Table 17: Bare recognition and co-ordinate usage :subgroup scenario

Subgroup	% recognise	% location
Urban school students	44	34
Good school students	41	32
Urban good school students	64	40

The better off subgroups record only 10% points above the overall situation (see table 17). It is seen that location of places is not caught on well even by the better off pockets.

In fact the best school subgroup i.e. urban good school shows the largest gap between the ability to recognise and to locate. At postgraduation, whereas 80% of students recognise these lines correctly, only 43% identify their usage in location of places. This implies that in the best of situations the knowledge about latitudes and longitudes is quite marginal. They are able to recognise but not identify of use the co-ordinate functions. This could probably mean that the practice of usage of these lines is minimal, even in situations where exposure or resources should not be a constraint (like the better off subgroups). Does the curriculum encourage this ability? We did not find that much encouragement is provided (see previous chapter).

Even a liberal assessment of the descriptive answers show that very few students are actually aware that these lines function as co-ordinates. The nearest response to this that we have obtained goes as "ये रेखायें स्थिति बताती हैं।" "कौन सा देश कहाँ है, यह पता चलता है।"

These responses definitely cast a doubt on whether they are actually referring to functions of maps per se on which they have noted these lines going criss-cross. Some extremely rare responses at the 10^{th} standard throw light on function of latitude and longitude as co-ordinates. Here the use of lines for location of places has been elaborated as 'intersection of latitude and longitude lines" or "first we have to know the degree measures given behind the map in the atlas, then with the help of these lines we can find the place." This is a rare reflection of familiarity with usage of index of atlases.

LONGITUDE AND TIME

The association of longitude with time (and time calculation of different places on earth) is conceptually a deeper understanding of earth's rotation and of the process of day and night. Since the earth rotates from west to east, the advance of morning to noon and to evening and night follows an east – west pattern (i.e. the east followed continuously by the west). With this logic and with the factor of rate of rotation, time calculation of any place is possible. Since the earth takes 24 hours for a full rotation which is 360 degrees, it implies a shifting of 15degrees every hour. On this mathematical basis, it is possible to calculate the time on any part of the globe if we know its longitude.

Children's responses show that the longitude-time association is a clear case where the concept has been totally skipped.

The discussion with children reveal that usage of these lines is generally a bleak area on which children did not have much to say. The association of time and longitude figured

nowhere in the discussion. In fact discussions were reaching nowhere in the vicinity of this concept.

STRATEGIES OF PERFORMANCE

The status of conceptual understanding is quite dismal. This is demonstrated by the finding that on one hand major and crucial issues are not being reflected by children and on the other hand many misunderstandings have filled up the vacuum. In such a backdrop, there seems to be certain specific strategies that the system perpetuates. These strategies sometimes help children to perform at sufficient levels for the examination. It then passes off superficially as achievements. These will have to be understood to analyse the problem at root level; they should be seen as symptoms of systemic problems. Major strategies are seen in the form of formula learning and a certain groping for concrete explanations etc. We will examine them in detail.

FORMULA LEARNING

Given the fact that conceptual understanding is not happening much, one prominent method is of rote-learning. Within rote, 'formula' takes up a special position since it is perhaps easier to memorise. We have been able to trace its popularity in children's responses.

There are some instances where the formula pattern is explicitly brought out. One of them is Q2. The question mentions that Sheila's statement is wrong, it is then surprising that 40% students still said that the statement is correct. The number of such students vary from 40 to 58%. In the descriptive answers a large number of children supported the wrong statement most tried to explain why Shiela was correct. This is true even at senior classes. The fact is that the wrong statement made by Sheila has all appearances of a formula i.e "When the northern part has day, the southern part has night". Children cease to examine what the linkage really signifies.

The prominence of formula being embedded in the student's mind can be judged from the fact that even among graduate and postgraduate students, the preference is shown for the option that Sheila is right.

Generally we find that the state of children traversing from definition levels to those of reasoning is very poor explanations given by children often revolve around attempts to build around formulas. How one part of the earth gets light and not the other is explained by some children through revolution or through some other manner by which the earth is placed in a position where it alternatively falls in light and shadow areas of the sun. The written responses therefore appear to be a play of words around the formula in their mind.

Where rote is not successful, i.e. memory fails or where drilling has not been sufficient, explanations are put forward with lot of terminologies that are often meaningless. Some examples are given below:

'Due to the rotation of the earth, different temperature masses be in different parts of that place. This phenomenon causes changing of seasons'.
"पृथ्वी अपनी धूरी पर चक्कर लगाती है जिससे तापान्तर उत्पन्न होते है।"
"प्रतिचकवात के कारण।"
"पृथ्वी के घूर्णन गति के कारण।"

This tendency is quite prominent, more so amongst senior students than among junior ones. The volume of such terms accumulated because quite large as students reach senior classes these are possibly being extended to portray sophisticated explanations. These are actually effects of rote learning. Some terms remain in the mind. Since their implications have never been understood, they are fitted into all the wrong places. They are then used to build in a shield of defence when we go around and question them.

Another prominent pattern is that of tautologies. This is seen in the entire range of children's responses. Children seem to function in a two- point system where one point is the cause and the other is the effect. Sometimes this corresponds to correct rote, say, 'rotation causes day and night'. At other times, the pattern is utilised to express some common-sense notion, say, 'earth is near the sun and we have summer'.

GROPING FOR CONCRETENESS

Using concrete situations, children often tried to explain various processes. Their plank of understanding and their expression is rooted in that arena which they can feel and relate to. The processes of day and night and seasons in terms of movements of earth occur in a different plank which they find difficult to relate to. But when affronted with a query, they try to reason it out in their minds. Here is a typical example where many children tried to explain seasons (this came out largely through the descriptive paper) :

"श्रतु परिवर्तन होता है क्योंकि समुद्र का पानी वाश्प बनता है। फिर वाश्प बादल बनते हैं तथा बारिस होती है।"
"Seasons change because rainfall on earth and rain water make river and river goes to ocean. Rainy season changes with the help of the sun. Sun produces more heat to make water into vapour and rain is falling."
"जब अधिक गर्मी पड़ती है तो भाप पानी के रूप में बारिस करती है। बारिस के बाद धरती पानी सोख लेती है, तो ठंड पड़ती है। फिर धरती से ठण्डाई हट जाती है तो गर्मी पड़ती है। उसी परिक्रमा में श्रतुएँ बदलती हैं।"
"जब पृथ्वी सूर्य के निकट आती है तो बिजली चमकने लगती है। और गरमाहट के कारण बारिस होती है। बारिस हमेशा श्रतुएँ बदलती है।"

These descriptions reflect that part of seasons whose occurrence is most easily perceived Evaporation of water, cloud formation and rainfall are easily perceived while process of earth's movement and the consequences of its tilt are not. At times children have tried to link their perceptions with the plank of *earth's movement*. But the effect is disjointed like the example given below:

"Seasons change due to the tilt of the earth. The seawater evaporates and forms clouds by which rainfall occurs. This rainfall causes winter."

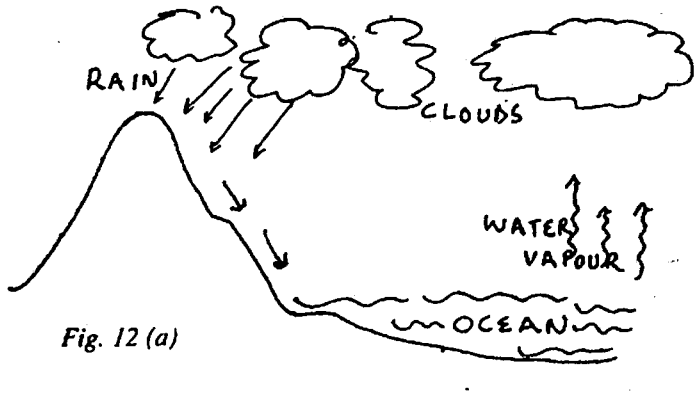


Fig. 12 (a)

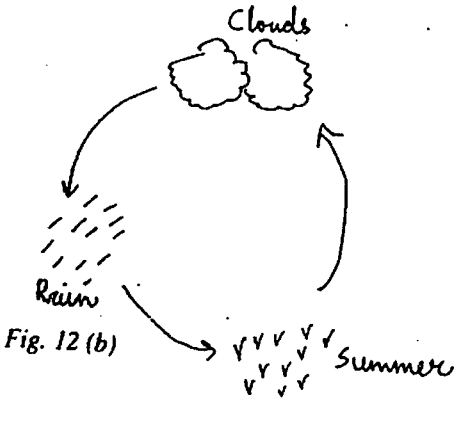


Fig. 12 (b)

The dichotomy between the stated reason of the text and the logical concreteness desired by children is only too evident. These responses also indicate that explanations had been constructed largely from their own experiences of seasonal change. In the former case, it is built on a logical and observation based framework the sequence of which is true, i.e. summer - rains – winter. The reasons stated are based on temperature i.e. high temperature leads to evaporation and to rains, rains cause a fall in temperature, which leads to winter. It apparently has nothing to do with the tilt of the earth or the revolution of the earth around the sun.
Another attempt at concrete ways is seen is explanation of why Australia and India had different seasons.

"अस्टेलिया पानी से धिरा है और वह पथ्वी के किनारे मे बसा है। जिससे सूर्य का प्रकाश पूर्ण रुपसे नी पहूंच पाता।"

This could be the child's interpretation of Australia on the globe. It is seen to be on the edge of a sphere and therefore away from the core areas of the globe where more sunlight would reach.

"चूंकि आश्ट्रेलिया में पहाड़ व वृक्ष बड़े–बड़े होने के कारण वहॉ सूर्य की किरणें पहुँच नहीं पातीं।"
"आश्ट्रेलिया में ऊंचे–ऊंचे पर्वत होते हैं इसलिए वहॉ ठण्ड पड़ती है।"

Especially among junior students (6th std. etc.) concrete explanations dominated wherever they opened up and talked. The delinking of the concrete from the abstract was only too evident. Children often stated correctly which months had summer, winter, rains etc. They also went to lengths describing the sort of cultivation that took place in various seasons. But as for the explanations in terms of earth's movements, they were not very forthcoming.
In the context of latitude and longitude, we were hardly able to derive any discussion from children. Within a limited frame of using these lines on maps. This concept could have provided an interesting task for children. But ironically we find that children discussed much more on complex concepts like day / night and seasons. The implication is that these topics have an actual life experience on which basis children become articulate. That is not the case of latitude and longitude.

Thus groping for concreteness is an activity that children illustrate quite prominently. This is larger amongst junior children and situations change towards senior classed. This could be an implication of movements from concrete to abstract or towards 'dismembered' thinking as analysed in the proceeding chapter. The main question is of how much we enable and equip children to synchronise learning process with and el3ementary need to associate with the 'concrete' and get help in a movement towards larger/abstract/disembodied areas

CONCLUSIONS

A number of popular wrong notions on processes like the earth's movements can be traced out. This means that crucial conceptual areas are not being understood by children. This state of affairs is generally true from junior to senior levels of school. This focuses the question as to how children cope up with the situation. Responses of children reveal that there are certain patterns in the strategy adopted by them. These revolve around formula learning, whereby conceptualisation can be skipped. Another tendency seen is of children's leaning towards concrete explanations. Thus the plane of discussion drawn out by children and that designed by the text seem to function separately, each on its own track.

CHAPTER 3

LEARNING MATERIALS

INTRODUCTION

Visualization of solar system demands that of simultaneous movements of a number of spherical bodies. It is not akin to balls rolling around on the floor. There is no floor. These bodies do not hang from above. There is no ceiling. It is an infinite space. Movements of the spherical bodies mean their spinning around as well as moving ahead. The latter movement is along an elliptical path. These movements are not haphazard, but quite well orchestrated. The sun, which is a star, keeps the solar family moving around it and the earth is one of its members. Gravitational force keeps these bodies moving. The solar system is only a speck in the universe. There are so many stars and so many systems moving on endlessly in infinite space like a grand symphony !

The status of conceptualization of such processes by children was examined in the previous chapter. It indicated that concepts were not understood as desired and that wrong visualisation was very popular. What are the probable circumstances that lead to such flaws in conceptualization? In our school system, the learning and teaching material boils down to the text. Its crucial role gets manifested in examinations, which act as test of success of students. What is the nature of and limitations of teacher's contribution through classroom transaction? These factors are analysed here to understand their role in contribution to popular responses of children.

A REVIEW OF CHAPTERS AND CLASSROOM TRANSACTION[1]

The movements of the earth and associated processes are topics of geography in early middle school. A shortened version of the same forms part of social studies in the primary school. These topics get treated as elementary geographic concepts. Here we review two chapters of sixth standard ('motions of the earth' and 'latitude and longitude') and class room transactions of the same.

(1) MOVEMENTS OF THE EARTH

The earth's movements are explained separately and associated with their impacts like day & night and seasons. The text addresses vertical and slanting rays of the sun in the explanation of rotation as well as of resolutions. The maximum elaboration of this is obtained as "The rays of the sun are almost vertical at noon and slanting in the morning and in the evening. Vertical rays of the sun fall over a small area, giving it a greater amount of heat. Slanting rays on the other hand, spread over a wide area and give less heat".

[1] Classroom observation was done in nine classes in various schools. This involved different types of schools, of various managements (govt: & private) and mediums of instruction (Hindi & English).

It is doubtful whether children at sixth standard can really take in and understand this phenomenon of heat distribution per unit area of the earth and how this variation is caused by the angle of incidence of the sun's rays on the earth. Similarly in the explanation of seasons, direct' and 'slanting' rays are used to explain how summer and winter are caused. But we have not seen any such understanding being reflected in the children's responses on seasons. Instead the reason for greater and lesser heat over earth at different seasons is attributed largely to the increased and decreased distances of the earth from the sun. As seen in previous chapters, this is a very predominant misunderstanding.

The inability to cope with the complexities of the process coupled with some factors of the text seem to have induced a certain pattern of misunderstanding. For instance, let us look at the diagram given to explain seasons. Four of the positions of earth around the sun in the four major seasons are illustrated (see fig.1)

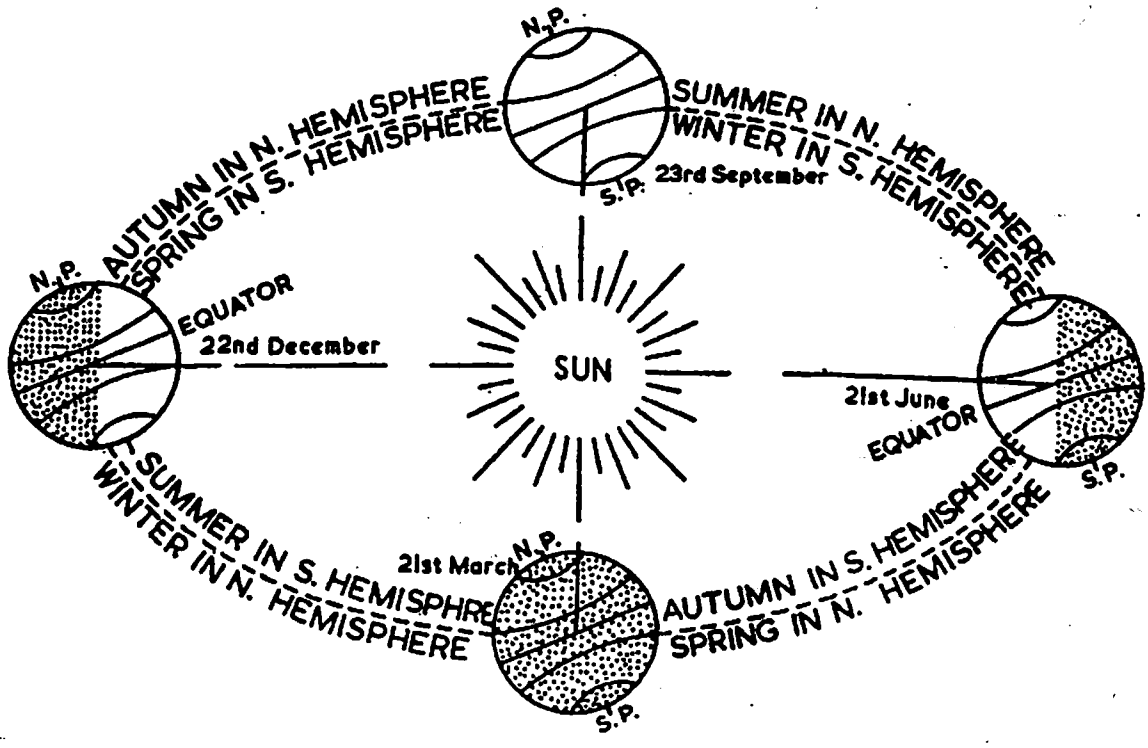


Fig.1 Revolution of the earth and the seasons

The autumn and spring positions (23 sept. and 21 march) give a notion of the earth being nearer to the sun. This imagery seems to have been partly taken in by children and then used to strengthen a common sense notion of "nearer to the sun, greater is the heat received and farther away from it, lesser the heat".

In the context of earth's movement on its axis, we have seen that children hardly recognised this movement rightly. In the text, the major part of the section on earth's rotation is taken up by an experiment. A candle and a ball are used to visualise sun and earth respectively. The experiment is as follows:

"Let us now perform an experiment to see how the sun rises and sets at any place. Take a ball to represent the earth and a lighted candle to represent the sun. Mark a point on the ball to represent a town X. Place the ball in such a way that the town, X, is in darkness. Now rotate

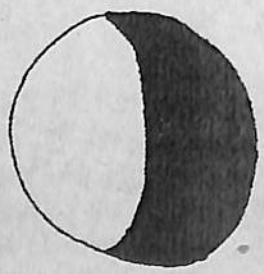
the ball from left to right. The town, X, would gradually turn towards the sun (which is represented by your candle) and reach a position when it will receive come diffused light. It means that the town is having its DAWN or the time just before the rays of the morning sun appear. As you move the ball slightly, the town will have its SUNRISE or the first rays of the rising sun. At sunrise the sun appears on the horizon and its rays are slanting. As the ball continues to move, the sun seems to be climbing up in the sky until its rays are more or less vertical. This is NOON time in the town X. after that, the point, X, gradually moves away from the sun until it appears as if the sun has descended to the horizon. This is SUNSET. This is followed by a short period of diffused light, again, which is known as DUSK. When the town, X, has moved farthest from the sun, it would be MIDNIGHT. Therefore when it is dawn at one place it may be noon, dusk or night in other places".

We tried to do this experiment. It was seen that many factors like the size and texture of the ball, intensity of light of candle, distance between candle and ball etc. play important roles that could shape the result of this experiment:

Nature of ball – A smooth and light coloured ball (like a tennis ball) seems to produce more clarity in observation of light and dark areas. Rough textured balls make observation of light and darkness on it less clear. Large plastic balls produce many confusing results mainly because of its translucent nature, the fallout being of the night side getting illuminated.

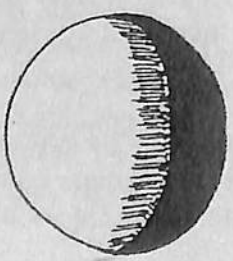
Intensity of light source – This becomes important in terms of in relation to the ball used. Larger balls need larger and brighter candles to produce any significant effect.

Distance between candle and ball – When the ball is held quite close to the candle, we get a clearly demarcated patch of darkness and light.



In such a position, as the ball is rotated, the point marked as town X travels from night to day in a quick transition. On further rotation, a similar sudden change from day to night is observed. Thus it leaves no scope for observation of dusk and down as elaborated in the text. This is so because we do not get a zone of scattered light that acts as transition between day and night.

We tried to get such a position where the scattered light was also marked out on the ball. If the ball is moved sufficiently away from the candle, the line of demarcation between the day and night areas as a clear-cut one ceases to exist.



This is actually the situation that falls more in line with the realistic earth-sun model. But it is still quite difficult to convey the dusk and dawn area because the general scattered light effect is too much for such fine demarcations. Such an experiment can convey results only if the role of the scattered light is worked out appropriately. Moreover it will be necessary to

work out the factors that can be controlled in such an experiment. In the present form demarcation of dusk and dawn area is really difficult.

It is surprising that the experiment recommends a ball and not a globe. The stark difference between the two is that in the latter the tilt factor is implicit and in the former it ceased to be an important factor. Loss of simultaneous occurrences of phenomena through oversimplification is a running theme in the story of the text. The text seems to be avoiding the really exiting complexities.

(2) EARTH'S TILT

Children's responses had shown us that the tilt of the earth is hardly registered anywhere. Even at the college level, students do not express any clarity. The text deals with earth's tilt very. "The earth's axis is tilted at an angle of 23 ½ degrees from a perpendicular to the orbital plane. In other words, the earth's' axis makes an angle of 66 ½ degrees with the plane of the earth's orbit." The accompanying diagram is given below: -

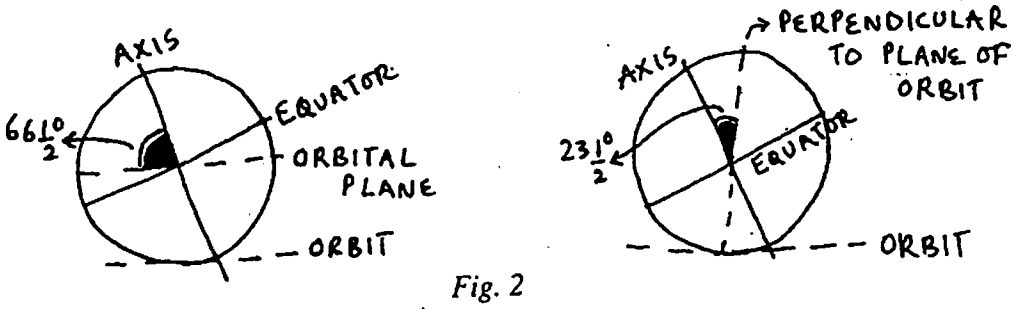


Fig. 2

Such terse explanation using terms like 'plane of orbit', 'axis' etc. and the various angles are definitely do not help the learner. The problems arise. both in terms of communication and in terms of other requirements of learning. The latter mainly pertains to the fact that 'plane of orbit', 'axis', etc. are not areas of children's familiarity so how can we use these terms as building blocks to create larger structures? In such situations, if a teacher searches for clarity (for her students) by using models like globes, all the building blocks seem to tumble down. This is so because the globe throws light on all the complexities that we tried to underplay or hide. The tilt, the their dimension...etc. suddenly become visible. The child tends to get flabbergasted, the extent of which depends on her of his age.

(3) ANGULAR DISTANCE

Angular distance is an important term used in the text. This is because the approach adopted to teach earth's movements and latitude, longitude lines has heavy "borrowing" from spherical geometry. Children of sixth standard are not groomed to such levels of that discipline. Hence it is quite predictable that the parameters of explanation will be difficult for children to handle.

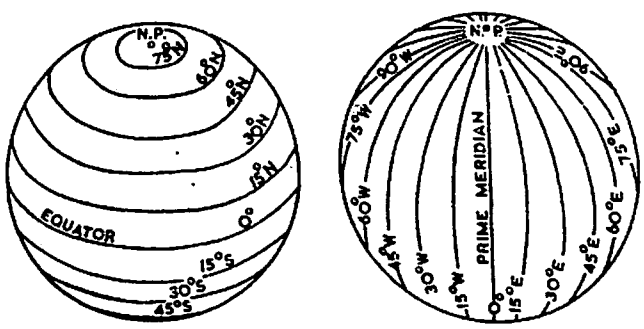


Fig.3 Latitude and longitude

Let us examine the sections on latitude and longitude. The main parameter of definition is the angular distance (also see diagrams fig 3). The reference points used are poles, equator and the prime meridian.

Latitude is defined as "a measure of the angular distance of a given point from the equator. It is measured in degrees from the equator toward either pole". It is doubtful whether children (at sixth standard) are sufficiently familiar with angles and their measurement. Children can possibly be at the most familiar with measurement of angles with a protractor and some prominent angles of mathematical usage like 90°, 45°, and 60 ° etc. They can possibly construct angles on a paper in two dimensions. But in actual terms, on a sphere or globe, what do these angles imply? Between which points are these angles drawn? If we search the text, the only clue obtained is that it is to be measured from any given point (whose latitude we are concerned with) and the equator. From this explanation, we can at the most understand situations by drawing a diagram (see fig 4). But which is the plane from which the angle is constructed?

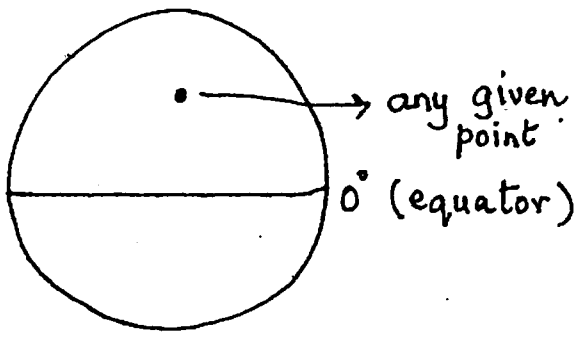


Fig. 4 Angles Between Points: No Clarity

This question becomes very important since we are handling a three-dimensional medium and children are provided with no clue as to the sphere's center being an important reference point.

The only other information we receive about degrees is of its sub divisions. "One degree (°) is divided into sixty equal parts and each unit is called a minute ('). A minute is further divided into sixty equal parts and each unit is called a second ("). There is no attempt made to address obvious confusions on these units with that of temperature and time. Moreover, we find no explanation to clear obvious confusions of angular distance with the more common and familiar linear distance (measured in kilometers etc.). This is very crucial in the context of the text using the term with an ease that presupposes a certain level of familiarity and understanding amongst children on these matters, e.g.: "since the distance from the equator to either of the poles is one-fourth of a circle round the earth, it will measure ¼ of 360 degrees, i.e. 90°". Here 'distance' actually means angular distance. It requires a good amount of maturity to actually understand such statements. It is not as though the sentence is followed by some elaborations or explanations. The space provided in the text for elaboration is very minimal, Compressed presentation of this sort is a consistent character. Thus prerequisites required to understand these concepts are simply taken for granted. Such frameworks could be giving children the wrong message. E.g. the popular response of latitude and longitude being used to find distances between places.

In classrooms, we found that the teacher was inevitably finding difficulty to come to terms with the third dimension. Some teachers simply asked children to imagine a rubber ball with latitude and longitude marked on it. The most commonly used method was to draw circles on the blackboard to visualize a sphere. For example:
In most cases, difficulties arising out of such visualization were to be seen. Some such instances are given below-

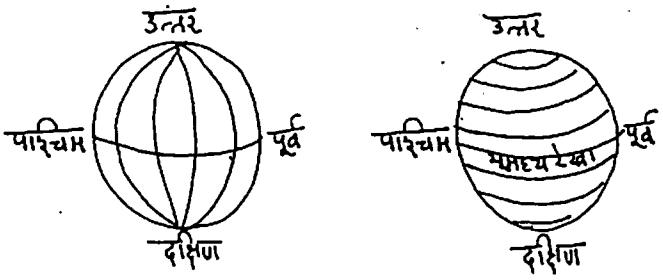


Fig.5 Circles to represent spherical earth

Teacher: What is the measurement of a circle?
Children: 180°
Teacher: No
The teacher then drew a circle on the blackboard. She explained 360° as the angular measurement from the center of a circle. This explanation was given in the context of teaching latitude and longitude. From here she took off to 360° of longitudes. The earth as a sphere was demonstrated by another circle.

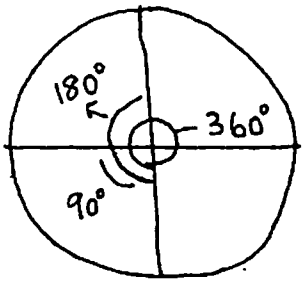


Fig.6 360° of a circle

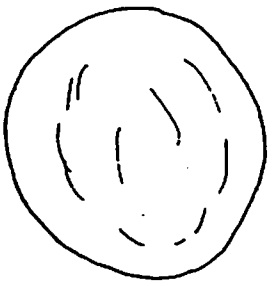
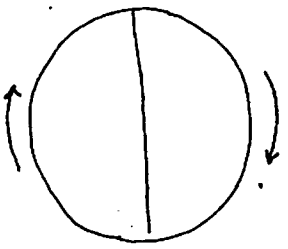


Fig7

Figure 6 was meant to be any circle and figure 7 was meant to be a sphere to represent the earth. The linkage between the two was not mentioned at all. There was no attempt to look into how the angular properties of the circle apply to the sphere.

There were instances when the teacher herself seemed to lose sight of the visualization of the third dimension. E.g. - a diagram was drawn on the blackboard to explain the rotation of the earth (figure 8). It was explained that the earth moves 360° in 24 hours. Nothing more was said. The impression one gets is of a two dimensional movement (circle) of 360°. If the circle was used to visualize a sphere it should have been drawn out differently (see figure 9).



24 hours

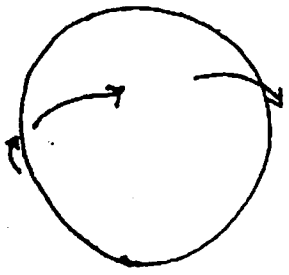


Fig. 9 East to west movement of the earth shown by a circle

In the explanation of local time, the teacher drew a circle (see Fig 10).

Longitudes are not made to converge at the poles. Hence it is difficult to visualize this circle as representing a sphere.

There are other situations that clearly demonstrate the difficulty experienced by the teacher. Some diagrams used by teachers in different

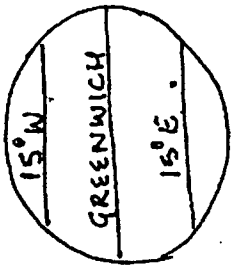


Fig. 10 Local time

schools are given (see fig 11).

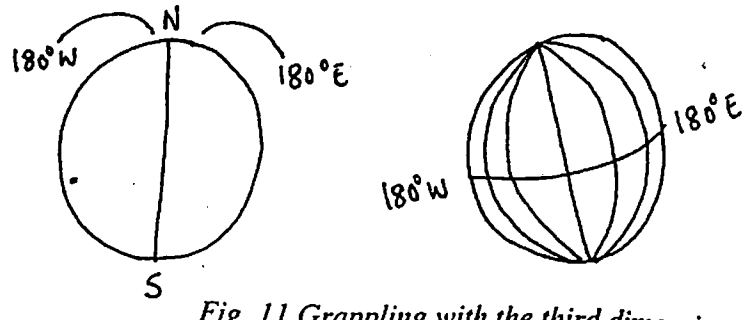


Fig. 11 Grappling with the third dimension

These show attempts to mark the longitudes that are seen east and west of the Greenwich meridian. The fact that 180° west and east become one and the same meridian on the other side of the globe becomes miscommunicated this way.

(4) HEAT ZONES

The earth is divided into various heat zones, the lower latitudes being warmer and the higher latitudes cooler. The reasons for such demarcation is made on the basis of different angular incidence of sun's rays at different latitudes. This gets explained, as "The mid day sun never shines overhead on any latitude beyond the tropic of cancer and the tropic of Capricorn. The angle of the sun's rays goes on decreasing towards the poles. Beyond the arctic and antarctic circles, the sun does not rise much above the horizon. As such the areas bound by the tropic of cancer and the arctic circle in the northern hemisphere and the tropic of Capricorn and the antarctic circle on the southern hemisphere, have moderate temperature. "Nowhere is the child helped to understand what is meant by the angle of the sun's rays. Moreover, how does variations in angle of the sun affect the heat received on different parts of the earth? Searching for this we find a sentence that tries to explain the coldness of the polar region. "It is because the sun does not rise much above the horizon. Therefore its rays are always very slanting". We do not get any explanation of what slanting rays are. No reasons are provided for the situation of varied angles of sun's rays in different parts of the earth. Some explanation of this is provided in another chapter dealing with movements of earth (we had elaborated this earlier).

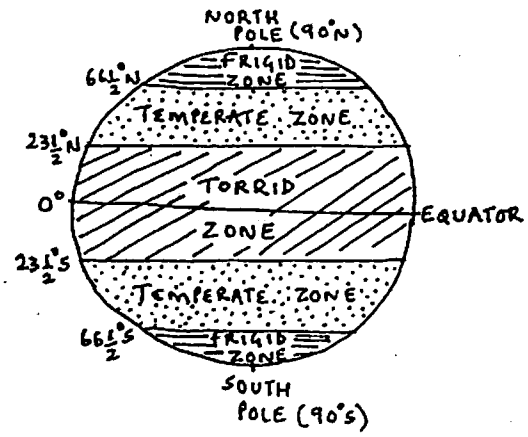


Fig.12 Important parallels of latitude and heat zones

Only an understanding of reasons behind processes will help children to reach some level of conceptual clarity. When such provisions are not made. it is possible for them only to reproduce textual terms and attempt to rationalize situations through sheer application of commonsense. This is exactly what seems to be happening as we have found through the survey. We have illustrated the elsewhere how 'slanting rays of the sun' is used by children to explain the coolness of places at 80° latitude but the same logic is not applied to 90° latitude. Similarly the heat zones and latitude linkage has very popularly been interpreted by children as "latitude and longitude lines showing temperature in degrees". In short many factors that have contributed to construct popular conceptual misunderstanding amongst children can be traced to the text.

(5) TIME AND LONGITUDE

The association between longitude and time has the direction of rotation of the earth as one of the key thrusts. Hence time demarcation on earth is found in an east –west basis and not on a north-south basis. But such reasons are stated so scantily that they are all suppressed in a single sentence as "As the earth rotates from west to east, those places east of Greenwich will be ahead of Greenwich time and those to the west will be behind it".

Though space devoted to this section is brief, actual mathematical calculation of time is given priority. "The earth rotates 360° in about 24 hours which means 15° an hour or 1° in 4 minutes. Thus when it is noon at Greenwich, the time at 15° east of Greenwich will be 15 x 4 =60 min i.e. one hour ahead of Greenwich time which means 1 pm but at 15° west of Greenwich, the time will be behind Greenwich time by one hour i.e. it will be 11 am". As seen earlier, the perquisites of understanding this e.g.: concepts of sphere and angular measurements etc. are assumed to be understood by children. Apart from the mathematical details, no significant attempt is made to help children understand time differences across the world and its association with longitude. Therefore, it should not be surprising that this association has hardly been expressed by children.

(6) APPLICATION OF 'BASIC'

A review of the geography texts of post sixth standard (up to tenth) shows that the concepts related to the movements of the earth hardly find a mention or application. The only instances of their appearance are found in the following ways:

Latitudinal and longitudinal extend of different countries – studies of various countries start with such an introduction. Latitude and longitude are used to identify the location of place and regions. Hence, there is an assumption that children are sufficiently accustomed to it is co-ordinate function of these. There were no exercises to specifically strengthen this area. The only references obtained are of the nature of "look at the map of Argentina and find out the latitude and longitude between which Argentina is situated" or "look at globe. Find out the location of North America in latitudes and longitudes."

Even studies of different countries/regions of the world do not recall or make use of concepts like heat zones, earth's tilt etc.. to explain climate and other characters. There are references which assume an understanding of 'heat zones' discussed at class 6.

Thus the overall situation is that everything that had to be conveyed on earth's movements and latitude, longitude was done is sixth standard. This is a one shot-situation. The implication need to be looked into because (1) Concepts are too complex to be imbibed without provision of continuity or application (2) If these concepts represent 'basics' of the discipline, there should be scope to analyse and apply them at higher classes.

STRATEGIES REVISITED

In the process of simplification and compression of information the teaching – learning system seems to perpetuate certain clear strategies. Its reflections were seen in children's responses. Here we examine the text and classroom transactions for systemic characters that contribute to such fallouts.

(1) FORMULA LEARNING

Texts try to teach students tautologies e.g. the part which faces the sun will have day and the other part night. The sun could move around to face a part of the earth or the earth could move around or both could move at varying speeds and directions etc. Any such logic can satisfy the tautology. Why is a particular explanation better than the others? That recognition calls for deeper understanding. Children's responses have shown us an underlying method by which they answer questions. There appears to be a logical pattern by which the subject is tackled. It also seems that this pattern is emphasized by the text.

In a number of concepts the cause and effect relationship can be presented as two binary sets such as

Fig. 13

Hence the possibilities become "if a causes x, then b causes y" or the other way round ie..if a -> y, then b -> x. this is the kind of logic that operates. For instance in the context of day and night, the following presentation is popular.

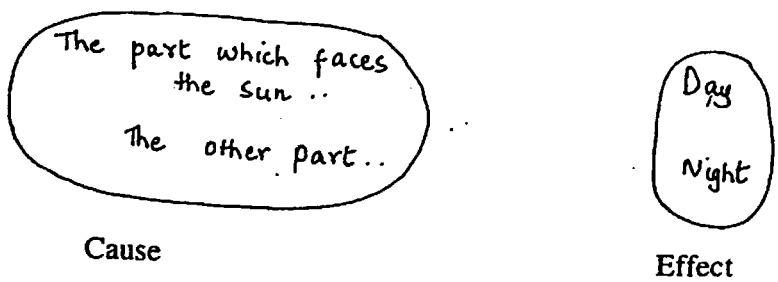


Fig. 14

This appears to be the reason why in Q2 of section 2[2] which is a play on this logic, most students have demonstrated the pattern.

Fig. 15

[2] This tried to test the direction of rotation. Does the earth rotate in an east-west or north-south direction?

Sheela's statement (in the question) thus becomes logical in such a mapping. The fact that the set of causal statements itself is meaningless is not noticed and this holds true across age groups.

A very popular association given below also adheres partly to this sort of logic (though there are some other common sense situations also involved in this case).

Fig. 16

In Q5 all the options provide such logic. A meaningless set of statements are used such as:

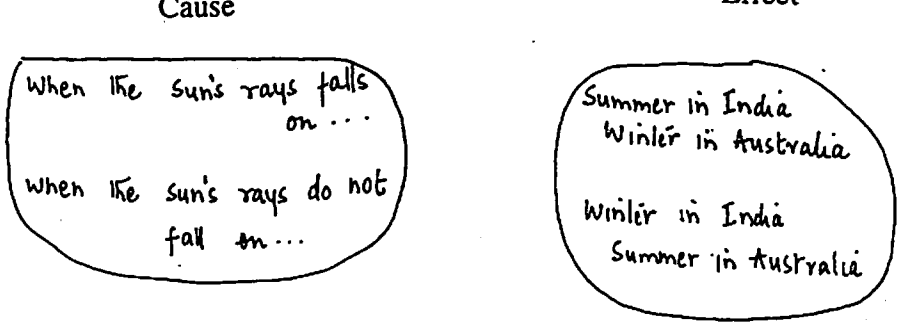


Fig. 17

In most cases, the logic appears to be perpetuated by pattern of the textbook like:

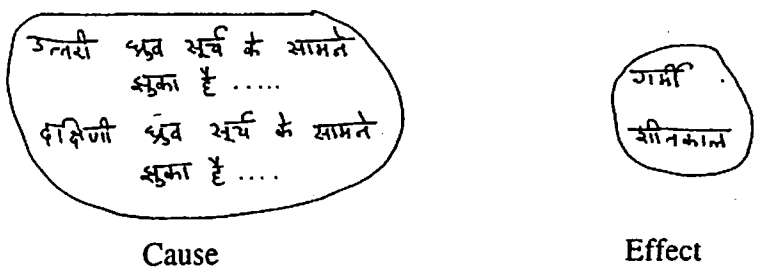


Fig. 18

In a situation where maximum information is attempted to be provided through minimum space, it is inevitable that formula become prominent. On the other hand if time and space are allowed for exploration of concepts, formula might not become important as a success (or escape) strategy. The strategy therefore is to take in and reproduce a process akin to that a photocopy machine. Most children succeed partially, some exceptionally and others group around.

(2) MODELS AND METAPHORS

In discussion with teachers, we found many of them voicing the difficulty to convey the sphericity of the earth and the various associated processes that can be understood only with the basic concept first cleared. "पृथ्वी गोल है – यह समझाने के लिए हमारे पास कोई तरीका नहीं होता है।"

Methods used by teachers are defined by actions and through usage of blackboard (ie: to show the circle) and sometimes with the help of a globe.

In one class we found the teacher using a globe to demonstrate the inclined axis of the earth. She also told them that the blue portion indicated water and the other portion was land on which we live. In the other case we noted that though the teacher had a globe on the table, all communication of sphericity were made through a circle drawn on the blackboard.

It will be useful to recall here that our own efforts at communication through globes (during the discussion rounds) had shown us that the usage of models have their limitations. However sincerely such usage can be tried, children at early middle school, have problem to grapple with and visualize these processes. With the globe in hand and the tilt and the sphericity much more evident and real than on a two-dimensional representation, the complexities of the concepts also become more real. It is then not easy to brush off conceptual prerequisites say like those of space, angles, properties of light etc. to understand earth's movements. The necessity to have conceptual requisites in such situations become even more demanding. When and how can children handle these prerequisites? Such questions become very real if we are to handle the text along with models like a globe. Many of these aspects have been elaborated in the previous chapter.

It is not surprising therefore that teachers often find the use of metaphors more communicative than other methods. Here is an example:

The teacher had organized the children outside the school beneath a tree. Linking their hands, the children were made to stand in a circle. They were moving in the circle. The shadow of the tree fell on some of them and the others were in sunlight. The teacher explained day and night with the use of such metaphors. He used the moving circle of children to demonstrate the rotating earth (circle represented the earth's circumference). While half the circle was in darkness (night), the other half was in light (day). The situation kept changing; as the circle kept moving; the day portions transited into darkness and the night portions received light. Such a metaphor does not take into account any of the factors that actually play key roles in causing day and night. But it is pitched at a level where children can realistically take it in. They can come into terms with such an illustration just as they can with a story, play or a game. It is also a sufficient plot to remember the formula that the text sticks on to. i.e.. When the earth rotates, that half of it which faces the sun receives daylight and the other half of it remains in darkness.

Another demonstration seen was of making a child spin and move ahead at the same time. This was meant to signify the simultaneous movements of the earth on its axis as well as on its orbit.

Such typical efforts are made when the teacher is aware of the communication problem such topics can cause amongst small children. Along with it she/he is also aware of the compulsion to somehow handle these topics for the examination. Otherwise children will not fare well. In such circumstances, metaphors act as a memory-aid rather than as a conceptual-aid. The visual impact of such an exercise would easily stay in their minds to enable some reproduction sufficiently satisfactory for the examination. The crucial question here seems of how teachers and students cope with an impossibility. This refers to the requirement of

conceptualization in learning processes. This seems remote within the given framework of topics and the class (sixth standard) chosen.

All through our observation, we had found committed teachers take to similar paths and each of them had one objective ie.. to somehow help memorization. Some did it by explaining meanings of difficult words and asking children to repeat sentences.Others focussed on diagrams which helped children in recalling the answers All these indicate the fact that rote becomes an inescapable route to cross the examination in such given conditions. If conceptualization and understanding are required, then curriculum and texts will have to be suited for that. Teachers alone cannot do this job especially in cases of such abstract topics. Good teacher themselves are at the receiving end in such difficult circumstances.

(3) IGNORING THE COMPLEXITY

Through out this report, we have attempted to focus on the abstract and complex nature of the concepts involved as well as need for sensitivity towards children's age. The latter signifies status of receptivity that children naturally show towards learning of complex processes. But in the argument put forward by many that 'basics' need to be given at an early age, the logic and methods seem to follow quite a different path. Everyone agrees that small children at primary and early middle school levels do not grasp complex situations as high school and more senior students can do. Yet the argument for early introduction of 'fundamentals' of subjects is strongly adhered to. The way seeked out is to express complex processes in simplified form. Thus we have a very 'simplified' version in the primary school and a less simplified one in middle school. Simplification actually is streamlined to mean summarization or compression of information and deleting of some information. It is a very widespread method followed by textbook writers in the hope that it would cater to a required sensitivity towards children of smaller age groups. There is much that is wrong with such simplification. They usually represent only the end results and all the derivative processes and implications of the results are ignored. Hence the kind of understanding achieved this way remains superficial and lacks depth.

M.Donaldson uses the term, *disembedded thinking*, which is useful in understanding the problems of 'simplified' explanations. She describes disembedded thought as follows:

"It is when we are dealing with people and things in the context of fairly immediate goals and intentions and familiar patterns of events that we feel most at home. And when we are asked to reason about these things, even verbally and at some remove from them, we can often do it well. So long as our thinking is sustained by this kind of human sense, and so long as the conclusion to which the reasoning leads is not in conflict with something, which we know or believe or want to believe, we tend to have no difficulty. Thus even pre-school children can frequently reason well about the events in the stories they hear. However, when we move beyond the bounds of human sense there is drastic difference. Thinking which does move beyond these bounds, so that it no longer operates within the supportive context of meaningful events, is often called "formal" or "abstract". But these words are used in so many different ways that, to reduce the risk of confusion, they are perhaps best avoided here. I shall speak rather of "disembedded" thinking, hoping that the name will convey the notion that this is thought that has been prised out of the old primitive matrix within which originally all our thinking is contained.

Nevertheless, it is easy to see why the word " formal" is often employed to refer to disembedded thought, for one way to move beyond the bounds of human sense is to express

the form or logical structure of the reasoning in a way that leaves out content or meaning entirely". (Donaldson,1985, 76)

She cites many examples of children (and also adults) who when faced with new concepts/questions tend to give meaning to this in a human sense manner, thereby at times changing the intention or the premises of the question.

Donaldson further argues that though disembedded thought is one of the goals of formal education, one must recognize the difficulties in acquiring such a mode of thought:

At this point it may be well to emphasize that movement beyond the bounds of human sense is not an all-or-none affair. It is not a matter of taking a single step which makes us capable of efficient disembedded thinking thereafter in all circumstances. Thus a child who has begun to learn to tackle certain problems which have been "prised out" from the supportive context of the rest of his experience is not thereby rendered instantly competent in the handling of formal systems of thought such as mathematics. And after in life it remains possible-indeed normal-to come to be at ease with some formal system but not with others.

Simplified texts are neat presentations in a formal manner (usually very tight and terse). When a student tries to construct meaning out of this, he/she would by natural inclination try to add human sense to this, i.e. to embed it. Problems begin since their question largely remains unanswered. The easy way sought out is to cram the formal logic and ignore the curiosity as to how it is arrived at.

There is no scope here for the numerous human sense questions, which would arise like:

If the earth is spinning how come we don't feel this?
On what does the earth rotate? Can we see it rotating like we can see a top spinning on a floor?
Which way to rotate the globe, east to west to east, north to south, south to north?
Why don't we fall off the sphere (earth)?

A formal presentation is seen whose logic is tight and terse and reads like the concluding statement of a complex model. The premises of the model are not handled anywhere. It is simply assumed that children will understand the arguments. The complexities are avoided or hidden and we assume that we have thereby made things easier. But the fallacy of the whole situation is precisely that. As elaborated earlier children cope with the situation by searching for some logic with examples from life around them. Thus the complexity we conveniently pushed away gets thrown up as puzzles, confusions etc. In this way we create a situation which does not help children move from embedded to disemdedded thinking. The necessary and enabling route to disembedded thinking is largely neglected by our teaching- learning process.

What makes disembedded thinking even more difficult as in the case of concepts considered in this study, is the fact that the formal model often appears to contradict common sense. The fact that day and night are caused by rotation and not as it appears by the movement of the sun-this is not easy to internalize. The history of thought in astronomy shows that sun's movement around the earth was so prominent a notion that the earth's movement was not an easy question to settle, leave aside the prejudices. An earth- centric model was easier to

visualise since the sun *apparently* moves around the earth. Every day observations have to be thought of differently, if we have to grapple with this model.

Simplification does not aid the process of understanding when done at the expense of ignoring really occurring complexities. In fact it unnecessarily muddles up the situation by blocking off questions, and the natural urge to understand in an embedded manner. Hence it does not synchronise with the natural paths of learning.

CONCLUSION

The text shows all symptoms of doing an exclusive service of information provision. It does not seem to show concern on what children require in terms of conceptual understanding. The topics we dealt in the survey are abstract in nature and they are realistically complex. A large number of processes occur simultaneously. Hence a large number of subconcepts are involved. But it is only the final scene that is given to children using a method of simplification of complex processes. Prerequisites are simply taken for granted. All put together, children cannot come to terms with them, except at very marginal levels. With such marginal understanding, they construct commonsense notions, which have paved way to construction of lots of misunderstandings. This continues to higher classes as well because there does not seem to be more opportunities given to children after the sixth standard to really look into these topics. The system encourages escape methods like formula learning, tautologies and metaphors. Classroom observation have shown us that teachers independently can do very little to help children out of such situations because they are bound by the framework of the transaction which necessarily has to be the text.

CHAPTER 4

THE THRESHOLD

INTRODUCTION

We have had an elaborate look into the popular misunderstandings held by children. This represents the most striking scenario that the survey has revealed. At the same time, there remains a crucial question of what children have managed to understand conceptually. Here we try to map out the threshold. This mapping is not concerned with the popular error patterns or the exceptional remarkable responses. The mapping is of achievements that schooling has made in a true sense. It therefore provides a picture of what children have grasped and retained in the context of right conceptualisation.

The main framework followed is of assessing scores attained by children and interpreting this with the trends seen in the written and oral rounds. The threshold of understanding within each of the three concepts and the specific situations of the subgroups are looked into. Moreover, we search for patterns of change in scores from junior to senior levels in the background of popular hypothesis that conceptualisation matures with age.

THRESHOLDS OF EACH CONCEPT

The three concepts examined in our survey i.e. day & night, seasons, latitude & longitude are closely associated with each other. Here we take each of the concepts separately to view the thresholds drawn by children. They do mark different levels and the implications at more disaggregate levels of the concepts are also examined.

DAY AND NIGHT

There were three questions on 'day and night' accounting for a maximum mark of three. It is striking that only 57% of the students have a positive score (see table). The rest of the students have not got any mark at all. Amongst those who have got some marks, the majority (40 % of total) have only a score of 1.

Table 1– Scores for *'Day and Night'*

Marks	Students (%)
0	43
1	41
2	14
3	2

Amongst the three questions one is direct and the other two are application kinds. Hence only a score of greater than or equal to 2 can be considered to indicate some conceptual grip. Such

students form only 16% of the total. In other words, 84% of our students are unable to apply the concept[1].

The process of day and night is complex and involves simultaneous visualisation of a number of factors. Our application questions, written queries and discussion had provided a larger canvas for tracing children's grasp over these factors and processes. It was found that the status of children traversing from definition levels to that of understanding and reasoning is really poor. If we are able to draw a general threshold of right conceptualisation, it consists of (1) a feel of earth's sphericity and that therefore all parts of it cannot have day and night at the same time (2) an east-west demarcation of day and night areas on earth.

There is a general feeling that all parts of the earth cannot have day and night at the same time. This understanding or visualisation is inherent in popular response like "that part of the earth that comes in front of the sun will have day and the other part which comes behind will have night)" Children were commonly found to be demarcating a patch of darkness in areas away from the sun and daylight in areas facing the sun. These patches popularly followed an east-west pattern like that shown in fig. Inclusion of tilt factor was only rarely done like given in fig 2. But how does the light area change to darkness and vice versa? This largely remained unexplained (see fig 1)

Figure 1

The tilt is not generally identified, but there is an identification of east-west spread of light and dark areas. The polar areas, especially that which was tilted away from the sun became constant areas of doubt. Those were not identified as areas of daylight. Thus we had two patches on either side of "day area" where children could not make up their minds of a possibility of daylight falling at any time (elaborated in chapter 2).

Hence even though there is recognition of the earth's sphericity and some association of rotation with day & night , very crucial factors like spinning movement and the earth's tilt are not being touched at all by children. These remain outside the threshold of understanding.

SEASONS

There were only two questions on seasons, one direct and the other an application kind. Therefore we take a score of 2 as indicating some understanding. Only 5% of the students seem come in this fold. About 25% of the students indicating fall in what can be called the recognition area (recognition of definition, not implying any understanding). An overwhelming large bulk (70%) of the children seem to be quite lost as far as the concept

[1] For a very cautious view we could compare this distribution with a probability distribution, based on random choice. This would indicate results if children had used random ticking of answers (in the multiple choice questionnaire) without actually giving thought to what the queries and choices imply. The comparison shows that the two distributions are not different. This means that a mere random choice response to our questionnaire would have been no different from the pattern we have got. The implication is that schooling in geography does not seem to reflect any positive impact as far as understanding 'day and night' is concerned.

'seasons' is concerned (see table-2). A large number of children were unable to answer even the direct question mainly because tilt was not being recognised as a crucial player.

Table 2 - Scores for the *'seasons'*

Marks	Students (%)
0	70
1	25
2	5

From the written and oral responses, the threshold of right conceptualisation is seen to be limited to (1) earth moves around the sun; and (2) seasons change; all parts of the earth do not have same season. These indicate only a very bare threshold, which does not even touch the main body of processes and reasons that operate in causing seasons. Of all the three concepts we considered, 'seasons' define the most hazy threshold. Concepts like the tilted earth, direct and slanting rays of the sun etc. do not figure anywhere in the picture...[2]

LATITUDE AND LONGITUDE

Whereas two queries pertain to recognition of latitude and longitude lines, another one tests its imaginary nature. (Not really to be seen on the earth's surface). The remaining three questions are of an application variety. Therefore a score of > or = 4 is taken to indicate some conceptual grip. Such students form only 15 % of the total sample. Most of the students (67%) are concentrated around scores 1 to 3, meaning that they are able to identify the lines but not go beyond that. As compared to the other two concepts, students who are totally clueless on this concept are less (only 18%).

Table 3: Scores for 'Latitude & Longitude'.

Marks	Students (%)
0	18
1	27
2	23
3	17
4	9
5	5
6	1

Children (amongst those who have attempted to answer) generally seem to identify latitudes and longitudes as a set of lines on maps, even though they may easily switch one for the other[3]. The globe is not a familiar point of reference. Only in very few schools have children

[2] It is seen that the scores of probability distribution is better than that of the observed distribution (this further strengthens our observation that children have not generally resorted to random ticking of answers) This is an implication of a conspicuous low level of understanding of the concept. Without any grasp or schooling, children could have done better than what they did. Children seem to be consciously choosing the wrong answer. Here we recall the fact that the most popular misunderstanding of concepts were recorded for seasons (see previous chapter). This logically explains the poor distribution pattern .

[3] Considering the observed and the probability distributions, the mean of the former is greater than that of the latter and this differences is statistically significant. This indicates a positive impact of schooling, a departure from assessments of the other two concepts.

actually seen a globe and even then they have seen it at a distance, on the teacher's table. Only half of the children felt that latitudes and longitudes constitute an imaginary concept and is not one that can actually be seen on the earth's surface. Only one-fourth of the children can correctly name the lines. These two points together demarcate what can be called a general threshold of understanding on latitude and longitude. These are the main two factors that children generally seem to have understood. Desired or expected conceptual details beyond this seem very vague. Thus basic mathematical concepts of a sphere and its linkages with latitude and longitude or even the simple function of these lines as co-ordinates to locate places are not familiar at all. More complex functions like that of longitudes usage in finding time of a place etc. are not found anywhere on the scene.

Considering the second set of questions that looked into uses of latitude and longitude, it is difficult to mark out a threshold of understanding. Even a liberal assessment of answers show that very few students are actually aware of these lines as even serving the basic function of co-ordinates and hence of location of places.

Some extremely rare responses at the 10^{th} standard throw light on function of latitude and longitude as co-ordinates. Here the use of the lines for location of places has been elaborated as "intersection of latitude and longitude lines" or " first we have to know the degree measures given behind the map in the atlas, then with the help of these lines we can find the place". This is a rare reflection of familiarity with usage of index of atlases. In order to examine this ability in a more rigorous manner we looked at the number of students who were consistent in their answers. Only 16% of the students could recognise these lines on a map and also identify them as imaginary. However only 7% could both recognise and locate correctly.

The three questions in the written paper pertaining to uses of latitude and longitude focused on particular uses of the lines. Children were asked to opt for 'yes' or 'no' and give reasons for their answer. The queries looked into functions of latitude and longitude in terms of location of places, representation of temperature of different places and determination of distance between places. Obviously the latter two statements are not exactly functions of these lines. It would be useful to recall here that these statements were taken from children's own popular (mis) understanding of these concepts assessed during the pilot rounds of our enquiry. It is seen that children have in large numbers opted for 'yes' for each of the given three statements. This indicates a good amount of confusion and added to this is the fact that they have not been forthcoming in stating reasons for their choice. Wherever reasons are given, they are very vague.

The discussion rounds make the above findings even more glaring. It was more difficult to make a discussion on this topic compared to the other two topics (day and night and seasons) of our survey. In order to start the conversation, we had to often introduce latitude and longitude by demonstrating the lines on the globe ourselves. We found that the equator seemed to be a comparatively more familiar term. By giving a little time for children to explore the lines on the globe, it was possible to reach a certain level of minimum clarity to start the conversation. Though the names of these lines were often confused (i.e.. latitude as the east-west line and longitude as the north-south line), they took interest to explore the layout of these lines on the globe. This is particularly true of the eighth and tenth standard students. But even here the non-familiarity of these concepts and its newness amongst

children made a discussion with them on this topic not very feasible. After identifying these lines on the globe, they sometimes became doubtful whether these really are seen on the earth's surface as well. Sometimes they responded that these lines cannot be seen at all places, but at some places on the earth. Often we tried to make them trace a particular line with their finger and to tell them which is the latitude and which the longitude. After this, attempts at probing into how latitude and longitude indicates temperature of places, distance between places, location of places etc. Were done. But it was quite beyond them to actually reason out these matters. Often they became silent and we had to give up. This state of affairs was generally true across the board, from junior to senior classes

IMPLICATIONS OF SCORES

A total of 11 questions were given to students. For each correct answer, we assign a score of 1 and for each unattempted or wrong answer, the score is 0. The overall mean score is obtained as 3.02 with a standard deviation of 2.01[4].

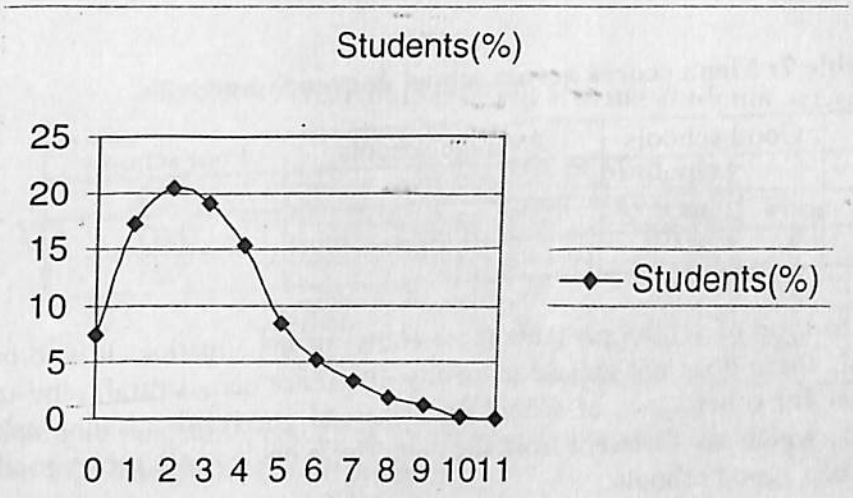
Table 4 : Overall scores

Marks	Students (%)
0	7.4
1	17.3
2	20.5
3	19.1
4	15.4
5	8.4
6	5.3
7	3.3
8	1.9
9	1.1
10	0.2
11	0.0

The largest concentration of students are seen around scores 1 to 4. From score 5 onwards, a tapering is seen. In other words, 80% of students have a score equal to or less than 4 (<4). A general thumb rule that one can follow is of a popular expectation of at least 50 % marks that is considered to show some achievement. But the situation here is far below such expectation. Only around 20% students seem to reach that level (students with score >5).

A more focussed scale of judgement of scores can be drawn in our specific context. Among the 11 questions, 5 are of a general and simple nature the remaining 6 are more demanding as they need application of concepts. Therefore a score of >6 (or atleast >5) can be considered to indicate some understanding. A score of 3 or 4 would indicate only a bare recognition of some factors, implying correct identification of definitions etc. This situation is strengthened by the fact that the highest scoring questions are all of the direct type (see table 5)

[4] If we examine the observed distribution with the probability distribution, both seem to follow a similar pattern. But the difference between them (one with a mean of 3.02 and the other 2.75) is statistically real..ie.. The difference is positive, but only marginal. This difference actually indicates the impact on geographic understanding by schooling. The impact seems to be marginal.



Distribution of Students by Overall Scores

Table 5 - Highest scoring questions

Question	Score (%)	Type of question
10	50	Latitude & longitude as imaginary lines
6	35	Recognition of longitude
4	33	Sphericity diagram
3	31	Recognition of latitude
1	29	Association of day & night with rotation

Around 35% of the children have registered at the level of 'recognition' and another 20% are able to move beyond (see table 4). Hence this is what we can broadly term the threshold of understanding.

Only less than 12% students can be said to show any understanding. Even if we use a more liberal scale of >5 as the cut-off point, only 20% are seen to register some conceptual understanding. Moreover the overall average score of 3.02 really stands in very poor light, being only half of the expected score for any level of understanding.

HIGHER THRESHOLD

During the course of our work we often encountered the remark that the urban environment is different and children with a lot of exposure are not faced with the conceptual problems that we are addressing. It was for this reason that as part of analysis in a previous chapter (Popular misconcepts) we examined the situations of various subgroup of school students. Looking at the overall scores (table 6), it does appear that the urban position is distinctively better than the other groups, even though it may not be satisfactory on its own. The urban mean score of 35% is low. As our earlier analysis shows popular misconception is dominant in the urban pocket too.

Table 6: Mean Scores of area subgroups

Subgroup	Mean scores	% Mean score
Overall	3.02	27%
Rural	2.50	23%
Semi Urban	2.75	25%
Urban	3.89	35%

Table 7: Mean scores across school & area Subgroups.

Subgroup	Good schools	Average schools	Poor schools
Rural	2.71	2.46	2.35
Semi urban	3.49	2.50	2.23
Urban	5.05	4.37	2.23

The data according to type of school presents more clarity of the situation. It is to be noted that for 'poor' schools there does not appear to be any difference across rural, semi-urban or urban area.. However for other types of school (average and good) urbanisation appears to have created pockets, which are different from the rest. These pockets are urban good, urban average and semi urban -good schools.

Whatever meagre understanding or threshold levels these figures indicate, there are pockets, which are in a relative sense better off that the rest.

Another way of looking at this situation is to trace the subgroups of students who show relatively better performance. We had five direct questions and six application kinds of questions for the multiple-choice paper. Hence a score of six and above would indicate some understanding of the concepts involved. Student's attaining such scores can be said to be at the threshold level.

Table 8 : Distribution of marks and for Overall and urban good school

	Overall		Urban good	
Marks	% students	cum %	% students	Cum %
0	7.4	7.4	0.5	0.5
1	17.3	24.7	3.3	3.8
2	20.5	45.2	8.0	11.8
3	19.1	64.3	15.6	27.4
4	15.4	79.7	13.2	40.6
5	8.4	88.2	16.5	57.1
6	5.3	93.5	16.5	73.6
7	3.3	96.8	11.3	84.9
8	1.9	98.7	10.8	95.7
9	1.1	99.8	3.3	99.0
10	0.2	100.0	1.0	100.0
11	0.0	100.0	0.0	100.0

We can say that 11.8% of the students (see table 8) have a score of six and above. Using the same cut-off point, (cumulative 100-88.2) the urban -good school group this percentage of students increases to 43. (Cumulative % 100-57) Whereas the threshold covers only 12% students in the overall sample it covers 43% students of urban good. This marks a substantial difference. This is the upper limit achieved in best of school situations. But even then at least 60% of students are below the threshold level.

When we trace the top 12 % of students (i.e. 240 students with a score of 6 and above) to their school and area background the following picture emerges:

Table 9 : Distribution of top scoring students across areas & schools

	No. of Students			
School/Area	Good	Average	Poor	Total
Rural	13	10	8	31
Semi Urban	25	15	3	43
Urban	91	68	7	166
Total	129	83	18	240

We find that students who show some understanding are mostly situated in the better off and average schools largely in urban areas.

To recapitulate, even in the best of situations such as the urban good schools the threshold level is achieved by only 40% of the students. The best students are scattered across the subgroups but they are concentrated in the urban-good, urban -average and to some extent in semi- urban good schools. These students are probably able to recognise the lines of latitudes and longitude and to a moderate extent apply these for locating places. They may also be able to recall the two movements (rotation and revolution) separately. Though they are not free of the common misconceptions, they are able to distinguish some totally irrelevant options and make a good guess. However overall conceptualisation among any category remains weak in any subgroup specially when dealing with the concepts of earth's phericity, its direction of rotation, its tilt and its movement around the sun (revolution), differences between its two movements (rotation and revolution) and functions of latitude and longitude for or not used for.

MATURING OF CONCEPTS

A view often expressed is that many concepts, which may appear to be apparently difficult, should be introduced early in the school curriculum because the understanding of such concepts will mature with time.

Does the understanding of these concepts mature as students move from class 6 to 10? This is the question that we would try to answer in this section. We have also taken a small sample of college students, - BA and MA for the sake of comparison.

One way of looking at the variation across class 6 and 10 would be to examine the scores in individual questions. An examination of this data (see table 10) does not reveal any dramatic progress as students traverse from class 6 to class 10. Both positive and negative variations negative variations (or growth) are seen in small quantities. The only exception is Q 10. The written responses of children also indicate similar trends. But they discussion rounds showed that though conceptual maturity was not impressive at senior classes children's eagerness and curiosity to explore complex situations did show an increase. As elaborated in the previous chapter, one of the problem area is that we to not take such matural growth of children (with age) into consideration. The irony is that the natural growth of maturity does not get synchronised with the way we handle concepts in school.

Table 10: Distribution of Right response across classed (% students)

	Class		Variation 6 to 10
Question	6	10	
	25	30	+5
	12	11	-1
	13	18	+5
	30	38	+8
	17	27	+10
	36	30	-6
	312	30	-2
	24	17	-7
	29	29	0
	38	55	+17
	26	28	+2

A different way of looking at variation across class 6-8 to 10 would be to examine the top 12% of students, who have scored 6 and above. These students seem to be almost equally distributed across class 6 to 10 (see table 11). If maturing with age is strong we would expect class 10 students to form a larger share than the others. But this is not happening.

Table 11: Distribution of top scoring students across classes

Class	% Students
6	34
8	32
10	34
Total	100

Another way of assessing this situation is through average scores.

Table 12: Average scores across classes

Class	Mean	sd
6	2.82	1.97
8	3.16	1.97
10	3.13	2.09

There is a small (statistically significant) growth from class 6 to class 8&10. However the differences between class 8 and 10 is not statistically significant[5].
Another assessment is done through examination of specific school situations. The question then posed concerns maturing of concepts in urban schools, in good schools and in the urban good schools.

The hypothesis is that in condition maturity, its visibility would be most in better off school situations.

[5] For testing of difference between means we have used the Z test. at 1% level of significance.

Table 13: Average scores across classes in best subgroups

Subgroups/classes	6th	8th	10th
Urban schools	4.03	4.04	3.62
Good schools	3.74	3.94	3.62
Urban good school	5.43	5.32	4.06

It is seen that in the better off situations there is not even a single indication of maturing leave aside an expected trend stretching from class 6 to 10 (see table 13). In the urban schools and good schools the differences between mean scores for class 6-8-10 are not statistically significant. To make matters worse there is some indication of statistically significant 'decline' in the case of urban good school, which symbolises the best school situations.

An examination of date for each concept reveals no great indication of maturity. For instance (table 14) there is no significant difference, (statistically) in the average scores for 'latitudes and longitude'. However, for 'Seasons' there is a marginal but positive move since class 10 seems to move ahead of class 6 and 8. For 'Day and Night' there appears to be a positive move at higher classes as compared to class VI. Thus for two concepts there appears to be marginal better performance at class X .

Table 14 : Mean scores of concepts across classes

Concept/Class	VI	VIII	X
DAY & Night	0.67	0.83	0.79
SEASONS	0.3	0.32	0.45
LATITUDE& LONGITUDE	1.85	2.00	1.89

We have looked at a variety of evidences for movements of maturity from class 6 t 10 i.e. response to individual questions and written responses; the scenario among the best students; overall average scores and average scores among the better school situations and average scores for the three concepts. Looking at all these together, we can say that there does not appear to be a clear indication of maturing. Therefore the logic that these concepts introduced at class 6 level should mature as student move to higher classes appear doubtful

COLLEGE SCENARIO

The scenario of graduate students (see table 14) is not much different from that of the 'good' or 'urban' school groups. Their scores could be compared with the urban sample. They are at the same level as the urban average schools. Their position is little better than the 'poor' schools but worse than the urban- good sample. This situation can partly be explained by the fact that they have had no opportunity to clarify the basics as part of the curriculum. It has also to do with the causal nature of graduate studies and predominant short-cuts like '20-question' approach where conceptual development is not an issue or priority.

Table 15 : Mean scores for college

Graduation	4.0
Post graduation	7.0

At Post graduate level, the performance (see table 15) is distinctly higher then the others. The

mean score (%) works out to be 64 as compared with 46 for the best group among school students. There appears to be stagnation for 10 years and after that a distinct spurt in achievement at the Post graduation levels. Hence it is not to be seen as the result of an increasing transition towards understanding concepts. The picture is more of a sudden jump at the postgraduation.

A question that arises is of whether the post graduate performance satisfactory on its own terms. Should it not have been much higher i.e. 80 to 90% considering the fact that these concepts are treated as 'basics'. Moreover postgraduation indicates traversing of 15-16 years of schooling and some years of specialised geography learning.

The situation seems to be that students do not appear to be 'challenged' in their basics, until they reach the post graduate levels. Data clearly show a stagnant position from class 6 to graduation. This stagnation spreads is over 5 years of general geography learning and 5 years of specialisation. Undoubtedly, this represents a tremendous waste of intellectual effort and energy. We recall the remarks of a Professor on his postgraduate students. He said that 'basics' had to be handled very tactfully, because students are resistant and put up a false front that they know `all these'. Beyond a stage, this stagnation may appear to become regressive. We may therefore be faced with a dual phenomenon i.e. it could be that very complex elements are introduced too early and the real effort at getting these concepts across is attempted too late. The idealised conception of a gradually maturing understanding appears to be totally absent.

An important indication obtained from our discussion rounds is that concepts are pitched at an unsuitable level and then assumed that these would be understood. At class 6 level discussions on earth's tilt, angles, direct & indirect rays of the sun etc could not proceed very much. The children lost interest and wanted to talk about much more concrete things. But at class 10 there was often a general curiosity to understand these questions. Children responded and asked questions. In some schools class 10 students wanted us to go through the paper with them. They would sense certain contradictions and also sense that they were going astray.

If for a moment one accepts the idea that the concerned topics are 'basics' that need to be introduced early in school, there are inherent problems of learning materials and processes. In such given conditions, the hypothesis of concept maturing with time is not exactly applicable.

CONCLUSION

In this chapter, we tried to map out the threshold of actual achievements of children (right concepts). Looking at the range of subconcepts of each of the topic (day and night, seasons, latitudes and longitudes), it is only a very marginal area on which children seem to reach ; it represents a very low threshold. Higher thresholds are found in urban pockets , especially in the 'good schools'. But even here the pattern of wrong notions are quite popular and a fairly large proportion of children still remain outside the threshold. Postgraduation represents an area of spurt in achievements. We do not find that a gradual process of improvement in conceptualisation takes place. The irony is that paths of schooling does not seem to synchronise with natural tracks of maturity that children exhibit.

CHAPTER 5

BACK TO GEOGRAPHY

There are two main implications of the study. One pertains to a pedagogical one where we look into possibilities of a better transaction of the concepts. Thus proposition stands within the given framework of enquiry. The second and perhaps more important implication pertains to the nature of geographic enquiry. Here the given framework is questioned and the feasibility of a range of starting points of a geographic framework is put forward.

PEDAGOGIC IMPLICATIONS

The most prominent finding of the survey is that the mental constructions of children on matter like earth's movements stand on a path quite diverged from what we try to teach them. This divergence is neither marginal nor representative of some transition. It rather seems to be representative of stagnation at levels of simple logic of commonsense. The role of schooling comes in to question here. After a long travel through enquiry into astronomy, the human intellect has derived and ascertained the nature of movements of celestial bodies. Schools would be expected to have dialogues on that with learners so that a student learning astronomy should be able to travel from commonsense inferences regarding the earth's movements to actually occurring processes. This, unfortunately, is not happening. Why is the system failing? Our enquiry takes us mainly to the factor of receptivity children can exercise at different age groups. Children naturally mark out a pattern of engagement with the world and of analysis, learning and intellectual exercises. These seem to need different parameters at different periods. The requirements of concrete situations which are strong amongst small children seem to diminish as they grow up and reach level where the can engage with abstractions (to whatever degree). Hence the complex model of earth and sum discussed in the framework of celestial movements, spherical geometry and physical properties of light and heat can not play the role of a learning material for children who are groping with concreteness to understand the world. Such material could be explored by more grown up children. Thus the main thrust put forward here is to call attention to the need to make learning materials that are appropriate for children's learning needs at various stages. This is a pedagogic/requirement.

Apart from the need to shift abstract and complex chapters to senior levels of schooling, there is also a need for the various disciplines to engage in some common designs and to play complementary roles. There is a need to break the barriers of rigid boundaries of disciplines. E.g. physics, geometry and astronomy will have to assess their inputs and synchronise them so that provision for learning and understanding of concepts becomes an enterprise of combined effort. It is also judge that there can be various starting points and phases of continuity in conceptualisation. Children need not be burdened with a one shot situation where everything they have to know about earth's movements is provided in a single exposure. Some exposure to history of astronomy, to observation, experimentation etc. at appropriate stages could lend meaning and dimension to the topic. These are some of the possibilities that came up in reflection on the probable circumstances that lead to the particular nature of children's responses.

GEOGRAPHIC IMPLICATIONS

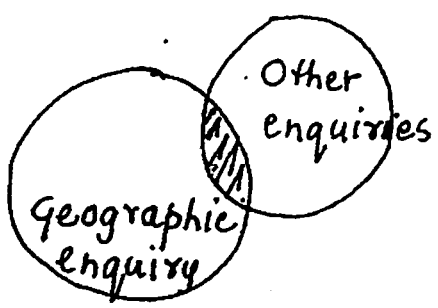
Every discipline has certain approach and parameter that define the particular nature of enquiry it undertakes. It is a basic understanding of these approaches that constitute the elementary knowledge 'fundamentals' of disciplines. The common practice in school education points out that topics like earth's movements occupy the space that should rightly go to the fundamentals.

This is felt because the approach used for teaching such topics fails to use a geographic perspective. A geographic framework has spatial interconnections at the core of its concern. This implies that the distribution of any factor, say heat (to stay within the context of topics like earth's movements) over the globe in itself does not form an exclusive and sufficient frame for geographic enquiry or understanding. Another concern is the need to assess and review the role played by interdisciplinary approaches. Let us examine these geographic implications.

INTERDISCIPLINARY APPROACH

Interdisciplinary planes become significant for inquiries and often become very necessary at research levels. Geography has defined innumerable such overlaps with meteorology, geology, physics, anthropology, history... etc.

We call attention to overlaps because the appearance and nature of many chapters in geography (the ones we have taken for the survey also included) owe heavily to them. The problem is not of overlap per se, but on the way that inferences are drawn from other disciplines to strengthen a geographic enquiry. In our geography school texts, we find chapters roaming around in the outer circle and not making an attempt to travel back to the circle of geographic enquiry (see figure).



'The movements of the earth' is an ample demonstration of this situation. From the circle of geographic enquiry, the geographer traveled to the circle of astronomy. After making the required queries, there should have been a return journey. Unfortunately, this was not done. Chapters like 'the earth's movements' was written from the outer circle itself., chapter. In doing so, the original questions in mind (for whose clarity the travel was done) were forgotten. Thus we failed to tell children the rudiments of geography. This is why a critical analysis of such chapters will find it difficult to place them within the discipline. The approach used is basically of an astronomical enquiry where the parameter relies very much on spherical geometry.

SOCIAL MATRIX

Even though the approach of chapter like 'earth's movements' is of astronomy, we searched for aspects that could be dealing with distribution (of any phenomenon) on earth's surface. This is the nearest demonstration of a geographic concern e.g. we find illustrations of heat zones over the earth's surface. But it does not give space for any explanation beyond global distribution. Such distribution patterns can only be a starting point for some analysis to come. Obviously that is has not the case here. It therefore does not go beyond 'a simple demonstration that the spatial lattice exhibits, in frozen and displaced form....' (Gregory, 1978, 120). A geographic inquiry will have to take cognizance of the fact that a spatial structure does not exist independently; its has the social matrix interwoven on it. "The real problem turns on the need to recognise (a) that spatial structures cannot be theorised without social structures and vice versa and (b) social structures cannot be practiced without spatial structures and vice versa (Gregory 1978, 121).

This really takes us back to many old debates over geography's unnecessary demonstrations of the 'physical' and 'human'. This gets recalled here because we still see the problem roaming around unresolved in our textbooks. Peter Haggett who tried to work out an approach of synthesis in geography aptly remarks on such textbook practices, "In doing so, there is a hope of some future integration of the two. But how such an osmosis is to take place is ever hardly defined."(Haggett, 1983,14).Practices in geography have gone far beyond this stage, but school texts strangely do not seem to keep in tune with them. Hence the crucial aspect to be tackled in school texts is the practice of geographic approach in tune with a social science enquiry which will bring forth fundamentals or 'basics' that children would appreciate.

BEYOND CONCLUSIONS

The need is to define and work towards curriculum and textbook practices that help children to develop a sense of geographic enquiry. This revolves mainly around two considerations, one of topics and another of approach. Decisions should be made on the understanding that we have a range of students before us from junior to senior levels. At different phases of this range there are varied learning needs that could be described by concreteness, abstraction etc. and movements of the enquiry from patterns and causation to spatial analysis of socio-political relations. Let us try to elaborate these requirements.

One dimension or stage of the range could be described like "as the sun is the primary energy source for the earth, so it is logical to start our investigation of the physical earth by examining its relationship to the sun" (Hardwick and Holtgrieve 1990, 91). We can describe another stage, which is perhaps more elementary in terms of learning needs. This would look into life experiences of people living in say, different heat zones. This would demonstrate patterns of land – human relations and causal relations. (Eklavya has used this approach in some chapters of geography in middle school). Again this zooming-in process which is highly useful, can be representative of only some part of the entire range of schooling.

It is important to note that construction of paths to 'zoom out' of the concrete experiences will be necessary for some proceeding stage. "Social construction of time and space... are shaped out of various forms of space and time and which human beings encounter in their struggle for material survival. For example, night and day, the seasons, life cycles in the animal and plant world, and the biological processes which regulate human reproduction and

the body, are typical encounters with various kinds of temporality. But each of these stands to be modified or even transcended as we harness sources of energy to turn night into day, as we use an international division of labour to put fresh produce into our shops at all times of the year, as we speed up the lifecycles of chickens and pigs through genetic engineering... (Harvey, 1996, 211)

Such spatio- temporal inquiries would throw light on interlinkages, on internal relation and their transformation. Perhaps his is a sort of area in the range which leads to the premises where debates over neutrality and commitment prevails. This is a plank which every social science inquiry arrives at. Since the interlinkages and relations examined are of real social dynamics, the inquiries stagnate in strict neutrality. "The regress of determining relations ends at the level of macro political economy"(Sayer, 1976). This question in geography is explicitly brought out by Smith, "... as soon as we turn our attention to human welfare, particularly to questions of distribution, ethical considerations can not be avoided and political controversy inevitably arises." (Smith, 1977, 364)

Within geographic inquiry, some range can thereby be drawn out. This signifies that various starting options are available and from each there can be long and short journeys which a sensitive pedagogy can tailor. Within such a canvas, how can critical inquiry in geography be developed? Or what is the nature of dialogue at different parts of the canvas? These are matters of detail to be brought out through rigour.

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APPENDIX

The details of the students who took part in the various components of the survey are presented below:

NUMBER OF CHILDREN WHO TOOK PART IN THE SURVEY

RURAL: Ghathi, Semrikhurd and Raipur of Hoshangabad district. Tonkhurd, Padlya, Choubardhira of Dewas district	Multiple choice paper/ classes			Descriptive paper / classes		
	VI	VIII	X	VI	VIII	X
Good Schools	67	61	55	14	15	17
Average Schools	139	62	71	16	12	11
Poor Schools	38	105	69	12	13	17
Total	244	228	195	42	40	45

SEMI URBAN: Pipariya and Parasia towns of Hoshangabad and Chindwara districts respectively.	classes			classes		
	VI	VIII	X	VI	VIII	X
Good Schools	94	46	45	14	15	21
Average Schools	115	90	121	12	13	15
Poor Schools	113	74	50	12	13	16
Total	322	210	216	38	41	52

URBAN: Bhopal & Indore	classes			classes		
	VI	VIII	X	VI	VIII	X
Good schools	83	77	52	14	14	13
Average schools	71	62	66	12	14	15
Poor Schools	57	57	93	10	12	14
Total	211	196	211	36	40	42

Grand Total	**777**	**634**	**622**	**116**	**121**	**139**

Total Sample 2033 Total Sample 376

SUB SAMPLE OF CHILDREN WHO TOOK PART IN THE DISCUSSION ROUNDS:

	VI std	VIII std	X std
Rural	1 group	1 group	1 group
Semi urban	1 group	1 group	1 group
Urban	1 group	1 group	1 group
Total	3 groups	3 groups	3 groups

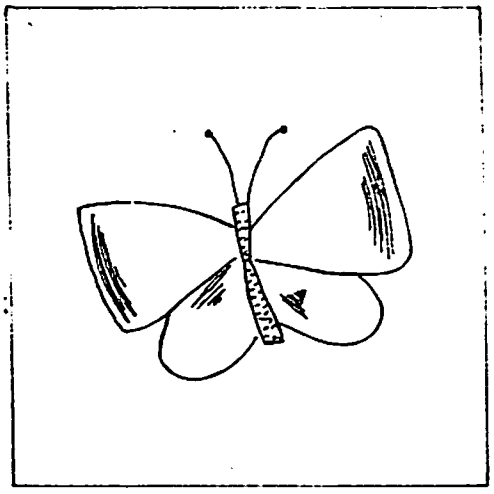
COLLEGE

	Multiple choice paper 1	Descriptive paper 2
BA	36	31
MA	30	29

RURAL: Ghathi. Semrikhurd and Raipur of Hoshangabad district. Tonkhurd. Padlya. Ghoubardhira of Dewas district	Paper 1 classes			Paper 2 classes		
	VI	VIII	X	VI	VIII	X
Good Schools	67	61	55	14	15	17
Average Schools	139	62	71	16	12	11
Bad Schools	38	105	69	12	13	17
Total	244	228	195	42	40	45
SEMI URBAN: Pipariya and Parasia of Hoshangabad and Chindwara districts respectively.	Paper 1 classes			Paper 2 classes		
	VI	VIII	X	VI	VIII	X
Good Schools	94	46	45	14	15	21
Average Schools	115	90	121	12	13	15
Poor Schools	113	74	50	12	13	16
Total	322	210	216	38	41	52
URBAN Bhopal & Indore	Paper 1 classes			Paper 2 classes		
	VI	VIII	X	VI	VIII	X
Good schools	83	77	52	14	14	13
Average schools	71	62	66	12	14	15
Poor Schools	57	57	93	10	12	14
Total	211	196	211	36	40	42

नीचे दिए गए हर प्रश्न के साथ चार उत्तर भी दिए गए हैं। इन चारों में से सिर्फ एक ही उत्तर सही है। इनमें से सही उत्तर चुनकर उसके सामने दिए गये खाने में सही का निशान लगाओ।

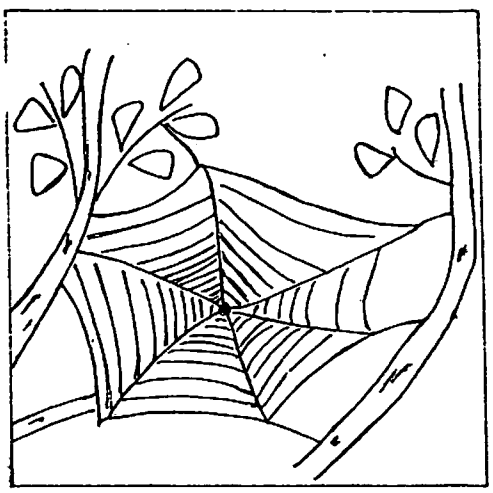
1. चित्र



ये चित्र है :

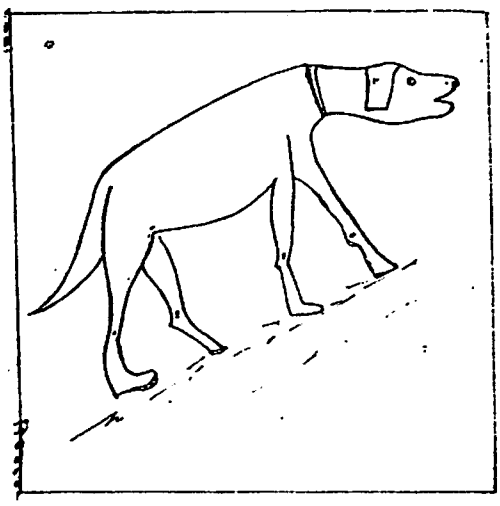
- ☐ चिड़िया का
- ☐ कीड़े का
- ☐ सुन्दर फूल का
- ☐ इनमें से किसी का भी नहं।

2. ये चित्र है :



- ☐ चिड़िया के घोंसले का
- ☐ चीटियों के घर का
- ☐ मकड़ी के जाले का
- ☐ इनमें से किसी का भी नहीं।

3. ये चित्र है :



- ☐ तोते का
- ☐ बन्दर का
- ☐ शेर का
- ☐ कुत्ते का

मेरे बारे में कुछ जानकारी

1. मेरा नाम..... है।
2. मेरी उम्र..... वर्ष है।
3. मेरे स्कूल का नाम.....है।
4. इन चारों में से जो विषय मुझ सबसे ज़्यादा अच्छा लगता है, वो है :
   - ☐ गणित
   - ☐ इतिहास
   - ☑ विज्ञान
   - ☐ भूगोल
5. स्कूल की किताबों के अलावा मैं सबसे ज़्यादा यह पढ़ती/पढता हूँ :
   - ☐ अखबार
   - ☐ पत्रिकायें
   - ☐ कहानियाँ
   - ☑ अन्य किताबें
   - ☐ कुछ भी नहीं
6. मैं एटलस पुस्तिका का उपयोग करती / करता हूँ:
   - ☐ बहुत बार
   - ☑ कभी-कभी
   - ☐ कभी नहीं
   - ☐ मैने कभी एटलस देखा ही नहीं।

ये तुम्हारी परीक्षा नहीं है। इसमें तुम्हें अंक नहीं दिए जाएंगे। इस पर्चे में हर प्रश्न के साथ चार उत्तर दिये हैं। चारों में से केवल एक उत्तर सही है। सही उत्तर चुनकर उसके सामने दिये गये खाने में सही का निशान लगाओ। ध्यान से सोचकर उत्तर लिखना। पर यदि तुम्हें उत्तर नहीं पता हो तो अंदाज से निशान मत लगाओ।

1. दिन और रात होते है क्योंकि

- ☐ पृथ्वी सूर्य का चक्कर लगाती है
- ☐ चन्द्रमा पृथ्वी का चक्कर लगाता है
- ☑ पृथ्वी अपनी धुरी पर घूमती है
- ☐ इनमें से कोई भी सही नहीं है

2. दिन और रात कैसे होते है– इसे समझाने के लिए शीला ने कहा "जब पृथ्वी के उत्तरी हिस्से के सभी स्थानों में दिन होता है तब पृथ्वी के दक्षिणी हिस्से के सभी स्थानों में रात होती है। जब पृथ्वी की स्थिति बदल जाती है तब उत्तरी हिस्से में रात होती है और दक्षिणी हिस्से में दिन।" शीला की बात :

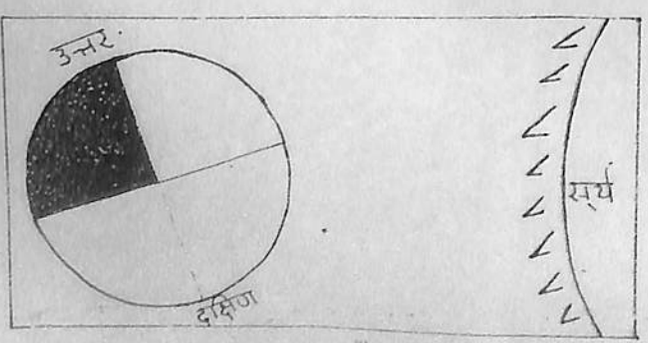
- ☑ सही है
- ☐ गलत है
- ☐ कुछ अंश सही है
- ☐ गर्मियों की ऋतु के लिए सही है

3. दिसम्बर, जनवरी में हमारे यहां ठंड की ऋतु होती है, परन्तु अप्रेल-मई में गर्मी की ऋतु होती है। ऋतुओं में यह बदलाव होता है क्योंकि :

- ☐ पृथ्वी सूर्य के चारों ओर परिक्रमा करती है
- ☑ पृथ्वी अपनी धुरी पर झुकी है और सूर्य की परिक्रमा करती है
- ☑ जब पृथ्वी सूर्य के पास आती है तब गर्मी की ऋतु होती है और जब पृथ्वी दूर जाती है तब ठंड की ऋतु होती है
- ☐ पृथ्वी अपनी धूरी पर घूमती है

4. दिन और रात कैसे होते हैं? ये दिखाने के लिए नीचे चार चित्र बनाये गये हैं। पृथ्वी का काला हिस्सा रात दर्शाता है और बाकि हिस्सा दिन। बताओ कि किस चित्र में रात और दिन सही दर्शाया गया है:

☐



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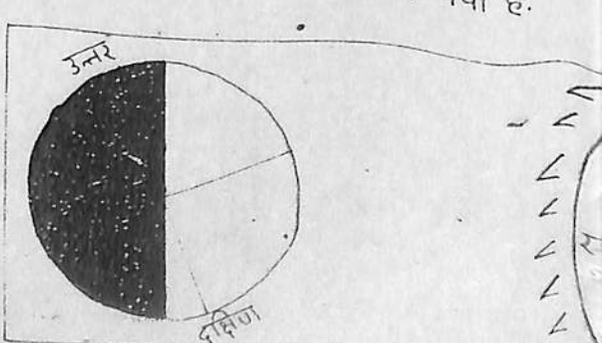
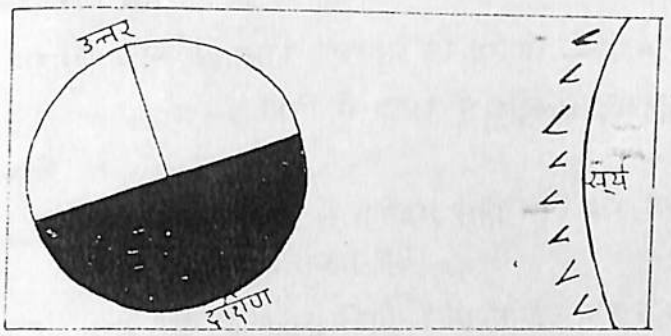
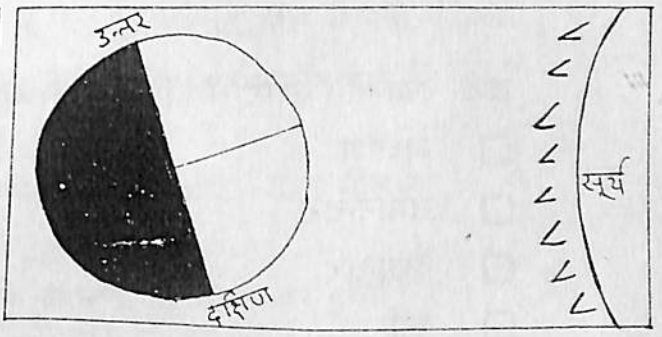


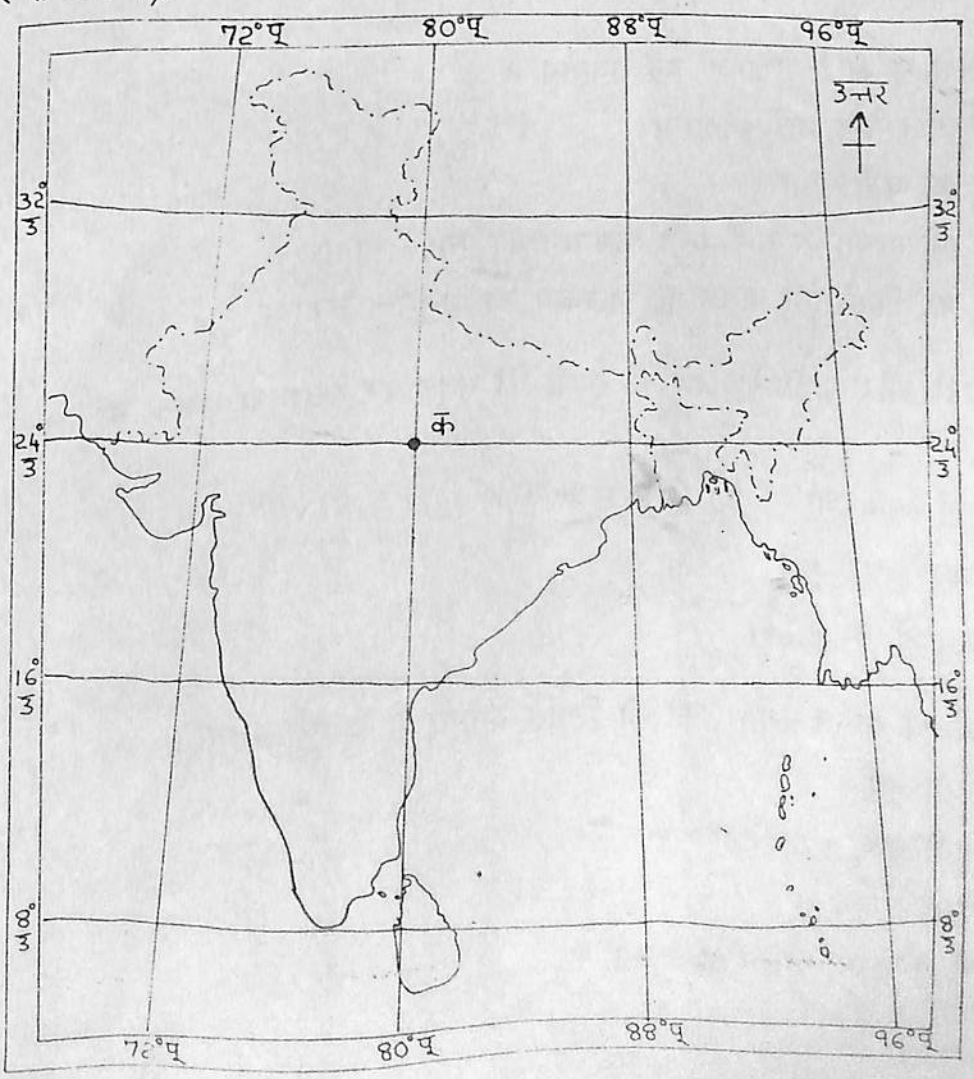




5. नीचे दिए गये ग्लोब के चित्र में भारत और ऑस्ट्रेलिया को देखो। भारत में जब ठंड की ऋतु होती है तब ऑस्ट्रेलिया में गर्मी की ऋतु होती है और जब भारत में गर्मी की ऋतु होती है तब ऑस्ट्रेलिया में ठंड की ऋतु होती है।

- ☐ पृथ्वी के जिस हिस्से में भारत है वहाँ जब सूर्य के किरणें पडती है वहाँ गर्मी की ऋतु होती है और ऑस्ट्रेलिया वाला हिस्से में सूर्य के किरणें नहीं पडती। इसलिए वहाँ ठंड की ऋतु होती है।
- ☑ ऑस्ट्रेलिया दक्षिणी गोलार्द्ध में है और भारत उत्तरी गोलार्द्ध में
- ☐ ऑस्ट्रेलिया चारों तरफ समुद्र से घिरा हुआ है और भारत की स्थिति ऐसी नहीं है
- ☐ भारत भूमध्य रेखा के पास और ऑस्ट्रेलिया भूमध्य रेखा से दूर है

6. नीचे दिये गये नक्शे में देखो। इसमें कुछ आडी रेखायें खिंची हैं (पश्चिम से पूर्व,) और कुछ खड़ी रेखाये खिंची हैं (उत्तर से दक्षिण)।



खड़ी रेखाओं (उत्तर से दक्षिण जाने वाले) रेखाओं को कहते हैं :

- ☐ अक्षांश
- ☐ समानन्तर
- ☐ देशान्तर
- ☐ कर्क

7. दिए गये नक्शे में बनी आडी (पश्चिम से पूर्व जानेवाली) रेखाओं को कहते हैं :

- ☐ अक्षांश
- ☐ मेरिडियन
- ☐ देशान्तर
- ☐ भूमध्य

8. दिए गए नक्शे में खिंची खडी रेखाओं का उपयोग हैं :

- ☐ तापमान का पता लगाना
- ☐ समय का पता लगाना
- ☐ सड़क एवं रेलमार्ग का पता लगाना ।
- ☐ बरसात की मात्रा का पता लगाना

9. दिए गए नक्शे में आड़ी रेखाओं का उपयोग है :

- ☐ सड़क और रेल मार्ग दिखाना
- ☐ समय का पता लगाना
- ☐ किसी भी जगह के सही सही तापमान का पता लगाना
- ☐ पृथ्वी पर किसी भी जगह की जलवायु का अनुमान लगाना ।

10. क्या इन आड़ी और खड़ी रेखाओं को पृथ्वी की सतह पर देखा जा सकता है

- ☐ हाँ
- ☐ नहीं
- ☐ कुछ जगहों पर
- ☐ कुछ ऋतुओं में

11. दिए गए नक्शे में अगर स्थान 'क' की स्थिति बनाना है तो ऐसे बनायेंगे।

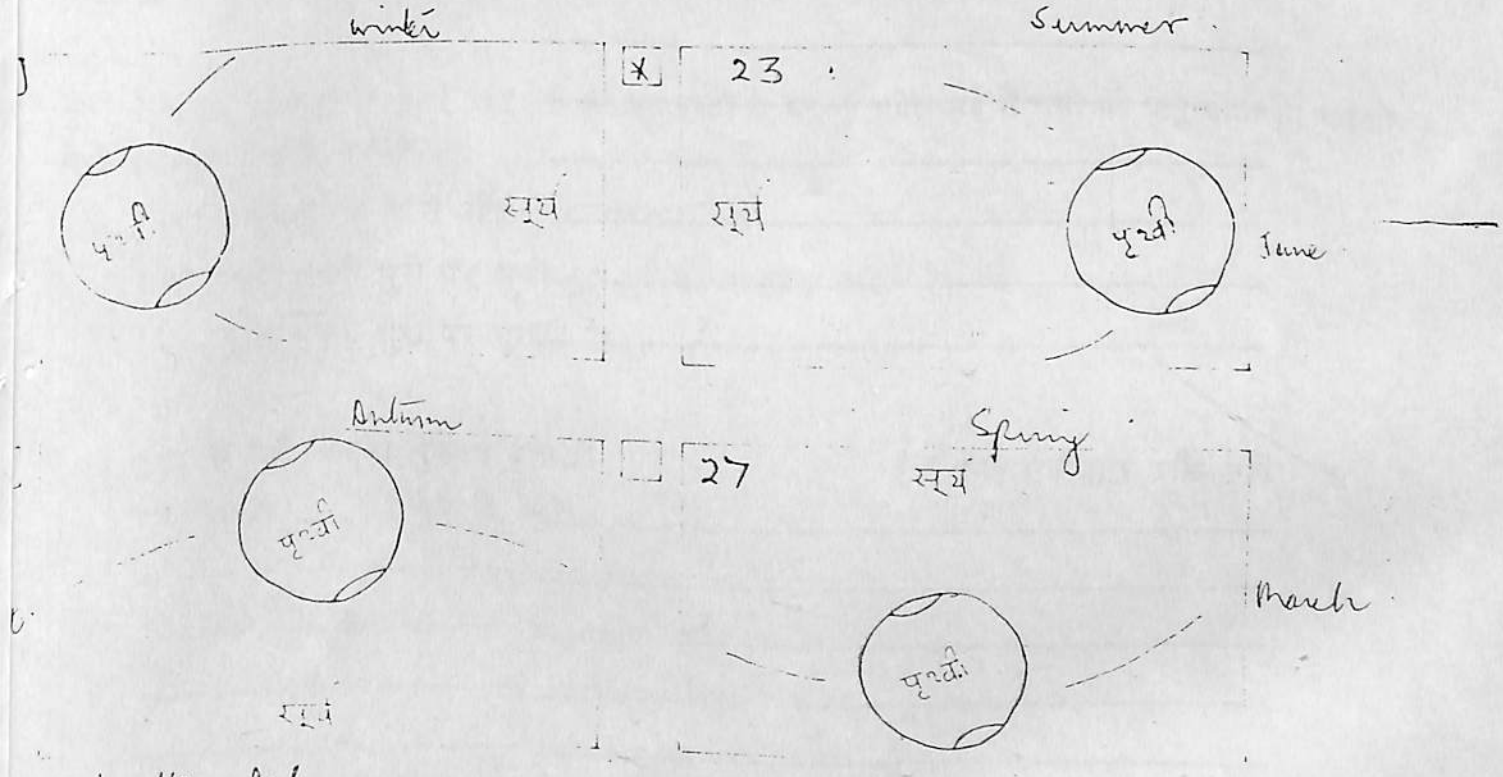
- ☐ 80 डिग्री पूर्व
- ☐ 80 डिग्री पूर्व, 16 डिग्री उत्तर
- ☐ 21 डिग्री उत्तर
- ☐ इनमें से कोई भी उत्तर सही नहीं है

. अक्षांश और देशान्तर रेखाओं को हमेशा डिग्री में नापा जाता है, किलोमीटर या मील में नहीं क्योंकि

- ☐ तापमान को डिग्री में नापते है और अक्षांश और देशांतर रेखाएं हमें तापमाप के बारे में बताती है।
- ☐ डिग्री के उपयोग से एकदम सही नाप कर सकते हैं जो कि हम किलोमीटर और मील के द्वारा नहीं कर सकते हैं।
- ☒ एक वृत को 360 डिग्री में विभाजित कर सकते हैं जिसके आधार पर गोलाकार पृथ्वी पर अक्षांश और देशान्तर रेखाएँ बनायी जाती है।
- ☐ इसमें से कोई भी उत्तर सही नहीं है

Not attempted

. नीचे दिए चार चित्रों में पृथ्वी और सूर्य की कुछ स्थितियाँ दर्शायी गयी है। उसमें से कौनसी चित्र हमारे देश की गर्मी की ऋतु की स्थिति दर्शाती है ?



Not attempted

. तुमने सुना और पढा होगा कि पृथ्वी 23.5 डिग्री के कोण से झुकी हुई है। यह कोण है:

- ☐ सूर्य और चन्द्रमा के बीच का
- ☐ सूर्य और पृथ्वी के बीच का
- ☒ भूमध्य रेखा और पृथ्वी के परिक्रमा पथ के बीच का
- ☐ पृथ्वी की धुरी और भूमध्य रेखा के बीच का

For Question, 12-14

Marks	No
0	4
1	19
2	7

Exercise

ये परीक्षा नहीं है। इसमें तुम्हें कोई अंक नहीं दिए जायेंगे। कोशिश करके सभी प्रश्नों के उत्तर लिखो। जहां आवश्यक हो चित्र भी बना सकते हो।

भाग -1

1. ऋतुएं क्यों बदलती हैं? अगर ज़रुरत लगे तो रेखाचित्र बनाओ।

2. दिन और रात कैसे होते हैं ?

3. अक्षांश और देशान्तर रेखाएं क्या है? उनका क्या उपयोग है?

भाग -2

1. दिन और रात कैसे होते हैं– इसे समझाने के लिए शीला ने कहा " जब पृत्वी के उत्तरी हिस्से के सभी स्थानों पे दिन होता है तब दक्षिणी हिस्से में रात होती है। फिर पृत्वी की स्थिति बदल जाती है और उत्तरी हिस्से में रात होती है व दक्षिणी हिस्से में दिन।" शीला ने गलत समझाया है। क्या तुम शीला की गलती पकड़ सकते हो? समझाओ ।

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2. दिसम्बर-जनवरी में हमारे यहां ठंड की ऋतु होती है, परन्तु अप्रेल-मई में गर्मी की ऋतु होती है। ऋतुओं में ये बदलाव होता है क्योंकि :

(अ) पृथ्वी सूर्य के चारों और परिक्रमा करती है।

(ब) पृथ्वी अपनी धुरी पर झुकी हुई सूर्य की परिक्रमा करती है।

(स) पृथ्वी अपनी धुरी पर घूमती है।

इनमें से सही विकल्प चुनकर बताओ

मैनें विकल्प ..... चुना है, क्योंकि

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3. दिसम्बर-जनवरी में हमारे यहां ठंड की ऋतु होती है। तब ऑस्ट्रेलिया में गर्मी की ऋतु होती है। जब हमारे यहाँ अप्रेल-मई में गर्मी की ऋतु होती है तब ऑस्ट्रेलिया में ठंड पड़ती है। भारत और ऑस्ट्रेलिया में गर्मी और सर्दी के महीने समान क्यों नहीं होते?

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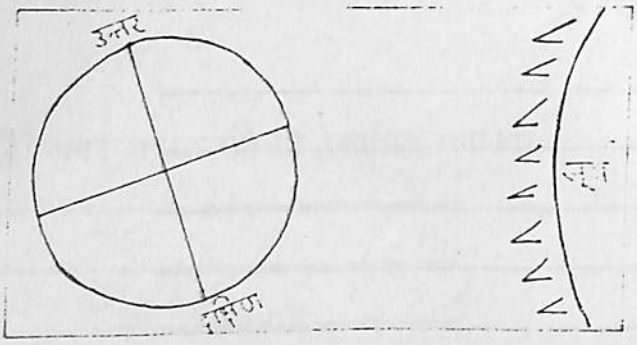
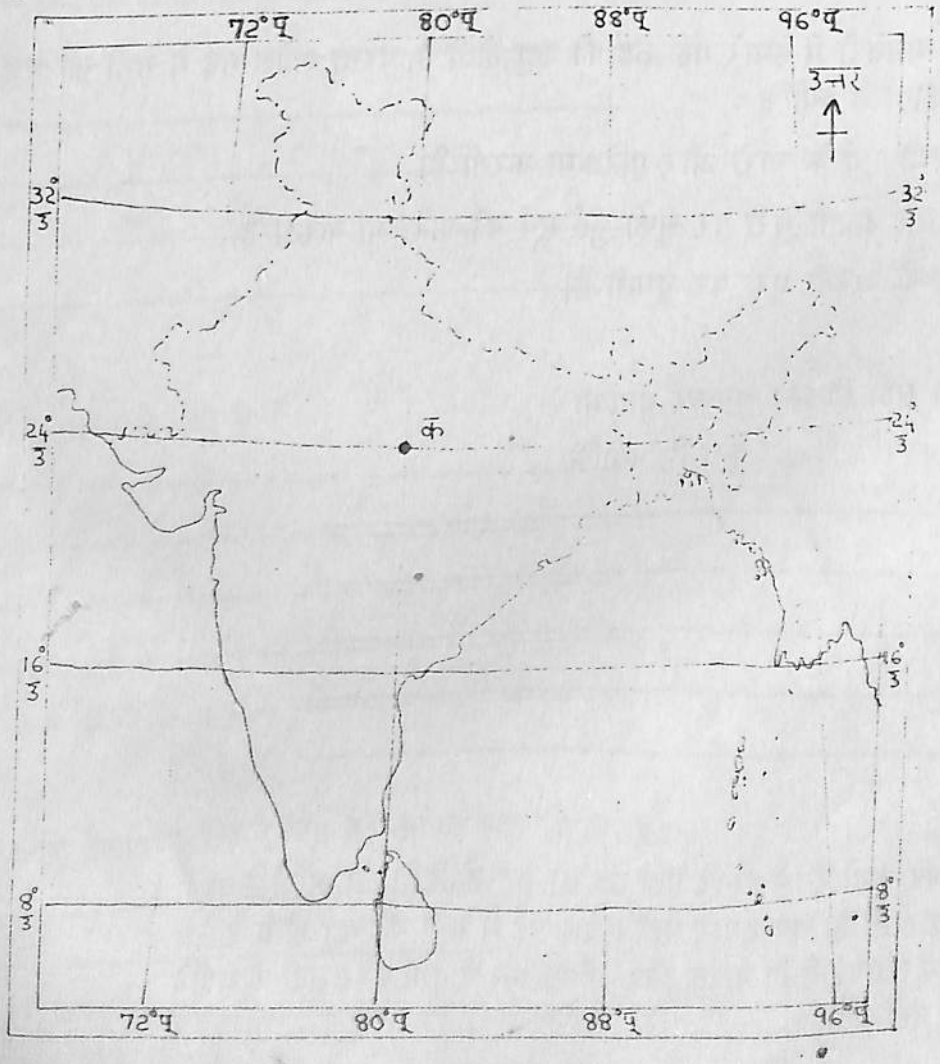
4. नीचे दिए गए रेखाचित्र में तुम सूर्य और पृथ्वी देख सकते हो। पृथ्वी के किन स्थानों पर रात होगी- रंग करके बताओ।



5. नीचे दिए गए नक्शे को ध्यान से देखो। इसमें कुछ आड़ी (पश्चिम से पूर्व) और कुछ खडी (उत्तर से दक्षिण) बनी हैं

रेखाएं



क्या ये रेखायें अलग-अलग जगहों का तापमान दर्शाती हैं?

हां/नहीं (जो सही है उस पर सही का निशान लगाओ)

यदि हाँ तो कैसे?

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6. क्या नक्शे पर किसी भी जगह की स्थिति पता करने के लिए इन रेखाओं का उपयोग किया जाता है?
हां/नहीं - (जो सही है उस पर सही का निशान लगाओ)
यदि हाँ तो कैसे?

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7. क्या इन रेखाओं की मदद से किसी भी दो स्थानों के बीच की दूरी का पता लगा सकते हो ?
हां/नहीं (जो सही है उस पर सही का निशान लगाओ)
यदि हाँ तो कैसे?

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