Inexpensive Physics Toys for Demonstrations and Hands-on Learning

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Abstract

Use of demonstration equipment and hands-on tools for learning has become order of the day in physics education. Research has proven time and again that learning is most effective when students build their own understanding by constructing models, building circuits, and testing their own system. Making hands-on activities viable, however, is not an easy task due to geographical and economic constraints in many parts of the world. Either due to lack of expertise or due to limited budget, many classrooms cannot afford equipment for demonstrations and hands-on learning. In this article, I discuss a useful series of videos that show how inexpensive, day to day objects can be used to create physics 'toys' that can become useful classroom demonstration equipment or hands-on activity themes for elementary-, middle- and high-school students.

Keywords: demonstration equipment, hands-on activity, physics toys.

Resumen

El uso de herramientas y equipos de demostración práctica para el aprendizaje se ha convertido en lo actual de la Educación en Física. La investigación ha demostrado una y otra vez que el aprendizaje es más eficaz cuando los estudiantes construyen su propio conocimiento mediante la construcción de modelos, la construcción de circuitos, y cuando prueban de su propio sistema. Hacer actividades prácticas viables, sin embargo, no es una tarea fácil debido a las limitaciones geográficas y económicas en muchas partes del mundo. Ya sea debido a la falta de experiencia o por falta de presupuesto limitado, muchas aulas no pueden permitirse el equipo para demostraciones y el aprendizaje práctico. En este artículo, se discuten una serie útil de vídeos que muestran cómo es barato, y fácil para día a día hacer objetos que se pueden utilizar como "juguetes de Física", materiales de demostración en el aula o temas prácticos de actividades para Primaria, y estudiantes de la escuela media y alta.

Keywords: Equipos para demostraciones, actividades prácticas, juguetes de física.

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I. INTRODUCTION

Teaching and learning of physics has fascinated educators because of the various possibilities of misconceptions that students can come up with [1]. After several decades of research in physics education, we now have a wide source of information that helps us design our lessons and class structure. There is a wide variety of teaching techniques available to teach physics that is used by teachers all over the world. Many teachers like to use physics demonstrations. Hands on experiments and interactive student engagement are a proven way to improve student learning and concept retention [2]. Computational tools such as easy java simulations and physics applets are used in many technology equipped class rooms [3, 4, 5, 6]. Video analysis tools such as Tracker are proving to be widely useful for use in physics classrooms [7].

Many of the teaching techniques mentioned above are useful to higher level physics classes, in which students have established their interest in physics, and have a genuine interest in mastering the subject. When we think about physics teaching at the middle school level, we are not trying to provide them with deep physics knowledge. Rather, we are trying to create an enthusiasm and spark an interest in physics. At this level, demonstrations shown as physics 'toys' tend to create an impression on the students' minds. The students tend to remember these demonstrations vividly, and this helps them not only retain concepts, but also create an interest in the subject. Even better, when these demonstrations are presented to the students as physics 'toys', the students love it even more!

In many cases, practical concerns preclude the use of such toys in the physics classroom, especially in many developing countries. The toys can prove expensive. There is only a limited number of toys that are inexpensive to make, which can demonstrate physics concepts clearly and

succinctly. The toys used for middle school level students need to be simple. Many a times, making a toy perform a particular task can make the construction of the toy complicated, thus driving up the costs and adding weight to the bulk of the toy, making it unsuitable for use by school students.

In this article, I present a review of a wide variety of inexpensive physics toys suitable for students of all ages. I was inspired to write this article after listening to Mr. Arvind Gupta, the maker of these toys, and a physics and engineering enthusiast [8]. Creating such inexpensive toys that spark interest in students in a developing world is challenging, but Mr. Gupta has used plenty of creativity to use a large number of day to day items such as pencils, small bulbs, pins, batteries, etc., to create these toys that induce a lot of fun, and can be made with a little time and effort by the teacher.

More importantly, the toys described in the video can be replicated by anybody in the world. The items required for making these toys are very easily available at inexpensive rates, and the procedure for making the toys is explained with video in various languages and is freely available on YouTube [9]. There are many such videos available. In the next section, I highlight some interesting toys and describe how it can be used in a physics classroom.

II. DEMONSTRATIONS

In this section, I present reports of a few interesting videos from YouTube channel of Arvind Gupta.

A. A simple hydraulic jack

This video presents an easy way to demonstrate the working of a hydraulic jack [10]. Hydraulic jacks are used to lift heavy weights with a little human effort. They make use of Pascal's principle which states that pressure applied to an incompressible fluid is transmitted equally in all directions. In this video, Arvind Gupta demonstrates making a hydraulic jack using flexi tube, cardboard piece, ice cream sticks, copper wires, needle and syringes.

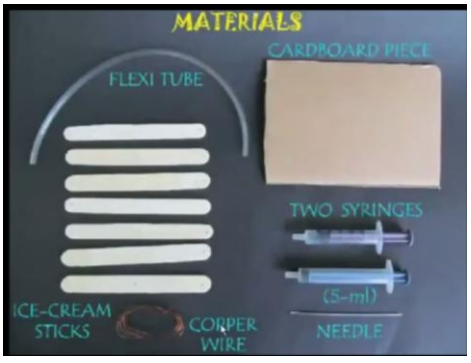

FIGURE 1. Materials required for demonstration of a hydraulic Jack [Reference 10].

Two syringes are connected via flexi tube, and a colored liquid is filled inside the syringes. One end of one of the syringes is connected to a hydraulic jack setup, made using ice cream sticks. As the liquid is pressurized from the free end of the other syringe, the hydraulic jack moves up and down. This is so much fun for the young students to watch.

B. Motor without magnets

This video uses simple household items to demonstrate the working of a motor. Usually, in these types of demonstrations, ferrite or other magnets are used to provide force that moves the motor. This demonstration uses an electromagnet.

A circular loop of copper wire is used as the rotating element of the motor. A bundle of copper wire wound on metallic bobbin used in sewing machines, is used to create the electromagnet. A 1.5 V battery provides the electric current and two safety pins mounted on either ends of the battery serve to hold the motor in place. As the system is turned on (batteries connected), magnetic force on the coil of wire rotates the motor. This provides a lot of entertainment and education to the young scientists.

FIGURE 2. Materials needed to make a magnetic motor powered by electromagnet [11].

III. CONCLUSIONS

In conclusion, I have introduced the readers to a freely available set of videos demonstrating how simple, readily available and inexpensive materials can be used to make physics toys that serve to explain several physics concepts to students of all ages. Since learning by doing is an important aspect of teaching and learning physics, I think this will be a promising teacher aid in teaching several aspects of physics. The students can make their own toys, making the process of learning student oriented, active, and fun. Some aspects of these toys can be used for creative research purposes, such as measuring efficiency and mechanical advantage of machines, conservation of mechanical energy, etc. It is my hope that the readers will find this article helpful and navigate through the large

number of videos available on Arvind Gupta's channel in YouTube.

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