Chemistry: The essential spark for engagement?

■ Andrea Mallaburn ■ Linda Seton ■ Menna Goodwin

Living in a socially deprived area can be tough. At least, that's what several recent reports looking at the secondary school experience of teenagers in this demographic have indicated. It is recognised that the UK economy needs a highly skilled workforce and, in the North West, we have a large employer base of biochemical and chemical companies (see www. chemicalsnorthwest.org.uk), so we need school pupils from all backgrounds to be scientifically literate. Those who grow up in a socially deprived group are less likely to pursue careers involving science than the general population (see web reference 1).

The high school experience is at the heart of choices that teenagers make. To enable our teenagers to study and work in chemistry, they need not only good science teaching but also exciting and motivating school experiences, which inspire them to a future career in chemistry. By improving their engagement and attainment in chemistry, so raising their aspirations and opening their minds to scientific career opportunities, there is a real prospect of making a difference to their lives.

Yet, this isn't happening. In a recent survey of over 4,000 pupils for the Wellcome Trust (2), over half of GCSE pupils said that they wanted to do more practical science and hear about the work being done by research scientists. However, if they go to school in a socially deprived area, they will more than likely do less practical science than their friends from more affluent surroundings, and are less likely to study separate sciences (2). In deprived areas, there is a gap of over 30% between learners who say in Year 10/11 (ages 15/16) that they wish to study science post-16, and those who actually do. So what is happening in the transition to post-16 study? The level of aspiration to have a career in science is similar in all social classes, yet learners from socially deprived areas are less likely to achieve this goal. Does a lack confidence or self-esteem cause this? A lack of role models? A lack of financial support? Or a lack of opportunity?

Is it more fundamental than that? Pupils from a more affluent background perform better in maths, science and reading than pupils from socially deprived backgrounds (3). This can impact upon their long-term prospects. Since 2012, both disadvantaged and affluent learners leave primary school with a similar academic profile; however, when they leave secondary school there is a significant gap in their academic achievements (3). So why does this happen? Could the major influence here be their home environment? Often parents can be uninterested or not financially able to support and enrich their children's out of school learning. The largest effect of this factor is seen in white British children.

It has been highlighted that there is a north-south divide in educational standards. The Northern Powerhouse independent review (4) indicates that around a third of disadvantaged students attending northern schools attain 5+ A*-C GCSE grades including English and maths. This compares unfavourably with the national picture, where disadvantaged students' attainment is 3% higher and over 15% higher in London. These figures paint a bleak picture for our northern pupils.

For those of us who have pursued a career in science, we know that the practical aspect fires up interest and makes the subject come alive. Would you expect to develop a world-class footballer from someone who kicked a ball once a month for about 35 minutes? Would you think that you could become a gifted musician by observing someone else play? So, can we expect to provide a scientifically literate workforce without getting our children in the lab to investigate, explore and nurture their curiosity? Inspiration doesn't lie in textbooks; science is a living subject that enhances modern life.

Provision for science, as with many subjects, is at the mercy of budgets for equipment, technician support, access to laboratories and even reductions in curriculum time. In recent years, with the advent of austerity, schools have seen budgets cut in real terms and many have cut back on provision such as technician support and teaching assistants. It is more difficult to conduct a lesson that has pupils on their feet and handling chemicals if there is less support. This can often be one of the reasons that there are more practical science lessons in better-funded secondary schools and so few in the primary phase. The future funding for schools is uncertain due to the political times we currently face, with a General Election due soon.

At Liverpool John Moores University (LJMU), we are aiming to address some of these difficult issues. As part of the Royal Society of Chemistry (RSC) 'Chemistry for All (CfA)' (5), we are delivering an intensive programme of chemistry intervention with six schools throughout the Greater Merseyside region, all of which fall in socially deprived areas. This is part of a larger, national programme funded by the RSC (6), which aims to study the longitudinal impact of such activities in this demographic.

It is an accepted approach in modern teaching that enjoyment leads to learning, and that some pupils are much better engaged 'doing' than 'listening'; active learning approaches (7) are more effective than passive or didactic

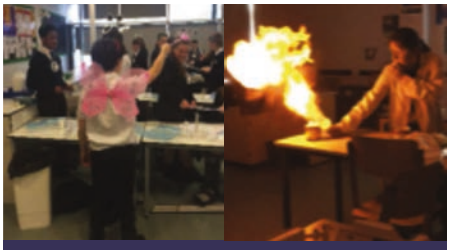
Don't believe us; listen to what the CfA pupils say!

Wordle produced from *Chemistry at the Crime Scene* responses to 'describe the event in one word' (University gala event).

Wordle produced from answers to the question 'Describe *Chemistry in your Life'* in one word (school event).

methods. The importance of hands-on experiential and practical learning is one of the cornerstones of the LJMU programme. We offer a mix of interventions delivered in the classroom, teacher-led activities and, once a year, a gala event in which pupils spend the day in University using the laboratories and facilities and working with real research scientists. This brings chemistry to life!

The LJMU programme aims to address chemical competency. We are currently in our third year of running this outreach programme of interventions. We have been working with the Year 10 cohort since the onset of the project and are now in the second year working with the Year 9 (age 14) cohort from each local school. Our dedicated project officer, an experienced and enthusiastic teaching practitioner, works closely with a lead teacher in each school. She visits all schools regularly to coherently deliver the chemistry interventions, which enhance their current school curriculum. A key aspect of the programme is to inspire and enthuse the pupils and set high standards for collaborative engagement with the chemistry and scientific equipment. University students support the events, which raises aspirations amongst the pupils as they see young people similar to them who are at university and working towards a career in chemistry or science.



The catalyst fairy starting off a polymerisation reaction and, on the right, *Boom!* – our teacher practitioner wowing with custard bombs to show rate of reaction chemistry.

The key to the success of this programme is knowing what deprived pupils need. When they get the chance to experiment in the laboratory, they are immersed in chemistry. They love reactions that blow up and change colour. They are mesmerised seeing chemistry in action! They adore investigating. Try our glow sticks experiment (8) for a great example of how a rate of reaction comes alive. Our polymers lesson, which relies on understanding chemical bonding and can be difficult for pupils to grasp, is one of our most successful on the programme. Using technical nomenclature and new symbols, it can be a challenging topic.

We have dissolved (pardon the pun) the stress by using the 'catalyst fairy' to help the children become atoms and act out the process of polymerisation. They love the experience, the concepts take hold early in the lesson, and the rest falls in to place.

A key feature of our programme is its in-school, compulsory nature. There are many, many excellent STEM enhancement activities (9) out there, but these rely on families engaging voluntarily outside of school (10). This can mean travelling, cost and time required, and in a context where money and time is tight. In the types of families we are working with, not everyone has the resources needed to become involved, and not everyone realises that they will enjoy it. The thirst for science has to be there in the first place. By engaging with our pupils within normal lessons, these barriers are effectively surmounted. Many pupils are surprised by their enjoyment of something that they wouldn't have chosen. After all, it is not the task of the pupil to direct their education – the more knowledgeable have to lead. We hope that our pupils will follow, catch up, overtake and fly.

Doesn't this look fun? Year 8 (age 13) pupils (above) enjoying an 'Elephant's Toothpaste' demonstration in *Chemistry in your Shopping Basket* school event and (below) formulating ointment in the University labs during the *Chemistry in your Life* University event.

Web references

(1) http://www.sciencecampaign.org.uk/resource/ImprovingDiversityinSTEM2014.html
(2) https://wellcome.ac.uk/what-we-do/our-work/young-peoples-views-science-education
(3) http://www.suttontrust.com/wp-content/uploads/2017/02/Global-Gaps_FINAL_V2_WEB.pdf
(4) https://www.gov.uk/government/publications/northern-powerhouse-schools-strategy-an-independent-review
(5) http://www.ljmu.chemistryforall.co.uk/
(6) http://www.rsc.org/campaigning-outreach/outreach/scientists/
(7) https://theconversation.com/active-lessons-can-boost-childrens-learning-and-health-72240
(8) http://www.ljmu.chemistryforall.co.uk/glow-sticks-and-the-rate-of-reaction/
(9) https://www.allaboutstem.co.uk/
(10) http://thestudioliverpool.uk/coderdojo/

Follow us on social media to hear more about LJMU's CfA initiative.

Dr. Andrea Mallaburn is Senior Lecturer in Teacher Education (Chemistry), **Dr. Linda Seton** a Reader in Crystallisation Science and **Mrs Menna Goodwin** an Outreach teacher practitioner, all at LJMU, Liverpool.