ARVIND GUPTA

Making Things, Doing Science

Simple everyday items and things that you were about to throw away can be fashioned into toys for science learning. Here are some instances of an innovative approach to science learning that is easy on the environment as well.

THE 1970s was a period of political turmoil throughout the world. Like the current Arab Spring, there was a political churning in society which released a lot of social energy. Scientists searched for a more "meaningful" role for themselves. Some scientists made a vow not to be involved in war or bomb research and do something more worthwhile to help ordinary people.

It was in this wave in the early 1970's that Dr. Anil Sadgopal – a PhD from Caltech – left the Tata Institute of Fundamental Research (TIFR) to initiate the famous Hoshangabad Science Teaching Programme (HSTP) in Madhya Pradesh. The HSTP aimed at revitalizing the teaching of science in resource-starved village schools. The renowned science educator Prof. Yashpal came as the first resource person in this initiative. In 1978, I took leave from Tata Motors and spent a year at the HSTP as an apprentice – learning from the people and simultaneously designing teaching aids.

We have a constipated notion that science can only be done wearing a white coat in labs full of glass burettes, beakers and test tubes. Often, all this fancy stuff is kept locked in school cupboards and gathers dust, and all the while children learn science by rote. We forget that the most expensive and creative apparatus in the science laboratory is the child's mind!

Before children can understand any scientific concept, they need experience: seeing, touching, hearing, tasting, smelling, choosing, arranging, putting things together and taking things apart. When children perform actual experiments with real things, it helps them understand the world around them.

These are some of the toys that we have created from trash for science learning.

Matchstick Models

In this model, my engineering background came in handy. I designed the simple Matchstick Mecanno using bits of cycle valve tube rubber as joints and matchsticks as members. It used very ordinary things – matchsticks, used to light the home fire, and cycle valve tube, which was easily available in small towns.

Children could make many two and three-dimensional shapes and understand a great deal about angles and structures in

At this link, you can find a demonstration to make your own matchstick models: http://www.youtube.com/watch?v=E0rLC_WY02Q.

Arvind Gupta demonstrating Matchstick Models

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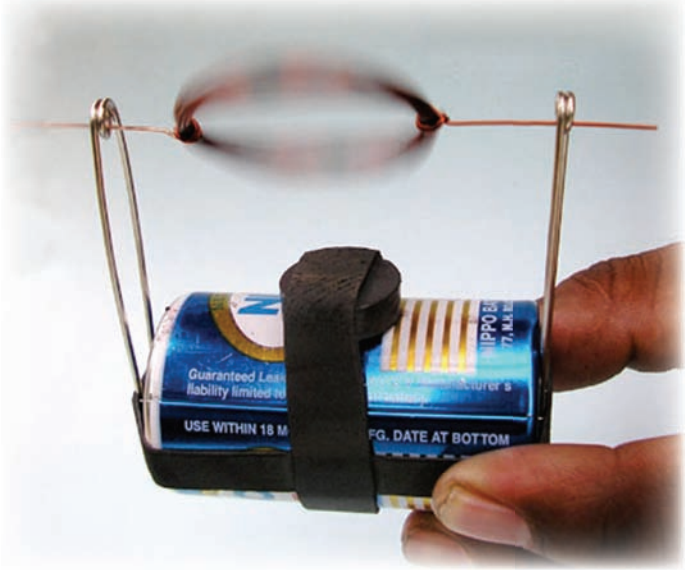
a concrete way. Children could easily see that the triangle was the only rigid polygon and why it was used to build roofs and bridges. Children also understood the rigidity of the Tetrahedron. Using simple, readily available materials, they could make a physical model of methane and other atomic structures.

In 1986, I wrote my first book Matchstick Models and Other Science Experiments. Soon it was translated by various popular science groups into twelve Indian languages.

Simple Electric Motor

Electric motors are widely used everywhere, modern life will come to a standstill without it. In a typical home the fan, cooler, refrigerator, washing machine, mixer, water pump all use an electric motor. Though the electric motor is very much a part of every high school curriculum, very few children ever make the motor despite being widely used at home. This is a scathing reflection of the mutilated way science is taught in our schools. Science is learnt by rote, seldom through experiments.

Everyday over 40,000 children and teachers across the world view them at http://arvindguptatoys.com.

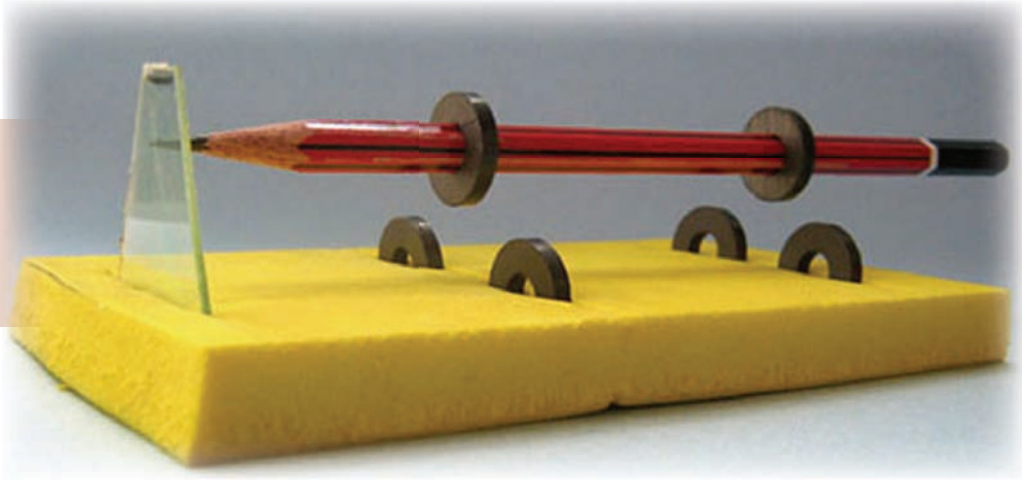


Films in various languages – Marathi, Hindi, Kannada, Telugu, Malayalam, Tamil, English, Gujarati, Spanish, Japanese, French and Russian – have been viewed twelve million times.

The Electric Motor is simple to make. If you have a 1.5-volt torch battery, it takes just five rupees more to make it. You need an ordinary ferrite magnet, two big safety pins, two wide rubber bands from an old cycle tube and one metre of insulated copper wire used for motor rewinding. The coil is wound using the battery as a former. One end of the coil is completely scraped of the insulation exposing the shining copper below. The other end is scraped only on three sides – the little remaining insulation on this end acts as an on-off switch. This improvised switch is the heart of the motor. This switch acts as the "brush" or the "commutator" of a DC motor.

Over the years we have made over fifty thousand motors with children and teachers. Every time a child makes an electric motor, you can see a gleam in her eye and a smile on her face. This has been our greatest reward. Watch this video on YouTube to learn how to make the motor: http://www.youtube.com/watch?v=vSPFwibREUg.

Watch a detailed video on how to make the Levitating Pencil: http://www.youtube.com/watch?v=33e8bfUqK2o.



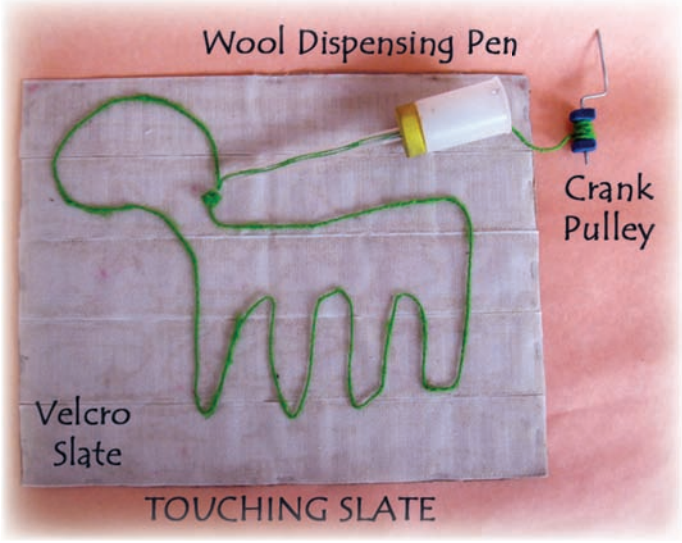
Levitating Pencil

At the heart of the Levitating pencil are six ferrite ring magnets. Four magnets are embedded in a rubber base. The magnet on the pencil near its pointed end attracts the two magnets below it. The magnet near the pencil base repels the two magnets below it and this makes the pencil levitate. As only the pencil tip touches and spins on the CD piece so there is very little friction. So if you twirl the pencil once it keeps spinning for a very long transport. Our children can get a glimpse of this phenomenon with this low-cost levitating pencil.

Five years back, Hamsa Padmanabhan, a student of Class X at the Kendriya Vidyalaya, Ganeshkhind, Pune, wrote a short scientific paper explaining the science behind the Levitating Pencil designed by us. This model costs less than twenty rupees and can be made in fifteen minutes. This paper won Hamsa the second Intel International Award of 2500-US$. Five years down the line, a minor planet has been named after Hamsa. This shows the innate potential of our children; they can compete with the best in the world.

Touching Slate

The Touching Slate is based on a simple idea that wool sticks to Velcro. The slate is made by sticking Velcro strips on a stiff cardboard. The drawing pen is essentially a "fishing line" which dispenses wool.



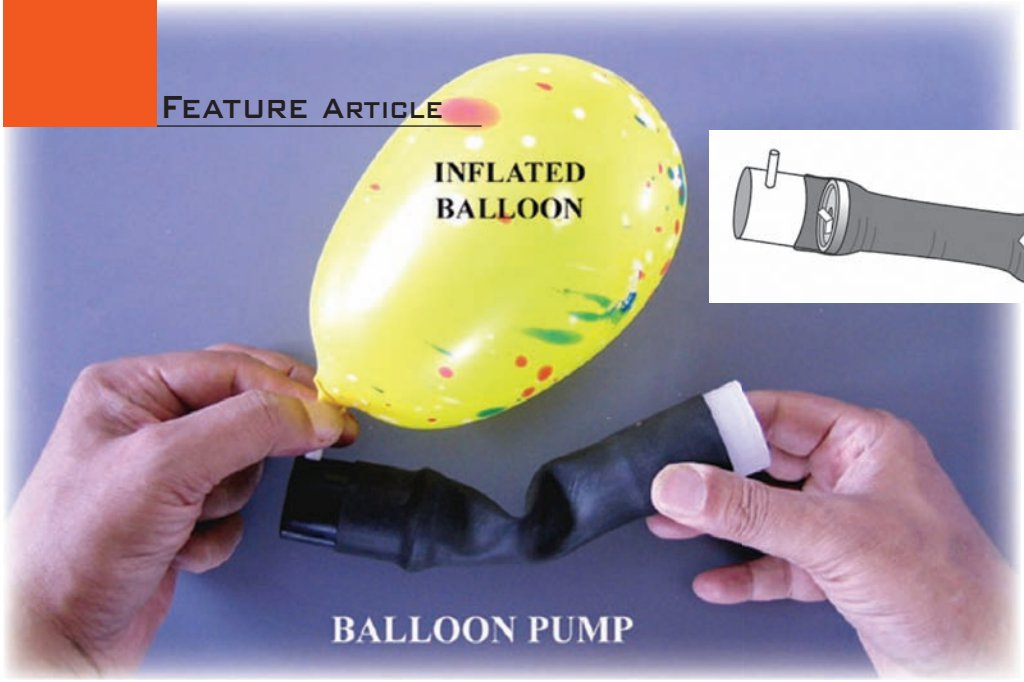
Blind children can draw their artwork on the Velcro slate. Later they can literally "feel" the drawing with their fingertips. The only thing to be bought is the Velcro. The rest of the material can be easily collected. This low-cost slate has been extensively used in Blind Schools throughout India. Our country has thirteen million visually impaired people – the largest number in the whole world. This Touching Slate has been a real boon to them. With the help of instructions on our website, a special needs school in Thailand made these slates for its visually challenged children.

Watch a video on making the Touching Slate: http://www.youtube.com/watch?v=LHXlKkS8La8.

Balloon Pump

We have designed over thirty different kinds of pumps but this one is stupendous. With this homemade pump you can inflate a balloon and pop it too! All the parts of this pump can be taken apart and assembled again. Two plastic film cans are fitted snugly at the two ends of a 25-cm long old cycle tube.

The left can lid has the delivery valve and the right film can base has a suction valve. These valves are simple "flaps" that open and close and allow air to flow in only one direction. Now tightly place a balloon on the delivery pipe and move the bellows to inflate the balloon. This superb pump very efficiently blows up a balloon. This pump certainly deserves an ISI certificate! Children love playing with this pump. In the process of making it they learn a great deal of science.



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Reduce, Reuse, Recycle

There is a very strong component of recycling in what we do. Our consumerist society produces a lot of junk; tetrapaks, plastic bottles, cardboard boxes can be found littered everywhere. We encourage children to pick this waste and make wonderful toys and teaching aids out of them. This imbues an eco-sensitivity in children and they feel happy about doing more with less and at the same time being good earth citizens.

Take, for instance, tetrapaks – multilayered packets of Frooti, Jumping Jack, Dhara Oil etc. They are made by fusing several layers of polyethylene, aluminum foil and card sheets into a multi-walled laminate. These tetrapaks are lethal for the environment and it is very difficult and energy intensive to separate these layers so these tetrapaks will lie buried in landfills for hundreds of years. Nature is totally helpless against this man-made material. We have made over forty science teaching aids and toys using tetrapaks.

Here is an example of a very useful purse that can be made from a throwaway one-litre fruit juice tetrapak. There are two pockets to keep money. The flap with the Velcro locks the purse. As tetrapak is water-proof, your money will remain safe in this wallet.

In the USA, a billion plastic bottles are thrown away every two days. We are learning the worst of the West. Plastic bottles can be found littered everywhere and have become an environmental menace in our cities. We have designed over hundred simple science experiments using plastic bottles, straws, lids etc. Through these low-cost experiments children can learn a great deal about air and water pressure apart from making some delightful toys that don't cost anything.

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Educational Resources

Since 2003, I have worked in the Children's Science Centre located in the Inter-University Centre for Astronomy & Astrophysics (IUCAA), Pune. Here, a small, focused team of competent and compassionate people tries to make science accessible and fun for the poorest children.

Twice a week, fifty children from a local school visit our science centre. Here they see possibilities of doing science using the humblest materials – rubber slippers, cycle tubes, plastic bottles, newspapers, broomsticks, straws, buttons and old CDs. In a course of four hours, children see numerous examples of low-cost science models. They also make a dozen things with their own hands – a newspaper cricket cap, an electric motor, a flying fish, helicopter, straw flute, straw sprinkler and a broomstick spinner. It is a unique life-giving experience which the children will never forget.

We have documented over 900 hands-on experiments with sequential photographs and simple instructions. We have also collated them in activity books and made short duration films titled Toys from Trash. We have uploaded 3200 short films in seventeen languages on YouTube. Our films in various languages – Marathi, Hindi, Kannada, Telugu, Malayalam, Tamil, English, Gujarati, Spanish, Japanese, French and Russian – have been viewed twelve million times. Every day over 40,000 children and teachers across the world view them at http://arvindguptatoys.com.

Mr Arvind Gupta has been conferred numerous awards for his work, including the inaugural National Award for Science Popularization amongst children (1988), Distinguished Alumnus Award by IIT / Kanpur (2000), Indira Gandhi Award for Science Popularization (2008) and the Third World Academy of Science Award (2010) for making science interesting for children.