Physics Education and PYPT

Dina Izadi

Ariaian Young Innovative Minds Institute (AYIMI), Tehran, Iran
http://www.ayimi.org, info@ayimi.org

Abstract
It has been recognized that physics learning and teaching should change from traditional to research method and findings from Physics Education Research (PER) had initiated a tremendous effort in improving physics teaching. New methods indicate that student understanding and misconceptions from quantitative interpretation research has built a pathway for curriculum development and effective teaching of introductory physics. Active learning is a method which has caused to increase student conceptual understanding. This encourages students to construct their own knowledge. There is increasing evidence that many students are unable to apply the physics that they have studied. For meaningful learning to occur, students need more assistance than they can obtain through listening to lectures, reading the textbook, and solving standard quantitative problems. Substitution the traditional models of teaching and learning physics with new one will promote active learning. Different national and international tournaments which are either valuable to students or educators will improve their skills. Persian Young Physicists' Tournament, PYPT, is one of the programs which Iran has involved since 2007. This tournament provides practice in interpreting various representations, e.g., formulas, graphs, diagrams, and verbal descriptions. Students solve the problems by research which is one of the most important parameters in physics education. PYPT workshops are another opportunity for students who have been in previous PYPTs to educate other students and learn how to be a teacher. In this case students will be trained to become future scientists. Ariaian Young Innovative Minds Institute (AYIMI) is the organizer of PYPT in Iran which holds this tournament with cooperation of universities and organizations each year to select team for International Young Physicists' Tournament (IYPT).

1. Introduction

Scientific laws, principles and concepts can be better understood and experienced by the interactions of individuals solving problems in groups and in a laboratory style and the correlation between algorithmic mathematical skills and problem solving in physics.

During the last 15 years, in most countries, the popularity of physics among students has been low and the enrolment has declined so different ways instead of traditional physical science instruction will lead to improve physics education for all students.

In active learning, Studio Model will help students work in a group and do their experiments to get the physics laws and teachers just help them with the experiments, arranging discussion, and guiding students toward a correct conclusion. Discovery Lab will provide an opportunity for students to carry out experiments with

mathematical expressions. They experiment to collect evidence and draw a conclusion based on that evidence.

Most students like novices see physics more as isolated pieces of information unrelated to the real world. But what we specifically should do students think like an expert. They should learn physics by experiments and see the content of physics as the concepts that describe nature and use in a wide variety of situations. Students should be able to solve problems correctly by learning the useful concept not by memorizing. So instructors can move students from mindless memorization to understanding. If teachers try to teach physics in the context of everyday life applications, students are more likely to recognize other applications where physics enters their daily lives. To engage students through interactive exploration of the physics and creation of fun, challenges are one the most important factors can impact their learning and attitudes towards physics.

International Young Physicists' Tournament, IYPT, and Persian Young Physicists' Tournament, PYPT, are new methods in physics education which students know and understand definitions, terminology, facts, concepts, principles and operations. They are able to communicate what they know with others and know how to apply what they have learned to analyze situations and solve problems; and can develop their ability to evaluate critically the usefulness of various problem-solving approaches.

2. PYPT in Education

To provide a program of educating and supporting teaching assistants, Persian Young Physicists' Tournament, PYPT, has been organized to develop assessment tools to evaluate student progress in problem solving, technical presentation in English which is not their native language, and team working. The 1st Persian Young Physicists' Tournament (PYPT) was in March 2008 which two selected teams participated in Austria (AYPT) and IYPT to get the first experience from this attractive challenge. Now students from different high schools in Iran are able to request entry into PYPT which is carried out in a period determined by the PYPT Executive Committee (ECO). The best teams challenge in final and receive rewards but the best students with highest individually scores as the PYPT Regulations are selected and after education, participate in International Young Physicists' Tournament, IYPT. The rules for presentation of the results, opposition, reviewing and judgment by the jury have been fixed in the Regulations of PYPT which is different from regulations of IYPT in some parts. PYPT Juror are selected from different universities such as University of Tehran, Amirkabir University of Technology, Sharif University of Technology, Alzahra University, Islamic Azad University, Tarbiat Modares Uniersity,…each year

There are three students in a group, from upper secondary schools, up to the age of 18 or 19, which are able to request entry into PYPT. They should work on IYPT problems which is on the PYPT website too (http://pyptonline.com). There are not specific solutions for these problems so research and experiment are the main factors to direct them in finding the best solution.

PYPT workshop is the other educational community which plays an important role in directing Jurors and students who need to learn more about PYPT regulations.

3. PYPT problems

There are 17 problems should be solved by each team but five problems can be rejected in PYPT without penalty. In solving these problems students learn how to research, work in lab, share their findings in their group and compare their results in experiments with principles and physics' laws. Some parts of three problems as follow define how students work to present in an international tournament.

- *Magnetic Spring (Problem has been solved by: Reza Montazeri Namin)*

Two magnets are arranged on top of each other such that one of them is fixed and the other one can move vertically. Investigate oscillations of the magnet.

The theory to solve this problem has two main parts: a) To find the force that the magnets exert to each other in different distances, b) Using the force, to find the equations of motion of the top magnet. Finding the force may be done using two main models: The Gilbert's model, which considers each magnet to be made of two poles, and every pole acts like an electric pole. The Ampere's model, which considers each magnet to be a solenoid, and due to the current in the solenoids, the magnets exert forces to each other. After finding the force that the magnets exert to each other, we can find the equations of motion and oscillations of the top magnet. We know that there are three forces exerted to the top magnet: Gravity, magnetic force & friction. So we have all the forces that are exerted to the magnet. But again, because of the complicated form of the magnetic force, the differential equations of motion will not be solvable, so again we use a numerical method to investigate the movements.

Similar to the theories, the experiments have two main parts: Checking the force to decide the correct theoretical model, and investigating the oscillations and comparing with the theories. The force evaluation was done by adding weights on the top magnet. By adding weights, the distance between the magnets would change. While we know the mass of the magnet and the weights, we could find the force that the magnets exert to each other in different distances (Fig. 1).

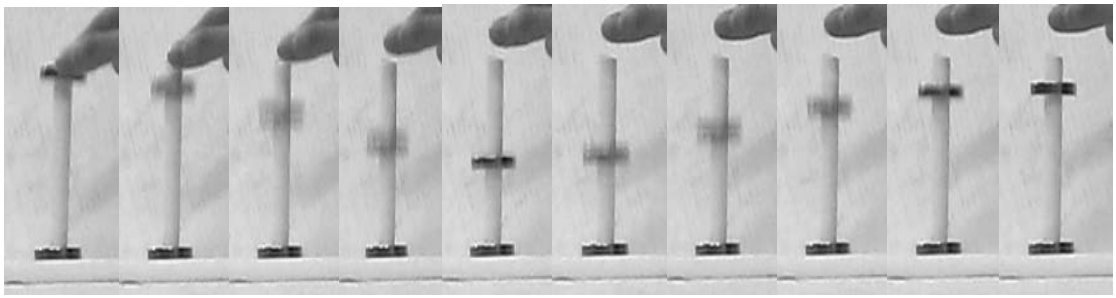

Fig. 1. Oscillations of a magnet in different distances

Shrieking rod (Problem has been solved by: Zahra Karimi)

A metal rod is held between two fingers and hit. Investigate how the sound produced depends on the position of holding and hitting the rod?

Working with the sound waves while there are several types of motion and several patterns, can be a complicated task. It's been proved that both longitudinal and transverse waves can propagate in solids.

In the case of cylindrical metal rod which should be held at a certain position within its length and be hit, for finding the right patterns of propagation paying attention to both holding point and hitting type is necessary.

Holding points can be considered as nodes because approximately there is no motion at these points, these nodes are really critical in understanding the accurate pattern of longitudinal and transverse waves. A metallic rod is quite similar to a tube which is open from both ends so when it comes to longitudinal motion only the fundamental frequency or harmonics which have the same place of nodes with the holding point can be observed. this means that the longitudinal wave can only be produced by holding the rod at even multiples of the length (1/2L.1/4L.1/6L,...) while there are transverse waves caused by vibration from the hitting all the time.(Fig. 2)

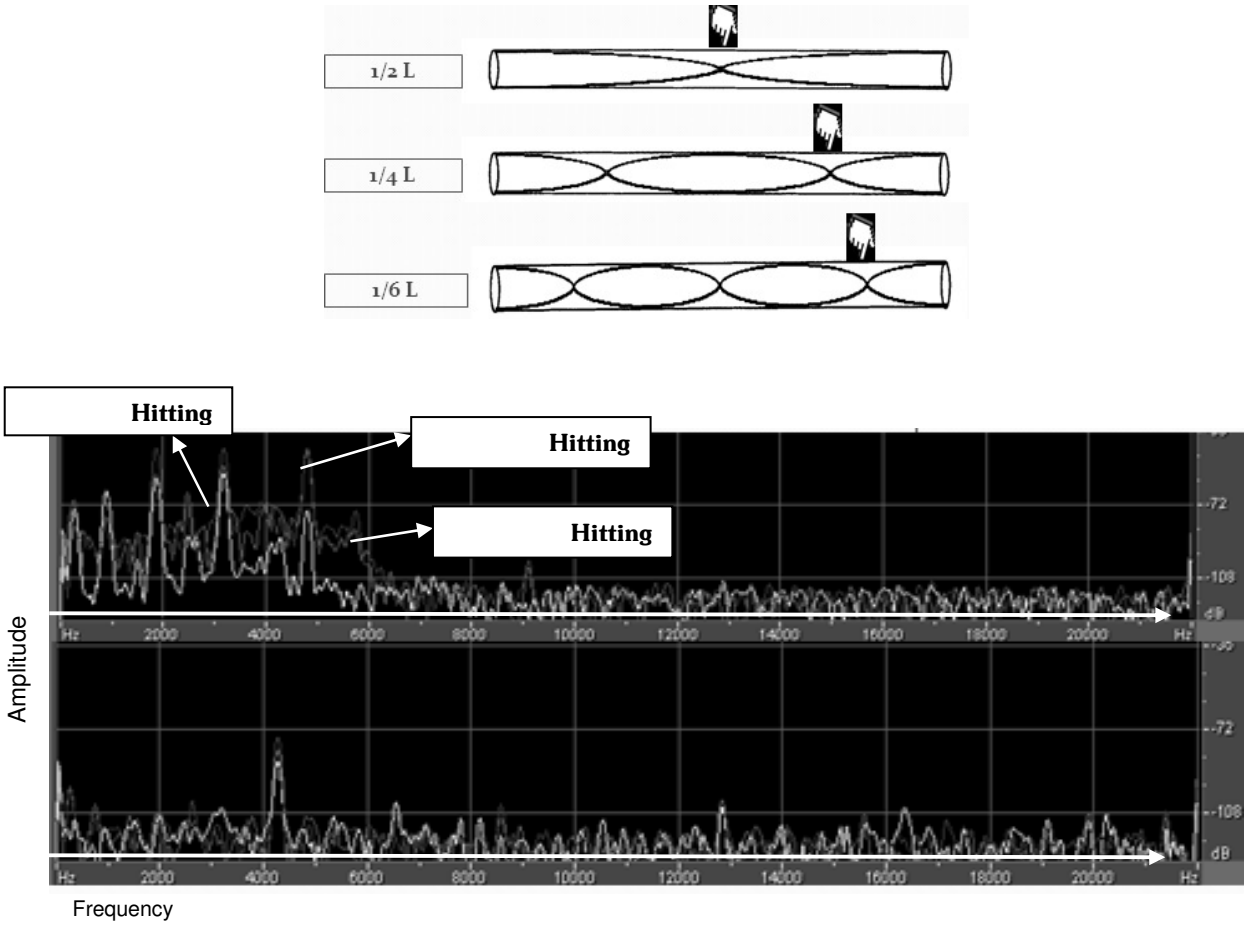

Fig. 2. Transverse waves cause by vibration from the hitting

- *Electromagnetic Cannon (Problem has been solved by: Saba Zargham and Hamid Ghaednia)*

A solenoid can be used to fire a small ball. A capacitor is used to energize the solenoid coil. Build a device with a capacitor charged to a maximum 50V. Investigate the relevant parameters and maximize the speed of the ball.

As we know, a solenoid consists of helical connected coils. When a current is sent through the solenoid, it generates a magnetic field, which its magnitude can be defined by the Bio-Savart law. This magnetic field can exert force on conductive material. Ferromagnetic materials are made up of many magnetic dipoles.(seen as current loops) When placed in a magnetic field, these dipoles tend to align with the field. Due to this alignment a current is produced throughout the matter. This force can therefore by calculated by the Lorentz force. And it is the same force used to build the electromagnetic cannon based on the solenoids principle.

The solenoid is wrapped around a diamagnetic_hallow cylinder. Depending on the shape of the coil, a plunger (that consists of two parts, a ferromagnetic part and a non-ferromagnetic part which is the shooter), can be situated in the solenoid in a way that can move in and out of the center. The plunger is used to provide mechanical force which will be used to kick the ball (Fig. 4).

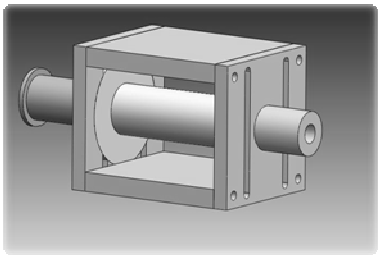

Fig. 4. The plunger used to provide mechanical force in electromagnetic cannon

The final speed of the ball is much related to the force exerted to it by the plunger which itself is only determined by the force applied to the plunger by the solenoid. Therefore calculating this force is necessary. To do so, we have first calculated the force applied to circular-shaped element_of the solenoid from a distance r. (the force along the x axis is the one important for us) and so by integration we're able to determine the net force applied to the plunger (Fig. 5).

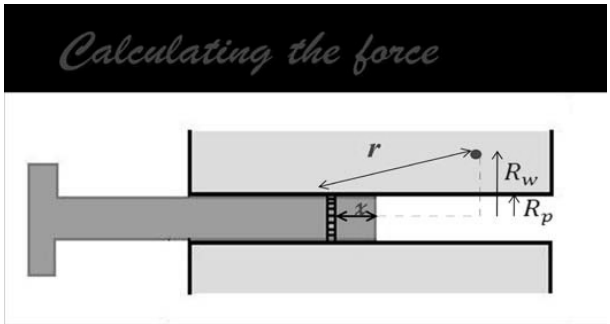

Fig. 5. Force calculating in Electromagnetic cannon

$$dF_x = i\left|dl_{plunger} \times B\right| csc\theta$$
$$dl = Rd\theta$$

(The full papers have been published in IYPT 2010-2011 Proceeding).

4. Statistical Survey

The number of participants in PYPT has increased in recent years in comparison with last PYPTs (Figs. 6). Students are girls and boys from different schools which during the period of training, their teachers or team leaders educate them practically. young students talk about the conceptual approaches which help them in solving problems. Combination of the knowledge and experiments to motivate students is an important factor in active learning but to improve it in a high level we need a debating and asking in a cooperative atmosphere.

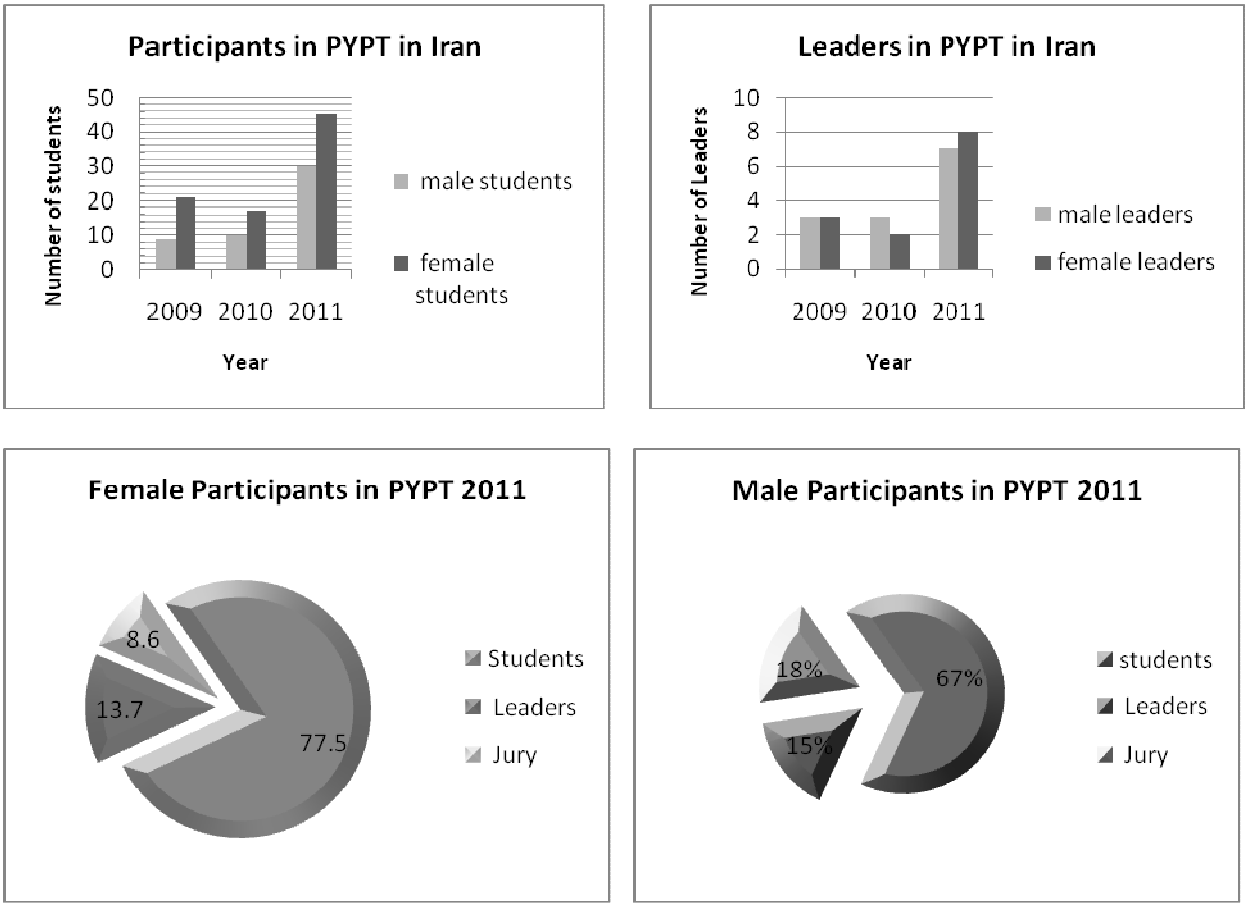

Fig. 6. Statistical survey in PYPT

5. Conclusions

In spite of the best efforts of teachers, typical students are also learning that physics is boring and irrelevant to understanding the world around them. Many college teachers today want to move past passive learning to active learning, to find better ways of engaging students in the learning process. But many teachers feel a need for help in imagining what to do, in or out of class that would constitute a meaningful set of active learning activities. So we need to change science education to make it more attractive and relevant for a much larger fraction of the student population than in the past. PYPT and IYPT is a new method in physics education which lead to greater retention of knowledge, deeper understanding, and more positive attitudes toward the subject being taught.

References

1-Izadi D., Torabi A. M., Mahmoudi N.,Izadipanah N.,Eshghi N., "Reports on Activities in Bssic Sciences in the Last Three Years in Iran", 4th ICWIP conference, South Africa, April 5-8, 2011.
2-http://www.pyptonline.com
3-http://www.ayimi.org
4-http://phet.colorado.edu
5-http://www.phys.washington.edu
6-http://groups.physics.umn.edu
7- Carl Wieman and Katherine Perkins, "Transforming Physics Education", Physics Today, November 2005, 58(11), p.36
8- Ian D. Beatty Æ William J. Gerace, "Technology-Enhanced Formative Assessment: A Research-Based Pedagogy for Teaching Science with Classroom Response Technology", Published online: 7 January 2009
10- Paosawatyanyong B, P. Wattanakasiwich, " Implication of physics active-learning in Asia", *Lat. Am. J. Phys. Educ. Vol. 4, No. 3, Sept. 2010*