Laboratories and Technicians in NZ School Science Teaching

Abstract

Data collected through a school science technician survey have been used to assess how well science teaching hours are supported by numbers of laboratories and technician time. Ratios have been used to relate both numbers of labs and technician hours to teaching hours. Comparisons were made for State, Integrated and Independent schools. Historical data for technician support show that median technician support has increased in State and Integrated schools, but has dropped in Independent schools. Lab shortages and limited technician support are indicated in some schools in each type, particularly in larger State schools, and reasons for this are discussed.

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Data Collection

A July-September 2015 on-line school science technician survey by Michelle Kiernan and Ian de Stigter gathered a range of school data. It included questions on technician hours, science teaching hours, and number of laboratories. These figures were used to calculate the ratio of technician hours to science teaching hours (service factor) and of the number of laboratories to teaching hours (lab index, defined as: numberof labs x 25/teaching hours).

Schools were designated as Independent, Integrated, or State, and the State schools grouped by roll numbers (1-800, 801-1500, 1500+) and by region (Northland, Auckland, Waikato, Bay of Plenty, Gisborne/Hawkes Bay, Taranaki/Manawatu/Whanganui, Wellington, Nelson/Marlborough/Tasman, Canterbury/West Coast, Otago/Southland). Data for technician hours and teaching hours collected in a similar survey in 2007 established service factor changes over the period.

Availability of Laboratories

The availability of science laboratories for science teaching is a major constraint for effectiveness. Limited access to labs for practical work impacts negatively on development of student understanding and practical abilities, and makes teaching

more difficult and stressful. Adequate availability of labs stands alongside adequate technician support to indicate a school's seriousness about science.

Labs need to be designed so that a variety of practical sciences can be taught in each (so that they are as interchangeable as timetabling variations require). They can all then be considered together, and a meaningful ratio derived with total science hours. The ratio assumes that a lab is large enough for a class (not just part of a class) so some smaller practical spaces in MLEs do not qualify.

Each laboratory could in theory be used for 25 hours per week. Timetabling difficulties usually prevent this being achieved in practice, but the lab index, based on 25 hours/week/laboratory gives a nominal basis for deciding whether there are enough laboratories for the teaching hours. A lab index greater than 1 will allow most science to be taught in labs. A lab index below 1 indicates a degree of difficulty in finding a lab for practical work. Lab indexes substantially below 1 indicate then that schools have not assigned high priority to science teaching. Data for lab indexes for schools in the survey are shown in Table 1 below.

Table 1: Lab index by school type and size

		min	LQ	median	UQ	<0.8	<0.9	<1.0	schools
State	**ALL**	0.560	0.984	1.231	1.420	11%	16%	25%	of 122
State	**1-800**	0.633	1.220	1.379	1.668	5%	8%	10%	of 59
State	**801-1500**	0.583	0.938	1.146	1.282	12%	17%	32%	of 41
State	**1500+**	0.560	0.833	0.984	1.226	23%	32%	55%	of 22
Integ	**ALL**	0.676	1.116	1.250	1.333	6%	9%	9%	of 33
Indep	**ALL**	0.578	1.000	1.205	1.364	6%	12%	24%	of 17

The lab index data in Table 1 show that one quarter of all State schools and Independent schools could be considered to be short of labs. A relatively small number of the State schools with 1-800 students (10%) and Integrated schools (9%) have a shortage. Difficulty in lab access is found in more of the 801-1500 student schools (32%), and the large schools with more than 1500 students (55%). A lab index below 0.8, indicating a *serious* lab shortage, is found in 11% of State schools, or 23% of those with more than 1500 students.

Technician hours: service factors

The 2015 service factor data have been examined according to school type (State, Integrated or Independent); region (Northland, Auckland, Waikato, Bay of Plenty, Gisborne/Hawkes Bay, Taranaki/Manawatu/Whanganui, Wellington, Nelson/Marlborough/Tasman, Canterbury/West Coast, Otago/Southland); and roll size (1-800, 801-1500, 1500+).

Comparisons are drawn with schools in the 2007 survey. Many of the schools surveyed in 2007 did not participate in the 2015 survey, and vice versa. So to validate the full 2007 and 2015 data sets (ALL), these are also compared below with the 2007 and 2015 data sets obtained from schools which took part in both surveys (CONT).

State, Integrated and Independent Schools

Table 2: Service factor by school type

		Year	min	LQ	median	UQ	max	schools
State	**ALL**	2015	0.053	0.146	0.181	0.240	0.600	of 138
		2007	0.097	0.152	0.174	0.213	0.370	of 129
State	**CONT**	2015	0.065	0.145	0.182	0.240	0.429	of 93
		2007	0.097	0.150	0.171	0.212	0.370	of 93
Integ	**ALL**	2015	0.103	0.175	0.214	0.270	0.473	of 35
		2007	0.117	0.182	0.204	0.238	0.469	of 22
	CONT	2015	0.150	0.179	0.236	0.288	0.400	of 16
		2007	0.144	0.189	0.216	0.244	0.469	of 16
Indep	**ALL**	2015	0.094	0.152	0.240	0.351	0.556	of 17
		2007	0.128	0.199	0.279	0.358	0.419	of 18
	CONT	2015	0.128	0.155	0.240	0.338	0.528	of 15
		2007	0.128	0.199	0.278	0.318	0.419	of 15

In 2015, there is a range for service factor values of 0.053 to 0.600, indicating a variation of more than ten times in the extent to which science technicians are used to assist science teachers in their teaching and administration. (The extreme values were both obtained from State secondary schools.) In general, technician resourcing of science teaching is greatest in Independent schools (2015 median 0.240), followed by Integrated schools (2015 median 0.214), then State schools (2015 median 0.181). Within State schools, the smaller 1-800 roll group is best provided for (2015 median

0.196), then the 801-1500 group (2015 median 0.178), and the schools with more than 1500 students provide their teachers with least assistance (2015 median 0.171).

For both State and Integrated schools, service factors have risen overall since 2007, as shown by increases in the medians for both the ALL schools data and the CONT school data. In contrast, the service factors for Independent schools have dropped since 2008, as shown by lower medians for both their ALL and CONT groupings.

While the service factor median increases for State and Integrated schools can be seen as positive for science teaching, there is a marked trend to greater differences between schools in their technician support, and this increased difference shows in all school types. The service factor lower quartiles are now lower and the service factor upper quartiles are now higher (except for inconclusive data from Independent schools). So there is now a greater proportion of schools with low service factors than there were previously. The already marked inequality in support for science teaching is growing worse: while many schools are better provided for, also many are worse off.

The Influence of School Size

Table 3: State school service factor by school size

		Year	min	LQ	median	UQ	schools
State	**ALL**	2015	0.053	0.146	0.181	0.240	of 138
		2007	0.097	0.152	0.174	0.213	of 129
	1-800	2015	0.054	0.159	0.196	0.272	of 62
		2007	0.103	0.147	0.190	0.233	of 53
	801-1500	2015	0.067	0.149	0.178	0.221	of 48
		2007	0.100	0.152	0.174	0.204	of 48
	1500+	2015	0.082	0.138	0.169	0.216	of 28
		2007	0.097	0.150	0.170	0.202	of 28

Sorting State school service factor data by school size shows that the technician support for science teaching can be related to school size. The 2007 survey report commented on the reduced technician support in larger schools. In 2015, the larger schools have a median service factor little-changed from 2007, but they show an increased variation, with the upper quartile of schools increasing service factors, and the lower quartile of schools decreasing their service factors. A greater variability is shown also in medium-sized schools, although there the service factor median has increased.

The group of small State schools is the only group in which there has been an increase rather than decrease since 2007 in the service factor lower quartile.

State School Regional Variations

Table 4: State School service factor by region

		Year	min	LQ	median	UQ	schools
State	**ALL**	2015	0.053	0.146	0.181	0.240	of 138
		2007	0.097	0.152	0.174	0.213	of 129
	Auck	2015	0.067	0.145	0.171	0.240	of 37
		2007	0.097	0.162	0.189	0.227	of 45
	North	2015	0.166	0.191	0.306	0.313	of 5
		2007	0.122	0.185	0.263	0.299	of 5
	NMT	2015	0.125	0.160	0.184	0.196	of 7
		2007	0.109	0.135	0.148	0.187	of 7
	TMW	2015	0.143	0.167	0.192	0.228	of 8
		2007	0.107	0.150	0.192	0.220	of 11
	CW	2015	0.067	0.149	0.172	0.217	of 20
		2007	0.100	0.153	0.157	0.195	of 17
	BOP	2015	0.082	0.130	0.200	0.273	of 10
		2007	0.138	0.139	0.144	0.148	of 5
	OS	2015	0.093	0.136	0.167	0.214	of 16
		2007	0.103	0.114	0.150	0.187	of 12
	Waik	2015	0.053	0.139	0.169	0.222	of 14
		2007	0.106	0.134	0.159	0.192	of 8
	Well	2015	0.144	0.163	0.187	0.212	of 10
		2007	0.159	0.161	0.172	0.202	of 10
	G/HB	2015	0.100	0.176	0.214	0.287	of 11
		2007	0.163	0.173	0.212	0.240	of 9

While the numbers of schools in some of the State school regional groupings is quite small, pronounced regional variations appear. The 2015 median service factors range from 0.167 for Otago/Southland and 0.169 for Waikato, through 0.171 for Auckland, 0.172 for Canterbury/West Coast, 0.184 for Nelson/ Marlborough/ Tasman, 0.187 for

Wellington, 0.192 for Taranaki/Manawatu/Whanganui, 0.200 for Bay of Plenty, 0.214 for Gisborne/Hawkes Bay to 0.306 for Northland. The regions also showed major differences in 2007, but the order then was different from 2015.

Auckland is the only region in which the service factor median is lower in 2015 than in 2007. In Taranaki/Manawatu/ Whanganui it has held steady, and there was little change in Gisborne/Hawkes Bay.

In every region the service factor upper quartile has increased, but the lower quartile changes may be in either direction. Lower quartile service factors have dropped in Auckland, Canterbury/Westland, and Bay of Plenty, but are higher elsewhere.

Specifying Technician Support for Science

In 1996, the New Zealand Association of Science Educators first surveyed NZ schools to assess science technician support for teaching. NZASE President Robyn Baker described the purpose for enquiry:

> *"The level of support given to teachers of science for the practical components of their classroom programme has always been a problematic area for New Zealand teachers. In a survey undertaken by NZASE in 1996 science teachers commented that while many aspects of teaching were common to all subjects, the laboratory preparation, the maintenance of resources, and the management of practical activities with large classes placed additional demands on them as teachers." (Baker, 1997)*

The increasing demands over twenty years to facilitate student success for all students (giving particular attention to priority learners) has only increased teaching pressures and resourcing needs.

In the UK, the Association of Science Education related technician hours to science teaching hours, and called this ratio Service Factor. (The Royal Society, 2001) The UK recommendation for a minimum service factor ratio (when adjusted to term-time-only employment, as is usual in NZ) was (0.65 x 45/37), or 0.79. (The Royal Society, 2002)

Following the UK studies, the Science Technicians Association of Victoria (STAV) recommended a minimum service factor of 0.45 in Australian schools. A study of science technicians in Australian schools (Hackling, 2009) was funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR). It found an average service factor of 0.45, and a median of 0.41, with school service factors ranging from 0.05 to 1.2.

The NZ surveys in 2007 and 2015 confirm that 1997 comments by Baker remain relevant:

"While the under-resourcing of education is a common complaint of educationalists it is certainly very evident in the hours allocated to technical support in school science departments. Technician hours compare poorly with countries such as England and Australia… the time available in New Zealand schools was inadequate for the efficient running of science departments. The tasks required of technicians in relation to the hours given to complete the work results in technicians not being able to complete some aspects of their job description and working at times without pay."

The 2007 survey report proposal of a minimum service factor of 0.25 was subsequently endorsed by STANZ. (The State school median was then 0.174.) The 2007 and 2015 survey data can be recast to further examine the concept of a minimum service factor, by showing the proportion of schools in various groupings to have reached levels of service factor.

NZ School Service Factor Levels

Table 5: Types of school achieving levels of service factor

		Year	>SF 0.25	>SF 0.20	>SF 0.15	>SF 0.10	schools
State	**ALL**	2015	20%	41%	72%	93%	of 138
		2007	12%	36%	75%	99%	of 129
State	**CONT**	2015	19%	40%	72%	96%	of 93
		2007	13%	34%	75%	99%	of 93
Integ	**ALL**	2015	31%	60%	86%	100%	of 35
		2007	18%	55%	86%	100%	of 22
	CONT	2015	38%	69%	100%	100%	of 16
		2007	25%	69%	94%	100%	of 16
Indep	**ALL**	2015	47%	65%	82%	94%	of 17
		2007	56%	78%	94%	100%	of 18
	CONT	2015	47%	67%	87%	100%	of 15
		2007	53%	73%	93%	100%	of 15

Table 5 shows that in 2007, 12% of State, 18% of Integrated, and 56% of Independent schools achieved a ratio of 0.25; 36% of State, 55% of Integrated, and 78% of Independent schools achieved 0.20.

In 2015, more State and Integrated schools than in 2007 have a relatively high service factor, but fewer Independent schools do. A service factor of 0.25 is present now in 20% of State, 42% of Integrated, and 47% of Independent schools. 0.20 is reached in 42% of State, 60% of Integrated, and 65% of Independent schools.

At the lower end of the ratios, more State, Integrated and Independent schools than in 2007 now have service factors below the levels of 0.15 and 0.10 levels.

Table 6: State school sizes achieving levels of service factor

		Year	>SF 0.25	>SF 0.20	>SF 0.15	>SF 0.10	schools
State	**ALL**	2015	20%	41%	72%	93%	of 138
		2007	12%	36%	75%	99%	of 129
	1-800	2015	29%	50%	79%	92%	of 62
		2007	23%	45%	75%	100%	of 53
	801-1500	2015	13%	35%	73%	94%	of 48
		2007	2%	27%	73%	98%	of 48
	1500+	2015	14%	32%	57%	96%	of 28
		2007	11%	29%	75%	96%	of 28

In 2015, all sizes of State schools are more likely than in 2007 to achieve a higher service factor. In the 1-800 student schools, a service factor of 0.25 is present now in 29%, compared with 23% in 2007. In the 801-1500 student schools, the change is from 2% to 13%, and in schools with above 1500 students from 11% to 14%. 0.20 service factor is attained now in 50% of the smaller schools compared with 45% in 2007. In the medium-sized schools it is up from 27% to 35%, and in the larger schools from 29% to 32%. However, larger school attainment of the lower service factor 0.15 has dropped from 75% to 57%.

Science Resourcing Provision Correlations

The connection between providing labs and providing technician hours is examined: school data for service factor and lab index were plotted for the various types and sizes of schools, and correlation coefficient calculated. Table 7 summarises the correlations obtained between these in different sizes and types of schools. Service factor and lab index correlate in State and Independent schools, but not Integrated schools.

Table 7: Lab Index and Service Factor correlations

		LI mean	SF mean	Intercept	Slope	Corr Coeff
State	1-800	1.441	0.2270	.0382	.1310	.6134
	801-1500+	1.126	.1870	.0630	.1102	.7304
Indep		1.204	.2784	-.0958	.3108	.6778
Integ		1.218	.2335	.2274	.0051	.0128

Figures 1 and 2 are example scatter graphs of service factor against lab index; Figure 1 illustrates the lab provision/technician time correlation for medium-sized and large State schools, while Figure 2 shows the absence of correlation for Integrated schools.

Figure 1: State Schools with 801-1500+ roll: Service Factor vs Lab Index

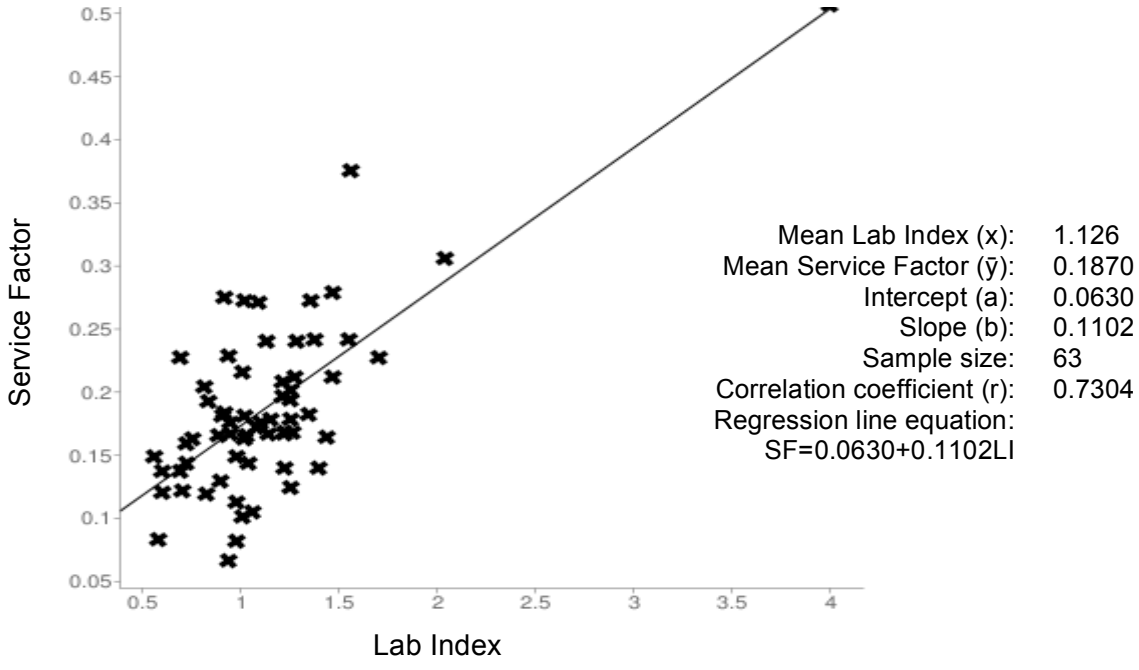
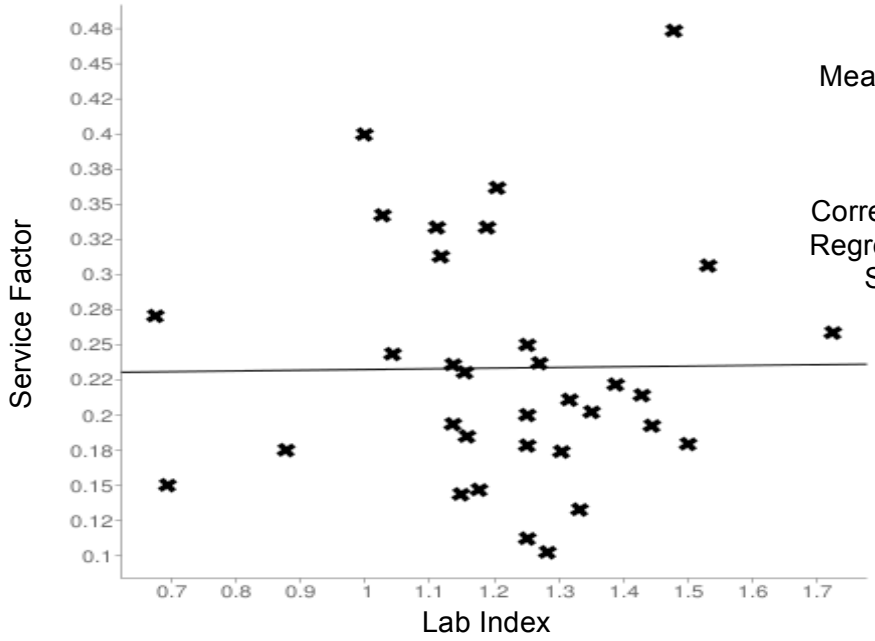


Figure 2: Integrated Schools: Service Factor vs Lab Index



Mean Lab Index (x):	1.218
Mean Service Factor (ȳ):	0.2335
Intercept (a):	0.2274
Slope (b):	0.0051
Sample size:	33
Correlation coefficient (r):	0.0128
Regression line equation:	
SF=0.2274+0.0051LI	

Science resourcing explanations

At a time when the median service factor for State schools has increased, that increase has not been observed in the group of large schools; many large and intermediate-sized schools have less technician support. The low lab index found now in many schools also indicates a decline; a failure to match roll growth and increased teaching hours with enough buildings for science.

The **Invisibility theory** is sometimes used to explain why service factors decrease with increasing school size. In large and medium-sized schools it will be more likely that the Principal and/or Business Manager will have less awareness (and value less) what science teachers and technicians do. If so, there is less likelihood that adequate technician hours will be initially provided, and more prospect that the budget will be later slashed in this area.

A complementary theory is **Diverse Facilities demand.** Since this also applies to larger growing State schools, it can be expected to correlate with the Invisibility effect. Under the provisions of Tomorrow's Schools, State school boards have wide discretion (in consultation with their communities) in assigning different emphases and priorities to the efforts of the staff and administration.

Schools where rolls are growing (usually intermediate-sized and large schools) have had increased community expectations of them, and with their building programs have had to weigh the demands for more diverse facilities against investments in traditional resource-intensive teaching areas such as science and technology. Some have made further capital investments related to cultural heritage, or the fine or performing arts, and for sports.

Some schools involved in a range of competitive sports at an elite level are now short of science labs (and Technology workshops) for their teaching. Many of the Independent schools have faced the same challenges (of increasing community expectations) as large State schools, but they have not had roll growth and State capital funding to finance improvements, and some are struggling.

Small State schools, with generally stable or declining rolls, cannot compete in offering more diverse facilities, but already have enough labs and generally recognize the value of technician support for science teaching, so it is usually at least adequate.

Diverse facilities demand seems to be particularly an issue in the Auckland region, where population growth has boosted many school rolls, and the building program given the opportunity for changed directions. College sport is at its most competitive in the Auckland region, and although sponsorships and fundraising have played major roles, the evidence is that insufficient labs have been built. Of 11 schools in the survey with a *serious* lab shortage (a lab index below 0.8) there are 9 in Auckland.

Integrated schools are more difficult to classify, but of 33 Integrated schools, only 3 have lab indexes below 0.9, and (a different) 4 have service factors below the State lower quartile of 0.146. The ownership and operating budget differences in Integrated schools allow adequacy of lab provision and adequate technician support for teaching to be disconnected – as shown by the lack of correlation in Figure 2.

Integrated schools own their properties and raise their own capital, and this means their facilities are only those that their communities will pay for. (Those wanting something more specialised may instead choose a large State school.) In general, they have chosen to build enough labs, and recognise the value of technician support.

What teaching support would you expect?

Some of the larger State schools claim a tradition of academic achievement, supplemented by sporting prowess. Some schools which have pushed teachers hard to enable greater numbers of scholars to higher levels of science attainment: (Merits, Excellences, Scholarships) may be providing less and less support for science teacher efforts.

It is ironic that lab provision and technician time are more adequate in schools where expectations of teachers and students are more modest. School managers in schools with elite achievements or aspirations could speak more convincingly and credibly about the value of student attainment goals (and the need for efforts to reach them) if they could show the school had invested in adequately supporting science teaching.

In an era when maths teachers are expected to turn out students who don't just memorise times tables and theorems, but deeply understand numeric concepts, it

seems that science teachers are implicitly expected to limit the practical science which has led students through involvement to: a recognition of science relevance; an interest in science-based careers; and a fuller understanding of science concepts. Something needs to change in large schools where there is decreasing support of science teaching.

That change can come at Board level. Providing boards of trustees with guidelines for adequate science support through science technician time and labs may help.

The Ministry of Education could have a role in technician support – perhaps this is more likely under a different government. NZEI has long had a policy of direct-funding for key support staff positions, and directly funding a minimum science technician time (based on science teaching hours) has merit in helping a school to balance priorities. Schools could advise an NZSTA stance in bargaining to favour rather than oppose this approach.

Acknowledgements

The help of the science technicians in about 190 schools all over the country, who made this report possible, and warm messages of encouragement from many of them, are gratefully acknowledged. My colleague Michelle Kiernan shared with me the collection of survey data, and made possible what I would not have attempted alone. The comments on that data and expressed views are mine, and those of STANZ and Mt Albert Grammar may differ.

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