SSERC Bulletin

Ideas and inspiration supporting science and technology for all Local Authorities

No. 243 - Summer 2013

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 ISSN 1759-1082

Conductivity on the cheap

The conductivity of a solution is, not surprisingly, a measure of its ability to conduct electricity. The measurement of conductivity is a routine technique in many industrial and environmental applications as a fast, cheap and reliable way of measuring the ionic content of a solution. It is commonly used, for instance, as a method of assessing the effectiveness of water purification systems.

Figure 1 - A traditional conductivity flask.

In the classroom, conductivity is commonly used as a method of distinguishing between ionic and covalent compounds. It is also used as a means of following the course of chemical reactions, especially neutralisation reactions.

The measurement of conductivity of a solution is most commonly done using a conductivity meter. These are fairly expensive and quite fragile.

Another method is to use a conductivity flask. This is a modified conical flask which has an additional hole for a bung in its side. A 2-hole bung is placed in this and electrodes passed through the holes. You then pass an AC current through the circuit (An AC supply is used in order to avoid electrolysis) and measure the resistance.

This is much more robust but the flasks are quite expensive.
We have, however, come up with a simple way you can make your own conductivity apparatus and thus allow the whole class to carry out investigations into conductivity.

Apparatus

- Plastic drinks bottle
- Scissors/modelling knife
- 2-hole bung (to fit the bottle)
- 2 x carbon rods
- Crocodile clips and leads*
- AC power supply*
- Multimeter (capable of reading AC current)*

* You will probably be able to borrow these from the physics department.

Assembling the flask

1) Cut round the drinks bottle about 10 cm from the top and dispose of the bottom half.
2) Push the 2 carbon rods through the holes in the bung so that 2-3 cm or so are protruding. (You may need to use a little petroleum jelly to ease them through).
3) Push the bung into the neck of the bottle. Now is a good time to check it is waterproof by holding it upside down and filling the vessel with water.
4) Use a clamp to grip the neck of the bottle holding your flask upside down.
5) Connect up the circuit with the multimeter and conductivity flask in series.
6) It is now ready to use.

Figure 2 - Carbon rods pushed through the bung.

Figure 3 - An assembled 'flask'.

Using the conductivity flask

1) Use a syringe or pipette to put a measured volume of the first solution in the flask. (Ensure the electrodes are just covered - 20-25 cm^3 should be enough but it will vary depending on the shape of the bottle you are using).
2) Turn on the power supply and adjust the voltage until you get a reasonable value. (For the flask pictured, we found that 4 V gave approximately 0.6 A with 0.1 mol dm^{-3} HCl and 0.3 A with 0.1 mol dm^{-3} NaOH).
3) Record the value before any addition.
4) If you are carrying out a neutralisation reaction, it is interesting, though not essential, to add an indicator.
5) Add the second solution a bit at a time, recording the current after each addition. You can either use a burette or a graduated pipette. The graph (Figure 4) was obtained using a Pasteur pipette.

Results

The following graphs show sample results obtained with this apparatus.

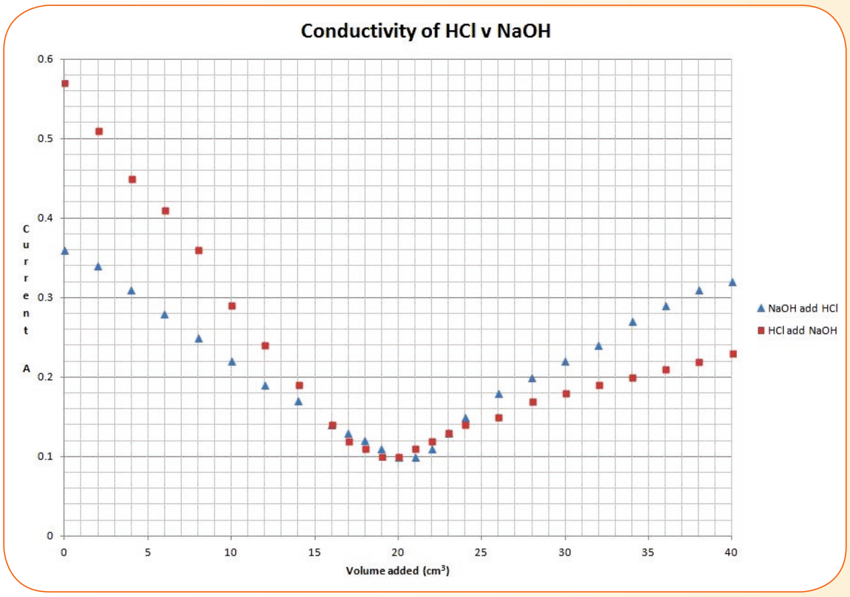


Figure 4 - Graph of conductivity in a reaction between a strong acid and a strong base.

Discussion

Strong acid v strong base

Figure 4 shows the results for a strong acid and base (both 0.1 mol dm^{-3}). The graph shows the results both ways round, adding acid to base and base to acid. From the graph it is clear that the acid has significantly higher conductivity than the base. This is due to the small size and hence high mobility of H^+ ions compared to OH^-. (See Table 1).

So what is happening here? To understand the shape of the graph, you need to know what reaction is taking place. In this case, it can be represented by this equation:

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

At the start of the reaction, you have H^+ and Cl^- ions to conduct electricity. As NaOH is added, the H^+ ions combine with OH^- to form water, leaving Na^+ and Cl^- ions. As Na^+ is larger and less mobile than H^+, the conductivity of the solution drops. After the end point, further addition of NaOH results in more Na^+ and particularly OH^- ions being present. OH^- ions are less mobile than H^+ but more than other ions and so the conductivity of the solution increases, but not to the level it was before.

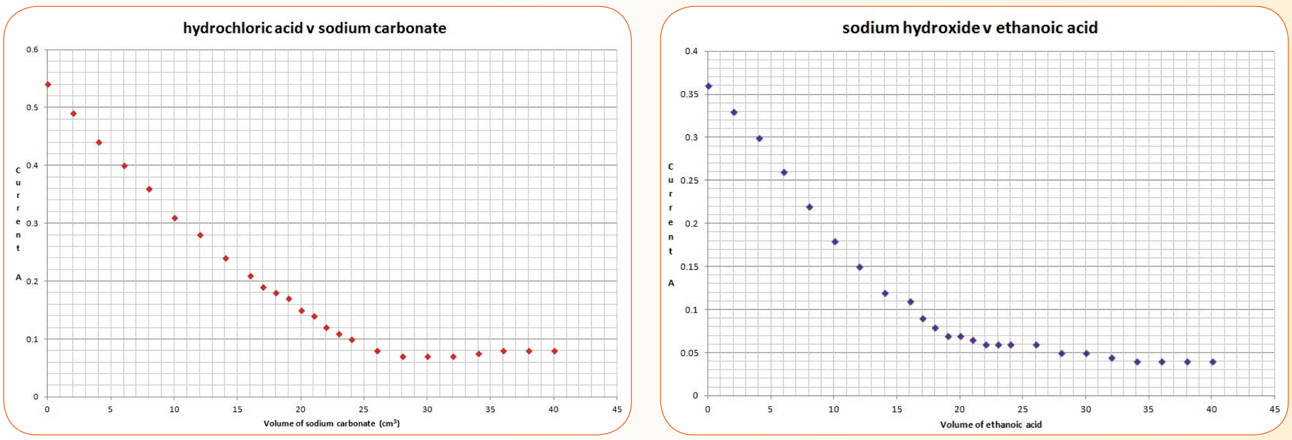


Figure 5 - Graphs of conductivity in reactions between strong and weak acids and bases.

If you look at the blue graph (HCl being added to NaOH) you will note that the conductivity at the end is much less than might be expected for that amount of HCl. This is simply the effect of dilution. The conductivity of 20 cm^3 of hydrochloric acid is about 0.58 A. The blue plot starts with 20 cm^3 of sodium hydroxide and hydrochloric acid is added, ending up with 40 cm^3. There is, indeed 20 cm^3 of 0.1 mol dm^{-3} hydrochloric acid in the flask now but it is in a total volume of 60 cm^3 and so the conductivity is less.

Strong v weak acids and bases
These graphs are less clear and the experiment works best if you start with the strong acid/base and add the weak one rather than the other way round. Because the weak acid/base does not conduct well, the conductivity of the mixture does not rise again after the end point of the reaction but there is still a clear end point to be seen.

Trying this with a weak acid and a weak base gave no worthwhile results.

Precipitation reactions
Any reaction can be followed as long as there is, at some point, a significant change in the conductivity of the solution.

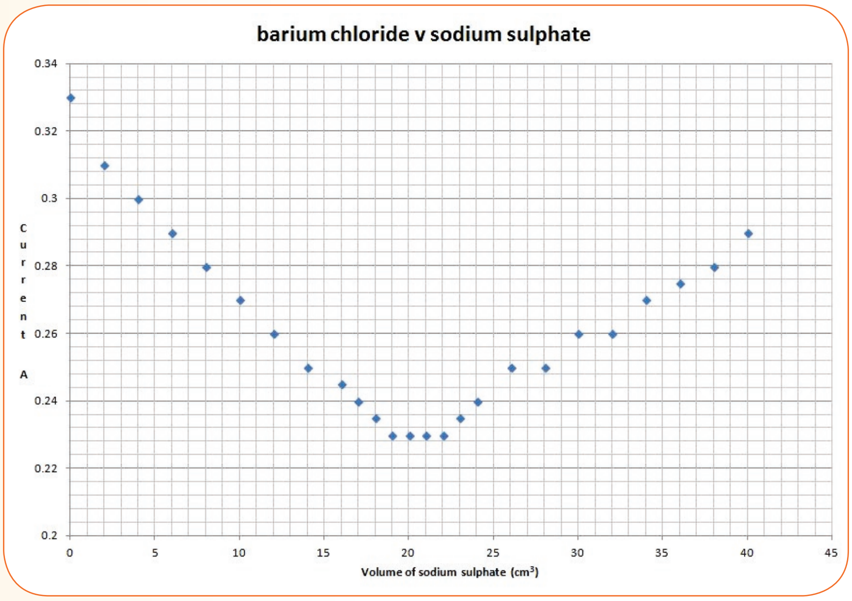


Figure 6 - *Graph of conductivity in a precipitation reaction.*

As well as neutralisation, a good example is precipitation. In this case, one of the products, being insoluble, (barium sulphate in this instance) is removed from the mixture thus reducing the conductivity to a minimum. As excess of the second reactant is added (sodium sulphate here) the conductivity increases again.

Where does it fit in the curriculum? There is no specific mention of conductivity of solutions at any point but, nevertheless, this apparatus can easily be used to demonstrate the different conductivities of ionic and covalent compounds in solution and also to show how the conductivity depends on concentration (N4 & N5 Chemical Changes and Structure: atomic structure and bonding related to properties of materials).

Using conductivity to follow a reaction as described above could fit into the Advanced Higher Physical Chemistry unit which covers acids, bases and indicators.

The method might find application for the N4/5 assignments and in the Higher/Advanced Higher Researching Chemistry units.

Safety considerations
All the solutions used are of low hazard. The electrical supply should be kept well away from the liquids and should have been PAT tested to ensure its safety.

Ion	Conductivity	Ion	Conductivity
H^+	35.0	OH^-	19.8
K^+	7.36	Br^-	7.84
$NH4^+$	7.34	I^-	7.68
Ag^+	6.38	Cl^-	7.63
Na^+	5.01	$NO3^-$	6.92
Li^+	3.87	$HCO3^-$	4.45

Table 1 - *Molar conductivities of selected ions (10^3 Ω m^2 mol^{-1}).*

Demonstration corner

The Silver Mirror

Just to show that chemistry is not all about whooshes and bangs, here is a quiet, gentle and beautiful demonstration that is really quite easy to do.

N.B. Do NOT make up the solution more than an hour in advance and dispose immediately after use. On standing, ammoniacal silver nitrate can form a touch sensitive explosive.

You will need:

- A round-bottomed flask - the bigger the better (once the demonstration has been completed you can remove the silver and re-use it).
- 1 x 100 cm^3 beaker.
- Stirring rod (or magnetic stirrer);
- Concentrated (16 mol dm^{-3}) nitric acid [**corrosive**] (from a dropping bottle*).
- 0.10 mol dm^{-3} silver nitrate.
- Concentrated (15 mol dm^{-3} [0.88]) aqueous ammonia solution [**corrosive**] (from a dropping bottle*).
- 0.80 mol dm^{-3} sodium hydroxide [**corrosive**].
- 0.5 mol dm^{-3} glucose solution.
- Hot water.

* *You can use a Pasteur pipette rather than a dropping bottle.*

Preparing the flask
(Wear goggles [BS EN 166 3])
Place about 3 cm^3 of concentrated nitric acid (16 mol dm^{-3}) into the flask and stopper it. Swirl the acid around to dampen the entire interior surface of the flask; this will clean off any residues on the inside.Pour the acid from the flask, and flush it down the drain with water. Rinse the flask with cold water and stopper it.

No more than ten minutes before presenting the demonstration, fill the flask with hot water to warm it (hot tap water is fine).

Preparing the mixture
(Wear goggles [BS EN 166 3])
Pour 30 cm^3 of 0.10 mol dm^{-3} $AgNO_3$ into the 100 cm^3 beaker.

While stirring the solution, add drops of 15 mol dm^{-3} ammonia [**corrosive**] until the brown precipitate which forms initially has just dissolved.

Add 15 cm^3 of 0.80 mol dm^{-3} sodium hydroxide [**corrosive**] to this mixture. A precipitate forms; to this precipitate add drops of 15 mol dm^{-3} ammonia until the precipitate dissolves once more.

Presentation
Empty the hot water from the flask.

Pour 10 cm^3 of 0.5 mol dm^{-3} glucose into the flask.

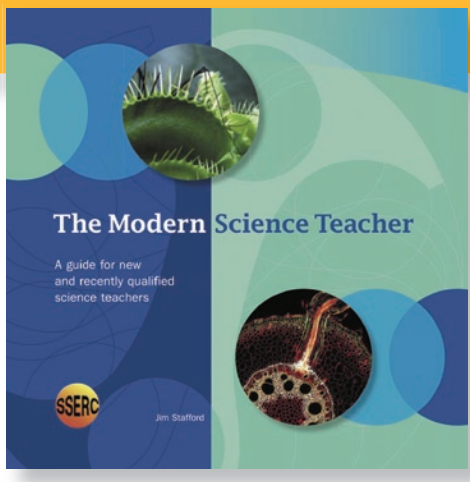
Add the contents of the beaker, and stopper the flask. Swirl the flask continuously to cover its entire surface with a thin coating of the liquid.

Within about a minute, the flask will begin to darken as a film of metallic silver forms on its inside surface.

Continue to swirl the flask until the entire interior of the flask is covered with a film of silver, and the flask looks like a mirror.

After the demonstration, do NOT save the silver solution in a silver residues container. The solution must be disposed of down the sink with plenty of cold water within 30 minutes of mixing at the start of the demonstration. This is to avoid any chance of the formation of a deposit of silver fulminate, a dangerously explosive substance.

As long as you have rinsed the flask out, with cold water, it is perfectly safe and you can keep it for as long as you want. To clean the flask, wash it with dilute nitric acid. Some of the silver will dissolve but most will just loosen and you can reclaim it by filtering to recycle.



The Modern Science

SSERC's latest publication *The Modern Science Teacher* [1] is designed as an introductory support for new entrants to the science teaching profession.

It is provided to all of Scotland's secondary PGDE science students as part of the Scottish Universities Science School (SUSS) provided by SSERC. It is also given to participants in SSERC's course for probationer science teachers and to participants on leadership and head of faculty courses who will have a role in supporting probationers.

In his foreword Graham Donaldson, author of the report Teaching Scotland's Future [2], observes that "It is relevant to all science teachers, irrespective of whether they have recently qualified or have been teaching for many years and is an important point of reference for those whose decisions will set the context for the kind of high quality science education which Scotland's young people need and deserve."

BOX 1
A modern science teacher will be expected to:
- have expertise in their science subject(s), pedagogy and educational theory that they keep up to date throughout their career;
- take responsibility for their own professional development and progress;
- contribute to the development of other teachers;
- engage in innovation and change that is based on research, thought through and well planned;
- evaluate the impact of what they do in relation to the improvement of children's learning.

Adapted from the Donaldson report - *Teaching Scotland's Future.*

Divided into three parts, part one 'Starting a Career in Science Teaching' covers teaching in a laboratory setting including health and safety. Part two covers 'Developing Science Learning and Teaching'. The third part 'Continuing to Make Progress' covers CPD, action research, and self evaluation and inspection.

The second part 'Developing Science Learning and Teaching' is the largest and most demanding component. Relevant to the new era of Curriculum of Excellence it recognises the classroom practitioner as the driver of curriculum development and improvement. It draws together the key features of learning and teaching, assessment and the principles of curriculum design in science in an integrated way to support the development of a science curriculum suited to the 21st century.

In learning and teaching about science, attention is drawn to the culture of science in drawing conclusions and making decisions based on evidence rather than on opinion. The honesty and integrity of the scientific research involved in presenting results, considering alternatives and contrary points of view by accepting that scientific explanations are always reviewed in the light of new knowledge and experience is also considered. The importance of practical work in science having a clearly defined purpose for learning is stressed. The different possible purposes of practical work are outlined (Box 2) emphasising that practical work should be 'minds on' as well as 'hands on'. Curriculum progression is viewed as involving both progression in depth of knowledge and understanding through developing concepts, big ideas and that which is important and powerful to learn in science (Box 3) along with the application of science skills in more complex and unfamiliar contexts as the curriculum progresses.

BOX 2
Science practical work can fulfil a number of educational purposes including to:
- illustrate scientific phenomena to support and develop deeper understanding;
- develop competence in practical techniques;
- develop valid and reliable experimental designs;
- generate data for subsequent analysis;
- test hypotheses and draw conclusions.

In assessment, emphasis is placed on the importance of teacher belief that high quality learning experiences will not only stimulate deep and lasting learning but they will also result in higher attainment than emphasis on rote learning, drilling and rehearsal. In short, teaching *for* the test rather than teaching *to* the test. The importance of gathering evidence of achievement to support learning as well as to inform of progress in terms of breadth, challenge and application is also considered as is the importance of school based

Teacher

moderation practices to develop a shared and clear understanding of expectations and standards between teachers and learners.

In curriculum design a number of different frameworks for developing a science curriculum are offered from which teachers can develop their own curriculum framework for science. Central to that is the importance of developing scientifically literate citizens (Box 4). Scientifically literate citizens are able to identify the scientific issues underlying national and local decisions and to pose and evaluate arguments based on evidence from which they can apply conclusions to real life situations. Interdisciplinary learning is approached from the point of view that learners should have the opportunity to integrate their knowledge and ways of thinking from other disciplines with their science to raise questions, solve problems and offer explanations of the world around them in a way that they could not do with science alone. Emphasis is placed in particular on integrating learning from Health and Well Being, Literacy and Numeracy with their learning in science.

Copies of The Modern Science Teacher can be downloaded from the SSERC website www.sserc.org.uk or printed copies can be requested by email from sts@sserc.org.uk.

BOX 3
Why big ideas of science education are important:
- The goal of science education is not knowledge of a body of facts and theories but a progression towards key ideas which enable understanding of events and phenomena of relevance to students' lives.
- Identifying big ideas in science is a natural accompaniment to promoting inquiry-based science education.
- Current school science leaves many students untouched in developing broad ideas of science that could help understanding of things around them and enable them to take part in decisions as informed citizens.

From Harlen W. (2010) *Principles and big ideas of science.education* [3].

BOX 4
The three elements of scientific literacy are:
- how things work - the knowledge of science;
- how science works - how science is done;
- making decisions - what is done with science.

References

[1] *The Modern Science Teacher - A guide for new and recently qualified science teachers*, SSERC, 2013. www.sserc.org.uk

[2] *Teaching Scotland's Future - Report of a review of teacher education in Scotland* (The Donaldson report), Scottish Government, 2010. www.scotland.gov.uk/publications

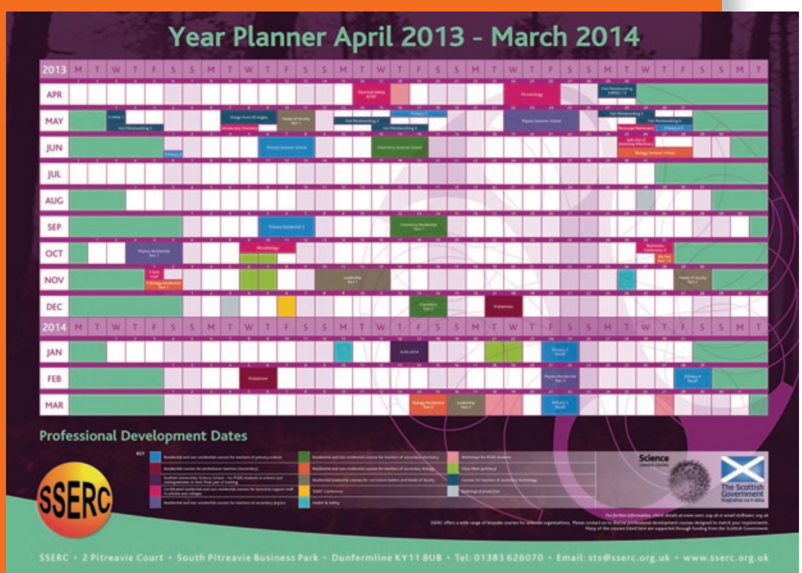
[3] Harlen W. (2010) *Principles and big ideas of science education*. ASE: Hatfield. www.ase.org.uk

A year in the life of SSERC

For the past few years SSERC has published a year planner which features our professional development courses for the coming 12 months. The most recent version has been printed and copies have been sent to schools throughout Scotland.

As we add new courses the planner will be updated and it can be accessed on the SSERC website.

Copies of the Year Planner can be requested - email us at **sts@sserc.org.uk.**



Risk assessment revisited

It has been some time since we published specific guidance about the process of risk assessment. Recently, we have noticed an upsurge in the number of enquiries about this, so we felt that it was a good time to address some of the frequently asked questions on the topic.

Before we go any further, it has to be said that SSERC's advice can't override your employer's policy. Most employers do, however, follow SSERC guidance on science and technology health and safety.

The bottom line is that all activities that present a risk of injury or ill-health have to be risk-assessed and the significant findings from that process must be recorded. This does not mean that there will be a paper risk assessment for absolutely everything that you do. For many activities, there will be no significant hazards. For most others, somebody else will have risk assessed before you. More about using existing or model risk assessments later.

Who should risk assess?

Your employer sets out the procedure to be adopted. Hopefully, it will follow the HSE "Five Steps Model". The task of risk assessing can be delegated to employees, though it falls to your employer to check that it has been done properly. For the majority of science and technology pupil activities, teachers are the best people to carry out risk assessments.

What if I risk assess an activity and someone gets hurt? Can I be sued?

This is extremely unlikely. Your employer has ultimate responsibility for risk assessment. It would have to be shown that you had been negligent when risk assessing, for example ignoring a very obvious hazard. Do not hesitate to consult SSERC resources or personnel for help.

Can I use model risk assessments?

Yes, though you must check that the activity they cover matches the one you are proposing to do. If you plan to use powdered magnesium and the model risk assessment uses magnesium ribbon, you may have to amend the model RA. Consider too who will be doing the activity and where. The control measures you need for S4 may be different to those for a visiting P7 class. Your employer may insist that all your risk assessments conform to a particular template.

Is "cut and paste" OK?

See above. Yes, if it passes through your brain between "cut" and "paste". You can also avoid duplication by including statements like, "See SSERC guidance on Optical radiation, Section 3.6".

What's the difference between a hazard and a risk?

A hazard is something that can cause harm. A risk takes into account the likelihood of harm happening and the severity of that harm. For example, if you were to risk assess crossing the road, one hazard would be moving traffic. If the road was the one through the SSERC car park, the chances of being hit by a car would be small and, though unpleasant, if you were hit it would be unlikely to be fatal. Contrast this with crossing the M8 motorway. The hazard is the same, but the risk is so great as to be intolerable.

I can't find any significant hazards. Have I failed?

No. Focussing on insignificant hazards and trivial risks is the real danger. It's what gives health and safety a bad name and it distracts us from the real issues.

What are the "five steps"?

This is an approach to risk assessment devised by the Health and Safety Executive. In general, if the HSE suggests a way of doing something, it's best to go along with it unless you are really sure that your way is at least as good.

Step 1 - Identify the hazards.
Step 2 - Decide who might be harmed and how. Consider pupils, teachers, technicians involved in preparation and anyone who might be involved in clearing up.
Step 3 - Look at existing control measures. Are they adequate or are additional measures required?
Step 4 - Record your findings.
Step 5 - Review and revise if necessary.

Remember to consult with and involve staff in the process. A "Five Steps" template is available from the SSERC website, or your local authority may provide you with their design of form.

So what do I record?

If you have found no significant hazards or particular groups especially at risk, you don't need to record anything. If you do find something significant, it is worth printing out a "five steps" form to have as a working document (see next question) but the most important thing is that work cards, pupil, teacher or technician guides contain the safety information your risk assessment deems to be necessary.

When do I review?

You must review if there is an accident, a near miss or a significant change to the activity. Other than that, it is good practice to have a look at risk assessments and the resulting safety advice at departmental meetings just before a particular group of activities are carried out. If you do this, sign and date the RA.

What about COSHH assessments?

There are a number of pieces of legislation that require employers and the self-employed to carry out risk assessments in order to make decisions about the actions required to prevent injury and ill health. The underlying management principles of COSHH assessment, ie finding out and then deciding what to do, are the same as those for assessment required by other health and safety legislation. Our view at SSERC is that the requirements of COSHH can be met as part of the more general risk assessment requirements of the Management of Health and Safety at Work Regulations using the "five steps" method. Regarding the requirements of COSHH, much of the work has been done for you and can be found in the Hazardous Chemicals area of our website. When you risk assess an activity involving chemicals, all you may need to do is refer to or get information from that part of the SSERC site.

My risk assessment says "wear safety glasses". Wee Johnny won't wear them. What do I do?

Simple. He can't do the activity and it probably isn't safe for him to be in the room where the activity is taking place. You risk assessed for a reason.

Wee Johnny's dad is a chemistry teacher. He doesn't wear goggles either, though he insists that his pupils do. As an adult, is this his right?

This is a terrible message to send to the children. It suggests that control measures are just another set of rules dreamed up to hassle pupils. If they meant something, surely teachers would conform to them?

We've been a bit behind with this whole risk assessment business. Where do we start?

Start with the really big issues - flammables, strong acids and alkalis, lasers, radioactivity, microbiological cultures and so on. You will find lots of information on the SSERC website. SSERC runs courses on health and safety for teachers and technicians needing an introduction or refresher, or for those with a management role within a science department. Look under the CPD tab on the SSERC website. Schools can request a custom-made course, and local authorities are entitled to a free course approximately every three years.

RME & Science teachers working together

UK science curricula ask teachers to include areas of contemporary science in their teaching and to encourage informed discussion of social, moral, and ethical issues. Meaningful interdisciplinary learning is one of the drivers of these new curricula and schools wish to explore realistic links which will enhance teaching and learning.

Research evidence indicates that many science teachers feel they lack the skills and confidence to initiate and manage classroom discussions. There is a view that they could benefit from support in this area from teachers of religious and moral education, who often use discussion techniques. On the other hand some RME teachers may feel limited by their knowledge and understanding of science and this may constrain the discussion in topic areas, which they feel confident to explore with their pupils. Areas of science and RME do overlap but they are often taught separately and can be seen as being 'in opposition' and this may lead to a closed approach to learning. Research has shown that young people are motivated by meaningful, well managed discussion where complex issues can be explored taking into consideration different cultures, values and beliefs.

The project

Two years ago SSERC received a '*New approaches to Learning*' Award from the Esmée Fairbairn Foundation. Through this project we set out to answer two questions:

- Can science and RME teachers work together on themes in a way which will enhance the pupils understanding of science/religion issues?

- What are the resource and CPD needs of both groups and can we establish an effective model for interdisciplinary working?

Primary and secondary teachers of science and RME from eight Local Authorities have taken part in the project. Initially teachers completed a background survey in which they were asked questions about current collaboration in their schools, their confidence in teaching controversial topics, and their pupils' perceptions of the relationship between religious and scientific perspectives. Around 70% of teachers thought that pupils perceive no relationship between the two curricular areas but around 90% of teachers believed that closer collaboration between the two subjects would be beneficial for their teaching and for the pupil experience.

Teachers of RME and science from the same schools were invited to a CPD session. Equal numbers of secondary Science and RME teachers attended the meetings together with primary teachers who taught both science and RME in P6 and P7. The teachers were introduced to the background to the project and to a variety of activities and methodologies which they could use in their own schools. Several representatives from the Scottish Government, the Local Authorities and from other Educational Trusts also attended the meetings. There was a very positive response from the teachers and there were lots of different ideas about how this collaboration might take place.

It was acknowledged that the teachers involved would need support from the leadership within their schools and indeed this did turn out to be a vital component in schools where the project was successfully implemented.

Over the next year a variety of further support was offered to schools in terms of both CPD and resources.

The outcomes

The outcomes from the project were very varied. A second survey was done and teachers were asked to evaluate the project in their schools. Visits were made to schools and several case studies were produced. The answer to the initial question ('*Can science and RME teachers work together on themes in a way which will enhance the pupils understanding of science/religion*') seems to be 'yes' but this only takes place with adequate support from the leadership within the school.

Other clear requirements for success are outstanding resources and the support offered by SSERC. Further details of the project outcomes are available in the final evaluation report.

New resources

Perhaps the most tangible evidence of success is in the form of a combined science/RME resource produced by three teachers (Nicola Young [Biology], Eilidh Colligan [RME] and Orla Payne [RME]) from Cathkin High School in South Lanarkshire. Their aim was to promote an informed discussion about stem cells and use an innovative technique to ensure that their pupils entered this discussion with a wide, global perspective of the topic. Although stem cells was the final topic chosen for discussion, the technique which was developed could be used for any other controversial topic.

The activity supports the following outcomes:

Science

a) I can debate the moral and ethical issues associated with some controversial biological procedures - *SCN 4-13c*.

b) I have researched new developments in science and can explain how their current or future applications might impact on modern life - *SCN 4-20c*.

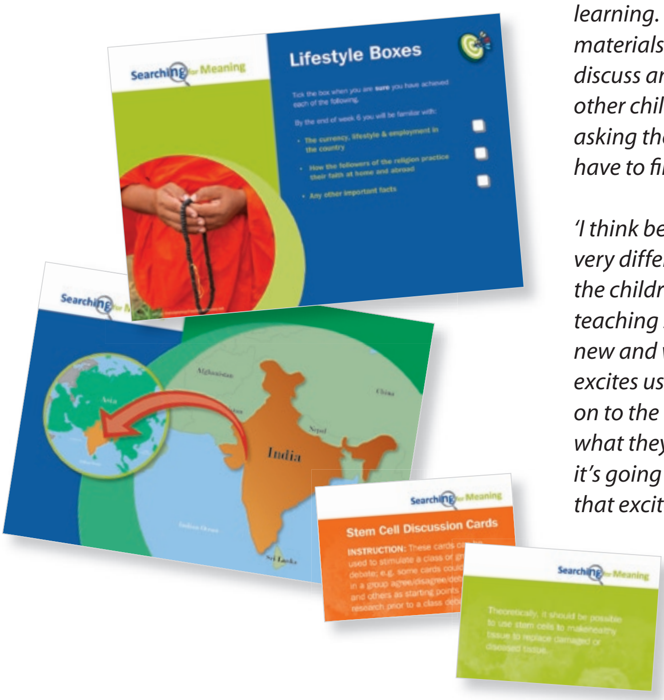
c) Through research and discussion, I have contributed to evaluations of media items with regard to scientific content and ethical implications - *SCN 3-20b*.

RME

a) I have developed awareness of the elements essential for making informed decisions and I have examined situations which pose a moral challenge in life. I can describe and explain my response and the responses of others to these situations - *RERC 3-23a/RERC 4-23a.*

b) I am able to apply my understanding of a range of moral viewpoints, including those which are independent of religion, to specific moral issues and am aware of the diversity of moral viewpoints held in modern Scotland and the wider world - *RME 4-09b.*

c) I am able to apply my understanding of a range of moral viewpoints, including those which are independent of religion, to specific moral issues and am aware of the diversity of moral viewpoints held in modern Scotland and the wider world - *RME 4-09b.*



Comments from teachers

Science Teacher (asked what the involvement in the production of this resource has meant to her):

'I think I've adapted my teaching to try and involve things and think about ethical issues when I am teaching biology. I don't want to be giving just my opinion to kids. That to me is wrong. I want them to form an opinion for themselves and I think when studying RME that's obviously what they're trying to do. I don't know the whole course content of RME, but when it comes to the biology aspect I think it's important that pupils get a sense of what they think themselves instead of just being told facts and try to get them to form opinions. I was really shocked to see how much RME and biology linked together, so I've definitely taken that on board and consider different beliefs and different reactions and ethical issues that maybe involved.'

RME Teacher (asked what the impact has been on pupils and on her own teaching when developing and using this resource):

'Independent learning - because they're very, very much in control of their own learning. It's nice to just give somebody materials and they go away with it, they discuss and then as they present the other children in the class are actually asking them questions and then they have to find the answers for themselves.'

'I think because it's something that's very different I think it has excited the children. It certainly excited us as teaching staff because it's something new and when it comes down to it if it excites us and you can put that passion on to the kids at the end of the day that's what they're there for, so if it excites us it's going to excite the kids and without that excitement there's nothing.'

Comments from students

'We were all working in groups like we had to work together. It wasn't just our opinion, we had to take into consideration all the others' opinions.' (asked what difference this experience made to their classes in RME and science)

'It's a good experience. It's not just the usual stuff.' (asked if the experience had been a good thing)

'It was more relaxed in class so it made it better like you weren't so uptight about trying to get everything right straight away. You would just sort of take it in and I think it made you learn more because you were genuinely interested in what you were learning about.' (asked if it changed the way of working with the teacher)

'I would like to learn more about the stem cells.' (asked if there was anything else they would like to say)

Comment from a Development Officer

'Over the last 20 years I have been leading projects which aim to help teachers to explore controversial scientific issues with their pupils. This aspect of science has been seen as a priority in science education. This project has been quite unique as it has approached the issues from quite a different angle spending much more time finding out why people have different views. This has lead to much more meaningful discussion where the pupils are already open to different ways of thinking. I have found working in this way very enlightening and I feel that the project has highlighted a way in which teachers can work together to improve the experiences and attitudes of their pupils.'

The project was managed by SSERC and evaluated by SCRE (Scottish Centre for Research in Education). Electronic copies of the final evaluation report and the new resource can be obtained from SSERC.

Logging in a wireless wonderland

Here we look at some further developments in the rapidly-changing world of data logging and interfacing.

Texas TI graphical calculators have been used by science departments for data logging for a number of years. We revisit them here because the latest models have some new features that highlight interesting developments in interfacing technology. Figure 1 hints at what these features might be.

The picture shows a Texas TI-Nspire CX calculator connected to a temperature probe via a mini USB port. Nothing new here, except perhaps for the colour screen, but take a closer look at the yellow plug-in module. It sports a wireless symbol, because this device can now join a dedicated WiFi network.

This is done by attaching a USB wireless access point (figure 2) to a classroom computer. Software then allows the teacher to look at what is happening on individual handhelds or to send data to and fro. Individual students can be selected to be "live presenters", showing their results on the central PC. There is also a facility to set up multiple choice tests (with pictures) or class polls.

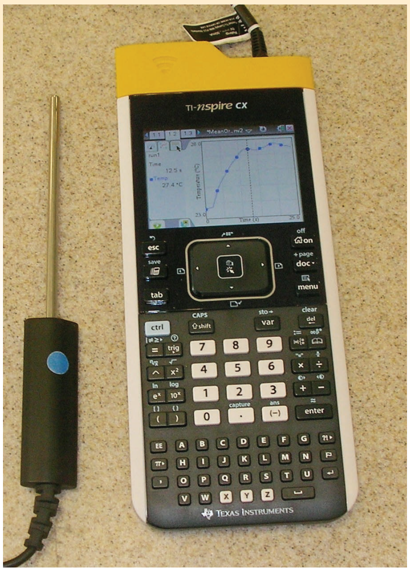


Figure 1 - Texas TI-Nspire CX calculator and probe.

On its own, the TI-Nspire has a fairly lowly sample rate of 200 Hz, but berthed in a cradle (Figure 3), this increases to 100 kHz. The cradle adds 3 analogue ports and 2 digital ports that are compatible with most Vernier sensors.

At the time of writing, a TI-Nspire costs £80, the cradle £100. WiFi hubs, wireless adapters and sensors are available separately. Texas instruments are keen to lend out units on a trial basis. Contact us at SSERC for further information. The Labquest 2 is the latest incarnation of Vernier's touch-screen handheld interface (Figure 4).

Figure 2 - TI WiFi access point.

The Labquest 2 takes a different approach to wireless connectivity. It can be connected to a school's wireless network. The unit then generates a web address and QR code (Figure 5). Any other browser-equipped device connected to the same wireless network can then "see" the Labquest, can access its data and even start and stop data acquisition.

Not every school has a wireless system, so the Labquest allows you to build a so-called ad-hoc network with the interface itself at the centre. Figure 6 shows the sort of screen that appears on a smartphone linked to the Labquest.

Both the TI calculators and the Labquest are distributed by Instruments Direct in the UK (www.inds.co.uk).

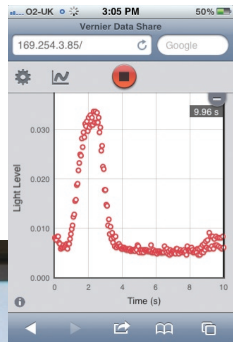


Figure 6 - Smartphone Labquest screen.

Figure 3 - TI-Nspire in cradle.

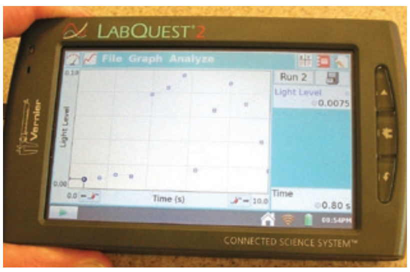


Figure 4 - Vernier Labquest 2.

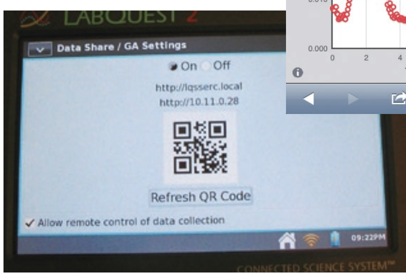


Figure 5 - QR code.

The SSERC Bulletin is published by SSERC · 2 Pitreavie Court · South Pitreavie Business Park · Dunfermline KY11 8UB
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