Smartphones, time-lapse and responsible use in the school laboratory

Nicky Souter and Graeme MacVicar

As teachers, we often explain biological phenomena as a 'given' and omit seeking evidence to support our assertions. Experiments that take longer than a standard science lesson may frequently be ignored or at most observed as '*One I prepared earlier*' or '*We'll see what has happened when you come back on …*'. A suitable example is the first stage of germination and authors such as Holman *et al*. (2007) indicate that this involves '*imbibition – the physical process of water uptake into the dry seed*' but this is rarely observed or demonstrated.

Although we set out to report how observing and recording simple biological phenomena over an extended timescale could be enhanced by digital technology, the journey took surprising turns and twists into questions relating to ethics, child protection and reviewing acceptable use policies on information and communication technology (ICT).

Image capture

A series of photographs was taken at frequent intervals during a 6.5 hour period with a digital SLR camera. Although the quality was limited by a number of factors such as ambient lighting, accidentally nudging the tripod and slight irregularities in timing, an acceptable series was collected and displayed as a *PowerPoint* presentation (available from the authors). Figure 1 shows how the appearance of haricot beans in a wine glass changed following the addition of 60 cm^3 of tap water.

Observable changes took place in the volume of seeds (most notably during the first 1.5 hours); we noted that further investigation would be possible on the mass of seeds and on their biological behaviour, for example enzyme activity.

Colleagues suggested that time-lapse photography could be used here and although we did not have the required equipment with our digital camera we were both owners of smartphones. The versatility of each smartphone is breathtaking. Chen *et al*. (2010) pointed out that:

> *Mobile phones have been popular personal devices in recent years. They are used not only as communication tools but also an integrated platform with the support from powerful hardware. Rich applications are also provided for mobile phones.*

Application software, known as 'apps', is exchanged and purchased through a marketplace. Apps are varied and represent the entire spectrum of ingenuity, and there are several relating to time-lapse photography.

We used *TimeLapse!* (from ExplorerDC) and *Time-Lapse - Lite* (from Sheado.net). We have not carried out detailed evaluations since these two apps were straightforward to download and provided reasonable results. They were additionally appealing since they were free on our Android telephones. Time-lapse calculators are also available and these assist in planning

Figure 1 Haricot beans immediately after the addition of 60 cm^3 of tap water at 12.43 (left) and at 19.08 on the same day (right)

the delay between each shot in order to achieve a good frame rate in the eventual short movie clip. Smartphones are notoriously greedy with regard to battery usage, as Strohmeyer (2011) suggested: '*For all of their power and versatility, smartphones – even the best of them – are cursed with abysmal battery life*.' We filmed with the power lead attached, as shown in Figure 2.

The experiment

Haricot beans would be treated in the same way as previously. Further preparation involved attending to issues such as lighting and ensuring available space. We realised that, in the same way as still photography is assisted by devices to include guidance relating to scale, it would help if we included a clock to show the passage of real time during the experiment.

We focused initially on the imbibition stage of germination. After receiving the *Science and Plants for Schools* newsletter (2011) that outlined an investigation of gravitropism with dandelions, we repeated the procedure for this experiment. The possibilities are seemingly endless, for example the action of catechol oxidase in browning fruit or circadian rhythms in plants showing movements of leaves.

Transferring movie clips from the smartphone to your computer is straightforward and they can even be uploaded directly to *YouTube*. Our *YouTube* videos can be found by searching for 'Strathclyde PDGE Biology'.

Use and abuse of the technology

We sought guidance on using smartphones and mobile phone technology in schools and consistently met barriers that had been established to prevent bullying and inappropriate filming (Denholm, 2007). These restrictions have placed an emphasis on 'no use policies' and confiscation (Dundee City Council, 2010). Concerns exist around the globe and policy advice in the USA from the Consortium for School Networking (2011) also focuses on internet filtering laws and cyberbullying. Some positive aspects are emerging, for example '*Some districts … have altered the perspective on "acceptable" use policies by framing them as "responsible" use policies*' (p. 3). Nevertheless, the default position sits largely, and understandably, in the realms of child protection.

Yet we seem to be 'missing a trick' in the school classroom. Information *and* communication technology is contained within these superb hand-held devices.

Brief literature searches revealed that current educational research relates to justification, software development, information retrieval, developments in other curricular areas, and future opportunities. It was disappointing that few items could be found that exemplify good practice

Figure 2 The laboratory set-up for recording a time-lapse movie

in science classrooms since smartphones offer such rich opportunities to extend the quality of classroom and home investigations.

SSR sets out to share good practice among science teachers – let's use these pages to exchange the exciting data-capture capabilities of smartphones and transform these unwelcome intruders into assets that can enrich the science classroom.

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Nicky Souter is a senior lecturer in science education and **Graeme MacVicar** is the biology technician in Strathclyde University's School of Education.
Emails: n.t.souter@strath.ac.uk and g.j.macvicar@strath.ac.uk

Teaching potential difference using a track lighting model

Alaric Thompson

I have sometimes experienced difficulties teaching students of all levels the idea of potential difference (pd) in simple series and parallel circuits. At the level of 'difference in energy per unit charge' or 'what is the voltage across …?', students often struggle with understanding the concept, despite being able to perform calculations that are used to determine the pd or that make use of the pd across components.

While sitting in a restaurant one evening, I noticed the track lighting system and wondered whether a similar model could be used to help describe the situation to students. Closer inspection revealed a wall-mounted mains-to-12 V transformer and two lengths of stiff wire fastened across the room. Clearly one wire was 'at' 12 V and one 'at' 0 V or Earth and, despite this being an alternating current (AC) system, I realised that a similar one using direct current (DC) could provide an effective teaching model. Two parallel wires with a pd of 6 V seemed suitable, with one regarded as being 'at' a potential of 6 V and the other 'at' 0 V or Earth potential.

Bulbs would be connected across the gap between the wires, each working at 6 V pd. Although it is a good way to start, I realised that the tracks need not be parallel; in fact, they could be any shape and any distance apart provided the bulbs were connected across the two.

Back in the classroom I set up the apparatus shown in Figure 1, having made stiff wires from two straightened coat hangers, a 6 V supply and bulbs that could sit across the two. The bulbs were in holders where the contacts protrude such that they touch the wires without fixing or clipping them in place. In the absence of such bulb holders, crocodile clips and short leads may be used to similar effect (as with bulb D in Figure 2).

Starting with just the two bulbs (A and B in Figure 1), my students could immediately see how