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A WIDER ROLE FOR TECHNICIANS IN SCIENCE PRACTICAL WORK WITH SCHOOL STUDENTS?

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Abstract: This paper reports the results of a study made on the impact of improved deployment of science technicians in the classroom could directly benefit students in practical science investigations. Science technicians are skilled individuals whose understanding of practical work is a valuable resource not being used of in support of students understanding of science. Aspects of practical work and technician support were scrutinised, through information attained from a post-16 student survey to improve understanding about this teaching tool, to establish if it was being used to its full potential within science lessons. Analysis was also made of students' perceptions of school science. The main outcomes were that the majority of students enjoyed science practical work and felt that science could not be taught without it. Students studying science at pre-university level[1] attained a greater understanding, through participating in relevant practical work, than students who had studied it at earlier, compulsory levels. Students reported that science technicians provide impact on student learning when contact time was the greatest.

Key words: school science technicians, practical work, extended projects

1. Introduction

This is the companion paper to 'The Role of School Technicians in Promoting Science through Practical Work' [1].The number of students opting for pre-university physical science subjects in the UK is decreasing [2]. This decline, also echoed in Europe as a whole, affects availability and regeneration of these skills which damages any country's progression and development [3-6]. To encourage greater supplies of skills into these science areas, schools need to identify and ensure student's learning requirements, during science lessons, are successfully met. Science technicians have the capabilities to help students with their learning of science and support non-specialist teachers, enhancing the expertise within science departments. However, where school managers and educators have neglected to look at this role, these skills have been left redundant. One solution, where student's lack of interest in science is affecting the future economy and well-being of the country, is to look at the expertise science technicians may offer students in the school laboratory.

2. Technical support for students' practical work in science

Studies have shown that the total amount of classroom support science technicians in the UK provide has increased [7], with 27% of science technicians often assisting in practical lessons and only, 18% never; although, this large proportion of deployed time is not always realised by heads of science departments [8]. Science technicians possess the technical skills unavailable to unspecialised

[1] In this paper' pre –university' refers to the higher level courses taken by students aged 16-18. In the school in the project these were Advanced levels ('A' Levels).

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classroom support. Their classroom presence also alleviates concerns over pressurised science teachers, apparatus and health and safety issues during practical lessons [9]. Furthermore, many technicians enjoy the opportunity of working with students, which is also shown to be effective for science departments [8]. However, Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS) has concerns over this deployment being abused and the possible negative affect caused to other team members, together with disruptions to general routine workloads, if some colleagues are in the classroom working with students and teachers and no additional technician time is bought in to do the work otherwise scheduled [9].

At the school being reviewed, science technician contact with students is likely to be more prevalent during A-level practical project time due to increased demands for extra student support with more complex techniques and more sophisticated apparatus. However, this presents difficulties for technicians as the practical project period runs concurrently with heavy routine workloads hindering the ability to, satisfactorily, accommodate all. Again if greater consideration was given to the role, plus additional hours, science technicians' skills could be well used to increase the direct support for students. This would greatly assist students and their teachers.

3. The aims of the study

With school's current dilemmas of decreasing expertise in science departments and student's growing negative attitudes towards science, a study was devised to realise how enhancement of the technician role could help in alleviating these concerns. This research was especially necessary as there are few studies available in this field, with none, specifically, on technician impact on student's learning.

The study directly investigated accumulated student perceptions of the role of the science technician. Where science technicians' responsibilities predominantly consist with the provision of practical work, different aspects of this educational tool's effect on student's classroom learning were also examined.

Pre-university students, aged 16-18, may work very closely with science technicians during their assessed practical coursework period. The amount of direct contact time is dependent on the examination board[2] adopted. In the research project all three science disciplines were independently studied to see if there was any disparity between these groups. This also allowed opportunity to assess students' perceptions of physical science subjects, in relation to practical work, to compare with external findings. Obtaining data from pre-university science and non-science students allowed trends to be elucidated over science practical work implementation and how it may have affected their pre-university subject choices.

More generally, a clearer identification of students' attitudes towards science technicians and practical work would allow crucial information in understanding how the role could be modified to improve teaching and learning and student support. Changes to the role would effectively use science technician's skills; alleviate teaching pressures, whilst promoting a more positive attitude to students' interest in and learning of science.

The research study took place in a mixed gender state comprehensive school in the south-west of England. The school had a student population of 1,829 11 – 18 year old students whereby, approximately 340 were studying pre-university courses. The school is classified as good/outstanding with above average examination results [10] by the UK's Office or Standards in Education (OFSTED). The school's science department consisted of 19 teachers: - 6 physics (one part-time) teachers, 6 chemistry (one part-time) teachers and 7 biology teachers. It had 5 science technicians: - 4 technicians (three part-time) and 1 senior science technician, totaling 137 hours support per week. Each science subject had a specialist technician. The school maintained 13 laboratories. Parts of the science learning, in all years, were subjected to out of laboratory teaching whilst awaiting the construction of four more laboratories.

[2] Examination board' refers to the several commercial companies that set examinations for England and Wales.

4. Method

The school chosen for the research has a fairly even distribution of expertise, as other studies have shown [11] there is still a deployment of advanced skills into A-level and/or examination classes. Consequently, post-16 science teachers were all subject specialists, at the time of survey; however, this was not always the case pre-16. Furthermore, the majority of science teachers, regardless of specialism, working with pre-16-students mainly adhere to the schemes of learning and automatically assume the practical work components for their lessons.

A stratified study sample of year 13 students, aged 17-18, was used, providing responses from students receiving the full secondary school experience of teaching and learning in the sciences. Information was collected via a questionnaire submitted to all students in attendance on February 2010. Internal data showed 159 students on role at the beginning of that school year (September 2009), with 59 studying science. Information was collected from students selecting physics, chemistry and biology at the pre-university course termed A-level, as well as those opting out at non-compulsory level. Quantitative and qualitative data were gathered (Tables 1 - 4). Qualitative replies were coded to enable quantitative interpretation and students taking more than one science subject were grouped separately.

5. Results

Completed questionnaires were obtained from 45 science and 32 non-sciences students which represented 76% and 32% of the available numbers of Post-16 students in attendance. This vast difference between returned questionnaires, from the two groups, was partially due to difficulties accessing non-science teachers to promote the survey distribution. Another contributing factor could also have been attributed to non-science pupils' lack of related interest towards the topic matter. Breakdown of science disciplines showed opinions contained, approximately, a third more (33) biologists, than physicists (23) or chemists (24).

Results from the study (table 1) show 88% of students not studying A-level science and 76% of those who were, suggested that science subjects could not be taught without practical work (question 7). A breakdown of related qualitative responses are illustrated in table 2. However, both sets of students considered science could be made more enjoyable (question 3). The main qualitative solution, suggested by over three quarters of science and the majority of non-science students, was to increase the amount of practical work used in science lessons. External studies [12] and accumulated data (question 2) show students are positively influenced by subject enjoyment when selecting their pre-university subjects.

Practical work used in science lessons (question 6), was generally deemed relevant by students, especially, those studying A-level sciences. However, practical work implementation, to improve students' scientific conceptual understanding (question 5), was shown, by the majority of student's, to be less effective. This is in line with findings in the literature. Students require well placed practical work, showing relevance towards the taught concept. This then enables improved understanding and a greater enjoyment of the subject [13-15]. Where science students selected 'always', for topic 'relevance', more frequently than non-science (question 6), insinuates the science practical work, adopted for lessons, was more productive during this stage of education.

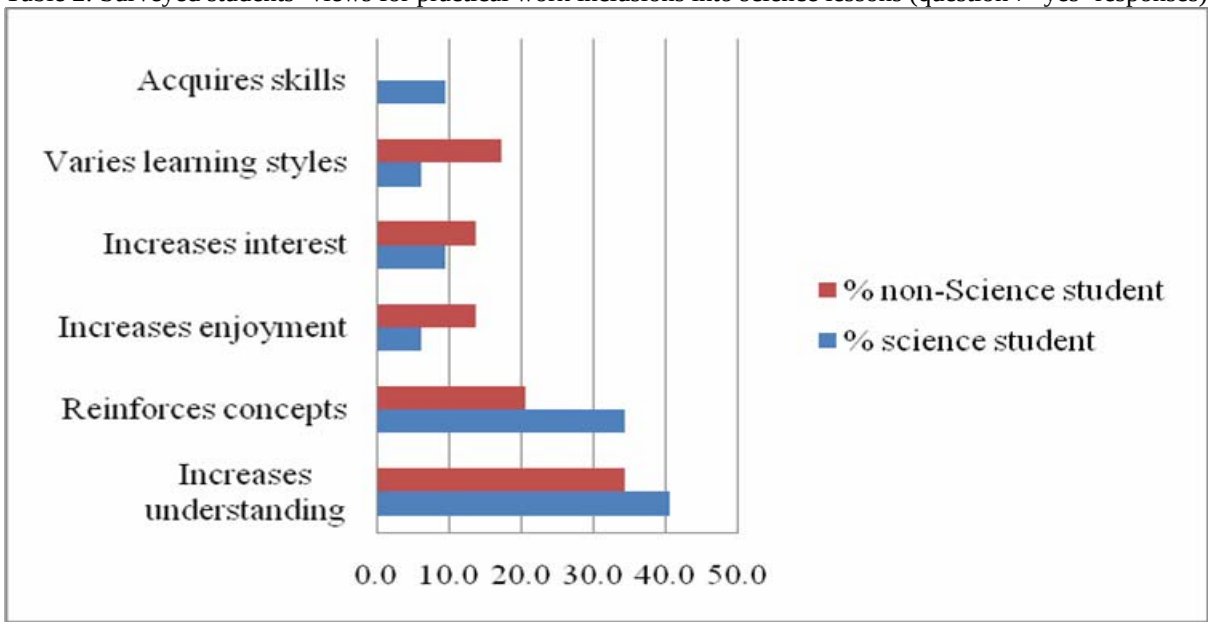
A-level physics student's findings portrayed practical work to provide the highest relevance and improvement to understanding. Furthermore, 9 of the 10 physicists stated qualitatively, that practical work could make science more enjoyable (question 3). Physics, with its abstract concepts, is perceived difficult for students to understand [12]. Relevant practical work helps students with clarification of conceptual ideas, increasing the enjoyment towards the subject taught [16]. This was illustrated by one physicist stating, 'Physics particularly, good to have concepts shown to you'.

Results portray that non-science students were noticeably less able to relate concepts with scientific subject matter than science students. Lack of relevance prevents ease in understanding the taught concept, detracting from students' enjoyment towards their science learning.

Table 1: Quantitative Survey Data

		No Science %	Science %	No Science	Science	Biology	Physics	Chemistry	Bio/Phys	Bio/ Chemistry	Phys/ Chemistry
1. Pupil numbers						12	17	5	1	8	2
	Totals			32	45	21	19	15			
2. Factors influencing subject choices post-16	Career	26	27	14	20	4	6	1	0	7	2
	Subject enjoyment	46	38	25	28	4	12	4	1	6	1
	Subject success	22	27	12	20	4	8	1	1	5	1
	Teacher related	18	5	2	4	1	3	0	0	0	0
	Other	5	3	1	2	2	0	0	0	0	0
	Totals			54	74	15	29	6	2	18	4
3. Can Science be made more enjoyable?	Yes	67	58	20	26	10	10	3	1	1	1
	No	33	42	10	19	2	7	2	0	7	1
	Totals			30	45	12	17	5	1	8	
4. Do you/have you enjoyed practical sessions in Science?	Always	34	40	11	18	6	8	2	0	1	1
	Sometimes	63	58	20	26	6	8	3	1	7	1
	Never	3	2	1	1	0	1	0	0	0	0
	Totals			32	45						
5. Has the Science practical work improved your understanding of the concept taught?	Always	38	42	12	19	6	11	1	0	0	1
	Sometimes	63	53	20	24	6	5	4	1	7	1
	Never	0	4	0	2	0	1	0	0	1	0
	Totals			32	45						
6. Did you find the practical work used in lessons relevant to the Science topic?	Always	59	71	19	32	8	13	3	1	5	2
	Sometimes	41	29	13	13	4	4	2	0	3	0
	Never	0	0	0	0	0	0	0	0	0	0
	Totals			32	45						
7. Do you think Science can be taught without practical work?	Yes	13	24	4	11	4	4	1	0	2	0
	No	88	76	28	34	8	13	4	1	6	2
				32	45						
9. Have Science Techs had any impact on Science learning?	Yes	45	82	14	37	6	16	5	1	8	1
	No	55	18	17	8	6	1	0	0	0	1
				31	45						

Table 2: Surveyed students' views for practical work inclusions into science lessons (question 7 'yes' responses)



The majority of all students identified science practical work preparation and transfer to and from the lab was the most recognised of all science technician's task (table 3). Photocopying, cleaning and clearing away equipment was only recognised by a few science and none of the non-science students. Furthermore, students offered no real consideration towards the repair of damaged apparatus or the replacement of stocks, which is significant in a school with large numbers of students. Where A-level sciences students identified more science technician tasks than non-science students, it is most likely due to increased student/technician contact time during A-level practical coursework periods. It was surprising to see a greater percentage of non-science students, than science, to identify 'help/advice' as a task performed by technicians.

Although themes of 'help/advice' and 'teacher support' were included in the 'correct' section (table 3), they are fairly non-specific descriptions of science technician's responsibilities. With the exclusion of practical work preparation/delivery, student's responses were very repetitive, with many offering a very narrow spectrum of replies. This, together with comments of 'teach' and 'being friendly', suggests that many students have little extensive idea of the duties performed by science technicians. One prime illustration of this being:-

> [response a] make sure everything is ready for practicals
>
> [response b] prepare practicals
>
> [response c] clean up after practicals (biologist)

Where surveyed students have poor perception of the role, it demonstrates how understated the role must appear to staff members outside of science departments [13] especially senior management [14].

55% of non-science students did not find technicians offered any impact to their learning (question 9, table 1). Qualitative content in 7 of the 17 'no' replies portrayed their lack of direct contact with science technician's provided them with no personal gain towards their science learning. Non-science students responding 'yes' appeared to be basing their opinions on how they considered the assembly/delivery of practical work affected their Science learning. This conclusion was formed from the 75% of student's qualitative replies expressing terminology to that effect.

Table 1 (question 9) illustrates technicians' impact to science learning was more apparent with students studying A-level Science (82%). For the science students, qualitative results (table 4) show impact to be more related towards support received during practical coursework. These results were

dissimilar to non-science student's feedback. Breakdown of surveyed data shows that biologists considered science technicians offered the least amount of impact from all the science disciplines. The possible reasoning could be attributed to the fact that different practical coursework assessments are used for each of the three sciences. Physics and chemistry courses awarded 10% and 15%, respectively, towards the final examination marks for individual practical investigations. This selected coursework extends over a period of weeks during which students may encounter unfamiliar techniques and equipment. Consequently, technicians provide a great deal of time and expertise to these students throughout this period. In A-level biology the practical skills are assessed by one hour set tasks where student/technician contact is small. Where all three science disciplines require a considerable preparation time for practical assessments, knowledge of this 'behind the scenes' workload is probably not realised by many students. Consequently, results show, students appear only to assess the impact science technicians have to their learning by the direct support time they received. Unfortunately, with no relevant available research literature there is no comparative evidence to compare these findings.

Table 3: Data of identified science technician tasks (Question 8)

Science Technician tasks	**Science**	**Non-Science**	**Student total**
Correctly Identified Tasks			
Preparation/delivery of equipment/solutions for lessons	58	32	90
Apparatus repairs	6	1	7
Book supply	0	1	1
Cleaning equipment	5	0	5
Help/advice	8	8	16
Ordering /stock control	7	3	10
Photocopying	5	0	5
Research	2	3	5
Safety	8	9	17
Scaffold learning	0	1	1
Teacher support	3	3	6
Testing experiments	3	1	4
Understanding experiments	1	0	1
Total of correctly identified tasks	106	62	168
Incorrectly Identified Tasks			
Being there/friendly	1	1	2
Connecting results with improvement with knowledge	0	1	1
Distilling water	1	0	1
Making tea	1	0	1
Recording results	0	1	1
Supervise	0	1	1
Teach	0	1	1
Total of incorrectly identified tasks	3	5	8
Final total	**109**	**67**	**176**

Table 4: Qualitative results of science technician impact (Question 9)

Question 9 'Yes' responses	
Biology	Getting equipment Provided solutions needed for experiments They do things above to help (prepare stuff, provide chemicals, clears stuff away)
Physics	Really helpful with Physics coursework Helped setting up Physics coursework No Technicians would make coursework impossible Without them wouldn't have right equipment for practical work. Helped with physics research As Helped with coursework Wooo Pat!!! Very helpful in organising & arranging coursework practicals Pat is a legend Setting up practical demos Ensure there was enough equipment for practical coursework Provided materials Collected equipment for my coursework Getting things with my coursework Behind the scenes helping with lessons
Chemistry	Preparation & assistance during A2 chemistry Individual investigations They have been extremely helpful with individual investigation Introduction to new chemicals/how they are made
Bio/Phys	Helped provide coursework equip/ helped provide equip for practical lessons
Biology/ Chemistry	Great help with chemistry coursework Given the correct apparatus needed for some things Helped make solutions/ made me some. Showed some procedures -All in chemistry coursework Helped with chemistry coursework- making my chemicals, helping with advice Support in individual investigation Helped with chemistry individual investigations Helped with visuals for practicals Amazingly helpful with individual chemistry investigation
Phys/Chem	Preparation & assistance during A2 Chemistry coursework
Question 9 'No' responses	
Biology	Never see them much, they aren't often around students Never spoke to them

6. Conclusions

Analysis from the survey conducted by Cerini, Muray and Reiss [16] concurred with other studies [15] that the majority of students enjoyed practical work, with its inclusion enhancing science lessons. Physicists, showed the most positive attitude towards practical work and its importance to science learning, reinforcing the speculation that relevant practical work provides vital links to improve understanding towards the subjects' inevitable, abstract concepts [16]. Another element ascertained

from data, was that topic enjoyment was considered the main reason behind subject selection, post-16. These facts portray, were practical work implementation increased, into science lessons, not only would student's enjoyment of science subjects be augmented but more students may be encouraged to select science at non-compulsory levels.

However, students found discrepancies between practical work used for science lessons and the taught concept. Undiscerning use of practical work in this fashion, especially with non-specialists science teachers, was identified in Abraham's study [15]. The lack of deviation from the examination specifications, especially by non-specialist teachers, suggests poor practical work use. It also shows why noticeably more non-science students' find science practical work to be irrelevant than post-16 science students'. Further evidence of this was supplied by several non-science students' qualitative responses stating that the lack of relevance prevented their understanding of the concept and applications towards 'real life' would enhance the science subject matter (table 1, questions 3 and 5). This disparity occurred more frequently from students studying at the non-compulsory stage of education. As clearly identified from surveyed and external findings [13-15], practical work needs to be relevant to gain understanding and enjoyment. Decreased enjoyment in science lessons would explain why these students chose not to study these subjects at higher levels.

The perceived impact science technicians had on students' learning in the compulsory science years was limited to their role of equipment preparation and delivery, with no real insight to other technician skills. This contrasts with pre-university students who, having received greater contact time with technicians, showed huge appreciation of the support and expertise they offered. Comparisons between the three science disciplines~~,~~ clearly showed impact was mainly judged by the one-to-one service provided. Where that was less apparent with biologists, illustrated no consideration was given to the level of preparation that went on behind the scenes. The latter was also evident with non-science student findings. Science technicians require expertise, often widely unrecognised, to prepare for pre-university practical science examination components. Although students had a lack of awareness regarding science technicians' responsibilities, science students, who did receive direct support and contact time with technicians, found it had a positive impact to their learning. This suggests that were technicians to provide a greater amount of individual time and support to students, not only would this supply the crucial, practical work expertise for students and teachers, it would also raise the profile on technicians' unique skills, within the wider school.

7. Recommendations concerning the potential role of science technicians

For students to gain increased understanding of science topics through the use of relevant practical work, better use could be made of science technician's practical work skills. School managers should recognise the potential many of these individuals could offer and should support and promote their more effective deployment within science departments. This would improve the support, within schools, students and for science staff. To achieve this school management would need to:

a) Realise the potential of willing and adequately skilled science technicians.

b) Organise appropriate science technician training to enable classroom confidence and ensure their existing theoretical knowledge is accurate.

c) Ensure that deployed science technicians hours are covered to. Ensure that the time required to release technicians from their scheduled are covered by additional technical staff.

The cost to schools will be negligible, incurring only the provision of science technician training and some additional technician time.

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