Learning Science through Activities and Toys

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Children learn best through doing

Before children can understand a thing, they need experience: seeing, touching, hearing, tasting, smelling; choosing, arranging, putting things together, taking things apart. Experimenting with real things.

Old-time school teaching used only words and the teachers thought children knew something if they could repeat it. Now we know better. To reach practical understanding we do not need to use many words with young children.

Children are clever. They learn a lot, without being taught. The greatest skill – to be able to talk, to communicate is learnt outside school. In the classroom it's the children who need to talk the most. Unfortunately it is the teacher who does most of the talking!

Everything Has A History

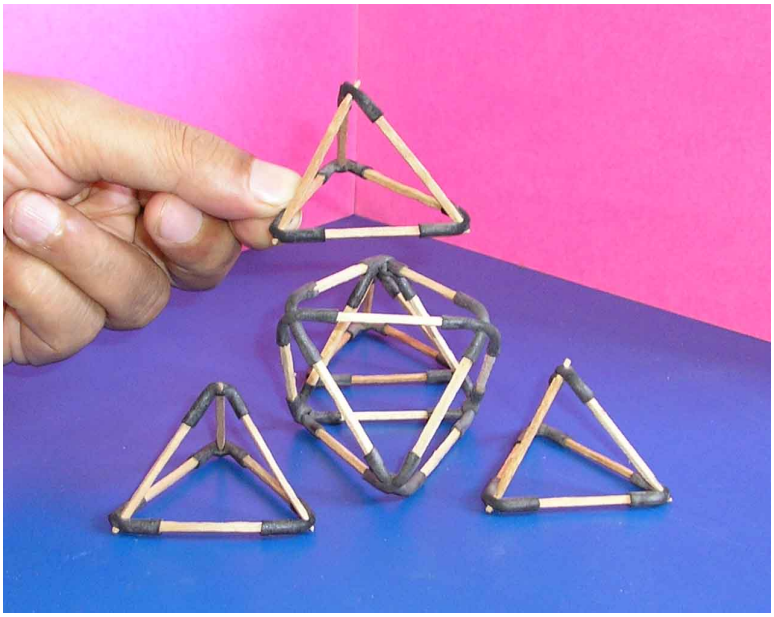
Many nations were totally devastated during the Second World War. Later on these countries were able to build schools but had no money to set up science laboratories. At the behest of UNESCO, J.P. Stephenson, science master at City of London School prepared a book on science activities titled *Suggestions for Science Teachers in Devastated Countries*. This fully illustrated book showed teachers how to make their own apparatus from simple, everyday materials at little cost.

This book got a thumping response. It was also very successful in other regions where there had been little or no equipment for science teaching. The book was considerably expanded with suggestions for making simple equipment and for carrying out experiments using locally available materials. In 1956 came the first edition of the *UNESCO Source Book for Science Teaching* which, periodically revised, and updated, has been translated into more than thirty languages, reprinted scores of times and has sold several million copies. The *New UNESCO Source Book for Science Teaching* has been a bible for science teachers' since 1973. It has been translated into many languages and very favourably accepted world-wide. In 1963 this book was translated and printed in Hindi by the Publication Division. It is sad that this book is not available in all Indian languages.

History changed on October 4, 1957, when the Soviet Union successfully launched the Sputnik. Sputnik's launch changed everything. As a technical achievement, Sputnik caught the world's attention and the American public off-guard. That launch ushered in new political, military, technological, and scientific developments.

The Sputnik shock shook the US and UK science establishment. Several new initiatives were taken to make science teaching more interesting. The Nuffield Science Programme in the UK in the early 60's based itself on the discovery approach. Science through activities became the buzzword.

The Hoshangabad Science Teaching Programme (HSTP) in India though inspired by the Nuffield philosophy had to reinvent all the hardware to suit local conditions. This programme covered over 1000 schools in the villages of Central India. The idea was to critically look at local resources and find possibilities of doing innovative science using local, low-cost, easily accessible material. The *Matchstick Mecanno* was used successfully to learn geometry and three-dimensional shapes. It used little bits of cycle valve tubes and matchsticks to make an array of 3D structures.



(Matchstick Models)

The programme recycled a lot of consumerist waste to make amazing teaching aids. The *Film Can Balloon Pump* was made using a piece of old bicycle tube; two film cans and bits of sticky tape for valves. With this pump children could inflate and pop a balloon. This pump was low cost – did not burn a hole in the pocket. It was fun and exhilarating science.

(Balloon Pump)

String and Sticky Tape Experiments

We live in a vicarious age. We often experience the world through TV rather than doing the touching and feeling ourselves. Physics is an experimental science and only by doing "hands-on" experiments, messing around with equipment will you get a feel of it. Most physics gear sold to schools is too expensive to allow students to work with it alone, and to have the teacher hovering by is inhibiting. To avoid this the equipment must either be very strong, unbreakable, in fact, so cheap it can be replaced at little cost. The

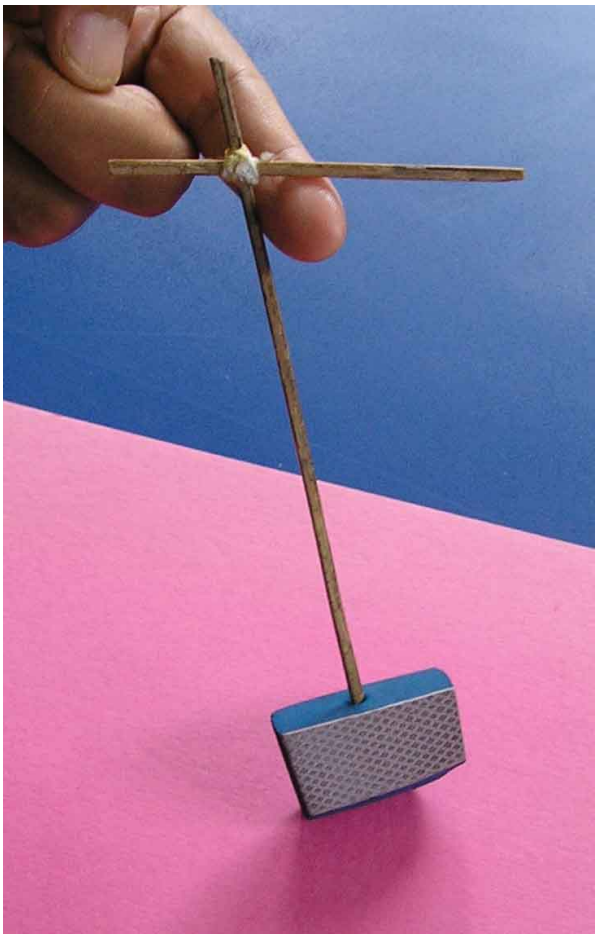
String and Sticky Tape Experiments column was introduced in the magazine *The Physics Teacher* in the early 80's. It showed experiments using the simplest, least expensive materials. The materials could be purchased at the nearest store – you did not anything expensive – not even need a stopwatch. All you needed were common rubber bands, cello tape, Styrofoam or paper cups, string, drinking straws, glass marbles, plastic ruler, coins, pencil, paper and scissors.

In 1905 the father of Russian popular science Yakov Pereleman (1882-1942) wrote *Physics for Fun*. He showed that children could use standard coins – roubles and kopecks as standard weights. It is sad that the chapter on *weight* in most Indian books starts not with coins (which are accessible to every child) but with a picture of a fractional weight box! (Which most children will never see in their whole life).

Toys and Trinkets

Toys have been used successfully to demonstrate principles of physics. Most inspiring physics teachers have their pet toys hidden away in drawers, cabinets and pant pockets. They include things like the dunking bird, gyroscopes, yo-yo's, a tippy-top, propeller on a notched stick, Newton's cradle, slinky and coupled pendulums. Most toys have an advantage over conventional demonstration equipment in their relatively low-cost and the fact that children relate well to them. Unfortunately most toys are not made for repeated use and that they are often no longer available when one looks for replacements!

Some traditional toys can be used to great advantage in a science class. It is unfortunate that science teaching ignores traditional toys. *The Joy of Making Indian Toys* by Sudarshan Khanna, documents over a hundred toys which have been made by Indian children for generations – much before sexist and violent toys like the Barbie and Skull Man made their debut. Traditional toys are R & D for hundreds of years. Generations of children have made them and perfected them. The *Sudarshan Chakra* is a classic example. It is made from a coconut broomstick, some thread and an injection bottle rubber cap. It costs almost nothing and can be used to demonstrate the force of rotation. Every child – even the poorest could afford and play with it.



(Sudarshan Chakra)

The Notched Pencil – another traditional toy has now become a darling of science teachers. It can be made in less than five minutes. You just have to make a few notches on a pencil. Then insert a card fan

on a paper pin at the end of the rubber. If you now rub the notches with an old ball pen refill the fan magically rotates! Many people think that it has to do something with airflow or static electricity. Far from it. This toy is based on vibrations. The physics behind it is non-trivial and quite sophisticated. Several learned research papers have been written on the working of this toy.

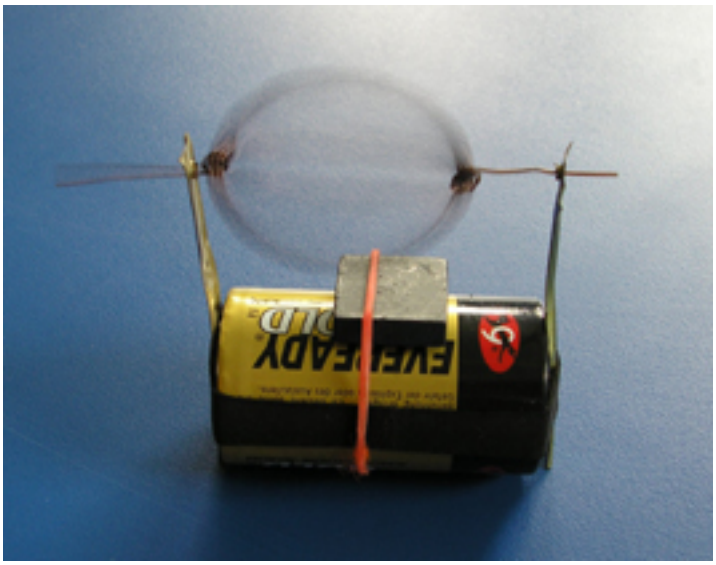
(Notched Pencil)

Simple Motor

This simply is the simplest motor on earth! The most expensive thing in this motor is the torch battery! The other parts are a broad rubber band from an old bicycle tube, a metal strip (broken stove pin), a cheap ferrite magnet and one meter of motor rewinding wire. The rubber band keeps the two metal strips in contact with the battery terminals. There is 1.5-volts across the metal strips. If you connect them with a torch bulb it will glow. Wind the copper wire on an old battery. There will be about 10-12 loops in the coil. Tie the ends on the coil (this prevents the loops from separating). Then straighten them so that they jut out diametrically opposite each other. If you now put the ends of the coil in the holes of stove pins no current will flow through the coil (because both the ends are coated with insulation varnish). Now scrape of all the varnish from one end (this whole end will be shining copper). On the other end, scrape the varnish only from three sides, leaving the insulation intact on one side. The little strip of insulation acts like a switch. This amazing "brush" or "commutator" switches the current on and off to the coil in every single rotation.

After putting the coil in the holes of the metal strips you will have to "kick start" it. Once it gets going, it will keep rotating until the battery drains off! Children have loads of fun making this motor. They do a lot of experiments with it, too. What happens if the length of wire is double? Or half? What happens if

the wire is thicker, thinner? What happens if you change the cross-section of the coil? What if you add another battery, or bring another magnet on top? There is so much in it to discover for an inquisitive child.



(Simple Motor)

Balancing Beam

The Balancing Beam is another remarkable experiment. This involves the balancing of 12 large nails (10-cm) on the tip of another nail. This is easily done. First put one nail on the table. Then put 10 nails across it – 5 heads facing one way, and 5 the other. Then place another nail along (and top) of the first nail. The whole assembly of 11 nails can now be lifted with both hands and placed on the head of the 12^{th} nail which is vertically nailed in a piece of wood. The great thing about this self-supporting roof is the simplicity of assembly. It can be done anywhere with very little money.

(Balancing Beam)

IUCAA's Children Science Centre

The Inter University Centre for Astronomy & Astrophysics - IUCAA's Children's Science Centre has recently gone on stream. Unlike science museums it is conceived off as a Children's Activity Centre. Children learn best when they see science in simple things around them. Every day 50 children from one particular school come to the centre and spend 4 hours making toys that spin, fly, whistle, jump, and hop. They make "action" toys – for all children are attracted to dynamic toys. Children learn to fold a dozen different caps using old newspapers (the cheapest paper). They learn geometry by paper folding – making the rotating hexa-flexagon using an old photocopy paper! The ability to make and improvise experiments with almost zero-cost equipment holds great promise for every child in this resource-starved country. The message is loud and clear – school kids can do great science experiments at very little cost. The great pioneers of science did their work with very simple equipment. It is possible, therefore, to follow their footsteps and learn to do scientific thinking without fancy and elaborate apparatus. After all, the student's mind is the most expensive piece of equipment involved!

If you want to encourage a child to explore science, you first have to abandon a few traditional ideas you may have about scientific learning. Ask most people what a science toy is, and you'll get the obvious answers: microscopes, magnifying glasses, and prisms. Any toy can end up being used for scientific exploration, whether it is Silly Putty, toy gliders, balloons, mini-cars, or action figures. The nicest thing about using toys for teaching science is that children can mess around with them freely, without being reprimanded for breaking precious equipment!

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