INTRODUCTION

The study has been conducted with the main purpose of developing a multimedia instructional strategy to teach the full course in Biology for the year 1978-79, to the students of Standard VIII, Shreyas Vidyalaya, Baroda, as prescribed by the Board of Secondary School Education, Gujarat. The strategy comprised of the following instructional components.

1. Introduction by the teacher
2. Programmed Learning Material and Deviated PLM.
3. Lecture method.
4. Team teaching.
5. Inquiry technique.
6. Pupil activities and Teacher demonstrations.
7. Discussion sessions.
8. Audio-visual presentations.
9. Historical background of scientists and scientific inventions.
10. Summaries
11. Criterion tests and feedback.
12. Exercises and Assignments.

The details pertaining to development and validation of the strategy have been given in Volume-I of the thesis. The developed software material for each of the components which comprised the instructional strategy have been structured and are given in this Volume along with necessary directions for their implementation with a view to facilitating the reproducibility of the instructional strategy by any institution, if, so desired.

UNIT - I

IMPORTANCE OF STUDYING SCIENCE

UNIT - 1

Importance of Studying Science

In your environment, you see many things like cars, trains, watch, telephone, camera, electric bulb, fan etc. You would be interested in knowing how man has been able to make these things. Also, in your environment, you see that a small plant becomes a tree, animals grow, you also grow, you resemble your parents, day and night occur, you experience rains, when you throw up an object it falls, iron rusts when exposed to air etc. You would also be interested in knowing how water from a lower level is raised to buildings, how an air plane floats in air, how a ship floats on water etc. Through the study of science, you would be able to understand the underlying principles of these occurrences.

Think of all the activities you perform in a day from the moment you get up in the morning until you to to bed. In all these activities you see the influence of scientific advancement in your life. You wake up from a comfortable cot, brush and clean yourself, have your breakfast which has been cooked on an electric or gas stove, you drink from a cup and saucer made of porcelain or glass or metal like steel, you dress up in your school uniform which is made of cloth of a particular colour and texture, you get into a pair of shoes

made of leather and travel to school, by some vehicle. On the way to school, you see somany things. (Refer to diagram No.1). Perhaps you see several other vehicles, things being sold and bought, some of you may, perhaps, see a hospital, a fire station, a post office, or telegraph

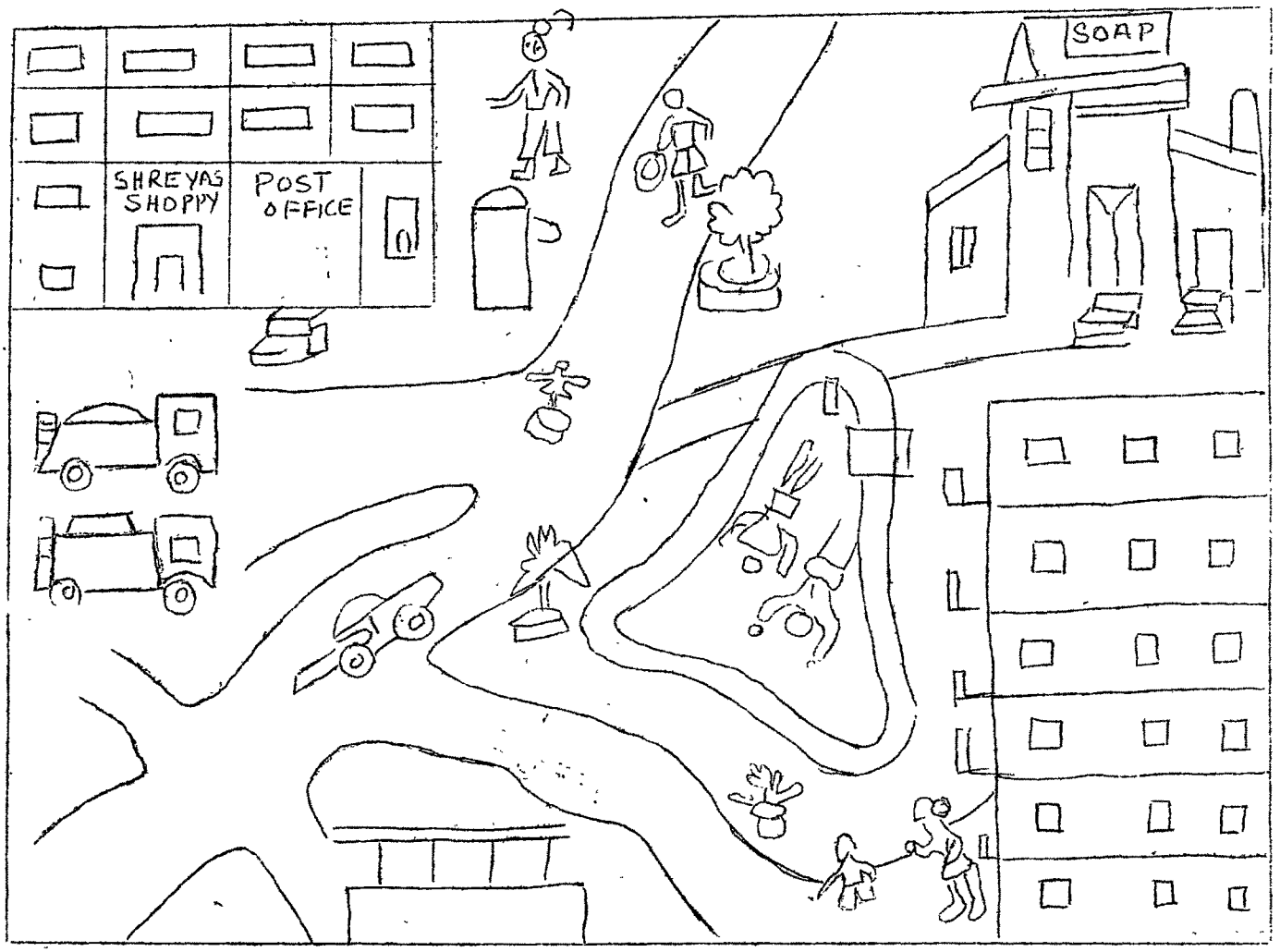


Diagram-1

office or an industry and most of you may see the petrol bunks. Oh! so many things. All these demonstrate the application of scientific principles. When you reach school, your teacher teaches you with the help of a black board and chalk, she conducts experiments and you perform a few of them. Using a pen, you make a note of what is required in your note-book. You perhaps, even read much of printed material from text-books. During some part of the day, a child like you would naturally like to play and should play (you know, "all work and no play makes Jack a dull boy"). You perhaps, play games like cricket or badminton or table tennis and others. For all these games, you definitely require some special equipment. Can you play cricket without necessary bats and ball and stumps? Could you actually play badminton or tennis without the rackets and shuttle cock or ball? When you return home from school, you play and perhaps, listen to the radio or a record-player. Later, you dine and go off to bed. Besides these activities, you may do several other things and engage in activities of your interest or hobbies, whatever they may be. Compare your life to that of a boy or girl of your age, several years back. Could they lead such a comfortable life as yours? Could they reach a place within a few minutes or hours? Could they wear so many synthetic clothes? Could they send messages from one place to another so quickly? Could they have so many medicines to get over diseases? Could they know what was

happening in different parts of the world? Could they cook within a few minutes? They could not do many things which you are able to do today. Their life was less comfortable than yours. What has helped you to have so many comforts? Yes, of course, development in science and its application to daily life.

Now you may try to answer the following questions and check your answer with the answer given after it.

Q. Why is life today more comfortable than it was a few years ago?

A. Development in science has made our life more comfortable than the life years ago.

But what is science? Science is the result of man's observation and thinking in a particular way. All around him, in the environment, he saw that several things occurred — plants and trees grow, day and night occur, rains, decay etc. Man observed these occurrences over a period of time very carefully. Of course, as he made these observations for a long time, he began thinking about them. As he deeply ~~throug~~ thought about these observations, he found that all these things occurred in a regular way. A portion of time when we are able to see the sun, it is day and when we are away from the sun, the portion of time would be night. Plants and

animals would grow bigger and bigger over time and after a few years they would die and decay. He observed that after a spell of heat, it would rain. Lightening always came first and then thunder. When he observed such things over time and thought about them, he was able to discover that each of these have a cause. He established relationship between these causes and the occurrences in the environment. These relation -ships he called as laws, principles, theories etc. The whole set of laws, principles, theories, facts, phenomena is science.

The discovery of laws, principles, theories etc. helped man in two ways. With the help of these he was able to explain natural events. He answered why they occurred and how they occurred. As a result of this, today, we know so much about plants, animals, mountains, sky etc. Thus science helps man in understanding the natural environment. The other way in which science helps man is in finding out ways in which his life could be made more comfortable. With the help of principles, laws, theories, etc., man tried to study the environment and think of ways in which these could be used in making gadgets like fan, radio, television etc., fast-moving vehicles for quick transportation like car, airplane etc. and materials for growing more and rich food like fertilisers etc. When man develops these aids, he does not stop once they are made.

Again, he thinks of ways in which these aids could be more effectively used and also how they could still be improved. This is the man-made environment which is created by man's application of the principles of the natural environment to his daily life. Can you see how much the man-made environment keeps changing? You can see that the science is concerned with the natural environment and the man-made environment. (Refer the diagram No.2).

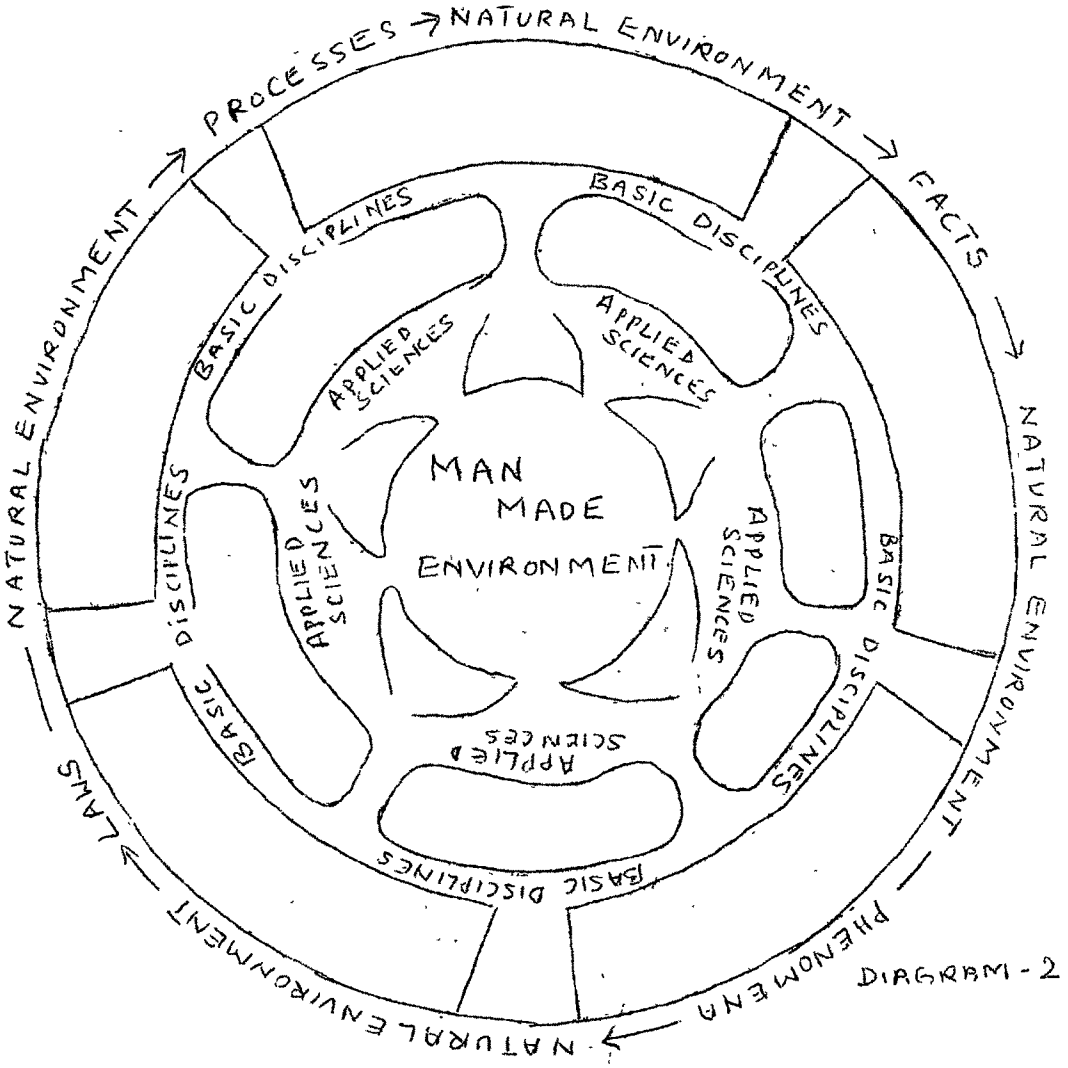
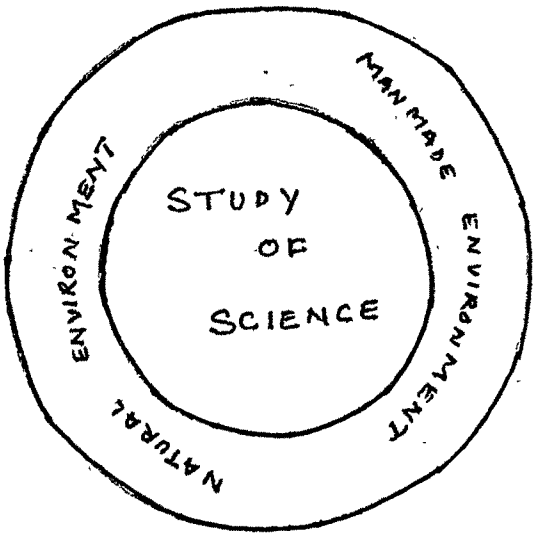


DIAGRAM - 2

The outer circle represents the natural environment. As you can see from the figure, the laws, phenomena, facts, principles, processes operate in the natural environment. The number of principles, facts etc. which operate in the natural environment is vast. In this vast number of principles,laws,etc., man was able to observe that a certain number of them were similar, again, another set of facts, principles etc., were similar and so on. As time passed on, there was a vast expansion of knowledge. So man, for convenience, grouped each of the similar facts, laws, phenomena etc. together to form the disciplines like physics, chemistry, biology, astronomy etc. In many events or occurrences, he was able to find that principles, facts, laws etc. of two or more disciplines could explain these events. For example, in understanding about eyesight, he could use the principles of biology and physics to explain it. Thus, he grouped certain principles from different disciplines together to form the applied sciences like biophysics, biochemistry, etc. In developing the man-made environment, we apply the knowledge of the basic and applied disciplimes. The study of science is the study of the natural environment and the man-made environment. (Refer the diagram No.3). It explains that the study of science is

the study of the natural environment and the man-made environment.

Diagram No. 3



Now you may answer the following questions and check your answers soon after.

Question 1 What is the study of science?

Question 2 What does the natural environment consist of?

Question 3 What does the man-made environment consists of?

Answer 1 Science is the study of the natural environment and the man-made environment.

Answer 2 The natural environment consists of facts principles, laws, processes, phenomena.

Answer 3 The man-made environment consists of the application of the laws, principles etc. of the natural environment.

Now, you may read on :-

By now, you know that man has thought in a particular way to develop the sciences. What qualities are needed to think this way? You might be familiar with the names of scientists like Newton, Galileo, Fleming, Pasteur, Madam Curie, Sir C.V. Raman etc. Let us study some of their life situations and see what qualities they had.

Galileo was a great Italian scientist. One day, he received a letter. In the letter he read that a lens maker from Holland had developed a simple device which made distant objects look closer and also upside down. Galileo was impressed by it and he thought further and developed a telescope which made objects look closer and not upside down. So, although Galileo got the idea behind the telescope from a person from Holland, he did make use of the idea of a simple toy like lens and developed it into a highly useful scientific instrument,namely, the telescope.

Another thing that Galileo did was to use his telescope for scientific purposes. Galileo was curious about the moon, sun, planets and stars. So one of the first thing he did was to turn his telescope towards the sky. He was the first to see the spots on the sun. While people of his day thought that no object could revolve around another object in the sky,

Galileo observed that four moons revolved round Jupiter. He made use of this knowledge to remove the earlier belief that people had, that the earth was the centre and not the sun. From the way Galileo made use of a lens to make a telescope and utilized it to observe keenly the sun, moon, jupiter etc., with a lot of curiosity, you can easily see that for carrying out scientific activities a person should possess the qualities of curiosity and keen observation.

Let us look into the life of Alexander Fleming. One day it so happened that Fleming left a few slices of bread in his laboratory. The next day, he observed that some growth had developed on the bread. He became curious to know what this growth on the bread was. He observed the growth under a microscope. He noticed that wherever the growth was found, around it, the bacteria were dead. He then guessed that this growth would kill bacteria. To make sure of this, he tested his guess. How did he do it? He grew more of the growth and again made observations. Then he found that his guess was right, that this organism could kill bacteria. This organism is a fungus which is known as penicillium today. From this discovery, the whole group of medicines called 'antibiotics' developed. From this incident we can see that Fleming was sensitive even to the objects and occurrences that appeared to be unrelated to one's work. Of course, Fleming was curious

and he made keem observations. But, on the basis of his observation, he did not simply conclude that fungus kills bacteria. Perhaps, this could have occurred by chance. Therefore, he first made a guess and then tested several times the guess, to see if it was true. This shows that a scientist just does not jump to conclusions. He keeps an open mind and concludes only when he has verified and gathered sufficient proof.

Have you heard of Madam Curie and her daughter Irene Curie who were women scientists? Today, you hear so much about nuclear physics. Madam Curie made a very valuable contribution to this field. She worked hard to isolate an important element called radium. This isolation of radium was a very difficult task because out of a very large quantity of a substance called pitch blende, only a very small quantity of radium can be removed. This large amount of pitch blende had to be stirred continuously as it was heated in a lead container for a long time. Finally a very small amount of radium would be available. Today, radium is used to cure important diseases like cancer. Madam Curie also had qualities —— patience and hard work.

So, from the life of scientists which we have considered here, you have come to know that scientists should have qualities like:

- curiosity
- keen and exact observation
- not jumping to conclusions
- patience
- willingness to work hard.

All of us can develop these qualities. We should be curious about what is happening around. A simple occurrence like rain would be interesting to understand. When you start thinking how rains come and try to find answer to this question, you will study many things. You would keenly observe what happens a few days before rains and then find out the factors which cause rain. You would come to know many details about evaporation, clouds, density etc. Water kept in an open vessel, if you observe it patiently over a few days, you would find that it evaporates after a few days. Similarly, there are many simple events in daily life which, you can understand well if you are patient and make keen observations and start thinking about these observations. Of course, through your observations you would not jump to conclusions. You would try to get proofs. If you find your answer is wrong, you would try to get the right answer by looking for right proofs. And in this way, you would perhaps one day, discover things. We shall, in the course of our science

classes this year, try to perform experiments and activities, make keen observations, question many of the things we see and try to find answers to these questions. In this way, we shall try to develop these qualities.

You may now answer the following questions and check your answer.

Question : What are a few qualities needed for scientific thinking?

Answer : A few of the qualities needed for scientific thinking are:

- curiosity
- keen and accurate observation
- not jumping to conclusions
- patience
- willingness to work hard.

Let us now examine what would happen to many of the beliefs man holds, when he starts thinking in the way we have described earlier. Long back, man believed that the occurrence of comets in the sky indicated some disaster to the country, or to the world. For example, in the play Julius Caeser, a comet appeared in the sky and the people thought that a great disaster would take place. This disaster was

the death of Julius Caeser. In those days, people believed that he died because of the appearance of the comet. Let us try to see whether there could have been any connection between appearance of the comet and the death of Juluis Caeser. For understanding this clearly, one should know what a comet is. Comets are heavenly bodies which move round in paths in the sky. As they move, at different times, they become visible. This knowledge, you have today which man did not have earlier. Since we know the scientific reason for the appearance of comets, we would not relate the appearance of comets to disaster, How does such knowledge develop? Through the development of science. In this way, the development of science helps man to remove many beliefs. In a similar manner, people of ancient days, believed that certain diseases like plague, cholera, small-pox, chicken-pox were caused by the anger of Gods or demons. Today, of course, you do not believe so. You know today, that science has proved that many of the diseases are caused by certain organisms like bacteria, viri etc. Here again, you see how science helps man to get over many of his beliefs by giving proofs. Science makes us reason out, why a certain thing happened in a certain way. It makes us reason out that even though things might happen at the same time, one thing need not necessarily cause the other. By chance, it may

happen that a mirror breaks and you fall sick, but, why you fell sick may be due to some other cause, not the breaking of the mirror. Even today, we believe certain things blindly without knowing why we do so. During an eclipse, we believe that we should not eat anything but we may not know why. There is a scientific reason behind this. During eclipse the atmosphere is full of cosmic rays which has injurious effects on our health. Think of many beliefs you hold today and test whether they are scientifically true.

Of course, all what we have considered so far shows that science has helped us. Let us see whether the development of science has created any problems for us. You know, man wanted to make his life comfortable by reaching places quickly, by transporting things from one place to another soon etc. For this purpose, he applied his knowledge of scientific principles to develop motor vehicles, airplanes etc. There is no doubt that these vehicles help us in many ways but can you think of any problem these things have created for us (Refer to diagram No.4). You often see the thick smoke that a lorry or bus would leave behind it. Above the factories, you see pipes leaving out thick smoke. Where does all this smoke go? Naturally, it would spread throughout the air around you. This is air pollution. Can you think of water pollution. Many industries, require water

for the work they do. After their use, the dirty water is left out in drains. This would pollute the surroundings. Thus, you see water being polluted. Similarly, you can think of sound pollution also being caused by scientific

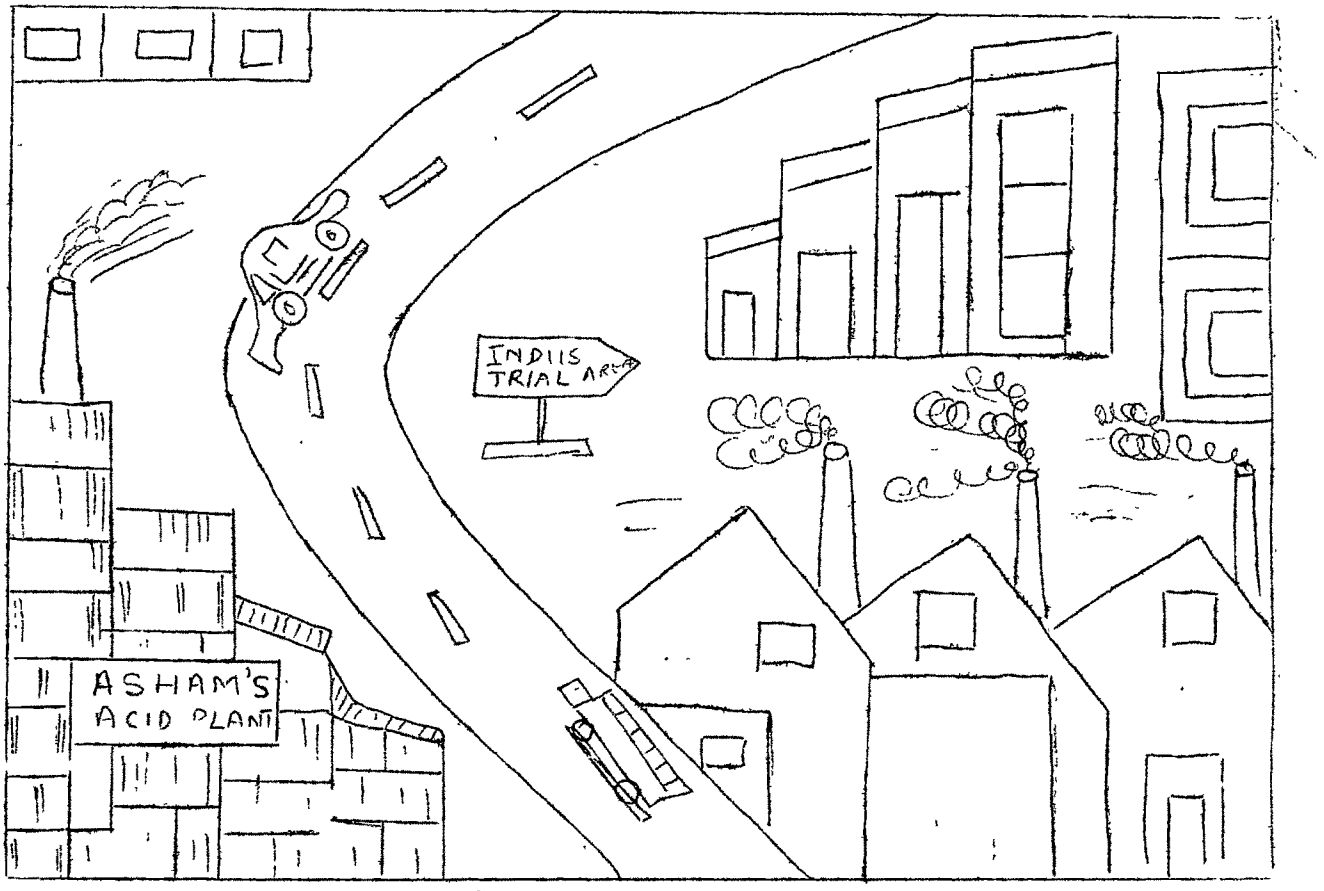


Diagram-4

developments. So, while science helps us through its developments, it also creates problems for us. Scientists again think about these problems and try to find out ways of solving them. For example, to overcome the problem of water pollution, the water from industries is led back to the rivers and lakes. This water which would be used for

drinking purposes or industrial purposes later is treated with many chemicals in the water purification plant before being sent to the cities for use. To overcome sound pollution, scientists have used the principles of science to build devices which would make rooms sound proof. So you see that science works continuously to help us through its development, it also creates problems and again tries to solve these problems. Of course, what we have discussed now is the problem science creates through its development. But there are certain problems which man creates for himself through the misuse of science. Let us discuss a few of such problems caused by man's misuse of scientific developments. You must be aware of nuclear energy which is used for certain purposes. Perhaps, you have read about the nuclear explosion in Rajasthan which helped to locate oil. Of course, this is a constructive use of nuclear energy. But nuclear energy can also be used for destructive purposes e.g. to make nuclear bombs. Let us consider another example, where man has misused scientific developments. Science has helped to develop drugs. For example, the drug called 'morphia' is used in medicine to help a patient not to feel pain after he is operated upon by putting him to sleep. But, this drug is being used by healthy people too. They would become addicted to this drug which would have ill-

effects on them. This is another example which shows how the products of science are misused.

All the problems which science creates have to be solved. Those problems which are created by the developments in science are being solved through further developments in science. But the problems created by man's misuse of science have to be solved in a different way. The scientists alone cannot solve these problems. Every citizen in the country should be made to think in an intelligent way as to why certain items have been produced by science. He should understand what bad effects would result if the scientific developments are not used rightly. Once he knows the good and bad effects of a scientific development, he should try to use only where it would have the good effect. So don't you think it is important for us to know the intelligent use of science? Now you may answer the following question and check your answer later.

Question: Which are the two kinds of problems created by science? Give one example of each. How are these two kinds of problems to be solved?

Answer : One kind of problems created by science is that created by its development. For example, pollution. The other kind kind are those problems created by man's misuse of science. For example, nuclear

energy. The former problems are solved through further developments in science. The latter are solved through man's thinking in an useful and intelligent way.

All around, today you see many scientific developments which are being used. In your daily life too, as you read at the beginning of this unit, so many scientific principles operate. To use many of the products of science, it would be necessary to know a few of the principles on which they work. This would help you make the maximum use of these developments in all walks of life. Examples of such simple useful knowledge are : mending a fuse, fixing a bulb on to a holder, the use of good and poor conductors of heat and electricity, balancing weights, constituents of a balanced diet, first-aid etc. Such knowledge would enable you to lead a more useful life. In the units of instruction in science which have been planned for you this year, various methods of study have been chosen for you. You would sometime learn on your own, you would sometime discuss with your friends or teacher, you would perform several activities individually and in groups, you would conduct experiments, sometimes you might also be taken on a trip to study some aspect of science. All these experiences have been planned so that you would get a good knowledge of scientific concepts

needed in daily life and beside this, you would be able to develop the qualities which we have seen in the lives of scientists. All these experiences would help you to adjust better to your environment and become a useful and intelligent citizen. Hope you would enjoy all these units of instruction in science.