

# PHYSICS IN PRIMARY SCHOOLS (PIPS): FREE FUN PHYSICS FOR YOUNG CHILDREN

BY ANN MARKS

## MOTIVATION: WHY SHOULD PHYSICISTS VISIT PRIMARY SCHOOLS?

In 2002 the first International IUPAP Conference on Women in Physics<sup>[1]</sup> was held in Paris and the scarcity of women physicists highlighted as a worldwide problem. Soon after, a UK Government report<sup>[2]</sup> identified shortages in the future supply of physical science graduates, and of girls in particular, as being detrimental to the economy. For some years various national initiatives to encourage girls into science had focussed on secondary school students, those aged between 11 and 18<sup>[3]</sup>. Physicists involved in some of these initiatives had visited schools for activities such as talks and demonstrations. However, changes to the secondary school curriculum had generated pressures which made it more difficult for such visits to take place. At the same time, there had been a considerable increase in the amount of science taught in primary schools, the schools for pupils up to eleven years old. It was also shown that many children make career decisions at an early age<sup>[4]</sup> and that special events have a lasting impact. The Women in Physics Group (WIPG) of the Institute of Physics in the UK decided to explore ways of enabling physicists to visit primary schools, to work with both young girls and boys.

In the UK primary schools the majority of the teachers are required to teach reading and writing and literacy skills as well as about twelve subjects in the curriculum. 'Science' includes physics but very few primary school teachers

### SUMMARY

**The Physicists in Primary Schools (PIPS) project aims to inspire young children with the enjoyment and excitement of science. Twelve 'presentations' have been developed, which can be found on the Institute of Physics website at [www.iop.org/pips](http://www.iop.org/pips). All the material is free to download. Physicists who use the materials to conduct primary school visits in the UK do not ask for payment from the schools. In these school visits, basic physics is explained through fun activities - then applications are linked with the children's real life experiences!**



Fig. 1 A class watches a demonstration.



have a background in physics. They therefore lack confidence in their ability to teach physics and welcome physicists' support very gladly. In the UK there are five times as many primary schools as secondary schools<sup>[5]</sup> and all children spend at least six years at school before the age of eleven. This had posed a challenge which had seemed insurmountable because of the huge number of schools. A few individual scientists had successfully visited primary schools. However, WIPG would need to persuade a large number of physicists to visit these schools, for the project to be effective.

### CREATION OF THE WEBSITE

To gauge the level of interest, pilot events which attracted large numbers of enthusiastic physicists were organised. Both men and women at all stages of seniority attended. At one meeting, a primary school teacher appealed for help with "the difficult parts of the primary school physics" then added "all the bits I cannot see". She was referring to the numerous abstract concepts in the primary curriculum. For example, electric currents, which cannot be seen, are included as well as non-contact forces such as gravity and magnets acting at a distance.

However, volunteers without previous experience of working with children also requested help: many were accustomed to university lecturing and would be far outside their comfort zone (Fig. 2). It became clear that busy physicists needed easily accessible presentations, at the correct level and with detailed instructions on a website. In 2005, a team from the University of Sheffield, under the leadership of Professor Gillian Gehring, obtained UK Engineering and Physical Sciences Research

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Fig. 2 Classrooms are very different from university lecture theatres.

Council (EPSRC) funding to develop the material and the Institute of Physics agreed to set up and maintain a website [6] with free open access, as an enduring resource.

The topics that teachers found most difficult were prioritised and experts were enlisted to advise on aspects such as the safety issues and vocabulary. Novel activities were developed by the team and new ideas gathered, so that sessions can be presented either before a topic is covered by teachers or as revision (Fig. 3).

Each presentation was trialled twice, in schools with different characters, and then modified in response to the children's reactions, feedback from teachers and advice from experts. The apparatus used mainly consists of items which can be found around the home. The kit is therefore cheap, simple to locate and familiar to the children. A bonus is that the children can replicate the activities at home for parents and friends. It could be argued that children have access to excellent science on the television and the internet. However, this project has two distinct advantages: firstly, the physicists are very happy to answer the children's penetrating questions and secondly, the presentations involve the children doing activities themselves. Feedback from the children has shown that girls particularly benefit from this involvement (Fig. 4). Children are delighted



Fig. 3 A novel way to explain the seasons: this approach has been copied widely.

to meet real scientists and the presenters aim to show that being a scientist is exciting. After the visits, teachers do contact the physicists with the children's queries.



Fig. 4 The whole class is involved.

## THE WEBSITE MATERIAL

The presentations on the website cover topics, including electricity, forces (gravity, magnets and springs separately), sound, light, solids liquids and gases (which uses liquid nitrogen), electricity generation and energy resources, as well as the Solar System and space. Each session begins by explaining very basic physics concepts but finishes by describing applications which link the science to the children's everyday experiences. Examples of these links are: magnets with computer memory, gravity with space travel and also sound with ultrasound scans and iPods. Another session includes an explanation of how springs save lives. All the presentations can be downloaded in a form which may be modified to include suitable applications of the presenter's own research – providing opportunities for the researchers to demonstrate their enthusiasm. As a long-term aim of the project is to encourage more young people to embark on science careers, it is important that the children learn that there are numerous unanswered questions. Consequently there is a huge amount for them to discover if they become scientists.

In addition to detailed descriptions of the activities, the kit, safety issues and best practice guidelines, there are PowerPoint presentations which are brightly coloured, with simple diagrams, many pictures and few words (Fig. 5). Our key advice on how to begin a session is 'Don't start talking – do something!' Therefore, each presentation begins with an activity that catches the children's attention. Then, asking the children to

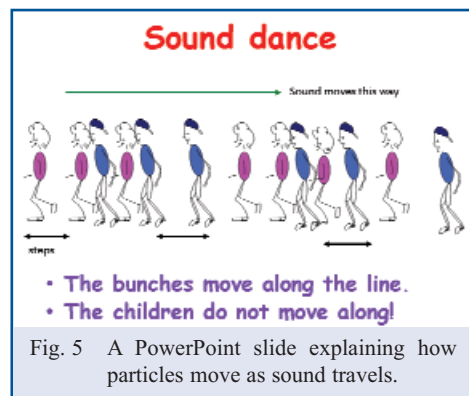


Fig. 5 A PowerPoint slide explaining how particles move as sound travels.

explain what is happening provides ideal opportunities to discover what children know about the topic and to identify their misconceptions. The individual activities involve the whole class or are demonstrations needing the assistance of the children and, as their attention spans are relatively short, there are a large number of fun activities with numerous 'WOW' moments. However the presentations are NOT 'magic shows'! It is vital that each logical step is explained so the children gain a clear understanding of the physics and learn to delve for underlying concepts.

Sessions finish with a message such as "Physics is everywhere", "Keep asking questions" or "Lots of jobs need science", encouraging the children to be inquisitive about the world around them.

## A FEW EXAMPLES OF PIPS ACTIVITIES AND FEEDBACK

'Electricity' uses a class game to explain how a current flows and a 'sound box' (the circuit is supplied) which, when an object is placed across its terminals, emits a frequency which varies with the conductivity. This removes the need for demonstration meters, because the whole class can hear whether a component is a good conductor. Consequently, this makes it simple to experiment with semiconductors and enables the children to invent uses for sensors.

The session on light does not require a darkened room, because primary schools are bright places. 'Sound' has a class dance to explain how a longitudinal wave travels and unlikely objects are employed for the children's experiments. The presentation using liquid nitrogen explains the low temperature of 'liquid air', with a pictorial temperature scale on a washing line.



Fig. 6 An activity in 'Forces and gravity' to demonstrate that gravity acts vertically downwards. — A child picks up a ping-pong ball by sucking on a straw; then finds it is very difficult to pass the ball to another child.

Recent feedback from a physicist was: "I think my PIPS visit went better than any of the many class-visits I've done before over the past several years. I'll do more of them now." Most importantly, children have been heard to say "Now I know what I want to be when I grow up".

## DEVELOPMENTS

Following the launch of the website in 2006, experienced presenters used the material enthusiastically, but many without previous experience hesitated to get started. In order to show the eagerness of the children and how much the teachers welcomed the visits, in 2008, video clips were added to the website, showing team members presenting to classes of children. In addition, 30 training workshops have been run across the UK, providing physicists with opportunities to try the activities themselves, as well as to discuss classroom techniques and their concerns. The workshops were well attended and feedback ratings were very high. All the volunteers have been encouraged to become STEM Ambassadors<sup>[7]</sup> so that they receive CRB<sup>[8]</sup> checks and have local support.

The above developments were funded by a second EPSRC award, which also enabled the team to increase the number of presentations on the website. Now, in the current phase of the PIPS Project, the Ogden Trust<sup>[9]</sup> is funding a further development which involves teams of undergraduates taking the presentations into schools. Looking forward, the availability of the on-line material is assured because the Institute of Physics has undertaken to continue its valuable support by maintaining the website for the foreseeable future.

The use of the PIPS material is snowballing. For example, many primary school teachers repeat activities with other classes and secondary school teachers find the material ideal for their primary school links. Additionally there is a growing international interest in the PIPS presentations, which is not limited to the English speaking countries because the slides are simple to translate into other languages. Also the material is particularly useful in developing countries and Eastern Europe where resources are in short supply. Statistics show that PIPS website has received over 150,000 page views in total and in the last twelve months the material has been downloaded in over 35 countries.

Children are universally keen to meet real scientists whose enthusiasm for their subject makes them excellent role models. Why not visit the website and consider using the PIPS material in schools yourself? You will find you have as much fun as the children!

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