



THE ROLE OF SCHOOL TECHNICIANS IN PROMOTING SCIENCE THROUGH PRACTICAL WORK

Anne T. Helliard, Timothy G. Harrison

Abstract: This is a review of the role of practical work in UK's secondary school science lessons, the impact that practical work has in the promotion of science, the challenges created through use of non-specialist science teachers and a possible additional role for science technicians. The paper considers how improved deployment of suitably experienced school science technicians and their recognition, by schools' management, for their involvement in the delivery of training in the use of practical work, for less experienced teachers, could benefit schools and their students. This together with its companion paper endeavours to show how the more effective use of practical work and technicians can encourage more students to select science at higher, non-compulsory levels.

Key words: school technicians, practical work, non-specialised science teachers, training

1. Introduction

Provision of competent scientists is crucial, for countries to prosper, when competing within the world of commerce [1]. Unfortunately, the United Kingdom's availability and proficiency of scientists has fallen, forcing companies to recruit externally to replenish some desirable skills [2,3]. Students are showing a decreasing interest in the physical science subjects of chemistry and physics within English secondary schools at the optional, pre-university level. There has been a 40% decline in Physics uptake during 1985 to 2008 [4]. Consequently fewer individuals progress into higher education which prevents the growth of expertise within these fields [5]. These circumstances are not unique UK. They are also perceived by other European countries, where physics university entrants have been halved since 1995 [6]. This decline in interest with physical science has provoked many countries to become concerned over their future economic growth and well-being [5-7].

2. Why use practical work in School Science?

Practical work has existed in UK School Science for nearly 200 years [8] however, not all students learn by its practice and its redeeming qualities have been contested by many [9,10]. Nonetheless, its implementation, within schools, is integral to students' Science learning due to its capability of promoting student's interest, skill and knowledge towards scientific subject matter [11,12]. Students are also shown to enjoy learning by its experience [13,14] and teachers' access to this kinaesthetic style of learning is important where 37% of students have a preference to acquire knowledge through physical actions [15]. For students choosing a career in science, the development of good skills in practical activities is considered vital [2] especially for budding chemists who are expected to 'think with their hands' [16].

Practical work is an effective, versatile tool that teachers can adapt and apply, into science lessons, to meet student's specific learning needs [11]. One teacher's comment, regarding the importance of its inclusion, was 'Science without practical is like swimming without water' [17]. Science teachers use practical work to link and scaffold scientific concepts with 'real world' situations, providing relevance, which assists with students' understanding of difficult subject matter [8,13]. This is especially important with the less tangible subjects of physics and chemistry, which students find 'harder' to attain at A-level (pre university level) [18]. Well used practical work is shown to clarify

abstract phenomena and provide a greater relevance, ownership and insight for science students [19-21].

Industry is seeking new employees to be equipped with procedural as well as inquiry skills, reinforcing the need to include practical work in schools [22].

3. Practical Work and the Student's Learning of Science

Good use of practical work can help students become positively motivated towards the science. Conversely sub-standard implementation can have the adverse affect. Recent studies have observed science teachers' poor use of this tool and the negative affect it has had on students' opinion of science [12].

Where science teachers focus more lesson time on assessment, less time is available for practical work. A diminished use of practical work is shown, not only, to be detrimental to student's understanding of scientific concepts, but also, to quash their interest towards science [23].

4. Who is teaching our students?

General disenchantment towards teaching has depleted supplies of physical science expertise within UK Science departments [24]. Furthermore, difficulties have prevailed with the recruitment and retention of teachers specialising in these subjects [11]. For schools to ensure the delivery of these sections of the Science curriculum, new directives have been introduced, whereby qualified science teachers, irrelevant of subject, are expected to adopt any of the science disciplines to teach to students [5]. Where students have perceived, and consequently selected, pre-university biology courses, as the easiest science qualifications to attain [5], biology graduates, and hence postgraduate-trained biology teachers have become more prevalent [25]. As a result, there are more biology trained teachers than physical science teachers, especially physicists, within science departments [26,28]. Schools, lacking in any specialism supply, have been compelled to fill these gaps with non-specialist science staff [29]. These sequences of events have culminated to significantly decrease the numbers of students exposed to teachers with physical science subject knowledge. Moor's study [27] identified this whereby 40% of teachers teaching students compulsory science to sixteen years of age (GCSE) offered no post-16 physics qualification and 21% no chemistry.

5. Why do students need specialist teachers to supply their learning?

Studies portray non-specialist teachers produce more rote learning, 'recipe style' practical work and less creativity in students' science lessons. This is attributed to science teachers being insufficiently confident with technical ability to safely deliver practical work during Science lessons [14,32]. Furthermore, non-specialist teachers, allocated with physical science subjects, display a greater reluctance to use practical work [17]. Effective practical work becomes more unlikely in science departments, where teachers lack crucial updates in technical skills and the available skills are dissipating [17,33]. How teachers' portray their subject matter can drastically influence students' career choices and options at non-compulsory qualifications [32].

6. Problems with non-specialist science teaching: Why do students need specialist teachers to supply their learning?

Studies portray non-specialist teachers produce more rote learning, 'recipe style' practical work and less creativity in students' science lessons. Blame has been attributed to science teachers being insufficiently confident with the technical ability to safely deliver practical work during science lessons [14,32]. Furthermore, non-specialist teachers charged with physical science subjects display a greater reluctance to use practical work [17].

Practical work needs to be appropriately implemented, within science lessons, to provide a relevance for students and an improved access to understand abstract, scientific concepts [8,12]. However, literature shows, schools with insufficient supplies of specialist science teachers affects student's 'choice and performance' at pre-university level (A-level) [18] and lowers their chance of attainment [11]. Although quality teaching and passion, towards subject matter, are important, for student motivation and interest [5,11] this wanes where students attain no inherent value, for inspiration [13].

7. How can technicians help alleviate these challenges?

The role of the science technician in UK secondary schools has, to date, been poorly considered by many schools [31]. This has impeded opportunities which could offer essential practical work support for science teachers [32]. Reasons are attributed to the lack of knowledge and understanding of how the technician's role, by school's senior management, is structured [32]. Although expertise has been externally recognised, the technician's profile and professionalism has been underrated and unacknowledged by non-science school staff [29]. This poor regard, often by senior management, not only frustrates and offends technicians but also has prevented training and mutually beneficial progression of the role [32]. Technicians are not in schools to simply prepare solutions, wash glassware, clear away equipment and make the science teachers' coffee!

The value of such practical training by technicians has been recognised by some. A local school which accepts 6 or more trainee teachers a year has adopted a practice to improve trainees' support during their school placement. A new instigation, introduced by the Gordano School Science mentor, was for Science technicians to provide Trainee teachers with practical work training sessions to attain guidance and familiarisation with more technical types of School Science practical work. Science technicians also offer trainees an opportunity to become more familiar with practical work prior to teaching their designated lessons. This exposure to practical alleviates the trainee teachers' concerns with practical work, allowing them to concentrate on developing their pedagogical skills. Unfortunately, incentives like this rely on school technician's goodwill as UK Government cuts in The Training and Development Agency for Schools (TDA) funding prevent remuneration towards this [33]. The Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS), the UK's advisory service providing support in science and technology in schools and colleges [34] has also advised that science technicians would be useful facilitators to train non-specialist teachers in practical work skills [35]. Implementation of good technical support has been suggested, by science teachers, as a resolution for inadequate supplies of expertise within science departments [26, 33]. However no real consideration or move has been made to adopt this nationally.

8. Conclusions

It is already realised that science technicians provide practical work support to trainee and newly qualified teachers and, where non-specialist teaching has increased, this advice has become increasingly sought after [29,33,38]. Studies show that science technicians are in post for many years. This service longevity facilitates crucial continuity of knowledge of experiments, practical skills and correct equipment usage presently lacking within some science departments [37]. Technicians also have more flexibility to manage workloads, than teachers, as they are not confined by lesson timings, to provide training in practical work. Science technicians can offer help and training to all science teachers unfamiliar with pieces of practical work contained in the science curriculum and in many cases already provide this service. Understanding how school science experiments work, their health and safety considerations is the main function of their role and so technicians are in an excellent position to offer training for less experienced teachers and consequently their students. Much more should be made of the skills that this body of people has to offer.

References

- [1] Royal Society (The), (2010), *Science: an undervalued asset in governance for development*. Policy document DES 1667, London SW1Y 5AG.
- [2] Association of the British Pharmaceutical Industry, (2005), Sustaining the skills pipeline in the pharmaceutical and biopharmaceutical industries. ABPI report [online]. Available at URL: <http://www.abpi.org.uk/publications/pdfs/2005-STEM-Ed-Skills-TF-Report.pdf> (last checked 5th August 2010).
- [3] Her Majesty's Treasury. (2004). Department for Education and Skills, Department of Trade and Industry. *Science & innovation investment framework 2004 – 2014*, HM Treasury.
- [4] Institute of Physics, (2010), Post-16 Statistics. *1.1 Table: The number of entries to A-level examinations in sciences and mathematics 1985-2008* (source JCQ). Available at URL: http://www.iop.org/policy/statistics/education/page_43188.html (last checked 6th March 2010).
- [5] Robert, G. (2002), *Set for Success: The Supply of People with Science, Technology, Engineering and Mathematical Skills*. The Report of Sir Gareth Roberts' Review, London: HM Treasury.
- [6] Rocard-Report, (2007), *Science Education NOW: A renewed Pedagogy for the Future of Europe*, Office for Official Publications of the European Communities, Luxembourg.
- [7] House of Commons, (2002), Science and Technology Committee, *Third report. Science education from 14 to 19*, HC 508-1 London: HMSO.
- [8] Lunetta, V. N., Hofstein, A. & Clough, M. P., (2007), Teaching and Learning in the School Science Laboratory. An Analysis of Research, Theory, and Practice. In, S. K. Abell and N. G. Lederman (Eds), *Handbook of Research on Science Education* (pp. 393–431). Mahwah, NJ: Lawrence Erlbaum Associates.
- [9] Abrahams, I., (2009), Does Practical Work Really Motivate? A study of the Affective Value of Practical Work in Secondary School Science, *International Journal of Science Education*, 31(17) 2335 – 2353.
- [10] Amos, S. & Boohan, R., (2001), *Teaching Science in Secondary Schools: a Reader and Aspects of Teaching Secondary Science: Perspectives on Practice*: Routledge Falmer.
- [11] Office For Standards In Education, (2008), *Success in Science*, A Summary of the Ofsted Report – Ref No: 070195.
- [12] Science Community Representing Education, (2009), SCORE Report: *GCSE Science 2008 Examinations*, London SW1Y 5AG.
- [13] Cerini, B., Murray, I., & Reiss, M., (2003), *Student review of the science curriculum. Major findings*, London: Planet Science/Institute of Education University of London/Science Museum.
- [14] Abrahams, I. & Millar, R., (2008), Does Practical Work Really Work? A study of the Effectiveness of Practical Work as a Teaching and Learning Method in School Science, *International Journal of Science Education*, 30(14) 1945 – 1969.
- [15] Sorensen, P., (2004), *Teaching Strategies and Organising Learning* in Frost, J & Turner T, *Learning to Teach Science in the Secondary School: a Companion to School*, Taylor & Francis Ltd.
- [16] Kovac, J., (2002), Theoretical and Practical Reasoning in Chemistry, *Foundations of Chemistry*, 4(2) 163 - 171.
- [17] Science Community Representing Education, (2008), SCORE Report: *Practical work in Science: a Report and Proposal for a Strategic Framework*, London SW1Y 5AG.
- [18] House of Lords, (2007), Science and Technology Committee, *7th Report of Session 2006-07, Science Teaching in Schools: Follow-Up*, HL 167 London: HMSO.

- [19] Millar, R., (2004), The role of practical work in the teaching and learning of science, *High School Science Laboratories: Role and Vision*, National academy of sciences, Washington, DC.
- [20] Wellington, J. & Ireson, G., (2008), *Science Learning*, Science Teaching, Revised & updated ed, Routledge.
- [21] Woolnough, B., (1991), *Practical Science: the Role and Reality of Practical Work in School Science*, Philadelphia: Open University Press.
- [22] Hanson S., Overton, T.L., 2010, Skills required by new Chemistry graduates and their development in degree programs, *Higher Education Academy Physical Sciences Centre*. http://www.heacademy.ac.uk/assets/ps/documents/graduate_skills/chemistry.pdf (Last checked 2nd May 2011).
- [23] Osborne, J. F. & Collins, S., (2001), Students' views of the role and value of the science curriculum: a focus-group study, *International Journal of Science Education*, 23(5) 441- 467.
- [24] Menter, I., Hutchings, M. & Ross, A., (2002), *The crisis in teacher supply: research and strategies for retention*, Stoke-on-Trent, Trentham Books.
- [25] Ross, A. & Hutchings, M., (2003), *Attracting, Developing and Retaining Effective Teachers in the United Kingdom of Great Britain and Northern Ireland*, OECD Country Background Report, London: Institute for Policy Studies in Education, London Metropolitan University.
- [26] Smithers, A. & Robinson, P., (2005), *Physics in schools and colleges: teacher deployment and student outcomes*, University of Buckingham, Centre for Education and Employment Research.
- [27] Moor, H., Jones, M., Johnson, F., Martin, K., Cowell, E. & Bojke, C., (2006), *Mathematics and Science In Secondary Schools: The Deployment Of Teachers And Support Staff To Deliver The Curriculum*, DfES report.
- [28] Smithers, A. & Robinson, P., (2005), *Physics in schools and colleges: teacher deployment and student outcomes*, University of Buckingham, Centre for Education and Employment Research.
- [29] Kind V. & Taber, K.S.,(2005), *Science: teaching school subjects 11-19*, Routledge, London.
- [30] Childs, A., & McNicholl, J., A. & McNicholl, J., (2007), Science Teachers Teaching Outside of Subject Specialism: Challenges, Strategies Adopted and Implications for Initial Teacher Education, *Teacher Development*, 11(1), 1-20.
- [31] Consortium of Local Education Authorities for the Provision of Science Services, (2009), DL228, *Technicians and Their Jobs*, Uxbridge.
- [32] Soares, A. & Lock, R., (2007), Pre-Service Science Teachers' Perceptions of Written Lesson Appraisals: The Impact of Styles of Mentoring, *European Journal of Teacher Education*, 30(1) 75-90.
- [33] Department for Education & Skills, (2010), What are Training Schools? Standards Site, [online]. Available at URL: http://www.standards.dfes.gov.uk/trainingschools/what_are/?version=1 (last checked 16th August 2010).
- [34] URL: <http://www.cleapss.org.uk/about-cleapss> (last checked July 2011).
- [35] Consortium of Local Education Authorities for the Provision of Science Services, (2004 updated 2007), L238, *Health and Safety Induction and Training of Science Teachers*, Uxbridge CLEAPSS
- [36] House of Commons, (2002), Science and Technology Committee, *Third report. Science education from 14 to 19*. HC 508-1 London: HMSO.
- [37] Royal Society (The) & The Association for Science Education, (2001), *Survey of Science Technicians in Schools and Colleges*, London: The Royal Society.

Authors

Anne T. Helliar, Senior Science Technician, Gordano School, Portishead, Bristol, UK.
ahelliar@gordano.n-somerset.sch.uk. Corresponding author.

Timothy G. Harrison, Bristol ChemLabS School Teacher Fellow, University of Bristol, UK.
t.g.harrison@bristol.ac.uk