Learning to Teach Physics

A guide to support for Newly Qualified Physics and Science Teachers
Congratulations!

Welcome 2012 newly qualified science teachers.

Whatever your specialism, if you will be teaching physics then you are now part of the physics community. That is because teaching physics is doing physics.

Let me explain:

Firstly, you will be doing physics simply by discussing physics with your students. You will be showing them what it is like to think like a physicist, helping them see the world in a physics way and, above all, demonstrating the beauty of a physics explanation.

Secondly, as a classroom teacher, you will be the single biggest influence on the physics-future of your students. So you are directly improving the health and prospects of physics.

This may seem a little daunting, but help is at hand through the Institute’s Education Department. We hope that you will engage with us as you develop as a teacher because we can offer support, resources and opportunities to get involved. This booklet describes just some of our activities.

We’re looking forward to working with you, and wish you well in your career!

Charles Tracy
Head of Education pre-19
Institute of Physics
IOP support for NQTs

We have a range of support for all teachers who are Learning to Teach Physics.

**Learning to Teach Physics**

LTP supports early-career teachers of physics (whatever their specialism) through e-newsletters, resources and events. All trainee science teachers who sign up for IOP Student Teacher Affiliation automatically become part of the LTP programme. You can sign up at any time by contacting student.teacher@iop.org.

**School Affiliation**

Make sure that your NQT school is affiliated to the IOP. We currently have more than 1600 affiliate schools and colleges. They receive our teaching newsletter *Classroom Physics*, all of the latest IOP teaching resources, invitations and discounts to our teaching events and conferences, access to our journal *Physics Education*, input into our education forum and other benefits. [www.iop.org/affiliation](http://www.iop.org/affiliation).

**We have 49 physics network co-ordinators (PNCs) in the UK and Ireland.** Mainly practising or retired physics teachers, they organise and co-ordinate local CPD events and build links between school sectors and between schools and universities. They act as a source of local physics-teaching information and generally provide help and advice in response to requests. [www.iop.org/network](http://www.iop.org/network).

**TalkPhysics**

TalkPhysics is our community website for all teachers of physics. Lots of non-specialists use the site regularly and it is a safe place for new teachers to ask questions, look for suggestions or share great resources. You can also join networks, chat to more experienced teachers and take part in online training. Join now at [www.talkphysics.org](http://www.talkphysics.org).

**Stimulating Physics Support (SPS)**

Stimulating Physics Support (SPS) is a new scheme enabling us to mentor a proportion of early career physics specialists across England. The mentors will also run workshops and events open to all local, early career science teachers in their region. For more information, visit [www.iop.org/sps](http://www.iop.org/sps).

**SPS is part of the Stimulating Physics Network** that works directly with teachers and students to improve the uptake of physics A-level in England, providing specialist coaches and co-ordinators to boost the teaching of physics in science departments. If you think your NQT school may benefit from working with SPN, visit [www.stimulatingphysics.org](http://www.stimulatingphysics.org).
Our PGCE blogger’s year

A trainee physics teacher generously agreed to record his year for us, telling it like it really was. Here are some edited highlights, but you can read his postings in full at www.iop.org/ltpblogs.

September 2011
I’m looking forward to meeting my fellow PGCE students and I can’t wait to find out what schools I will be working in. I hope that I get two very different schools: a Waterloo Road style place and something traditional like Hogwarts.

October 2011
The best thing about the PGCE is that it has reinvigorated my interest in science. I’m noticing science everywhere, giving me ideas for lessons. I dream of every lesson being out of this world, full of trips, experiments and games to get the kids fascinated. I hope that the beginning of my placement won’t be too much of a comedown.

November 2011
I’m now spending four days a week at my first placement school. I had been warned to expect to spend about four hours to plan for a one-hour lesson initially but this turned out to be an underestimate! I can’t say the lesson went as I’d hoped. Immediately after, the teacher asked me how I felt it had gone. I could not think of a single thing I had done well.

December 2011
A month and a half later, having completed about 50 more lessons, that first lesson feels like a lifetime ago. I still have a huge variety of ‘good’ and ‘bad’ lessons, but in each one I gain victories: another shy pupil puts up their hand and answers a question, a pupil gets higher than they expected from tests or a spontaneous debate begins. I’m really tired, but I’m still smiling (most of the time).

February 2012
January was my last month at my first placement school. I went on my first school trip and I planned and delivered a training session for the department! It was sad to say goodbye to the first three classes of my teaching career. My pupils seemed to be genuinely sad to see me go.

March 2012
My second placement will be in a large mixed inner-city comprehensive. It has a dedicated physics department, so I will be amongst five other physics teachers and another physics PGCE student. After the pre-placement visit, I saw there was a job advertised in the department and I was offered a position at the school! They seem to have high expectations of me and I’m already being included in departmental e-mails preparing for the next academic year which does add to the pressure of the PGCE.

May 2012
The biggest struggle so far was the beginning of the second placement. Some of my fellow PGCE students dropped out. We all felt a huge jump in expectations as we were meant to be closer to the finished product. I had my difficulties too. Initially, my confidence lessened as I felt that everything I had done was being scrutinised and criticised. But now I want to be in school as a qualified teacher – I want my own classes. I want my own room. I want my own posters up!
Halfway through their induction year, we asked a group of science NQTs how they were finding their first year of teaching physics. Here are some of the responses:

**Best aspects?**

Being free of all of the paperwork that was involved during my PGCE.

Having my own room, making my own decisions as to how I teach my own groups.

One observation per half term is manageable, much better form of feedback.

Moments when I could step back while my class was working and realise that I actually enjoy what I’m doing.

**How your view of teaching changed?**

I’ve realised it’s not about the work, it’s about relationships. I work in an inner city school and if you don’t take the time to build up the relationships, the learning doesn’t follow.

I’ve had to realise it’s OK if we don’t meet all of the learning objectives because they can be picked up on in the next lesson.

I’m more aware that teachers don’t necessarily have much more knowledge on a topic than the pupils, but can still use that knowledge to produce outstanding lessons.

**What has surprised you most?**

The state of my school’s science department – definitely not transparent at interview!

How some pupils speak to teachers: I only experienced high set classes in placements, so seeing how some of the bottom set classes behave is a surprise.

That I can cope with a timetable and my own groups! I was really worried that I wouldn’t be able to before I started my job. My subject knowledge is also a lot better than I thought too.

The way I can change what would normally be classed as a boring subject into something fun and exciting.

**And lesson planning...?**

I tend to design my own lessons rather than spending hours scouring others, but I use existing worksheets and rarely make my own.

I can now plan a 100 min lesson in less than 30 mins, which I’m very happy with!

We have bought in schemes of work (SoW) which I adapt and take ideas from. Each lesson is my own twist on existing ideas.

**How does the IOP help you?**

The Learning to Teach Physics e-mails are a useful reminder of what’s available and a reminder of where things are is good.

I tend to visit www.iop.org when I need resources or lesson ideas. Since our SoW are all relatively new, I go online when I need practicals to explain certain concepts.
Teaching resources

Finding your own materials can be a minefield – wading through thousands of resources and checking that they are both relevant and correct. Fortunately, the IOP has everything you need to teach physics at secondary level.

**www.iop.org/spt**

You’ve not studied physics since school and need to teach energy to year 9? You’ve got a physics degree but you’re not sure how to pitch electric currents to year 7?

The Supporting Physics Teaching (SPT) materials are designed to help you to be confident with what you have to teach and to show you how you could teach it. They’re interactive PDFs, which cover the entire physics curriculum for the 11–14 age group and a proportion of the 14–16 curriculum.

**www.tap.iop.org**

Teaching Advanced Physics (TAP) offers a comprehensive set of detailed resources to help you to plan lessons for teaching physics to 16–19 year olds. Topics include: electricity; mechanics; vibrations and waves; fields; atoms and nuclei; energy and astronomy. The resources don’t assume that you have lots of equipment or advice from experienced colleagues – download them and adapt them so that they work for you.

**www.practicalphysics.org**

Physics practicals are a vital part of students’ experiences at school. The Practical Physics website describes tried-and-tested experiments in sufficient detail that they will work in any school laboratory. It also provides notes about teaching and learning, as well as health and safety issues. The site is particularly useful for teachers who wish to develop their practical craft in physics.
Teaching Radioactivity
Teaching Astronomy & Space

These sets of videos and computer animations support teachers who are new to teaching these subjects at 11–16. They are available on our website at www.iop.org/education/teachingradioactivity www.iop.org/education/teachingspace or on DVD by getting in touch at education@iop.org.

Classroom Physics

If your school is affiliated with the IOP, it will receive Classroom Physics, the Institute’s newsletter for teachers. It will keep you informed of meetings, INSET courses, resources and other support that the Institute and other organisations offer to all teachers of physics. It also includes some starter ideas, teaching tips and worksheets, particularly for 11–16-year-old students. You can find it online by searching the IOP website at www.iop.org/education.

Physics Education

Physics Education is the Institute’s international journal on research into physics pedagogy. It contains informal articles about the teaching of physics, news, teaching tips and reviews of textbooks and software. It’s a great way to keep up with the latest ideas in teaching physics and to keep your teaching fresh. Affiliated schools have free access to the online archive. www.iopscience.org.
Tackling the marking mountain

Marking is one of the major pressures on all teachers’ time. It can seem like it is eating too much of your time, both inside and outside school. But there are a few tricks from the physics-teaching community that you may find useful.

Think about why you’re setting the homework

A lot of homework is set with no particular purpose other than to generate a mark and that usually means teacher marking. It’s worth asking the question – what is the purpose of homework? I imagine that most enlightened senior leadership teams would like teachers to spend time planning and would be dismayed if the marking load was getting in the way.

Research evidence shows that Assessment for Learning – giving feedback which focuses on what a pupil can do to improve – is one of the most powerful ways a teacher influences their students’ learning. There are no shortcuts as each student will have different needs but if you are going to spend time marking I recommend this approach where possible.

Sometimes you do need to set homework to create a mark, for example, before a parents’ evening. But if that is your aim, is it worth you putting in lots of hours of marking? Self and peer-marking are excellent ways to get your marking done whilst ensuring your students engage with the assessment process!

Set homework that is efficient and effective

As an NQT, I advise you to prioritise planning lesson content and developing your teaching skills over marking. Only then can you start thinking about homework. When that is in place, think about tests. And only when all that is working well can you realistically start working on how to get each individual student’s achievement levels up.

Physics has many mathematical elements which can be easier to mark so homework designed to test understanding does not need to be marking-intensive. Filling in the blanks, solving problems and questions requiring short answers can test a wide range of topics and pick up where they are struggling.

Think like a physicist

I often find myself saying the same things over and over again – underline headings, put units in, results table headings etc. So I wrote a list of all the things that crop up and put them onto a PowerPoint loop. When marking the reports, I just annotate them using a code e.g. M2 is method point 2, G4 is graphs point 4 and so on. On receiving the books the pupils have to write out the points in full as targets for the next time they write a report. I find they take the comments more seriously if they’ve written them out themselves.

To read more about marking – and to find some marking coding schemes – join the TalkPhysics discussion “Making marking less of a mountain” on www.talkphysics.org.
Fault finding in simple electric circuits

Building simple electric circuits should be easy. But in practice, however well you and your lab technician have prepared, you’re going to need to get good at trouble-shooting your students’ attempts, says Alan Baugh, IOP Teaching and Learning Coach.

First and foremost, resist the temptation to start replacing components immediately. Look at what you have in front of you – a visual inspection may throw up obvious problems.

If you find circuits daunting, use our check-list below to help develop your fault-finding skills. Take it slowly, think logically and you’ll find you can soon get those circuits working every time.

### Checklist

1. If it’s a complete bird’s nest of wiring, don’t even go there. Get the students to start again without using voltmeters. Then add voltmeters after the circuit is otherwise working properly.
2. Look for common mistakes such as:
   - incomplete circuit
   - reversed polarity components
   - a/c supply instead of d/c
   - accidental short circuits.
3. Verify the power source (battery or lab pack) is producing the potential difference expected by using either a voltmeter or multimeter.
4. Use a voltmeter to check that the potential difference across individual components of the circuit is reasonable. There should be no p.d. across the connecting leads and contacts.
5. If you still haven’t been able to identify the source of the problem, now is the time to try swapping potentially faulty components. Remember to do this one at a time!
6. Another approach that some teachers find works is to draw the circuit out on large pieces of paper and get the students to build their circuits over this ‘map’.

### Other common problems

- ‘Flat’ batteries
- Apparently identical lamps with different current or voltage ratings
- Connecting leads with internal breaks
- Loose or corroded connections
- Faulty ammeter shunts, voltmeter multipliers and ‘flat’ internal batteries (e.g. on digital meters)
- Finally, the most common problem of all: students. Sorry, but you can’t replace these.
Get your pupils talking in physics lessons

This may seem strange advice when others talk about class control. But it is essential to recognise the extent to which subject-specific vocabulary and technical terms are an essential part of the physics curriculum says, Phil Badley, IOP Teaching and Learning Coach.

I have heard it said that pupils come across as many new words in KS3 science as they do in a modern foreign language. Pupils must be able to recognise the words, know their scientific meaning and be able to use them in appropriate scientific contexts.

This is particularly important in physics, where there are a lot of specialist words which are used in everyday talk. For example, power, work, resistance and energy all have very specific meanings for a physicist.

The development of appropriate literacy skills will take time and talk is an important element of the process. Use structured activities to encourage pupils to talk to each other about the physics they are learning.

Initial activities could involve identifying appropriate terms, sharing information from a comprehension or working together to match appropriate pieces of information. More advanced activities will involve discussion, role play, preparations for presentation and the analysis of information. Make sure that group tasks are sufficiently challenging to require group co-operation.

Whatever the activity, don’t assume pupils will already know how to organise themselves or how to tackle the task.

Plan the activity carefully:
- control the groupings with allocated roles to suit the task
- give clear expectations and explicit outcomes
- demonstrate and scaffold the appropriate skills
- hold a plenary/debriefing to support learning about the content and the process.

Finally, a warning from bitter experience

Pupils who have been sitting quietly and passively in classroom-based lessons all day may need extra management when they get up for practical work or are invited talk to each other...DON’T get put off doing these activities. The buzz of a room full of pupils talking about physics will make it all worthwhile!

Activity ideas

1. Identify groups of words/terms from a list and explain reasons for groupings.
2. Match appropriate cards showing terms, definitions, units etc.
3. Give each group three different sheets of information about a famous scientist plus a series of questions that can only be answered by sharing information.
4. Talking Points – a list of 10 statements about a topic that may be correct, inaccurate or just interesting. Groups discuss and then feedback their ideas.
5. Concept Map – key terms and words in a topic that the group arranges on an A2 sheet of paper and writes a link between the words.
Many beginning teachers are surprised at the challenges they encounter when preparing lessons on energy. You will not be alone – the teaching of energy ideas has been debated for at least the last 50 years. So here are a few things to keep in mind.

In physics, energy is very much a bookkeeping tool. Analysing energy in a system is useful because we know that it is conserved. So we know the total amount of energy and can work out things like “How much fossil fuel do we need to burn to supply my electricity for a day?” or “How many chocolate bars do I need to eat to climb up this mountain?”

Using energy to describe a situation can often make something sound scientific. But very often, it doesn’t explain anything. Take these examples: “A power station converts chemical energy to electrical energy” or “A microphone converts sound energy to electrical energy”

They say nothing about the fascinating stories of how these systems work. And they imply there is some stuff or substance called “energy” which can transmute into different forms.

Try excluding the word energy from your explanations and you will see that the processes underlying them become much clearer.

You may find it useful to think about energy being transferred between different energy stores during a process rather than it being converted from one form to another. Read more at: www.nuffieldfoundation.org/practical-physics/helpful-language-energy-talk.

Example

Imagine a simple demonstration where you drop a set of keys and ask about the physics of the situation. Older students may want to tell you the keys have gravitational potential energy. But what does this actually tell you?

“The keys’ weight pulls them to the ground, where they make a noise.” All of this is valid, relevant physics and explains the situation well without any mention of energy. It’s only when we ask questions like, “How fast are they moving just before they hit the ground?” that it becomes useful to talk about shifting energy from the gravitational store associated with the keys, into their kinetic store. The only valuable reason to bring energy into the discussion is to answer a question that involves a calculation.

To find out more, visit the Energy topics in Supporting Physics Teaching at www.iop.org/spt.
Joining the Institute

Once you gain Qualified Teacher Status we encourage you to join the Institute in the following ways:

- If you have a degree in the physical sciences or engineering, you can apply to become an Associate Member of the Institute or, if you have an interest in but no formal background in physics, you can become an Affiliate Member. Both will give you access to IOP member benefits, such as publications (e.g. our international physics magazine *Physics World*), career advice, regional networks and discounted rates at meetings.

- If you are interested in subscribing to *Physics World*, join up as an IOP member.

For more details about joining the Institute, visit www.iop.org/membership.

The Institute also offers an affiliation scheme for schools and colleges. This entitles them to receive: *Classroom Physics, Physics Education, Physics World*, discounts on conferences and events, free resources and lots more. Contact affiliation@iop.org.

The Institute of Physics is a leading scientific society promoting physics and bringing physicists together for the benefit of all. It has a worldwide membership of around 40,000 comprising physicists from all sectors, as well as those with an interest in physics. It works to advance physics research, application and education; and engages with policymakers and the public to develop awareness and understanding of physics. Its publishing company, IOP Publishing, is a world leader in professional scientific communications.

Institute of Physics
76 Portland Place
London W1B 1NT
Tel: 020 7470 4800
www.iop.org
www.facebook.com/instituteofphysics
www.twitter.com/physicsnews

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