Experiences of Experiment-Based Instructions in Science

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Background

This article is based on our initial efforts and experiences of making science education interesting and meaningful in a government secondary and high school. In this endeavour we started using the informal and project-based approach to make learning process attractive. Later we started using certain methods that can be called Guided Learning, which were more acceptable to teachers and were in line with their school curriculum. In this article, we compare the merits and demerits of these alternative methods on different grounds - such as the needs of the school, providing a good understanding of science and creating interest etc.

The beginning of our work

From the very beginning our aim was that the students with whom we work in school should enjoy science and feel free to participate in the activities. We have established tinkering laboratories in four places with the aim of giving space to the creative energy of the children and to make them curious about science. Such labs work on the theory of constructive ideology, which promotes the use of methods that insist on learning by exploration. In such an environment, students need very little guidance from their teachers and can freely work on their own.

We found that the labs provide students with a space where they can be active practically. In our laboratories, students come with an idea of their own project and all we have to do is to provide them with the basic equipment they need and if they have any questions or problems related to the project, then provide minimum support by answering or solving them.

For example, a student comes with the idea of making a boat, he decides his design based on a basic original drawing. Then he arrives at an opinion by reasoning and based on a prevailing common theory as to why an object floats and which material should be used. The student initially makes a boat with a paper that floats. Next he decides to make a boat that runs with the help of an electric motor. But his boat is not able to take the weight of motor and other equipment and sinks. After this the student decides to make the boat using such a material which can take the weight of heavy things. So he makes the boat with a cardboard sheet and fits motor and other equipment in it. He finds his boat floating in water but after some time it sinks as the cardboard sheet absorbs water. After a second consecutive failure in his project, the child gives a serious thought to the problem and comes up with a solution. The next day, the child uses thermocol instead of cardboard, as it is lighter and stronger. This whole process enhances the student's cognitive skills. In this project-based process, we felt that though the student is getting a good opportunity for making things and understanding the properties of the material and he is very enthusiastic also but there is a huge lacuna in understanding the principles of science, which is to be filled up with the continuous support of an experienced teacher.

Our experience in secondary schools

Apart from the tinkering laboratory, we are also working in some selected secondary schools where the mode of working was a little different. Our aim of working in secondary schools was to create interest in science among the students so that they can talk to each other and then freely discuss their questions with the teachers. Alongside we were also trying to encourage the teachers to use the project based method so that the students learn easily according to their environment. In the beginning, we did a great job with the students in collaboration with the teachers, but because the teachers also had the responsibility of completing the syllabus and they expected us to help them do that, some of the interest waned. Project-based teaching was helping the students to master a topic, which at times, was not in the syllabus. But one thing was sure, the interest of students had started growing through project- based education.

Reasons for making a science kit

Working in secondary schools made it clear that if we want to work with teachers, we cannot ignore their problems. The teachers wanted the students to develop their understanding of science, but they had to complete the syllabus. This was a big challenge for us. We also checked the science kits given by the government. We did not get more than half of the things supposed to be kept in the kit and it was very difficult to use whatever little was available. Most of the material in the kit could not be reused and the teachers did not know from where to get them. So the teachers were not able to use kits even if they wanted to. We also tried to have the teachers come over to our block level tinkering laboratory, take required items from there and teach the students, but this did not work.

So we decided to make our own kit by including things that are easily available to the teachers and students. We also decided that we would make a kit for any one topic and make different kits for different topics and give students the opportunity to use the same kit for classes 6 to 10 for different principles. We also had to keep in mind that our kit should not be too expensive.

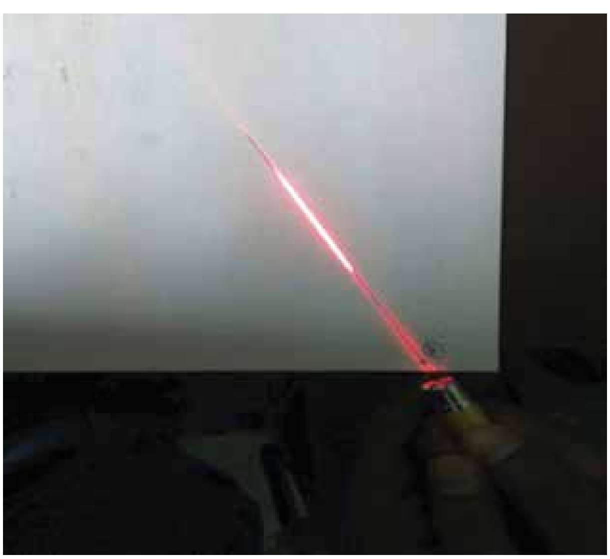
To make the kit, we selected four topics from physics – light, magnetism, magnetic effect of electric current and measurement. We created science kits for these topics and a successful demo was given in Bhopal's secondary schools. After making the science kit, they were distributed in selected schools. The teachers were given a demo and were made aware of the activities and its relation to the syllabus. They were used by teachers in secondary schools, and there is a great demand for it. What teachers liked about these kits is that even if the materials get over, they can be easily replaced either by them or the students.

Along with these kits, we have also prepared manuals to help the teachers, as well as the students as they could use the kit easily even if the teachers were not around.

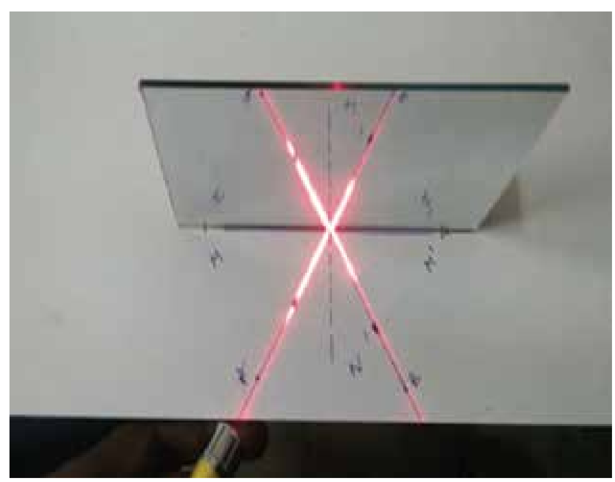
Some important activities that could be done using the kit

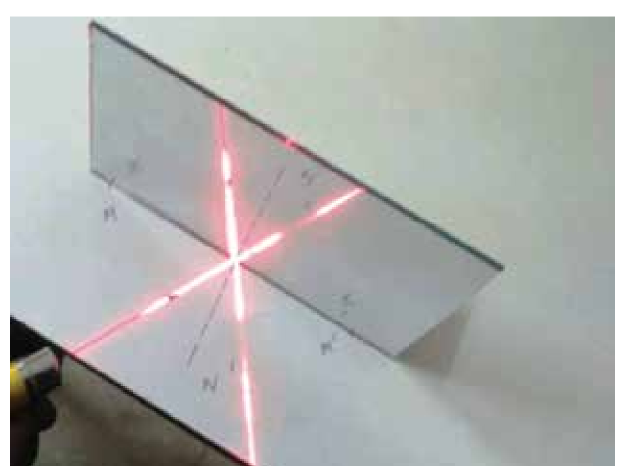
Light –

Study of the path of light

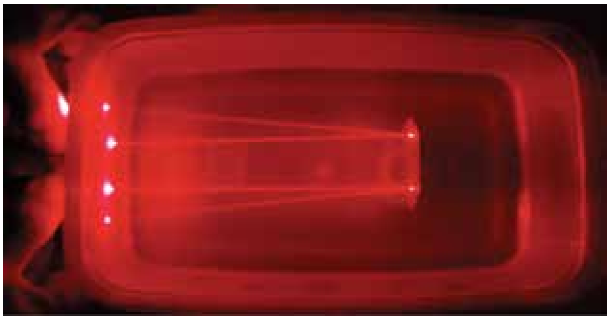


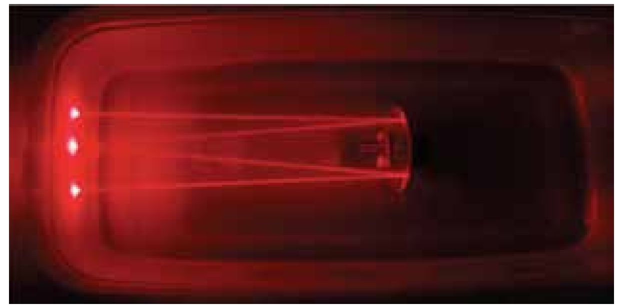
Verification of the laws of reflection



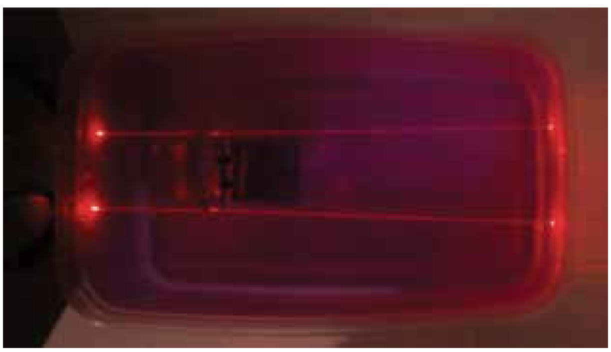


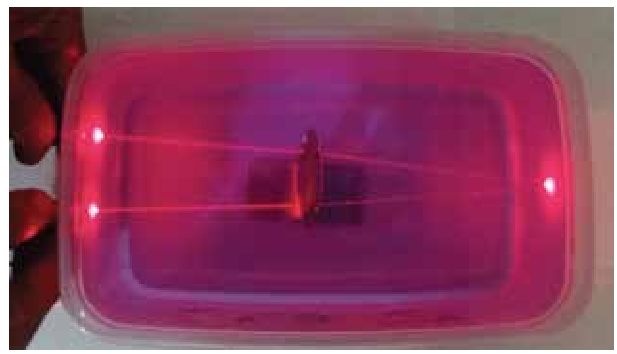
Study of refraction of light by spherical mirror



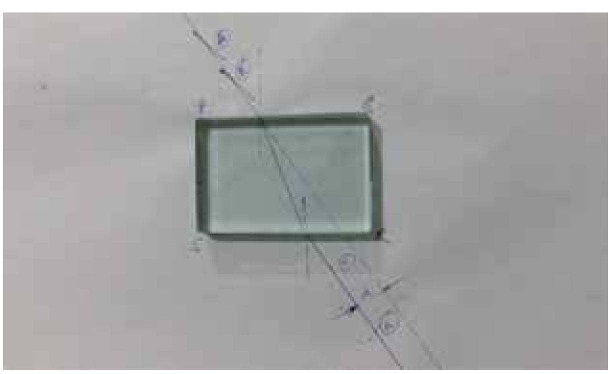


Study of refraction of light by spherical lens





Study of refraction of light through a glass slab



Study of refraction of light through the glass prism

Study of dispersion of white light by a glass prism

Find out how many objects kept in a room are attracted by the magnet

Find out the nature of force between two magnets. Is gravity the only invisible force?

Find out whether the magnetic force is generated due the effect of electricity

Understand the concept of magnetic field. Study the magnetic field of different configurations

Equipment:

1. One circular coil (set of 1 coil)
2. One square coil
3. Circular coil (set of 5 coils)
4. One bar magnet
5. One neodymium magnet
6. Iron filings

Process:

1. Mix the iron filings with water, drain it using a sieve and let it dry.
2. Spread the dry filings on a piece of white paper. Place the paper on a flat table.
3. Move some filings from the centre of the paper and place a bar magnet in their place. Now tap the paper gently. Observe how iron filings arrange themselves in a pattern.
4. Repeat the same activity with neodymium magnet. Observe how iron filings arrange themselves in a pattern.

Repeat this activity with circular coil (set of 1 coil), square coil and circular coil (set of 5 coils). Observe the pattern created by iron filings for every shape of the coil.

Discussion

1. What is a magnetic field?

Before understanding the magnetic field, we have to discuss the concept.
A magnetic field is the region around a magnet within which the force of magnetism acts. Although this definition is not total, it is enough to explain the concept.

2. Understanding the extent of a magnetic field

Take two magnets, A and B, and place them at the two ends of a sheet of paper. and a sheet of paper. Hold magnet A still and bring magnet B closer to magnet A. At a particular point we will begin to feel the force that is being applied on B.

Now, according to the definition given above, would it be right to say that the zone of magnetic field of A extends to the point where we begin to feel the force on B.
Now repeat this activity with magnet A and a compass. This time we may find that the force starts effect-ing the compass from quite far away and the direction of needle changes.
What can we conclude from this? We can probably say that the zone of magnetic field of A extends to a greater distance. Let us discuss this phenomenon. (Hint: Perhaps the mass of the needle is less than magnet B, perhaps the friction on the needle is less.)

If the weight of needle is further reduced, will the effect of the force on it be felt from a greater distance?

If yes, can we conclude that the magnetic field of Magnet A spans a longer distance? So if the weight of needle is reduced even further, the magnetic field of A will extend even farther.

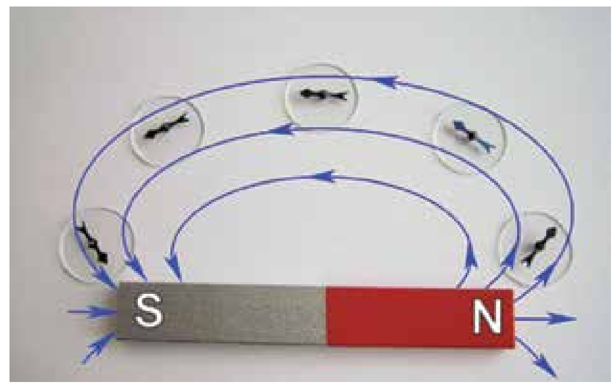
3. What are magnetic field lines?

Force is a vector quantity which is a quantity that has both magnitude and direction. Magnetic field is also a vector quantity. We have two options to illustrate the magnetic field of a magnet:

i. We make a vector at every point in the field around the magnet. The direction of the vector should be according to the direction of the magnetic field at that point and the length of the vector should be according to the magnitude of the magnetic field. (Or you can also make a vector and write the magnitude above it)

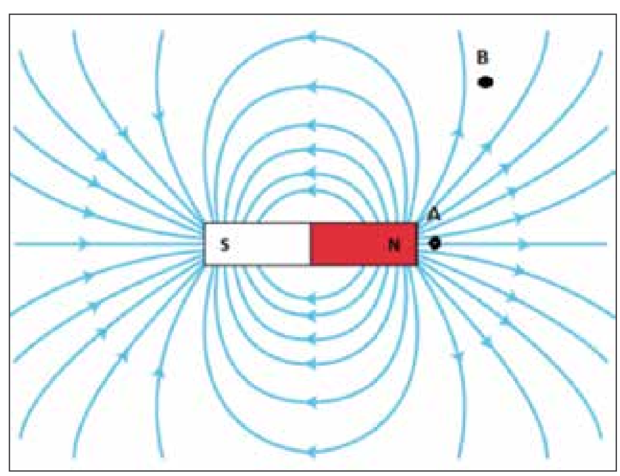
ii. Or we can use magnetic field lines. Actually these lines do not exist. They only show the direction of the magnetic field at just one point, and give the quantitative estimation of the magnitude of the magnetic field at that point (it is discussed later). Actually magnetic field lines are a very rough method of representing the magnetic field. It is impossible to accurately describe the magnetic field using these lines.

4. What is the direction of the magnetic field (or magnetic field line) at any point?
Take a magnet and put it on a sheet of paper. Place a compass on different places on that paper.



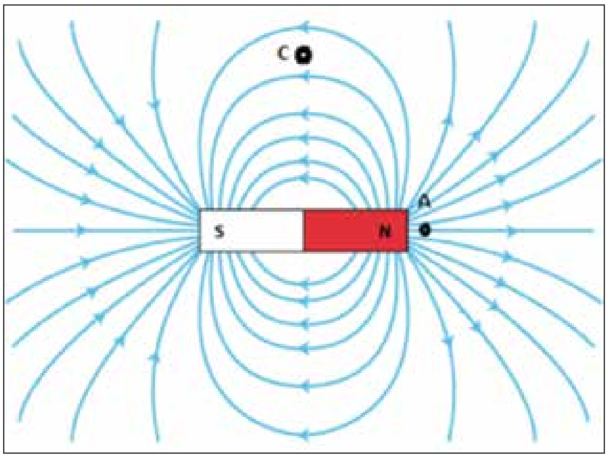
The direction of the needle shows the direction of the magnetic field (or magnetic field line) at that place.

5. How can we estimate the magnitude of magnetic field from magnetic field lines?

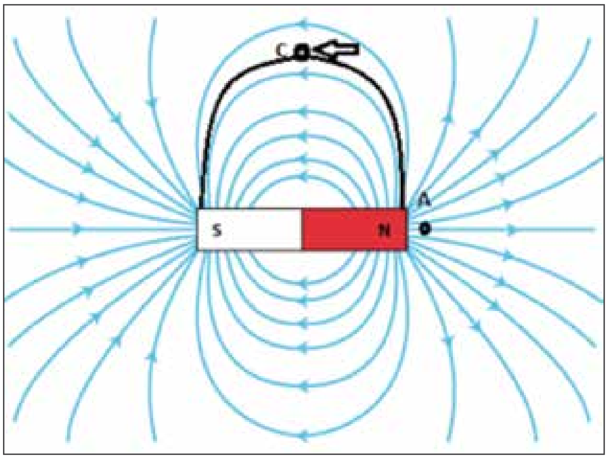


Around the point where the density of the magnetic field lines is greater than the other point, the magnitude of the magnetic field is also greater there. The magnitude of the magnetic field is higher on point A than on point B.

6. There is no magnetic field line passing through point C. Does this mean that there is no magnetic field around point C?



The magnetic field line passing through point C will look like this:



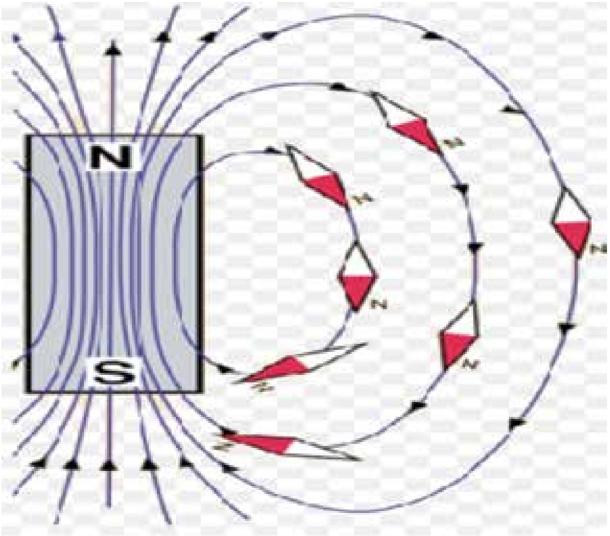
7. Some properties of magnetic field lines:

(I) Magnetic field lines start with the north pole of the magnet and end at the south pole.

(II) Two magnetic field lines do not intersect each other at any point.

(III) The magnetic field lines form closed loop.

Understand the magnetic force on the conductors Verification of Faraday's Law of Electromagnetic Induction



The entire credit of preparing the kit goes to Dr Anwar Jafri (Director, Samavesh, Bhopal), Nitish Sehgal, (Science Coordinator, Samavesh, Bhopal) and Sunil Prajapati, (Assistant Science Coordinator, Samavesh, Bhopal). I have only written the article in collaboration with Dr. Anwar Jafri, Nitish Sehgal and Sunil Prajapati. All the experiences regarding secondary schools are my own.

This article was originally written in Hindi. It was translated to English by Nalini Ravel.

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