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Laboratory Technicians in Australian Secondary Schools

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By Mark W. Hackling

A number of reports have argued that secondary science education needs to be more inquiry oriented and involve authentic and practical investigations to develop scientific literacy and better engage students in learning science. Inquiry-oriented approaches, such as those advocated in the new science national curriculum, require that teachers have access to good laboratory facilities and equipment and are supported by knowledgeable laboratory technicians. Without adequate and qualified technical support, the quality of the curriculum will be compromised. This paper reports on the status of laboratory technicians in Australian secondary schools and makes recommendations for improving the quality of training and support of technicians and the level of servicing of science programs.

Introduction

Science, engineering and technology play a crucial and increasingly important role in the Australian economy. The National Engineering, Science and Technology Skills Summit held at Parliament House, Canberra in June 2007 received a number of submissions from bodies including Engineers Australia and the Royal Australian Chemical Institute highlighting concerns about the education and training of scientists and engineers and the need to attract school students to science.

A high-quality science education in primary and secondary schools contributes to developing scientific literacy and would be expected to predispose students to study the enabling sciences at university (Goodrum, Hackling & Rennie, 2001). Participation rates in senior secondary school science, as a percentage of the Year 12 cohort, have declined over the last 30 years and university enrolments in the natural and physical sciences have remained static since 2001 (Ainley, Kos & Nicholas, 2008). 'Generating higher levels of participation in science-related studies at university appears to be partly dependant on strengthening science education in schools' (Ainley et al., 2008, p.82).

A number of reviews and reports on secondary science education (e.g. Goodrum et al., 2001; Tytler, 2007) have highlighted problems with engaging students' interest in the study of science and have suggested that the curriculum should be reformed so that it is more inquiry-oriented, provides greater opportunity for students to engage in practical science investigations and gives them a more authentic experience of science. Tytler, Osborne, Williams, Tytler and Cripps Clark's review (2008) found 'considerable evidence that, for the majority of students, life aspirations are formed before the age of 14, with the implication that engaging students in STEM (Science, technology, engineering and mathematics) pathways becomes increasingly difficult after the early secondary school years' (p. viii).

Science is a practical subject. Science curricula should give students the opportunity to practice the processes of investigation in authentic contexts, and in secondary schools this should involve working in well-equipped and supported laboratory environments. Authentic, practical science investigation work is needed to enhance the relevance of school science, actively engage students in learning and provide opportunities to develop the skills and processes that contribute to scientific literacy (Hackling, 2004; 2005). Science teachers are dependent on the support and technical skills of technicians in preparing equipment, solutions and reagents for practical science lessons, training teachers in the use of new equipment, obtaining and caring for animals and plants used in science lessons, purchasing materials and equipment, and working with the teacher in charge of science to ensure that the school complies with chemical safety standards, animals ethics requirements and other occupational, health and safety issues.

> *Everyone actively involved in science education recognises the central role played by school and college technicians in the provision of high quality science education. Yet surprisingly little work has been undertaken to establish any kind of profile of the technician workforce* (Royal Society and ASE, 2001, p. 1).

In response to concerns about the roles, training, support and conditions of service of school science laboratory technicians, the UK Royal Society and the Association for Science Education conducted a questionnaire survey of technicians (Royal Society and ASE, 2001) and a telephone survey of heads of science (Royal Society and ASE, 2002). This research identified concerns about a shortage of well-trained laboratory technicians, career structures, roles, staffing levels and ongoing training.

If the concerns about the lack of relevance and engagement, and the chalk and talk nature of secondary science education in Australia reported by Goodrum et al. (2001) are to be addressed and if the more inquiry-oriented curriculum advocated by Tytler (2007) is to be implemented, there is a need to ensure that the technical support provided for secondary school science in Australia is of the highest quality. This issue is particularly pertinent as the proposed national curriculum for science will place more emphasis on student engagement and inquiry through posing and investigating questions (National Curriculum Board, May 2009).

Given that there has been no research conducted in Australia on a national scale to investigate the status and quality of secondary science technical support, there is a need to investigate the nature of technical support, the role of technicians and how they are trained and supported in their roles. Findings from such research could inform policy and practice relating to the training, support and deployment of technicians in ways that would enhance the quality of science education in our schools. Concerns about the status of technical support for science teaching programs raised by the Australian Science Teachers Association and Science Education Technicians Australia led to the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) funding a study to investigate the status of school science technicians in Australian secondary schools.

Purpose and Research Questions

The purpose of this research study was to investigate laboratory technicians' qualifications, roles and responsibilities, working conditions, staffing levels and ongoing training and support. More specifically, the study addresses the following research questions:

1. What range of qualifications is held by school science technicians in Australian secondary schools?
2. What range of duties and responsibilities is included in the roles of school science laboratory technicians?
3. What training and support do school science technicians receive, what do they need and what are they able to access?
4. How can the role of school science technicians and their training and support be improved to enhance student learning outcomes in Australian schools?

Method

The study combined a large-scale questionnaire survey of Australian schools with interviews conducted with 18 key stakeholders with experience in the training, employment and support of science technicians.

Questionnaires were mailed to 2011 principals of schools that enrolled secondary students, with a request that the teacher in charge of science and the technician complete the survey or, if the school did not have a technician, the teacher in charge of science complete the survey and return it to the researchers. An overall return rate of 33% was achieved, with questionnaires being returned by 607 schools and 824 technicians. The study sample included mainly schools with technicians, secondary and K-12 schools, and schools from all jurisdictions and sectors. Small remote schools and NSW government schools were not represented in the sample. The research findings are therefore not generalised beyond the study sample.

The questionnaire comprised a mix of item types including open response items, items where participants had to select a response from a set of supplied alternative responses and rating scale items. A sample of the returned questionnaires were read and re-read to identify the types of responses that had been provided to the open-ended questions and categories of responses were identified, named and described.

A detailed coding manual was then written to guide the coding of responses to all items. All questionnaires were then coded and codes were entered into SPSS spreadsheets for statistical analysis.

The UK Association for Science Education (ASE) developed a metric called the service factor to quantify levels of technician support related to the hours of science teaching per week at the school. Reports of the UK research include data about levels of technician support in terms of a service factor (Royal Society and ASE, 2001). A service factor (SF) was therefore calculated for each school that supplied the data required for the calculation.

$$\text{Service factor} = \frac{\text{Technician hours per week}}{\text{Hours of science teaching per week}}$$

The technician hours per week are the sum of hours of employment in one week of all technicians working at that school during term time. The hours of science teaching per week is the sum of hours of science teaching per week for all secondary classes at that school (i.e. Class A hours per week + Class B hours per week + Class C hours per week etc). Five hundred and fifty-seven schools provided sufficient data for the calculation of an SF. Some schools made errors in calculating the hours of science teaching time and were excluded from calculation of an SF.

Telephone interviews were conducted with 18 key stakeholders in laboratory science who had deep insights into the work of school science technicians. These included school science technicians, regional/advisory technicians, teachers-in-charge of science, science policy officers, a representative of the Australian Science Teachers Association, an occupational health and safety officer, and lecturers within the VET/TAFE sector involved with training science technicians. Interview subjects were drawn from the government, Catholic and independent school sectors and from all states and territories. The telephone interviews were audio recorded using a digital recorder. After each interview an interview summary was written and important sections of the interview were transcribed in full. Interview summaries were read and re-read to identify issues mentioned by the participants. A form of constant comparative analysis was used to identify themes that emerged from the data and these were summarised and quotations were selected to illustrate the views of the participants. This paper provides a summary of the findings, which are reported in greater detail in the report published by DEERW (Hackling, 2009).

Findings

Technicians and their roles

The most common patterns of employment of technicians were full time only, part time only and a combination of full time and part time, and there were indications that contract and part-time employment are becoming more common. Forty per cent of schools reported difficulty in recruiting technicians. The main difficulties related to the poor conditions of service, and in particular the poor match between salary levels and responsibility, which made it difficult to attract suitable applicants for technician positions.

Interview participants described four models by which technicians are managed in schools. These were:

1. Teacher in charge of the science department manages the day-to-day duties of technicians.

2. Where there is more than one technician the senior technician manages the other technicians and reports to the teacher in charge of science.
3. Technicians may have to report to multiple managers if they work in two or more departments of the school and this can cause conflict.
4. Management by a member of the school administration occurs in schools where technicians are employed as general assistants rather than specifically as laboratory technicians.

A large majority of the Australian technicians in the study sample were female, only 22% were less than 40 years of age and 40% were over 50 years of age (Figure 1). It would therefore be expected that significant numbers of our most experienced technicians will be retiring in the next five years.

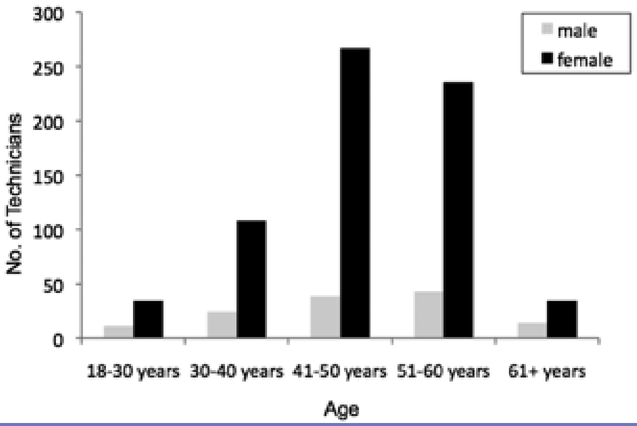

Figure 1) Age distribution and gender of technicians in the study sample

A core of the technician workforce is both experienced and well qualified but here was a wide range of experience amongst technicians in the study sample. The mean number of years of experience in school laboratories was 10.8 years, and 5.9 years in non-school laboratories. Two per cent of technicians had no experience in school laboratories, 35% had five or less years of experience and 27% had more than 15 years of experience in school laboratories. Sixty-one per cent had experience in non-school laboratories and 21% had more than 10 years of experience in these laboratories.

Thirty-eight per cent of the technicians in the study sample had an Australian VET qualification relating to laboratory work, 31% had science degrees and 50% had first aid qualifications. However, 9% had no post-secondary education relevant to laboratory work.

Analysis of the questionnaire and interview data indicates that school science technicians have significant responsibilities and make an important contribution to the quality of teaching and learning of school science. Science technicians have diverse and demanding roles that include preparing resources for and supporting the teaching of science practical work in their schools. They also have significant responsibilities for health and safety, first aid, operating budgets, training and supervising other technicians, the care of animals and plants, ensuring compliance with relevant codes, and the security of the school's science department. Some technicians are also required to supervise students.

Training and support

There are three main concerns regarding the training, knowledge and skills of the technician workforce. First, the initial training of technicians provided by the vocational education and training sector is geared towards the requirements of the mining and medical pathology industries and the courses lack relevance for the quite different job requirements of school science technicians. Second, there is a high proportion of technicians who have completed no in-school (47%) or out-of-school training (27%) in the past five years. Third, some staff providing support to science are employed as generalist school support officers and may have no science or laboratory skills training.

Lack of recent training would impact most particularly on technicians' knowledge of the rapidly changing OH&S environment and of contemporary laboratory and learning technologies. Large numbers of questionnaire respondents and interview participants indicated that technicians require regular updates and retraining in the use of science equipment, in first aid and OH&S, and they need further IT training. Messages posted to science technician Internet discussion boards indicate that many staff are struggling with inadequate science and technical knowledge. Twenty per cent or more of the technicians indicated they were in need of further support or training to competently perform a number of tasks related to newer laboratory practices and/or technology and 25% or more of the technicians indicated they needed further support or training with a number of important safety issues.

More than half the technicians reported that they had access to the Internet, a technician at another school, online discussion boards, the local science technicians association and WorkSafe as sources of support. The most frequently used sources of support were those that were Internet based and accessible by computer but there are concerns about the accuracy and consistency of advice provided by Internet-based discussion boards.

Level of servicing

The demand for services from technicians is influenced by the number of science laboratories, the layout of laboratories, preparation and storerooms, the number of science classes and students, and the range of science teaching programs to be supported. Over all the schools in the study sample that had technicians, a median of 1.06 FTE technicians per school supported a median of 700 students and four laboratories. In 90% of schools, technicians supported science teaching across Years 8-12, and also Year 7 in 63% of schools (which would be in the four jurisdictions where Year 7 is a secondary level).

Thirty-six per cent of schools did not have sufficient technical support during school holidays for maintenance, stocktaking and occupational health and safety compliance activities. Many schools indicated that if they had more technical support the number (46% of schools) and quality (59%) of practical work in the curriculum would be improved. This suggests that the level of technical support was less than optimal.

So that the Australian data gathered in this study could be benchmarked against the UK data, service factors were calculated for Australian schools based on the service factor metric developed by the UK Association for Science Education (technician hours per week/ hours of science class teaching per week). The ASE also established four standards of servicing. Descriptions of these standards are summarised in Table 1.

SERVICE FACTOR	DESCRIPTION OF SERVICE STANDARD
0.85	This is the recommended allocation of technician support to science teaching for a compact suite of laboratories with adjoining preparation and storage space.
0.70	At this level of allocation provision of the full range of functions will depend upon recruiting well-qualified and experienced technicians.
0.60	It will not be possible to deliver all functions adequately and a restricted range of priorities will need to be identified.
0.45	Functions will be markedly reduced and in most cases no more than simple, immediate maintenance and control will be possible.

Table 1) Service standards developed by the Association of Science Education (Royal Society and ASE, 2001)

Service factors were calculated for schools in the sample that employed technicians. Service factors ranged from 0.05 to 1.2 but the majority of values were between 0.25 and 0.55.

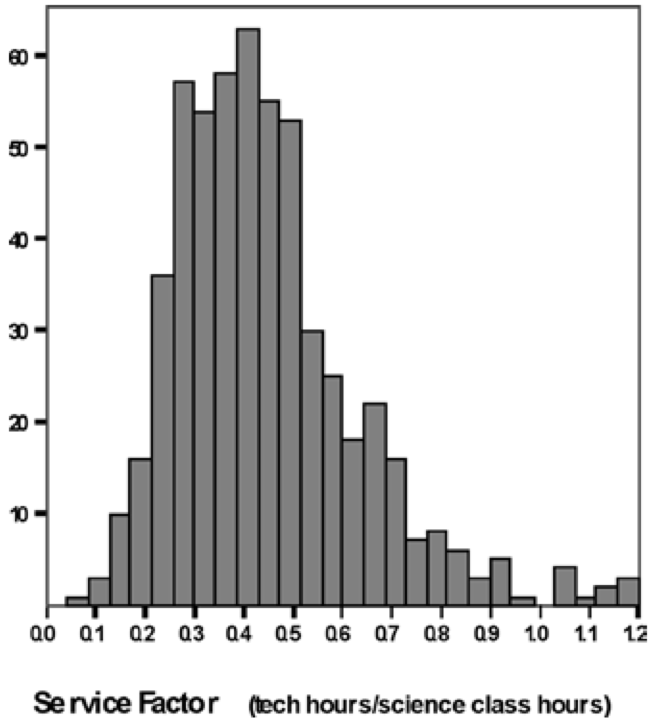

Figure 2) Service factor distribution for all schools in the sample that had a technician

Almost a quarter of schools with technicians had a service factor of 0.3 or less, almost half had service factors of 0.4 or less and 70% had a service factor of 0.5 or less. Fifty seven per cent of schools had service factors below 0.45, the lowest of the ASE benchmarks, and 96% of schools had a service factor lower than the recommended standard of 0.85. Some of the schools with high service factors appeared to be new schools with small enrolments that were establishing science departments.

There was some variation in mean service factor values across the three education sectors: government, Catholic and independent. Given that standard deviations were reasonably large, only median values are reported. The median values are lower than the means because means were strongly influenced by a small number of extremely high SFs. Median SF values ranged across sectors, from a low of 0.37 to a high of 0.44. Median SFs for all sectors are below the lowest of the ASE benchmarks. These data are represented as box plots in Figure 3.

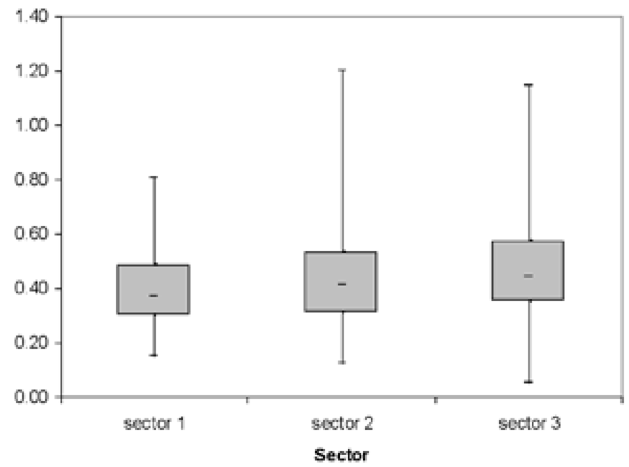

Figure 3. Box plots of median service factors by sector

The dark line in the middle of the box shows the median value and the upper and lower boundaries of the box include the second and third quartiles (25% to 75%) of schools. The ends of the vertical lines/whiskers show the range of values for all schools in that sector. The box plots show that the values for the middle 50% of schools are closely clustered around the median, which may suggest these schools are staffed by formula. However, the whiskers show widely dispersed values for other schools, with some extremely high and low values, especially for sectors two and three.

As expected there was variation in the medians and ranges of scores across the eight educational jurisdictions. These data are reported as box plots in Figure 4.

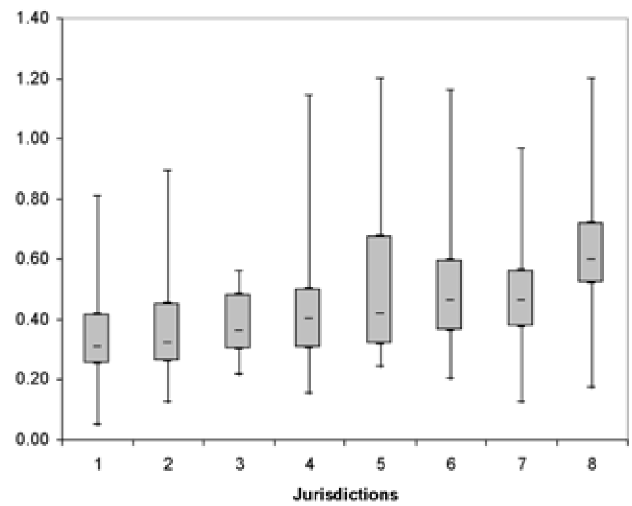

Figure 4. Box plot of median service factors by jurisdiction

The data show that median SF values range across jurisdictions from a low of 0.31 to a high of 0.6; that is, the median for the sample of schools returning questionnaires in the best-serviced jurisdiction is twice the median of the jurisdiction with the lowest level of servicing and the sample ranges vary considerably.

There is great variability across jurisdictions, sectors and schools regarding the levels of servicing as measured by service factors. The median service factor for the sample of Australian schools with technicians was lower than for all school types surveyed in a large UK study (The Royal Society and ASE, 2001) and 96% of schools with technicians in the study sample had levels of servicing lower than the standard recommended by the UK Association for Science Education. The median service factor for the study sample was lower than the minimum standard (0.55) set by the Laboratory Technicians Association of Victoria (LTAV, 2007). All sectors and jurisdictions had large numbers of schools with a level of servicing (service factor of <0.45) at which *functions will be markedly reduced and in most cases no more than simple immediate maintenance and control will be possible* (Royal Society and ASE, 2001) and one would expect that the quality of the science curriculum in these schools would be compromised.

Schools without technicians

Fifty three schools without technicians returned completed surveys. The main two reasons given for not having a technician were budgetary constraints and that the school was too small. In most cases the science teacher performed the duties of a technician. As indicated by the LTAV (2007, p. 5), *the skills required are not normally possessed by most teachers and this is not a task that can be safely and efficiently carried out by an untrained person*. Given the pressures on teachers' time, it is likely that teachers in these circumstances can only prepare limited resources for practical work and the quality of the curriculum will be compromised. This view is supported by data from these schools indicating that having a technician would improve the quantity and quality of practical work in the curriculum as implemented.

Conclusions

Efforts to reform secondary science education through the implementation of a new national curriculum and more inquiry-oriented pedagogy will only be effective if science teachers are supported with adequate laboratory facilities, science equipment and high-quality technical support. Higher levels of technical support will be required to implement a more inquiry-oriented and authentic science curriculum. Failure to implement a more engaging secondary science curriculum will see the continued drift of students away from the sciences in the senior secondary years, with serious consequences for university science enrolments and the number of trained professionals in science, engineering and technology needed to drive the Australian economy.

There is a need to raise standards where they are less than optimal and compromise the quality of support for teaching, learning and safety. The greatest challenges relate to: providing an initial training that is specific to the needs of school science technicians; ensuring that all staff providing technical support to secondary science programs have at least minimum standards of training; the provision of an Internet-based and authoritative source of advice and support; the provision of ongoing training and incentives for technicians to attend such training; providing levels of staffing that meet at least the ASE's 0.6 service factor benchmark in all schools and improving employment conditions, salaries and career pathways so that sufficient well-qualified staff can be attracted to the profession.

Recommendations

The following research-informed recommendations are made to provide direction for actions that can be taken to improve the quality of technical support provided for secondary science programs in our schools.

1. That the vocational education and training sector develops and offers courses for the initial training of technicians, aligned with the requirements of school science technicians and curriculum.

2. That minimum standards be established for the training required for employment of science technicians in secondary schools and for their induction into the role.

3. That nationally-consistent job specifications, linked to appropriate salary scales, be established for various levels of science technicians

4. That mechanisms be established to enhance the availability of ongoing training for school science technicians and to increase their participation in ongoing training.

5. That a minimum standard be established for technician servicing of secondary science programs.

6. That a national Internet-based advisory service be established to provide consistent and authoritative advice and support to secondary school technicians and teachers.

7. That resources be provided to facilitate ASTA's and SETA's involvement with, and leadership of, the development of national standards for the employment and roles of, and provision of training and ongoing support for, technicians.

8. That further research and development activity be funded to investigate ways of more effectively deploying paraprofessionals in Australian schools.

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