The Professional Life of the School Science Technician: The daily reality lived in schools and the virtual community of their professional websites

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The topic of this study is the school science technician and their work in the prep room of the school science department preparing practical materials for science lessons. It provides information about their work and their use of the professional websites for school science technicians. The lack of information on school science technicians has resulted in a situation where assumptions have been made about the work they do and the knowledge needed to undertake their work. The knowledge gap has resulted in a disregard of the effect of school wide changes on technicians, leaving them without a voice and vulnerable to change. Yet science technicians have alternative spaces where they can communicate, collaborate and create a close professional network. The aims of this thesis are: to reveal the work undertaken by science technicians; to show the effect of changes on school science technicians caused by the lack of understanding of their role, and to reveal the value of their professional closed websites to school science technicians.

The approach used the naturally generated digital artefacts of school science technicians belonging to three virtual professional websites. Such artefacts, in the form of questions asked by technicians and the comments received from technicians were collected over a period of two years with the full knowledge and consent of technicians. Content analysis was used to examine work practices and the effect of school wide changes on school science technicians. This approach provided a unique opportunity, as an insider at several levels, to represent the authentic voice of technicians. Besides the use of such material, the study also made use of a survey to gather demographic and job related evidence which could be used as a comparison with the few surveys presently available.

The findings on the technician profile show concurrence with previous surveys, showing that the population is ageing. The findings also reveal that the comparatively large reduction in numbers from the age where recruitment was traditionally expected is likely to create a catastrophic decline in school science technicians as many older technicians reach retirement age.

Evidence from the websites reveals the nature and extent of the unrecognised knowledge needed by technicians in order to do their work. As well as showing the extent of the work of technicians in the preparation for practical work of the laboratory the 'hidden' work they carry out is also shown. The complexity and diverse nature of the work of technicians revealed shows that they are an essential member of the science team. It does not appear that marginalisation or gender are the root causes of their present position. However, technicians are vulnerable to changes and their views on the remodelling of school support staff and the unification of all council workers onto one pay scale- the 'single status' agreement- show that a better understanding of their role is needed to support and protect technicians.

The lack of opportunity for technicians to attend training results in technicians becoming even more isolated. However the social and professional value of the websites in enabling the free exchange of knowledge and the establishment of supportive networks is also shown to be a means of filling the gap left by unavailable training opportunities. Nevertheless in view of the changing profile of technicians the establishment of suitable training platforms that would provide training by experienced technicians is needed. Although the exact nature of their community suggests that it is not a virtual version of a community of practice and may not exactly fit the criteria to be defined as an electronic network of practice, the use of websites should be encouraged so that all technicians can benefit from its use.

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Introduction

School science technicians (STs) work in the prep rooms of the science department and their main role is the preparation of the materials needed for practical work in the laboratory. This is the visible part of their work and is the culmination of their hidden work. The hidden tasks which are unknown include a wide range of activities associated with practicals including developing and modifying experiments; which requires extensive knowledge of physics chemistry and biology; and a number of associated tasks such as budgeting and ordering.

The Association for Science in Education (ASE) (1994, title page) described STs as ‘An invaluable asset’ but little is known about what STs do and who they are. Although STs are members of the school support staff their working life means that they are not prominent in schools and little is known about their role, except that it is based in the science department. The daily life and the professional nature of the work of the technician are hidden, which makes it more difficult for the senior management team (SMT) to fully appreciate the effect that changes made to support staff could have on technicians. This study aims to provide information that allows a picture of the technician to be produced so that the effects of present changes can be seen and the possible effect of future changes can be more easily identified.

The role of STs is important to me as it is my job, but this is not the only reason that I am doing this work. I have always worked in science but like most school science technicians I have met, working as a school science technician was not my first career. During my career in science laboratories I have worked for both a large multinational company and in medical laboratories, all of which had an element of research. It was the practical work at school that inspired me to work in science and part of my ability to work with apparatus with confidence in my first days in a real laboratory was due to the large amount of practical work that I undertook at school. Employers also expected that I would have these basic skills and this is why I think practical work is important in schools. Although there were STs in my school we never really got to know them below sixth form partly because they spent their time in the prep rooms and partly I suspect because school staff were probably more distant from students at the time and this situation is still much the same for STs. Consequently when I first took a job in a school as a lone technician - and it was because the work fitted in with family life; which at the time was not true for working in my field in medical laboratories; - I had only my previous knowledge of laboratory work to guide me. I had no knowledge of the work expected. This has not changed and lone technicians still have little if any guidance about the work expected. The necessity for practical experience in school for those considering a career in science has not changed: and it is important that all students have the chance to experience practical work so that they can also be inspired. This study will provide answers to the research question:

> To what extent and in what ways are qualified science technicians significant staff in the advancement of science in schools?

For the purpose of this study 'advancement' will describe the ways STs improve the science experience in schools. This will therefore include their visible work in providing practical materials to the laboratory, to show the work extends beyond simply following instructions and includes: piloting of practical work and reporting problems; refining practicals; developing new practicals, and ensuring the content and concentrations are correct for the key stage of the students. This work improves and enriches the experience of science for students. It will also include their other, invisible, work such as: their role in ensuring health and safety; in supporting teachers whilst they try unfamiliar practicals and explaining the practical when necessary; budgeting, and using their expertise gained in previous work to extend the knowledge of students. This promotes science and may inspire students. However because little is known about STs, there is a danger that their work will be vulnerable to cuts in hours or ST numbers when savings need to be made. It was therefore important as a first stage to gain the views of science technicians (STs). This is the reason this study focuses on STs to provide answers to the second question:

> How do changes to school structure and organisation affect the work of science technicians?

A larger project would be needed to include support staff in general or other interested parties.

These changes are not the only ones which have affected STs. The lack of interaction between technicians has increased as opportunities to meet have diminished. The virtual community of their professional websites has evolved and this study explores their use to answer the third research question:

> In what ways does the virtual community of their professional websites aid science technicians?

The aim of the research is to establish:

- the current position of science technicians within the school workforce
- the effect of changes on STs
- the use of their professional websites as a source of support and knowledge distribution

This will be done by allowing technicians the opportunity via the professional websites to speak in the first person about their work. It is important knowledge because without the school science technician practical work in science will not be able to continue in its present form.

Science education is important. Its value is acknowledged, for example The Wellcome Trust (2010) comments:

> Science education not only helps provide young people with skills and knowledge they can use in their life and work, but also inspires the next generation of scientists…those who go on to a research career usually have their interest [in science] sparked at school.
>
> The Wellcome Trust (2010, p.14)

If this is the case, then there is a need to understand how such interest is sparked at school and what role the science technician plays. Whenever I have asked individuals why they have taken up science as a career they have almost always said it was the result of the practical work they did at school and this was true for me.

Five areas introduce the topic and show why this study is important:

- comments from the scientific community and researchers show why the STs need to be appreciated and supported
- a description of the place of technicians as a member of the school support staff team introduces the subject of the study
- information is presented concerning the effects of changes on the identity and role of the technician and on their virtual community developed from their professional websites is introduced
- a review of the information gathered and the aims of the thesis
- the overall structure of the thesis

Comments on practical work and STs from the science community and researchers into practical science

Science needs practical work. The Science Community Representing Education (SCORE) (2008) considered that:

> The importance of practical science work is widely accepted and it is acknowledged that good quality practical work promotes the engagement and interest of students.
>
> The Science Community Representing Education (SCORE) (2008, p.1)

Furthermore SCORE (2013, p.3) defined practical work as ‘manipulating real objects and materials’ not viewing videos or using simulations, arguing that ‘practical work is an integral and essential part of learning in the sciences’. Endorsing this opinion The Science, Technology, Engineering and Maths (STEM) projects of the Nuffield Foundation (2013) confirmed that science needs practical work to ‘enable students to apply and extend their knowledge and understanding’ (website). STEM added:

> [it] can aid learning and memory and stimulate interest (in chemistry and biology) and sharpen students’ powers of observation, stimulate questions, and help develop new understanding and vocabulary (in physics)
>
> Nuffield Foundation (2013, website)

Furthermore, The Association for Science Education (ASE) (2006, p.11) regards the presence of practical work in science is ‘critical to improve[d] student attitudes to science and to the uptake of more advanced courses’. These comments suggest that practicals are considered important by the scientific community. SCORE (2013, p.10) commented that ‘inadequate technician support is limiting practical work’ and that schools state that they need more technicians.

However it appears the science community does not fully understand the role of the ST. SCORE (2013) comment that ‘schools are making increasing use of their technical staff to give advice’ that is technicians are being expected to add other tasks: advising which practical work is effective; providing support for inexperienced teachers, and monitoring budgets to their duties. These extra tasks would increase the workload of the technician which the authors have admitted is already stretched, and give them less time for their main work: the preparation of practical materials. Additionally, to establish whether there were sufficient number of STs, SCORE (2013) used the new reduced ‘service factor’ figure - a figure that is regarded as the minimum needed to provide adequate technician support - of 0.65 (CLEAPSS, 2009) instead of the previously recommended 0.85. This reduction was made because ‘a service factor of 0.85 has very rarely been attained’ (p.15) and The Royal Society and ASE therefore decided that their original figure of 0.85 ‘may have been a little high’ (p. 14). Therefore whilst suggesting that there are insufficient technicians, and acknowledging that ST workload is being increased, instead of promoting the hiring of more STs figures are used which suggest a reduced figure is adequate. CLEAPSS (2009, p.14) notes that ‘a significant number of schools were operating with a service factor around 0.35 with some below that figure’ which means that many schools have too few technicians even if the lower service factor is used. The actual work undertaken by technicians needs to be known so that STs are given the correct number of hours to complete their work.

Amongst those researching practical science, Braund and Driver (2005, p.88) note that ‘Pupils expect science to be a practical subject’, a view endorsed by Jenkins (2002, n.p.) who considers that ‘many students enjoy it [practical work]’. Jenkins (2002) also commented that ‘science teaching without practical work is, for most science teachers simply unthinkable’ adding ‘When asked to rank the resources needed for effective teaching, science teachers place the availability of laboratories, apparatus and equipment at the top of their list, just ahead of adequate technical support’ (n.p.). Although the use of practical work is considered important few researchers mention the need for technicians or the role of STs in making practical work successful: the connection between practical work and the need for science technicians is absent. For example, Roberts, Gott and Glaesser (2009) looked at the provision of the materials necessary for practical work but made no mention of the role of STs.

This suggests that the work of STs in the provision of practical science material to the school laboratory is not understood. Some authors when writing about practical science do not acknowledge that science technicians are required to produce the materials for practical work: others do not fully understand the complexity or the importance of the work of STs in the prep room in the provision of practical work.

Additionally it appears that authors who suggest that technicians can work in both the laboratory and the prep room do not realise technicians are busy preparing the materials needed for future lessons whilst classes are busy with their practical work, and therefore STs cannot also be in the laboratory with a class. It is important to reveal what technicians do so that suggestions are not made which increase their workload outside the prep room, reduce the time available for their main tasks and assume that technicians want to work in the laboratory.

Other groups also contributed thoughts on practical science. Despite being more aware of the work of science technicians CLEAPSS (2002, 2007, 2009) and ASE, (1994, 2006, 2007a, 2007b, 2009, 2010b) appear reluctant to admit the true extent of the role of the science technician. On the other hand science teachers value practical work, although this may be because science teachers regard practical work as something that defines their position in the school (Jenkins, 2002). Without the work of the technician being understood changes may be made which would adversely affect school science technicians and the provision of practical science in schools.

Science technicians as members of the school support staff.

Science technicians are included in schools as members of the school support staff and are therefore subject to changes that are aimed at all support staff. The problem is that those who have any knowledge about the activities undertaken by STs, for example science teachers, are not the ones who have any significant input into the actions that affect technicians even at school level. Such actions although ultimately directed by government are usually decided by the school management team (SMT) who lack familiarity with the work of STs. This has affected STs because without knowledge of their work the complexity of their role has not been appreciated.

Lack of familiarity and knowledge leaves STs at risk of being affected by undifferentiated changes proposed for support staff roles even if STs were not the expected target as the effect of changes on support staff with a higher profile may be more easily anticipated than the effects on support staff working in low profile jobs such as STs. Examples are the changes that have been made in the last decade about the reforming and remodelling of support staff (DCFS, 2007, 2009a, 2009b, 2009c; DfEE, 2003; DfES, 2002a, 2002b, 2003a, 2003b, 2003c, 2003d, 2003e), which related to the national agreement and envisaged that support staff would undertake more work with pupils (Hutchings *et al.* 2009). Remodelling changes can have serious implications for the work of STs and related to this, such changes have implications for the working relationship between STs and Teachers and STs and other support staff. This study needs to find out the effects of change on STs.

The role and professional identity of science technicians

As indicated in the previous sections, the school workforce is not a homogeneous group. Roughly speaking, it can be divided between teaching and non-teaching staff, but even this distinction is limited and wanting. With regard to the support staff workforce, some support staff have roles and responsibilities, which directly impact on teaching and learning, such as the work carried out by TAs. Others have only non-teaching roles. Science technicians are caught in a no-man's land between the two major groups. As part of the support staff in schools they are excluded from belonging to the teaching group as they do not teach. However, as members of the support staff who neither regularly support in the classroom nor support the school by taking on administration tasks, they have found themselves in a third support staff group that contains a wide variety of posts that have no commonality except that they do not fit into either of the other groups. Nevertheless school wide changes to the roles of support staff can affect the role and identity of STs even when this may not be the intended outcome.

STs tend to be 'hidden' in the science department because of their work pattern not because they are reclusive. The nature of their work means that they are at their busiest when the majority of the school workforce has the opportunity to meet in the staffrooms at break times and lunchtimes. This cannot be altered but has a profound effect on the opportunity of other school staff to interact with STs which would help to raise the ST profile and enhance their professional identity. This problem becomes even more acute when schools are divided into 'faculties' or 'houses' which have separate buildings which means staff may have little need to pass through a communal area. Even though this affects all staff, teachers have whole staff meetings (staff in this case means teaching staff) and work together during teacher training days so they do meet together more often: even though they rarely meet at other times if each building has its own staffroom. I have experienced this when a school moved site and changed from a single building to one where faculties were in separate buildings.

Even in the science department the work of the technician is mostly conducted behind the scenes in the prep room preparing the materials necessary for practicals to be undertaken in the laboratories. Their main job is to facilitate practical work, not to help in the laboratory, or undertake administration tasks or tasks such as marking work or administering tests. Science teachers visit the prep room but this is often for business rather than social reasons partly because teachers are mostly free, that is between lessons, when technicians are busy,. It is quite uncommon for other school staff to visit the prep room simply because they rarely have a reason to do so and these factors lower the profile of the technician still further.

Although the ST role is not laboratory based it is based in the science department and as a member of the science team it would seem more useful to use their team membership to define their role. STs should be an equal part of the team as both STs and teachers work together to provide the best possible experience of science for the pupils. As already mentioned, their roles and tasks might be different, but should be seen not as opposing, but complementary. Both teachers and STs need to work together to ensure that the material required for science lessons is chosen wisely and that it will be possible to prepare the materials in the timeframe anticipated. Technicians do this as fellow professionals with the expectation that their work will be appreciated as such. It is not their role to decide how the experiment is conducted in the laboratory, although they may be expected to give advice to teachers. Technicians do not expect, or require a teacher to oversee their work as they are professionals in their own right undertaking a job that is complementary to, but different from the role of the teacher. However, these dynamics can easily be changed by the assumption that as support staff they should also undertake other tasks. For example, fellow professionals would be unlikely to be expected, as a matter of course to put away worksheets used by another professional in the group. The dynamics therefore changes when ST are told to carry out tasks that they do not think should be part of their professional responsibilities. The same alteration of the dynamics results if arrangements suggest that technicians are regarded as inferior members of the team by not being automatically included in team meetings where appropriate or when meetings are held at times unsuitable for STs, such as when they are busy delivering items to the laboratories.

Staff outside the science department may think that the major task of technicians is the delivery of the materials and equipment needed to allow practical work to be undertaken by students to the laboratory. However one of the very few mentions of STs in journals that indicate that science teachers recognise that science technicians are needed to prepare practical materials for classes is found in Haigh (2007) where comments made by science teachers concerning the management of the investigative approach to practical work were reported:

> Easy availability of equipment was also a significant articulated issue for most of the teachers in all three phases of the project. There was concern over the lack of readily available equipment for the students to use when early notification of need could not always be given to the school's science technician. In an attempt to address this, these teachers found that they tended to cue the students to use certain equipment that they had already ensured would be available in the laboratory
>
> Haigh (2007, p.137)

However even here this is only relates to problems that affect the class. It does not suggest that the issues had been addressed by working with technicians to achieve the result required: but rather that the teachers did not try to find a solution to the problem by consulting with the technicians.

As mentioned in the opening paragraphs, the work of STs falls into two broad areas, one is the visible area, which is the delivery of the practical work to the laboratory and is the end product of the hidden or invisible work that is necessary for the production of the materials needed. The delivery of the correct materials in a form that is suitable for the age of the students with all the components needed for the practical work to proceed smoothly is the aim of STs but it makes the work seem easy. The complicated and sometimes dangerous work is hidden.

STs also take on other roles which may not be recognised and as well as those already mentioned they ensure that chemicals are stored correctly and disposed of appropriately, and STs may deal with first aid. This creates an identity crisis for STs who are on the one hand working as professionals in their own right, but on the other are regarded by SMT as lacking professional status. The effect of alterations of the workload on STs will be shown.

Science teachers may appreciate the work of STs, but do not as a department resist applying the changes which increase their workload. By not suggesting that the science department needs extra administrative help to undertake added tasks or that the tasks should not be added to the workload of STs, STs can feel unappreciated and isolated.

Isolation of STs is also a problem when decisions are made concerning support staff which are difficult to apply to their work. For example when changes are made to work patterns, instructions might suggest getting permission before working extra hours (those on longer than 39 week contracts) and working these hours in blocks. Science technicians work their hours when necessary, for example when they need to work longer to prepare or set out the materials required for exams and may need to work these hours at a time when the HOD is not available to approve them.

It could be considered that the issues noted suggest that STs are a marginalised group and because the majority of STs are female, gender might also be considered to be a factor that affects some aspects of their working life, and these will be considered as possible reasons for their current situation.

The virtual community of the technician

Technicians are difficult to reach because they may work alone or there may be only one or two technicians in each school; and any communication relies on messages being relayed to STs. Messages for the science department usually go to the head of science and may not be passed on to technicians. Despite these problems science technicians as a group are no more reclusive than others but their daily life causes them to be more likely to experience isolation than those who have more occasion to visit other departments.

Although more isolated within their school, there used to be more opportunity for technicians to meet at meetings and conferences: as these have been curtailed technicians do not have this network which used to aid their work. However STs do have a way to communicate. The websites that were originally provided to give STs a place to meet have become a place for technicians to seek advice and work as a team and to interact with other technicians to solve problems. The websites also provide a vehicle for disseminating knowledge between STs. The nature of ST work means that technicians encounter issues where the help of fellow technicians is needed to solve problems. The professional websites have given an opportunity for STs to develop their own virtual community and an aim of this study is to show the use of the websites as a source of support and knowledge and a place where technicians can work together as a team to solve problems and develop new experiments. The use of these sites is shown throughout the findings chapters and illustrates the work of the technician using their own voice. Their comments on aspects of their work are also revealed. This information is needed to fulfil the third aim which is to show the way that technicians use the websites. The websites could be a variation of a community of practice (CoP) and the use of the websites by STs can be used to determine whether their sites can be classified as a CoP.

The need for this study

Although there have been previous studies of the science technician (CLEAPSS, 2002, 2007, 2009; ASE, 1994, 2006, 2007a, 2007b, 2009, 2010a) these have their roots in the report by the Royal Society (2001). The studies have not been framed by STs and have viewed the ST using the lens of the outsider and what others think technicians do rather than seeking the reality from STs themselves.

Jenkins (2002) refers to surveys by the Royal Society/ASE (2001) and notes their comments suggesting that there were not enough science technicians in schools, but does not suggest where these extra technicians could be found. Most school science technicians have worked elsewhere (public sector or industry) before starting to work in schools. According to some surveys (The Royal Society/ASE, 2001; CLEAPSS, 2002, 2007, 2009; ASE, 2010), the majority of STs who have been attracted to work in schools are women with children. There can be no doubt that working in a school fits easily with other domestic duties: for example in other workplaces there is no guarantee that an employee can always take their holiday at a time that matches school holidays, or that they can take the same amount of time. It has therefore been a way to avoid childcare costs without having to make sharing arrangements with other parents or with family. Although previous reports indicate that the numbers entering the profession are diminishing, possible reasons for this have not been considered.

The lack of knowledge concerning the science technician has also produced a level of complacency concerning the qualifications already held by science technicians. For example, the paths mapped by the Training and Development Agency (TDA) (2007a, b, c, d; 2008a, b, c; 2009a, b; 2010; 2011) offered courses that are below the qualifications already held by the majority of science technicians as shown in the results of the surveys (CLEAPSS, 2002, 2007, 2009; ASE, 1994, 2006, 2007a, 2007b, 2009, 2010a). The courses mentioned by the TDA did not consider the extensive knowledge that STs bring to the job or the kind of knowledge required to carry out their work. The TDA either did not realise this discrepancy or considered that there would always be a pool of highly trained personnel who would not need basic training. The replacement for the TDA; the Qualifications and Credit Agency (QCA) (2012) concentrates on qualifications ‘for members of the school workforce who directly support the teaching and learning of pupils’ (website): there is no reason to assume that basic training may not be required in the future for science technicians given that the number of qualified technicians entering the profession is diminishing.

The research questions and the aims and objectives have been included in this introduction and are reproduced in table form on the next page:

Research question	Aims	Objectives
To what extent and in what ways are qualified science technicians significant staff in the advancement of science in schools?	To establish the current position of the science technician within the school workforce	To produce a study of the work of the ST to show why they are an essential member of the science team
How do changes to school structure and organisation affect the work of science technicians?	To show the effect of the changes on the science technician	To use the voice of the technician to reveal the effect of changes on the science technician
In what ways does the virtual community of their professional websites aid science technicians?	To show the value of the professional closed websites to school science technicians and their place in passing on knowledge and advice to other technicians	To use the words of the technicians to indicate their use of the professional websites to provide support and knowledge transfer

The next section maps out the structure of the thesis.

The structure of the thesis

The thesis contains nine chapters:

Chapter 1

Literature review 1

Views on the value of practical work in science and present knowledge of STs

This chapter reviews literature that contains views about practical work in science expressed by teachers, students, researchers and scientists. The rest of the chapter reviews literature available that provides information about STs and their work. It includes demographic information, shows how the population has altered over time and provides data that can be compared with data obtained in this study.

Chapter 2

Literature review 2

Whole school changes that have affected science technicians, marginalisation, gender and communities of practice

This chapter reviews the literature on whole school changes that have affected STs including the effect of the rebuilding of school science buildings, the single status agreement, and remodelling. It provides insight into the ways these alterations have changed perceptions of technicians and on the value placed on STs by others in the school. It also contains information on marginalisation and gender which will be used to consider whether these aspects affect STs. Information on communities of practice will be used to determine if this concept can be related to the ST websites.

Chapter 3

Methodology and methods

This chapter concerns the approach to the research and the methodology used to decide the most appropriate methods for the study. Sections are included which define the websites, the use of data collected from websites, and explain the reasons for the choice. The use of the interpretive paradigm, rigour, credibility, trustworthiness and triangulation and ethical issues are also included. The way the data collected was handled and information about the questionnaire used is also incorporated.

Chapter 4

The profile of the science technician

This chapter uses data from the questionnaire and from the websites to produce a profile of the technician it reveals the way in which the profile is changing and why these changes could affect practical science in schools.

Chapter 5

The use of the virtual community in the work of science technicians in the preparation of practical work

This chapter is about the visible aspects of the work of the ST. Data is used to illustrate the work of the technician in the visible aspects of their work, that is the preparation of materials needed for practical work. It shows the complexity of the work and the knowledge that is needed to produce practicals for the laboratory.

Chapter 6

The hidden work undertaken by STs and their views on the value of the websites.

Continues the findings chapters, exploring the hidden aspects of the work of STs and showing the range of tasks that are also included in the work of the technician but which are rarely considered.

Chapter 7

The effect of the remodelling agenda, the single status agreement and PFI building programme on STs and the views of STs on their status and the control of their work.

This chapter considers changes that have affected science technicians which have arisen from outside the science department demonstrating how the processes have altered some attitudes towards the work that technicians have previously undertaken.

Chapter 8

Discussion of the findings

This chapter links the findings of the study to the main points raised in the literature reviews including the technician and their work, and the findings in Chapters Four to Seven.

Chapter 9

Conclusion

This chapter reflects upon the purpose of the study and considers the extent to which the aims have been fulfilled. It includes: reflections on being an insider on the study; the research process; the limitations; contributions to knowledge, and recommendations and opportunities for further research.

This chapter has introduced the study. The next chapter is the first of the two literature chapters and provides information on the views about practical work in science and on the present knowledge of science technicians and their work.

Chapter 1: Views on the value of practical work in science and present knowledge of STs

The introduction indicated that practical work is regarded as an expected feature of the science curriculum: it also revealed that the need for science technicians (STs) to supply the practical materials was not emphasised or documented. Although it has been suggested that 'science without practical is like swimming without water' (ASE, 2009, p.1), the contribution of the STs to practical work has so far remained under researched and undervalued (Barley and Bechky, 1994). Lewis and Gospel (2011) concluded that the technicians they studied were undervalued because their knowledge was considered to be contextual and therefore inferior to academic knowledge.

This chapter reviews the literature in three areas:

- views of practical work in science, to reveal why the role of the science technician needs to be better understood and supported

- current knowledge about STs, to show why the authentic voice of STs needs to be heard

- present knowledge of the work undertaken by STs to show the need for STs to reveal their actual work to demonstrate their importance in retaining practical science in schools

1.1 Views of practical work in science

A search for literature was made using the databases available through the university search platform NELSON (Northampton Electronic Library Search Online) which gave access to all journals, including education journals, to which the university subscribes, free open access journals, books, e-books and other library resources. Google scholar was also used to locate literature and general internet searches were made. During the time of this study Sage allowed access to a number of journals that were not usually accessible which provided additional material.

Whilst searches using ‘school science technicians’ produced no articles, searches using ‘science technicians’ revealed many articles, however all were about science technicians in other fields such as industry and medicine: none included STs in schools. A search using ‘practical science in schools’ produced a number of articles and of that number twenty two articles were identified which studied the value of practical science in some detail. It is worth noting so as to stress further the argument about the invisible nature of the science technician that out of the twenty two articles only three (Donnelly, 1998; Haigh, 2007; Jenkins 2000) mentioned the work of the school science technician in the preparation of materials for practical work. Examination of the literature resulted in the identification of three groups with differing views on the place of practical science:

- science teachers and students who both expected science to include practical work
- scientists and employers who want practical work to continue to provide staff who have had experience of practical work
- researchers of practical school science who discuss the place of practical science in the curriculum

1.1.1 The views of science teachers and students

Whilst teachers use practical work as a pedagogical tool and decide the value they place on practical work, students are the recipients of practical lessons and have expectations about the practical work that will be included. The views of both teachers and pupils are therefore important since a positive attitude towards practical work from teachers and students would, in my opinion, add weight to the idea that STs should be supported because they are needed to produce the materials required for practical work.

There seems to be a general agreement amongst teachers concerning the importance of practical work. Teachers generally exhibited a positive attitude towards practical work viewing it 'as an essential feature of science education' (Abrahams and Saglam, 2010, p.753). It is used to give variety in lessons (Abrahams, 2009), and teachers believed it encouraged and motivated students (Donnelly, 1998; Toplis, 2007). Donnelly (1998, p.589) noted 'teachers were almost apologetic if there was no practical in a lesson'.

A number of researchers also thought the type of practical included was important whilst noting that teachers were reluctant to include practical investigative work which involves students solving problems, developing ideas or exploring concepts without following a prescribed approach (Braund and Driver, 2005; Braund and Reiss, 2006a, 2006b; Haigh, 2007; Jenkins, 2000; Juuti, 2010; Millar, 2006). Swain *et al.* (1999) suggested that there were fewer practicals included when exam success was paramount. The literature also showed that teachers regard practical work as a valuable teaching tool to reinforce the theoretical knowledge required for exam success and the traditional approach had to take precedence when there was pressure to increase student numbers crossing the D-C boundary (Haigh, 2007). Teachers also indicated that they use practical work to stimulate an interest in science.

On the other hand teachers also revealed that practical work helped define them as a science teacher (Donnelly, 1998; Abrahams and Millar, 2008; Abrahams and Saglam, 2010; Braund and Driver, 2005; Braund and Reiss, 2006a; Jenkins, 2000a; Millar 2006). Donnelly (1998, p.595) suggests, ‘The patterns of activities in science are, at least in part, constitutive of what it is to be a science teacher in England and Wales and the laboratory has a key role in this’. However researchers did not ask about the role of the ST in the provision of the materials for practical work and teachers did not mention STs. Practical work that engages and stimulates an interest in science defines not only the teacher delivering the lesson, but also the ST who provides the means for practical work to proceed.

The views of students were reported less frequently than those of teachers in the literature used but practical work is also considered by researchers to define science for students. Further literature in this area was not sought as the focus of the study was STs, not teachers or students: however researchers reached divergent conclusions about the reason for the comments of the students. For example whilst Abrahams and Millar (2008) found that practical work aided recall in students and Osborne and Collins (2001) suggested that students preferred lessons with a practical element, Abrahams (2009) thought that this was simply a result of practical work being more appealing than writing. Braund and Driver (2005) found that students entering secondary school were excited by the prospect of the increased inclusion of practical work and suggested that this would encourage students to develop a positive attitude towards science. Conversely, Abrahams (2009) suggested that for students, practical work ‘helps offset the image of science as difficult, dull and boring’ (p. 2346) and thought this gave a false image of science as being always fun. Contradictory ideas do not allow firm conclusions to be drawn about the reason students like practical work, but show that students expect practicals to feature in their science education and look forward to more practical work when they enter secondary schools.

Given the low profile of STs and therefore the probability that students do not know what STs do, for this study it is sufficient to know that practical work defines science for students and is something that they regard as a positive aspect of their science education.

1.1.2 Opinions on practical work by those employing science students

The views of those who employ, or are, scientists are also important as they have experienced school science and have translated that training into the workplace. Reports and the website of the Science Community Representing Education (SCORE) (2008, 2009, 2011, 20013), and The Science and Technology Committee (2011a, 2011b) reports on Science, Technology, Engineering and Mathematics (STEM) provided examples of the voice of potential users of the product of school science education. I have had experience of the expectations of employers on the practical capabilities of new entrants into science based work, both as a new recruit and as a senior member of scientific teams outside the school environment. As noted in the introduction I was expected to have practical skills on entry, and I expected the same of my staff.

SCORE (2008) emphasised that ‘the importance and value of practical work has again been re-enforced during this project’ (p.3) adding ‘[practical work] is a “hands-on” experience’ (p.3) that must be maintained as it cannot be replaced by other teaching methods. They stated that pressures to reduce the amount of practical work in schools must be resisted. SCORE (2011) considered practical work valuable because it developed skills such as the manipulation of equipment. They also considered that co-operation in small group activities provided experience of team working and was important because of the need to co-operate with others to achieve results. SCORE (2009, 2011) concluded that whilst practicals are part of science exams, practical work would be protected throughout the school despite curriculum changes. However, they did not mention that technical support also needed to be secured. STEM (2011b) regarded practical science as important for everyone and essential for those wishing to pursue a scientific career. In supporting their argument they reported a variety of comments had been sought which they included as personal communications. Three are noted below:

‘It is critical that students are able to develop technical skills as part of the science curriculum that they can then use in future careers’ (Baker, Natural History Museum, STEM (2011b, p.46)

‘Employers [in the STEM sector] require them not only to have academic knowledge of their subject but also some degree of work-ready, hands-on practical skills’ (Jackson, Engineering UK, STEM (2011b, p.47)

‘There is no doubt that well planned and implemented practical work enhances young people’s learning and understanding of scientific concept’ there is a ‘Need to recruit, train and retain high quality teachers and technicians...Without the appropriate specialist teachers and high quality technicians crucial practical skills will not be passed on’ (Walport, Wellcome Trust, STEM (2011b, p.50).

These quotes show that practical work is valued by scientists for the enthusiasm and skills that it develops in students and is valuable as it increased understanding, developed skills and helped in career decisions. The need for well-trained STs in schools was also noted ‘The Government recognises and fully appreciates the important and valuable contribution that science technicians make in schools’(STEM, 2011b, p.3) showing the need to support technicians in their work.

So far the literature review has concentrated on the views of those who deliver the science curriculum (teachers), take part in practical work (students), and employ the future scientists (the scientific community). These groups regard practical work as an essential part of science learning. However the views of researchers into practical science are important as their recommendations have the capacity to influence change in school science.

1.1.3. Views on practical work by researchers into practical science in schools

Not all researchers accept that practical work is an important part of science. Toplis (2007) concluded that practical work was value for money because England was better than average in international tests: others argued that it is too costly for all students to experience practical work which should be restricted to students who will become scientists (Osborne and Collins, 2001; Braund and Reiss 2006a). However Braund and Reiss (2006a) recognised that restricting access to practicals could cause the potential loss of able students to science. As a technician I know that the initial cost cannot be argued against because of the quantity of equipment required to furnish a set of school science laboratories. However the most costly items; accurate balances; good microscopes, and sets of power packs will last many years and are easily shared as they are not needed simultaneously by all classes. Also the more expensive items are usually reserved for advanced work with less expensive versions being sought for lower down the school. General items that are required in quantity such as glassware tend to be comparatively inexpensive if carefully sourced and with care will require minimal replacement. Although it could be argued that the cost of the STs is the reason that researchers regard practical science as an expensive area, my hypothesis is that as they exclude STs in their articles they have also been excluded from calculations related to cost. Also STs should be regarded in the context of the overall support staff budget where their cost would be dwarfed by that spent on staff that are more numerous such as TAs or are more expensive such as IT staff.

The need for practical work in school science was disputed. Although it was regarded as a traditional part of science teaching by Toplis (2007) Abrahams (2009) thought practical science had limitations and neither motivated nor increased the likelihood of a long term interest in science. Abrahams and Millar (2008) suggested that only practical work which linked to scientific ideas was valuable and Kirschner and Huisman (1998) pointed out that as most practicals could be viewed electronically practical work should be used only for experiments that need to be seen; for example actually watching magnesium burning cannot be matched by a video. Simulations are valuable for experiments that are too dangerous to attempt in school or are capricious such as photosynthesis but some aspects, such as smell cannot be conveyed on a screen. The value of practical work in the development of dexterity in handling science equipment which is identified by SCORE (2008, 2009, 20011, 2013), and STEM (2011b) as an essential skill needed by scientists is also overlooked. Braund and Reiss (2006a) consider that practical work does not prepare students for scientific work, showing conflict between researchers and practical scientists and although it might appear that practical work is only needed for ‘A’ level, basic handling skills need to be developed at an earlier stage as there is insufficient time to learn these within the ‘A’ level curriculum.

This section showed teachers, students and scientists value the use of practicals in schools with scientists being the most likely group to mention the need for STs. On the other hand it also showed that some researchers into practical work were less enthusiastic about practicals: regarding them as costly; were not sure that the opportunity for practical experiences should be extended to all students, and argued that practicals should be confined to those who were going to become scientists. However they admitted this might not give equal opportunity to all students. Electronic means of providing illustrative practicals such as videos were also identified as sufficient for most experiments forgetting that science is a ‘hands on’ subject SCORE (2008. p.3).

The role of STs in the preparation of equipment is not stated, perhaps because it is assumed that this need is obvious, or because STs are being taken for granted. Although it is unlikely that science teachers do not recognise the need for science technicians, teachers do not have the influence of researchers in decision making and researchers barely mention STs. This leaves technicians without support and vulnerable to changes suggested by research which is less favourable towards practical science: even though scientists regard both practical work in schools and STs as essential, and teachers and pupils regard it as an important and defining aspect of school science. STs do not have a voice and rely on others to support and protect them against adverse changes, but in order to do this extensive knowledge of STs is needed.

The next sections examine material available about STs: identifies what is already known about science technicians, and shows gaps in the knowledge about STs and their work.

1.2 Information about the school science technician

Researchers in practical science pay little or no attention to STs who provide the materials needed for practicals and journal material that mentioned STs was difficult to find. No journal articles about school science technicians were found even after returning several times to academic search engines available via the university library, google scholar and general internet searches until one article, Jarvis *et al.* (2008) was found in 2012 via google scholar which gave useful insight into the attitude of some teaching staff towards STs, the approach of STs to their jobs and included information about STs. It did not specifically concern the profile or the general role of STs but it gave a link to a second article (Busher and Blease, 2000) which contained some material about the profile and work of technicians in general and although their main concern was the management of STs it proved useful as it gave some insight into the mind-set of those managing technicians. A later search (2013) produced one article by Lewis and Gospel (2011), which although about university technicians gave useful comments about the causes of the lack of training available and the lack of status of technicians They regarded lack of status as an important factor in the lack of recognition given to the value of the work of technicians. A link in this article provided information about general attitudes towards technicians (Barley and Bechky, 1994). Of the many articles that were located concerning practical science in schools none included any information about science technicians or their work. Peer reviewed material was therefore limited to the articles noted and suggests that the link between practical science education and the need for school science technicians has not been recognised.

Although not studied by researchers, STs have not been totally ignored: but as noted in the introduction STs have been studied through the lens of the needs of teachers and science departments with little regard to the opinion of technicians. Questionnaires that were conducted by ASE (1994, 2010a) and The Royal Society/ASE (2001, 2002) were used in this review together with the peer reviewed material. The publication date of older surveys could be considered a problem, but the questions used in the initial survey ASE (1994) were also incorporated in The Royal Society/ASE (2001) survey and in ASE (2010a). CLEAPSS, 2002, 2009) used the figures produced by The Royal Society/ ASE (2001) which are included to show the figures they used for their comments on the data. It is possible to see some trends over time which can be used when evaluating the findings of this research.

All surveys except ASE (2010a) were postal surveys sent to the science department of secondary schools but not directly to technicians: as noted by ASE (2010a, p 3) ‘there is no register of technicians available’. The Royal Society/ASE (2002, p.vii) added that they ‘sought the views of heads of science and OFSTED and Further Education Funding Council inspection reports’. The Royal Society (2002) document was the same as the (2001) document, minus the case studies therefore The Royal Society/ASE (2001) document was used. CLEAPSS stated that CLEAPSS (2009) was an update of CLEAPSS (2002), therefore CLEAPSS (2002) was used unless figures had changed: because the results would have been generated in 2002. The ASE (2010a) survey had limited distribution being only accessible on the ASE official website and a number of technicians contributing to the three technician websites stated that they had not known it was available. The survey ASE (2010a) was conducted in 2009 and predates the questionnaire used in this survey. This section is based on the limited survey material and the small amount of literature available.

The survey of the ASE (1994) was ‘sent to a random 5% of schools in the UK catering for Pupils in the 11-16/18 age range’ (p.9). 250 replies were received ‘representing every sector of the education market’, 60% were comprehensive and 72% were 11-18 schools. No tables specified the number of technicians used for each chart or table. Tables produced (Bolton, 2012) show that in 1995 there were 4479 public secondary schools and 2259 independent schools in England and Wales. The Royal Society/ASE (2001) ‘sent a questionnaire to 4800 UK schools and colleges’ (p.1) and received replies from 1900 schools and colleges and from more than 5000 technicians. Twelve approximately 1200 word case studies were included, around half of each report was about the school and the science department. Although the work of the ST over a week is described it is not stated if this was requested information or if the researchers were present for a week. There were 4230 public secondary schools and 2250 independent schools in

2005 (Bolton, 2012). The survey by ASE (2010a) was an online survey which received 565 replies. ASE (2010a, p. 2) state that 'the lower response rate may have been due to the information not reaching the technicians, or technicians being too busy to fill in the online forms during the working day' There were 4249 public secondary schools and 2376 independent schools in 2010 (Bolton, 2012). The number of technicians used for each chart was not always specified in the surveys, but is included where known. Some of the data used in the next sections is demographic data from the questionnaires of The Royal Society/ASE (2001) CLEAPSS (2002,), and ASE (1994, 2010a) As the demographic data supplies quantifiable information about the characteristics that define a population or group it can be used here to provide: general information about STs; an overview of the whole group, and trends may be observed. However as there may be many individuals in the ST population that do not conform to the idealised picture produced generalisations would need larger numbers. The surveys used contain simple data such as age, gender, and qualifications and more complex data such as their status as wage earners, training, career structures, and qualifications.

1.2.1 Gender and age of the technician

Gender distribution remained at around 1: 3 (males to females) (ASE,1994; The Royal Society/ASE, 2001) until ASE (2010a) where the ratio is nearer 1:4. It can therefore be concluded that this has been a female dominated profession since at least 1994. ASE (2010a) thought the reason was that 'generally term time jobs are not attractive to most men and young people so the profile is unlikely to alter' (ASE, 2010a, p.3) but adds 'men who have taken early retirement or who had been made redundant from other jobs are entering the profession'. The specific lack of male technicians is not a problem as both are equally able to do the work, but the increase of older men could cause a lack of stability. Retired people may not stay long and technicians that were made redundant may seek work elsewhere as job prospects improve as the lack of career prospects may make ST work unattractive (The Royal Society/ASE, 2001). These older entrants may not be trained technicians and their experience may be less practical: this is an important distinction as technician work needs practical skills (Barley and Bechky, 1994; Lewis and Gospel, 2011).

Results of the surveys (ASE, 1994, 2010a; Royal Society, 2001, CLEAPSS, 2002) reveal changes in the age of STs. Table 1.1 produced from the figures given in the surveys shows that for all surveys the majority of technicians have always been over 40. ASE (2010a) points out that the number of technicians aged between 51 and 60 has risen to 43%,

Table 1.1

Percentage of technicians in each age range				
Age range*	ASE (1994)	The Royal Society/ASE (2001)	CLEAPSS (2002)	ASE (2010a) n=442
18-30	10	8	8	6
31-40	21	20	20	13
41-50	40	37	38	32
51-60	25	30	30	43
60+	4	4	4	5

Other numbers used for the figures were not specified

*ASE (1994) used age ranges 16-19, 20-29, 30-39, 40-49, 50-59, 60+

The surveys did not ask why technicians decided to work in a school but the lower number of technicians under 40 has been noted by Jarvis *et al.* (2008). Table 1.2 has been produced using the figures to show the percentage of technicians over 40.

Table 1.2

Percentage of technicians over 40	
Survey source	**Percentage of technicians over 40**
ASE (1994)	69
Royal society (2001)	71
CLEAPSS (2002)	71
ASE (2010a)	80

This demographic has been produced using data from the original table and could be the point when women whose children may have moved to secondary school and who have previously worked in science want to return to a science based job: but still find school holidays useful. The reason for suggesting this is a significant figure is that at the time of these surveys; apart from ASE (2010a); part time work in science was rare. Personal informal conversations with technicians over a number of years have revealed that ST work provides a job that combines the opportunity to use their science practical skills and the need for suitable breaks during school holidays. Being able to be at home during school holidays was considered to be an important factor by female STs.

It can be seen that the ASE (1994) percentage (69%) increased slightly to 71% in subsequent reports (Royal Society/ASE, 2001; CLEAPSS 2002,) until ASE (2010a), when 80% was recorded. This figure suggests a lack of recruitment from the youngest age ranges and has resulted in the observation that the population is ageing. Concern has been raised because ‘As the job can be physically demanding, this will impact on the health and wellbeing of the aging workforce’ (ASE, 2010a, p.3) although this is not consistent with the assertion that STs can be recruited from the retired.

None of the surveys suggested that there was a need to investigate why the profession is failing to attract younger people or considered the future consequences of the decline in younger entrants to the profession. My experience suggests that the lack of a career structure may be one reason, but another could be that job sharing has become more commonplace in laboratories. As Table 1.1 shows that a large percentage of technicians are reaching retirement. It is important that this problem is addressed. Lewis and Gospel (2011) reported a similar ageing profile in technician populations of universities especially in areas such as engineering and physics.

1.2.2 Wages and hours of employment and deployment

The Royal Society/ASE (2001, p.18) note that technicians commented on their low pay. Wages have been adversely affected by the implementation of the Single Status Agreement (SSA): a process applied to all council workers to unify their pay into a single pay spine which is explained in more detail in Chapter Two. Poor pay: around £15,000 for full time 52 week contract for STs with further reductions for term time only workers 'reinforces the perceived low status of technicians' ASE (2010a, p.8) They also suggest:

> wage scales are based on the job description, personal specification and qualification criteria' which are kept artificially low because at present schools receive applications from technicians with higher qualifications than are specified'
>
> ASE (2010a)

STs whose work provides the only or main source of income in a household are shown in Table 1.3 and although the luxury of the school holidays may be appreciated, qualifications held by technicians mean that they may be swayed by the higher wages available elsewhere.

Table 1.3

Percentage of 'only wage earners' and 'main wage earners'		
Survey source	**Technicians who are the only wage earner**	**Technicians who are the main wage earner**
ASE (1994)	26%	32.9%
Royal Society/ASE (2001)	24.2%	43%
ASE (2010a)	29%	43.7%

No ST numbers were attached to these figures

The ASE (1994) considered that the percentages were significant and results of The Royal Society/ASE (2001) and ASE (2010a) show a marked increase in technicians who are the main wage earners. The circumstances of the technicians were not recorded so the figures cannot be contextualised; it cannot be known why the STs were the main earners: another family member may have been made redundant; the situation could be caused by a temporary problem, or a suitable laboratory job may not be available in the area. However experience suggests that if wages are an issue and a suitable job is available, term time working becomes less attractive as the need for higher pay becomes more important than the advantage of school holidays. A point also noted by ASE (2010a).

The definition of 'full time' is confused in the surveys. ASE (1994) note that nearly 60% of technicians were 'full time', but do not give the hours worked so it could be term time only, time that only covers the school day, or time extending either side of the school day. They note that 35% are available 'throughout the year' (p.15), but not if this is 35% of the total or 35% of the 60% who work 'full time' or some variation of full time. ASE (2010a) report that 30% of technicians have a 52 week contract, but a similar number have term time only contracts. There are too many permutations for the figures to be meaningful. The Royal Society/ASE (2002, p.6) reported that 5% of Heads of Department (HOD) did not know how the number of technician hours was computed and for 32% this was a management or financial decision. In addition, ASE (1994, p.15) note that ‘anecdotal evidence suggests that technicians are the first to have their hours cut’. Without a voice, technicians cannot demonstrate their value and defend themselves against having their hours cut. It is important to note that the consequence of the reduced working hours can affect the ability of technicians to complete their work within the allotted time and therefore it should impact on the quality of the practical and ultimately on what teachers can teach and students learn. However The Royal Society/ASE (2001, p.6) report that ‘less than a third (31.6%) of technicians surveyed never do overtime’, which gives less impact than stating that 70% of STs work overtime. They added that ‘almost one fifth got neither time off in lieu or extra pay’ which suggests that technicians may be expected or feel obliged to undertake the same amount of work even if hours and wages are reduced. This point was not raised in the reports. This study will therefore include a question on hours worked

ST hours are affected by the ‘service factor’ which as noted in the introduction is calculated by dividing number of lessons by technician hours and is used to ensure adequate technician hours are available to service the practical needs of science: 0.85 was regarded as a suitable figure. This is a ‘quick and dirty’ calculation that, for example ignores the difference between ‘A’ level practicals and practicals for key stage 3. ‘A’ level practicals are more demanding because of the amount of work involved including: the preparation of several very accurate solutions in sufficient quantity to ensure students do not run out of solution; the production of special apparatus, and for exam work each student needs their own set of equipment. Most work at key stage 3 requires less precision and items can often be stored in class sets ready for use. When the service factor was reduced to 0.65 as noted in the introduction CLEAPSS (2009) commented that 0.85 was required to provide an adequate service, but then used the new target figures of 0.65. CLEAPSS (2009, p.14) suggested that ‘schools were operating adequately with a service factor below that previously recommended’, and used this as their reason to agree with the alteration. Not equating this reduction to their observation that a large proportion of technicians work unpaid overtime in order to complete tasks. ASE (2010a) notes that in England and Wales the overall service factor was 0.51, only 34% were above 0.6 and less than 25% were above 0.7 adding that little saving is made by reducing technician hours 'as most technicians are on low pay scales anyway only marginal savings can be made' (n.p.).

1.2.3 Qualifications of science technicians on entry

So far demographic features and employment and deployment figures portray a rather complex, and not always positive, reality. Even the qualifications needed to undertake the work of the technician are not recognised (Barley and Bechky, 1994). Lewis and Gospel (2011) suggested that the problem is caused by the different emphasis placed on practical and on academic knowledge as noted in the introduction and demonstrated in these surveys. All surveys stated that technicians have formal qualifications ranging from at least equivalent to GCSE science to PhD (ASE, 1994), over 60% had qualifications at Ordinary National Certificate (ONC) or above, and 22% had a degree (The Royal Society/ASE, 2001; CLEAPSS, 2002). ASE (2010a) reported that all technicians had formal qualifications, nearly 40% had degrees and 31% had unspecified technical qualifications (personal experience suggests that these were probably at Higher National Certificate (HNC) level and related to their previous work). However CLEAPSS (2009, p.41) comments 'it has been established that some of the qualifications may not be appropriate for technicians' work'. They suggest without explaining how this was established that a degree with insufficient practical content may not be useful; which is possibly true as some courses have a higher theoretical than practical content; or 'may have been gained some time ago' which could also be true, but perhaps not so relevant as the basics will still remain the same. STs stated that they explain practical work to teachers (The Royal Society/ASE, 2001, p.40) which suggests that ST qualifications are appropriate. It is recognised that technicians' work is complex, requires extensive skills and the ability to work across all three areas of science at a technical level beyond that needed by science teachers, but CLEAPSS (2009, p.41) still consider ‘a qualification in a single subject is insufficient’ without recognising the technical knowledge of STs bridges the gap between ‘the symbolic world of academics and the material world’ thus turning ideas into reality (Lewis and Gospel (2011, p.12). Unfortunately, no suggestions were made about what qualifications were appropriate given the salary offered. The extent of the knowledge of the technician and the way it is used to enhance science teaching is shown in chapters five and six and the problems caused by the lack of understanding of this role and the challenges it contains, are revealed by the comments of technicians.

1.2.4 Training, career structure and support available to science technicians

The lack of understanding of the work of STs means that training requirements are also unknown. ASE (1994) and The Royal Society/ASE (2001) considered the lack of career prospects deters younger age groups and creates recruitment problems, suggesting both a clear job structure and career path were urgently required. Table1.4 overleaf shows the ASE (2010b) model career structure where progression is clearly described. However it is suggested that STs would probably have to relocate to reach the highest level, and does not suggest why career progression cannot be reached via appropriate training courses. Jarvis *et al* (2008, p.37) suggested that ‘generally the technicians did not have high career expectations’ and ‘only two junior technicians saw the course as a possible aid to promotion to senior status’.

Table 1.4

Suggested levels required to undertake technician duties	
Technician level	**Duties at this level**
Assistant Technician Level 1 Basic level qualification	An Assistant Technician will normally be working under the direction of a Senior Technician/Team-Leader Technician to provide general assistance and information as required in the preparation of resources for practical lessons and maintenance of equipment.
Technician Level 2 1'A' level	A Technician will normally be working under the guidance of a Senior Technician/Team-Leader Technician to co-ordinate the use and maintenance of practical resources and facilities, and to provide assistance and advice in meeting the practical needs of the science curriculum. This may involve preparation of resources, constructing and modifying apparatus, together with assisting in demonstrations.
Senior Technician Level 3 2 'A' levels	A Senior Technician will co-ordinate the use of practical resources and facilities and provide assistance and advice in the practical needs of the science curriculum. This may, but not necessarily, involve organising and supervising Assistant Technicians, together with giving technical advice, and health & safety advice, to teachers, other technicians and students.
Team Leader Technician Level 4 Foundation level degree qualification	A Team Leader Technician will be responsible to the head of science. They will be responsible for setting up and monitoring systems used in the management and control of practical resources, including budgets. They will ensure the technician team keeps up to date with health & safety requirements and developments in practical science. They will manage and monitor the performance of and supervise colleagues.

Source ASE (2010b)

ASE (1994) noted that no structured training was available and BTEC courses were suggested as suitable. Comments from STs that courses were inappropriate were interpreted by the authors as meaning they were too intellectually demanding rather than irrelevant. Technicians suggested that they would like modular units, to study with other technicians at a local centre and to be taught by an experienced technician (ASE, 1994). CLEAPSS (2002) suggest that the induction courses for technicians should be taught by technicians, without suggesting how this could be accomplished. Jarvis *et al.* (2008) however caution that course attendance can have a negative effect because 'before the course, technicians' had a high degree of job satisfaction, but limited career expectations' (p.41) but post course there may be less satisfaction caused by the lack of opportunity to alter their situation. Jarvis *et al.* (2008, p.28) also consider that ‘technicians have gathered their skills and knowledge in an ad-hoc manner over a number of years’ rather than through planned training, and may have more knowledge than many teachers in health and safety matters. The increase of annual appraisals from 30-40% (the Royal Society, 2001) to 75% (ASE, 2010a) should have improved the likelihood of obtaining funding to attend courses however under half of STs thought appraisals were useful.

Jarvis *et al.* (2008) consider that joint training for teachers and technicians might be useful however the needs of these groups are different. The teacher needs to know what they are going to do with a bottle of sodium hydroxide delivered to the laboratory: the technician needs to know: what concentration is needed; what safety labels are needed; how to make up the solution; and how much solution will be needed for each student to determine the quantity required. Sometimes this is a process where support is needed if the method is unclear or unfamiliar. It was suggested that advice could be obtained from:

> [A] science advisor’ [probably meaning the local authority science advisor], 25% could contact an ‘advisory technician’ and a local technician support group but the major source of advice was from CLEAPSS...laboratory manuals, DfE guides the ASE topics in safety and Croner’s Manual for heads of science.
>
> ASE (1994, p.27)

Since this advice was given changes in science support to schools have resulted the loss of local advisors of technical advice and of the opportunity for STs to meet as a group. STs could therefore no longer receive help from these sources.

This section has provided information about the perceptions of a suitable career structure for STs and their training needs. It has shown that there has been insufficient interaction with STs to determine what training and support is needed. Without a structure or career path, training in its present form appears to rely on STs being trained elsewhere before being employed by the school and on technicians being able to meet or communicate with each other in groups as noted by ASE (1994). Without this opportunity STs could be isolated, and the exploration of the way in which STs use their virtual community to replace this loss is one of the aims of this study.

1.3 The work undertaken by the technician

It has been revealed in the previous section that little is known about STs. This section explores the views of those outside the ST profession on the work expected of STs which should be reflected in their job descriptions. This literature will then be compared with the work actually undertaken by STs and with their job descriptions as shown in Chapter Four.

1.3.1 The work expected of STs

CLEAPSS (2009) notes that without adequate job descriptions ST work ‘varies from school to school’ (p.8) without suggesting an answer to this problem. Busher and Blease (2000) note ‘none of the technicians in this study kept to their job descriptions, all of them doing additional work’ (p.100). The Royal Society/ASE (2001) suggested that generic job descriptions should be produced centrally by government in consultation with CLEAPSS, ASE and Unions however there was no mention of any STs being involved.

The Royal Society/ASE (2001) produced a list of tasks that were considered to constitute the work of the technician which are shown in table 1.5 overleaf.

Table 1.5

List of tasks carried out and their frequency			
Task	**% Often**	**% Rarely**	**% Never**
Making up solutions	84.6	11.4	4.0
Assembly of apparatus	88.6	8.8	2.6
Constructing and modifying apparatus	65.5	30.6	3.9
Delivery of equipment to rooms	95.2	3.4	1.5
Collection, checking and return of equipment to stores	96.3	2.3	1.5
Disposal of waste materials	74.6	20.1	5.3
General laboratory cleaning	66.6	25.0	8.4
Cleaning laboratory sinks	58.1	30.2	11.8
Care of laboratory equipment	94.4	3.2	2.5
Routine care of plants and/or animals	63.8	20.5	15.7
Organisation and storage of equipment	93.8	4.7	1.5
Maintaining resources	89.3	6.8	3.9
Carrying out/arranging for maintenance and repair of equipment	77.9	17.8	4.3
Stocktaking of chemicals and/or equipment	81.4	14.5	4.1
Obtaining materials by local purchases	77.5	17.8	4.7
Placing orders, checking deliveries and invoices	73.0	16.8	10.2
Keeping financial records	41.0	20.2	38.8
Trialling practical activities	51.5	35.6	13.0
Assisting in practical classes	27.0	55.0	18.0
Taking an active part in demonstrations	16.7	52.5	30.7
Assisting with field trips	14.6	38.0	47.4
Carrying out risk assessments for yourself	48.3	26.0	25.7
Checking fume cupboards	31.4	23.8	44.7
Safety checks on electrical apparatus	39.1	20.1	40.7
Checking first aid kits	33.2	26.9	39.9
Setting up IT equipment	35.9	35.8	28.3
Setting up AVA equipment	49.8	26.2	24.0
Off-air recording	22.0	18.2	59.8
Photocopying	65.2	20.1	14.6
Laminating, collating, binding	44.7	31.6	23.6
Checking textbooks back in after loan	52.5	25.3	22.2
Repair of textbooks	48.6	33.8	17.6
Providing technical assistance to student teachers	52.6	25.6	21.8
Providing technical assistance to NQTs	50.0	19.8	30.2
Providing technical assistance to students	48.9	33.7	17.3
Providing technical assistance to teachers	62.3	27.0	10.7

Source: The Royal Society (2001, pp.37-38)

This list is both extensive and superficial. For example, ‘making up solutions’ can involve extensive knowledge about safety issues and the list does not differentiate between making up a simple solution of sodium chloride and the knowledge and precautions needed to dilute concentrated sulphuric acid.

Frequency is not a useful parameter as this may depend upon the speciality of the ST who answered the question. For example a specialist chemistry ST may often make up solutions, but this could be a less frequent task for STs working across all areas

The long list of tasks suggests that a broad brush has been used to cover as wide a range as possible because little is known about the detailed work of the technician or the knowledge needed to perform the role effectively. All the subsequent surveys appear to have been based on this table.

Busher and Blease (2000) produced a table (table 1.6) overleaf which shows a selection of tasks and the relative perception of their significance in the technician workload, noting that:

> [However] teachers were more aware of the things done by laboratory technicians that directly affected whether they were adequately prepared and supported to teach the lessons they had planned. Technicians on the other hand emphasised the practical jobs they had to do such as cleaning laboratories, cleaning equipment putting away equipment and consumable resources
>
> Busher and Blease (2000, p.102)

This suggests that even science teachers do not really understand the work of the technician and see it only in terms of their own individual needs.

Table 1.6

The main jobs that technicians do regularly		
Science jobs	**Views of teachers x12**	**Views of technicians x12**
Preparation of equipment and materials for lessons	12	11
Clearing up labs	5	9
Washing up	1	
Putting things away		4
Cleaning equipment		5
Maintenance of equipment	7	8
Making up chemicals		1
In-class support for pupils	1	
Equipment advice to pupils		1
Administrative/clerical work		
Stock and ordering	6	6
Photocopying worksheets and examination articles	8	6
Administration and filing	4	
Computer work	1	
Supervising health and safety in the labs		3
Minor first aid to pupils		1

Source: Busher and Blease (2000, p.103)

On the other hand the list of processes that are expected of STs produced by CLEAPSS (2002) range from:

- knowing how to use an ammeter and a voltmeter to handling radioactive sources (Physics).
- naming equipment to working with bacteria (Biology).
- transferring solutions from stock bottles to smaller bottles to dealing with bromine (Chemistry).

The range and scope of the tasks expected shows the variety of skills expected of STs and the level of knowledge assumed. CLEAPSS (2009) also thought STs supporting students in the classroom was something that ‘schools may want to develop in the future’ (p.7) even though some technicians ‘do not see it as part of their job’. CLEAPSS (2009) do not defend the present role of the ST as needing no ‘developing’ or suggest that STs and TAs are not interchangeable. All STs at any level will from time to time file, photocopy and clean up, but as noted by (Jarvis *et al,* (2008, p.36) their job is 'providing appropriate learning resources for staff and students'.

1.3.2 The unseen work of STs

STs also undertake tasks which are expected but unacknowledged and as such are hidden from view including their role in balancing the budget and demonstrating experiments to teachers. Sometimes the need for the task is acknowledged but the extent of the participation of the technician is not revealed. 'Keeping financial records', for example, could mean being responsible for the whole budget although the head of department signs the paperwork, while 'providing technical assistance' could include demonstrating and explaining how an experiment works or providing health and safety information. Examples from the literature are shown in this section.

The Royal Society/ASE (2001) asked technicians if they demonstrated aspects of science to others. The results are shown in table 1.7.

Table 1.7

Demonstration of experiments and/or general science techniques			
	Teaching staff	**students**	**Other technicians**
Technicians	37.4%	38.1%	32.3%
Senior technicians	56.5%	38.1%	49.5%

Source: The Royal Society (2001, pp.40-41)

Only percentages were given in the source

The greatest numbers of demonstrations were general equipment (10.7%) and microbiology techniques (6.5%). Jarvis *et al.* (2008) noted that STs also support teachers when the teacher is working outside their specialism. The

Royal Society/ASE (2001, p.16) suggested ‘the better trained the technicians are, the better support and advice they will be able to offer science teachers’. This misses the point that STs already give advice: and whilst they noted that STs reported ‘that their role had developed to require high level skills’ they did not question where these skills came from.

ASE (2010a, p.15) note an increase in the work of STs in areas such as:

- Stocktaking (41% - 73%)
- Budgeting (81%-97%)
- IT equipment (in the form of datalogging equipment) (36%-85%)
- Class demonstrations
- Helping in the laboratory with practical work - where it is noted that ‘this type of work is sometimes done by Higher Level Teaching Assistants who often earn more than technicians and have higher status within the education hierarchy’

Busher and Blease (2000, p.103) consider that many of the jobs listed are ‘quasi domestic work’ and ‘the job of laboratory technician has been shaped by predominantly male teachers to fit socially stereotypical views of female roles’. However others suggest that shaping may more easily be associated with the status of the work (Barley and Bechky, 1994; Lewis and Gospel, 2011) which seems more likely as experience suggests that there are more female than male science teachers in schools.

It can be seen from these lists and the comments that have been made that the work of STs is wide ranging and that STs undertake many more tasks than might be expected. The visible part of their work, the delivery practical materials to the laboratories which is safe and appropriate for the students, is the culmination of their work and appears easy because, the difficult, complicated or dangerous work remains for the most part, unseen.

1.3.3 The management of technicians

Part of the problem of the lack of understanding of the role of STs is that ‘science technicians perform most of their duties without any direct supervision’ CLEAPSS (2009, p.39). They suggest this is because ‘teachers are too busy to spend enough time in prep rooms to supervise a technician’s work’ not because the work of STs is skilled and professional in its own right and cannot be supervised by teachers. The Royal Society/ASE (2001) note role confusion has resulted in technicians being line-managed by a diverse range of staff, suggesting that ‘whilst they [STs] are greatly valued within the science department, there is a perception that senior management does not understand the job of a science technician and consequently does not value it’ (p.16). STs thought their role was not understood by management. This affects ST pay and working conditions and although ASE (1994, p.27) considered that STs were ‘effectively part of the decision making structure of the school or college’ STs stated that outside the science department their work is unknown and they are seen as ‘washers up’ or ‘helpers’ to the science department.

1.3.4 The role of the technician in the advancement of science in schools

Although STs are described as ‘an invaluable asset’ (ASE, 1994) and as ‘supporting success’ (The Royal Society/ASE, 2002) neither expands upon this point. Although the obvious work of the ST is to prepare and deliver materials to the laboratory so that practical work can be undertaken the work of the ST involves much more. One object of this study is to provide information so that their role in the advancement of science in schools can be seen. At this point therefore it is useful to consider what is revealed by the literature.

The Royal Society/ASE (2002) note that:

> without adequate numbers of technicians in schools and colleges the learning experiences of students will be impaired, raising levels of achievement will be made much more difficult
>
> The Royal Society/ASE (2002, p. 11)

suggesting that STs are needed to advance science.

Tables 1.5 and 1.6 indicated the jobs that are thought to be undertaken by technicians. Some of these are peripheral to the provision of practical material and indicate other areas needed for the advancement of science. These include the checking, constructing, modifying and trialling of experiments which is important as experiments that do not work will not enthuse students and may make science less attractive. Both tables noted the role of ST in ordering which will ensure stocks of chemicals and apparatus are sufficient for the needs of the students allowing the 'hands on' approach favoured by SCOPE (2008). Table 1.5 shows over 50% of STs provided technical assistance to students, student teachers, NVQs and teachers which would aid learning, of students and teachers, Table 1.6 only mentions advice to students. Health and safety issues are not mentioned in table 1.5, although the Royal Society/ASE (2002, p.17) consider that 'safety in school and college laboratories would be compromised' without the help of STs. Table 1.6 suggests technicians should be involved in supervising health and safety in the laboratories. Teachers should be in charge of health and safety in the laboratory and this should be part of their risk assessment.

Other tasks were also included such as photocopying; such administrative tasks may advance science by making sure that paperwork needed is provided. It would appear therefore that the literature reveals that the work of STs is expected to include a range of tasks to advance science. Chapters

Four - Seven contain information that shows the wide range of tasks undertaken by STs which advance science.

1.4 Conclusion

The literature reveals that teachers and employers of scientists are most aware of the value of STs and researchers are the least likely to mention the need for technicians.

The surveys show a recurring call for urgent attention to be paid to the need for a career structure, job descriptions and a proper training programme for technicians and that ST work in schools is no longer attracting younger applicants. However the length of time covered by the surveys suggests that previous comments have not been acted upon. Surveys also showed that changes, such as reduction of hours, have not caused problems because technicians have worked extra hours that may be unpaid to ensure practical work is unaffected.

The investigation of STs has been relatively superficial and has not fully explored the range of work undertaken by the technician. Without a voice of their own, STs are vulnerable because they have to depend on others who have little understanding of their work to support and protect them.

The next chapter contains literature relating to other influences on STs including, remodelling, the SSA and the effect PFI building on STs and literature relating to communities of practice, marginalisation and gender.

Chapter 2: Whole school changes that have affected science technicians, marginalisation, gender and communities of practice

Chapter One reviewed literature which showed that practical work is an important aspect of science teaching. Despite this, it was shown that research on the role of STs is limited. Moreover, the little literature available shows a narrow understanding of the nature of the work of the ST. This chapter considers other areas where STs are affected by a lack of knowledge about their work.

STs are affected by a lack of communication which could be the result of STs being a marginalised group within the school. Information is included about aspects of marginalisation which can then be related to the authentic voice of STs to consider whether STs are marginalised. As the majority of STs are female aspects of gender are also noted in this section. Finally some characteristics of 'communities of practice' (CoP) and communities of practice on the internet (VCoP) are described. This information will be used together with evidence about the way STs use their websites to determine whether STs belong in either of these categories: or to a newer and different type of internet community, an Electronic Network of Practice (ENoT).

2.1 Science technicians and the changes to school support staff

This first section concerns areas which have affected STs as members of the school support staff: the Single Status Agreement (SSA); remodelling, and the new science facilities built under the private finance initiative (PFI) which is workplace of STs.

2.1.1 The Effect of the introduction of the ‘single status’ agreement

The ‘single status’ agreement (SSA) integrates all local government workers onto one pay scale and unifies work agreements: all school support staff employed by the local council, plus staff working for academies using local council pay scales are included. Started in 1997, the process has still not been completed (2014). The aim is to clarify the work expected at each pay grade, and ensure that schools use the correct grade for the work expected from their support staff.

The agreement has two sections. The first contains general conditions such as holiday entitlement and sick leave. The second is a set of job families into which specific jobs are slotted. This works well for clerical work where an obvious fit could be made, other jobs were more difficult to categorise. I was involved in a union capacity at the early stages of the process (2001-2) but my work in this area was curtailed by other duties concerning the local change from a three (lower, middle, upper) to two (primary, secondary) tier school system. I sat on a committee overseeing the change as a union representative and was involved with the practical changeover process and in the provision of advice to all staff at the school where I worked at the time, which took precedence.

Ned Hay founded The Hay Group in 1943 and over 100 County Councils used the Hay Group Method for evaluation, over 30 using it for all roles. The process analyses jobs, fitting them into groups, and aligning them with pay. The Hay Group (2005) suggests that it is used for roles where levels can be evaluated against factors such as the number of staff supervised and is useful for office work but is not necessarily suitable elsewhere. Northamptonshire County Council (NCC) (2010) is mainly used to illustrate the process as I have personal knowledge of their process however communications suggest that the process was also used in other counties.

The Hay method is useful for evaluating school administrative tasks but is less useful for other work. STs who work at a higher level but only supervise a few or no other staff are disadvantaged by Hay as supervising the correct number of people is mandatory to reach the higher levels. This study provides information concerning the ST and their work that could be used to ensure they are correctly graded in any future evaluation.

As summarised in table 2.1 overleaf Derbyshire County Council (DCC), (2010a; 2010b) provided a detailed guide to the process they used for their evaluation: NCC (2009) website only gave a summary of the process they adopted and the job family groups that they used for school support staff. NCC (2009) divided secondary school support staff into three job families: administrative (office support); teaching assistants (supporting teachers and pupils), and curriculum and resource support (all other support staff). Only headteachers were consulted about the roles of support staff in each family: specific jobs were only analysed if headteachers considered that it was not a close match.

Table 2.1

The categories used by the Hay method and by DCC: and those used by NCC	
Hay and Derbyshire County Council, 2010a) categories	Support staff categories (Northamptonshire County Council, 2009*)*
Know how Problem solving Accountability Additional work/working elements	Working in the environment Working with people Working with resources Working with information Knowledge, skills and experience Additional work elements

Butt and Lance (2005) noted that there is little understanding of the roles undertaken by classroom based support staff in schools. This also applies to STs. Hay states that the job must be understood when using this method, but as noted in Chapter One, there is little known about the work of STs: Job families were further divided however:

- five *groups* each with clearly defined tasks were used for administrative workers
- four *levels* with no clear definition of tasks at each level and only examples of workers in each family were used for the other groups

Suggesting there was less understanding of the work of those in the second group.

The cost of regrading may have also affected the outcomes: Johnson *et al.* (2004, p. 59) commented that 'schools have not been able to fund the level of upward regrading that might have been possible in a situation of greater financial flexibility'.

Although the complexity of teaching assistant (TA) and curriculum and resource jobs suggests that both families merit study, this study concerns STs therefore the rest of this section will concentrate on their job family, curriculum and resource, which includes everyone who does not fit into the other groups. This group contains a wide range of support staff; the generalised descriptions are less substantial than in the administrative group, and areas including invigilating and marking tests are included which are not usually a part of their work.

Their main work is often to prepare and deliver materials for practical work. Delivery of lesson material is included, but could mean delivery of the lesson, not the materials needed. Demonstration and assistance is also included, although only level 3 staff or above should give advice to non-specialist teachers (such as explaining chemistry to a physicist) in this group and the grading process could mean that no one is employed at this level in science. The group is also expected to run, or be present, at after school clubs. As noted in Chapter One ST contracts may only cover the school day therefore STs would not be available for extended activities. Terms such as ‘demonstrable’, ‘proven’, ‘significant’ and ‘substantial’ were not defined, so were difficult to challenge for individual jobs. Many support staff had salaries reduced: some by substantial amounts (personal communications). The process has therefore been disappointing for groups where the work has been insufficiently understood for successful application of Hay. Johnson *et al*., (2004) only looked at mapping qualification and career progression, but suggested support staff may become disheartened as a result of the process. Howes (2003, p.152) noted that ‘unwelcome changes alter the equilibrium of teams, making teamworking harder to maintain in complex situations such as education’. Support staff could be unwilling to engage as before especially if the areas were not included in their new grade, or they had worked unpaid extra hours to support the aspirations of the team. As a union representative and a supporter of support staff during the months following the receipt of the new pay scales I noticed that the process created disharmony because of a lack of understanding by teaching staff of the trauma it had caused. The thoughts of science technicians concerning the implementation of SSA are noted in Chapter Seven.

The roles of support staff have also been altered by both the previous Labour government and the present coalition government's remodelling and modernisation agenda. Remodelling of the school workforce also challenges the dynamics between teachers and support staff.

2.1.2 The effect of the remodelling of support staff on technicians

As seen in Chapter One the work of the science technician is poorly understood, therefore the major changes of remodelling, the 25 tasks (Blatchford *et al.*, 2006, 2007, 2008, 2009) which have been transferred to support staff may be thought to have little impact on STs, but some do affect technicians. The aim of remodelling, raising standards and reducing the workload of teachers (DfES, 2003f; Bach *et al.,* 2006), was approved by most teacher unions, the NUT did not sign the agreement. Reasons for the change included reducing the time teachers spent on non-teaching tasks ('the 25 tasks'), removing excessive paperwork, and reforming the way support staff help teachers and support students. Whilst Butt and Lance (2005, p.139) suggest that 'a rise in the quality of the labour force suggests that responsibilities of the worker should be reappraised and employers should encourage a shift in the type of work they undertake', Hutchings *et al.* (2009) note:

> Interviews with heads and senior staff responsible for support staff performance review suggested that recent developments in roles and training had encouraged many individuals... to have expectations about progression and pay that would be impossible to fulfil
>
> Hutchings *et al.* (2009, p.2)

Suggesting support staff would not receive increased pay for their new roles.

The theory was that it would 'free teachers to teach' ensuring increased value for money. Teachers would spend more time teaching and less time undertaking tasks that could be carried out by lower paid support staff (Reid, 2003). Carter (2012, p.484) considers that ‘the state needs to convert the purchased ‘labour power’ of teachers into realized labour’. So whilst the work of the teacher may not be being deskilled as described by Braverman (1974): remodelling is being used to ensure that teachers spend more time teaching.

Allowing unqualified staff to do most of the teaching and employing qualified teachers only for tasks such as planning and assessment or when expert teaching was needed would reduce costs (Hammersley-Fletcher and Lowe, 2006; Bach *et al.,* 2006). Teamwork is emphasised ‘Teaching is increasingly becoming a team game’ (DfES, 2002c, p.15) and the teacher is likened to a consultant surgeon. This approach includes STs but ignores their professional role; ST comments on the possibility of teaching are noted in Chapters Four and Seven. The Labour government suggested there would be increased recognition of the contribution of support staff with access to ‘expanded roles and improved choices and career opportunities’. DfES (2003f, p.3) considered the reallocation of the 25 ‘non-essential’ tasks have ‘professionalised’ support staff but Carter (2012) reported the NUT objected to TAs taking whole classes, as it undermined the professional nature of teaching. STs are already professionals even if this is not recognised, but are affected as members of the school support staff by school wide changes such as remodelling.

In science where the co-operation of staff is necessary STs need to feel part of the team. Howes (2003) considers that the work undertaken by support staff is not being acknowledged. The impact of support staff is not well understood and because of this they are not considered to be germane to the process of teaching and learning (Howes, 2003; Bach *et al.* 2006). Yet the reform process expects blurring of the demarcations between teachers and support staff. A whole school approach has been suggested with combined training for support and teaching staff (DfES, 2002a) which assumes all school staff need the same training. As seen in Chapter One

STs have a specialist role and need targeted training. Carter (2012, p.490) commented that teachers have been made to work harder whilst 'TAs and LAs swan around and make toast' suggesting there is conflict between support staff; who are considered to be exuding an air of superiority; and teachers who feel they are working harder than ever. Hutchings *et al.* (2009) report that headteachers considered support staff had more work, but no more time, increasing their stress levels. Neither group appears content with the change in dynamics between teaching and support staff. Howes (2003) commented:

> it is hard to avoid the conclusion that a deficit model of support staff is embedded within the agreement and one that is associated with a teacher centred view of the education process
>
> Howes (2003, p.149)

suggesting that impact will be greatest only when 'support staff are viewed as valued members of the school's staff team'.

STs have also been affected by PFI programmes which have rebuilt or refurbished science accommodation.

2.1.3 The effect of the Private Finance Initiative (PFI) building programme on STs

Schools that were not rebuilt as academies were part of a PFI scheme under which public buildings have been built or refurbished since 1997 (Fitz and Hafid, 2007). For many departments the buildings were straightforward, for science the structure was more complicated. DfES (2004) suggested desirable factors for science departments included: a maximum frequency use of 85% for laboratories 'because of the complexity of the timetable and the need for technicians to service the laboratories' (p.5); sixth form laboratories; greenhouses, and separate areas for microbiological preparation. Several possible designs were presented (p.8/9). Some place the prep room in the centre of the building: acknowledging this means no daylight, view out, or window, forgetting that this will be where STs spend most of their time. Others place prep rooms between laboratories. STs would therefore be disturbing classes when entering or leaving the prep room during lesson time. ST comments on the suitability of the new prep rooms will show how PFI has affected the working conditions of STs.

Reform changes have concentrated on classroom based support staff and STs have been overlooked because their role is different. Without a means of communication their position is vulnerable to adverse changes and their lack of influence can affect their working conditions. Lack of communication between sections of workers can be a result of marginalisation. The next section of this chapter considers marginalisation and relates this to the role of STs.

2.2 Marginalisation and the science technician

In section 2.1 details have been given concerning some changes that have affected STs as part of the school support staff. The views of Howes (2003) and Bach (2006) suggest that there is a lack of understanding about the role of support staff which therefore applies to STs. Howes (2003) considers that support staff are peripheral whilst teaching staff hold a central position and the comment by Carter (2012) indicates a degree of animosity exists between them. Section 2.1 has also shown there is a lack of communication with STs. It is possible that the way in which STs will be affected by the global changes proposed to support staff has not been recognised because STs are marginalised, whether this by accidental or design. Information on marginalisation will be used to identify areas where comments in Chapter One and in the findings chapters may show whether STs are a marginalised group.

2.2.1The concept of marginalisation

A search for literature using the university database Northampton Electronic Library Search ONline (NELSON) using ‘marginalisation’ produced a considerable number of articles. Refinement of the search title to ‘marginalisation of staff’ reduced the figure and revealed articles that provided general information (Simmonds *et al.,* 2014; Gleeson and Shain, 1999; Messiou, (2006). ‘Marginalisation of school staff’ further reduced the figure and although most articles related to teaching staff, one, (Bailey, 2000) included material that could also be related to STs, even though they were not the subject. Searching using ‘marginalisation in school support staff’ revealed no suitable articles: these typically concerned the effect of support staff on marginalised students; or teachers who supported in specific areas such as music. A general internet search produced useful general information concerning marginalisation and searching via google scholar using ‘marginalisation and school staff’ revealed another article (Smith, 2004) which concerned school nurses but proved useful because the work of the school nurse and that of the ST had many characteristics in common. Articles referenced by Smith (2004) were also relevant.

Marginalisation has been described in many ways, but does not appear to have a fixed definition. Whilst Boychuk Duchscher and Cowin (2000, p.289) consider ‘the concept of marginality has been used since the 1920s to describe ‘the experience of living between two cultures that have asymmetrical; power or living between two levels in a hierarchy’. Bailey (2000, p.144) described it as ‘an ambiguous and at times vague term’, Jenson (2000, p1) suggested ‘marginalisation is not one thing, not just one status’, and Danaher *et al.* (2013, p.3) suggests it ‘assumes many forms and has multiple causes and effects’. Specific definitions were however used for particular studies: Harsløf, (2002) considered that the significant feature was placement and all definitions ultimately subscribed ‘to the underlying notion of a social space with a centre and a periphery’ (p.7); Hall *et al.* (1994)

suggested peripheral status was caused by factors such as their location and the way they were perceived by others, and Broussard (2007) considered that marginalisation resulted in ‘a lack of a sense of belonging’ (p.323).

It would appear therefore that marginalisation can be used for many different situations and can take on many forms, although the overarching theme is the power of one group over another. This makes marginalisation more difficult to detect and less likely that ‘marginalisation’ would be the term in general use, therefore recognition would have to rely on other terms being used such as ‘distanced’ or ‘not consulted’.

When describing the marginalised, Jenson (2000, p.1) included ‘the unemployed, single mothers, the poor, the homeless, disability and discrimination’ amongst a list of examples of marginalised groups. The concentration on these groups is useful and necessary as they face problems on a grand scale, a large number of people are affected, and the groupings provide a foundation for looking at the issues that surround them, However it also has a negative aspect because it marginalises other groups that should also be included as they are also outsiders but are fewer in number and their needs are on a small scale. One of the problems noted by Smith (2004) is that because groups are marginalised they become invisible. This invisibility is also noted by Reggiori (2008), a science technician, who suggested that ‘support staff are invisible…nobody really seems to know (or care?) what technicians actually do’ (p.31) and Moore (2011, p.12) notes that ‘In my efforts to avoid participating I attempted to become invisible’. Perhaps in the case of STs lack of opportunity to participate leads to invisibility and vice versa. Smith (2004) recognises a lack of research in the area of school nursing and marginalisation. This is also a problem for STs.

For Jenson (2000, p.11) ‘social exclusion means to be shut out, fully or partially from any of the social, economic, political and cultural systems which determine the social integration of a person in society' and Bailey (2000, p.114) considered that marginalisation 'always occurred in a social context' and 'with respect to a particular group'. STs work in a school; which could be considered a microcosm of society; where, as shown in Chapter One, little is known about them or their daily life. This could be the result of STs being marginalised: or it could be because of the nature of their work. The information revealed in the findings chapters should make it possible to discover factors which would determine whether or not STs are marginalised in their workplace.

2.2.2 Factors that indicate marginalisation

This section will suggest some general factors that could be used to reveal whether STs are a marginalised group.

Harsløf, (2002) considered integration was another way of judging marginalisation and workers moved towards the centre by being employed, that is they became less marginalised and more integrated. This working paper concerned temporary employment but contained features that could relate to STs. Harsløf, (2002) on the subject of hours worked acknowledged that not all employees want to work full time, but considered that employees who would like more hours, but have not been able to secure these are less integrated than those who have the hours they wish. STs are usually appointed as permanent staff but have a range of hours as noted in Chapter One. Harsløf, (2002) also noted 'the issue of whether the employees are receiving training as part of their job will be regarded as an important indication of integration' (p17) suggesting it indicated investment in the employee. The degree of integration of STs can be shown in the findings and the literature by considering whether they are given the number of hours needed to do their job and whether or not they have training opportunities.

Messiou (2006) considers that although others may be aware of it, marginalisation may not always be recognised by an outsider or outsider group, and conversely, an outsider may feel they are being marginalised, but others may not see it. Taket *et al.* (2009) suggest one of the criterion upon which marginalisation can be established is if the person would like to join in but is not given the opportunity also adding that not all outsiders may be affected equally by this issue. Bailey (2000), continues this point, stating 'the impact of marginalisation is more severe for some people than others' (p.113), and although outsiders may feel 'powerless…there can be considerable variation' (p.114) and may only arise 'with respect to particular circumstances' or is 'issue specific' (p.115). It is therefore important to find out not only if the group or person is potentially being marginalised, but if, how much, and when they regard this as an issue.

The findings will show: whether STs are allowed to join in if they want to do so; if STs feel they are being excluded from areas in which they would like to be involved; what issues make STs feel marginalised, and whether they feel that this is important.

Bailey (2000) notes that 'teachers can be marginalised by the control and process of mandatory change … [which] can have lasting and negative results' (p.115). This chapter contains details of some changes that have been made to the whole of support staff (section 2.1). Bailey (2000) cautions that:

> it is impossible for change mandated by someone other than those who are to effect the change to take into consideration either teachers working conditions or their core values
>
> Bailey (2000, p.116)

which also applies to changes made that affect STs. Messiou (2006) comments that if they are included in the process, the voices of the marginalised should be more prominent.

The results on STs of the changes shown in section 2.1 are revealed by the voices of the STs in the findings. These can be used to consider whether the process has been undertaken in a way that marginalises STs.

Another effect of marginalisation noted by Simmons *et al*. (2014) was that it is 'creating a workforce that is suited the demands of employers' (n.p.), Bailey (2000, p.116) thought 'teachers will be less willing to collaborate' p.116). Taket *et al.* (2009) considered that social exclusion which is characterised by 'marginalisation silencing, rejecting and isolating' reduced participation' (p.3) and is the opposite of social acceptance which meant 'acceptance, opportunity and justice' (p.4.)

The extent to which technicians no longer wish to collaborate will show whether they feel marginalised in this area.

However these are general areas and as has been seen in Chapter One, little is known about STs or their work. STs work in a small group or work alone and are therefore a tiny minority or a lone person in the school workforce. This automatically makes their voice hard to hear and because of this it could be suggested that technicians are voluntarily excluding themselves rather than it being a result of their jobs and status within the school community.

The only other group I have found in a similar position: that is they work in a school, and have limited contact with other staff that have been studied as a marginalised group are school nurses (Smith, 2004). In the next section aspects of marginalisation of school nurses described in this paper that may also affect STs are noted. These, together with material from the findings, can be used to decide if STs are a marginalised group.

2.2.3 The marginalisation of school nurses as a tool for examining the marginalisation of STs

Smith (2004, p.311) suggests ‘school nursing is a unique school speciality’: as is the role of STs. Smith (2004) considers ‘School nurses stand astride the professions of nursing and education’; STs stand astride the profession of science technician and education. Smith also considers:

> as a result of practicing across two frequently differing paradigms, school nurses may feel isolated, distant and marginalised from the educational community in which they practice
>
> Smith (2004, p.311)

adding that their professional role is not valued and that ‘most principles and administrators are unaware of the complex role of the school nurse’ (p.315). The lack of value of STs may be considered the reason why little is known about them. This and other aspects will be revealed by the comments of STs. Smith (2004) suggests that nurses have to recognise that they are marginalised before they can attempt to change this position. Technicians may realise they are ‘invisible’, as noted, but may not consider that this is because they are marginalised.

Smith (2004) suggests the school nurse is marginalised by boundaries that are either established or implied resulting in the nurse remaining on the periphery and being unable to fully participate in the school community. Physical boundaries were also mentioned as the school nurse was often given the smallest space available. Boundaries exist for STs, for example as noted in Chapter One their working life means they are busy when other staff are free, isolating them from activities in which other staff can participate at both formal (staff meetings) and informal (coffee breaks) levels. They may not be given the smallest space, but are isolated because science is usually located away from other rooms, at the ends of corridors, on top floors, or in separate buildings, partly for safety reasons. Jenson (2000) noted that these aspects are features of marginalisation, but in the case of STs are also caused by their work.

Smith (2004) considers that some aspects that marginalise could have positive aspects. For example differentiation has been used as a definition of marginalisation as the separating out a specific group can result in its marginalisation. STs are readily recognisable by their white coats, which could therefore be isolating, but it could also act as a recognition point which would enhance their visibility. 'The level of ability to access resources' (p.312) is also regarded as marginalising. STs can have considerable departmental budget responsibilities, although the central management of this may be an issue and reveal marginalisation.

Smith (2004 p.313) notes that 'discounting behaviors' which included 'being ignored, blamed, excluded, stigmatised, and made invisible' and 'discounting structures' such as 'lack of administrative support, inadequate resources and ambiguous role expectations' had been observed in other fields of nursing specialities and could be applied to school nurses: also noting 'misconceptions of administrators and other educational personnel about the role of the school nurse regarding them as the 'band-aid lady'. STs have many jobs listed in Chapter One, some of which suggest that they are the "washers-up and cleaners" of science. Other factors, such as the 'school nurses' inability to define their role', that nurses felt their role was undervalued, that it was not understood by others in the school and nurses thought they were powerless 'even though they did have access to the people in power' (p.323), were also considered situations that led to marginalisation. The comments of technicians noted in the findings chapters can be used to show the extent to which these factors also affect STs.

Smith (2004, p.314) suggests strategies to overcome marginalisation by making nurses more visible, some of which such as 'scheduling break times to spend with other colleagues' (p.315) would be unsuitable for STs. Evidence for the use of other suggestions such as 'presenting school health issues (health and safety) at faculty meetings' (p.314) or 'offering to provide classroom presentations' may be seen in the comments by STs.

Smith (2004) also suggests 'meeting with teachers and administrators to discuss the goals for the school nurse and health services for the coming year' (p.315) including their role and responsibilities. Professional reviews as noted in Chapter One could serve a similar purpose and views of STs in this area may suggest whether this is a useful way of extending understanding of the ST and their role.

References used by Smith (2004) contained other ideas that could relate to STs, for example Broussard (2007) notes that 'school nurses were not required to hold a degree … consequently the school nurses believed that teachers did not view them as professionals' (p.323). Although Chapter One shows that many STs are qualified to degree level STs are not required to hold a degree so could also be affected by such views. Schneiderman (2004) commented that nurses were considered to not integrate with others. Lack of opportunity to mix with the rest of the school could make other staff think that STs were also only interested in their own job.

One other area that was discovered by chance was in an article concerning insider-outsider research (Durand Thomas *et al.,* 2000) where the ways nurses ‘coped with challenges … [and] ‘made meaning of their work’ (p.821) was noted. These two quotes:

> Nurses took pride in their ability to manage the challenges, feeling that many who stigmatised them would not themselves be able to work in the setting and that not just anyone could be a state hospital nurse (p.821)
>
> and
>
> Nurses constructed personal meanings about their work … often involving the impact they believed they had (p.822)
>
> Durand Thomas *et al.* (2000)

have resonance with the work of STs. Nurses are part of the medical team but rarely have equal status with doctors, STs are part of the science team, but rarely considered equal to teachers so a comparison could be useful.

This section has discussed marginalisation and considered aspects that may affect the ST in their working life. The material from the literature in Chapter One and results of the finding can be used to show if and to what extent the STs are a marginalised group within schools.

Smith (2004, p.315) suggests ‘joining your professional organisation’, as a way of alleviating loneliness and isolation because involvement ‘also provides increased educational opportunities [and] resources’. Mentoring is also suggested. STs have a virtual community within which they connect with other STs. The next section considers the status of their websites and provides information that will be used to determine if their websites are communities of practice.

2.3 Communities of practice and the virtual community of the ST professional websites

This section focuses on the nature of a 'Community of Practice' (CoP) to show what factors would be needed for the ST websites to be regarded as a CoP, a virtual CoP (VCoP) or a variation of the VCoP. The material in the findings chapters can then be used to evaluate whether the observed use of the websites fits any of the categories. A variety of sources obtained via NELSON, google scholar and the internet were used for this section

2.3.1 The nature of a community of practice

It has been suggested that CoPs have been around since ancient times (Wenger *et al*., 2002, Wenger-Trayner, 2015). However Wenger (1998, 1999, 2000) crystallised this process, naming it 'communities of practice' (CoP). Wenger (1998), initially associated CoP with the learning processes experienced by apprentices during their apprenticeships, adding:

> Our institutions are largely based on the assumption that learning is an individual process, that is it has a beginning and end, that it is best separated from the rest of our activities and that is a result of our teaching
>
> Wenger (1998, p. 3)

considering learning involved 'a more encompassing process of being active participants in the practice of social communication' (p. 4). CoP was regarded as 'a general term that can encompass a range of activities at home, at work at school, in our hobbies' (p. 6), and could include both theoretical and practical elements.

Elaborating, Wenger *et al.* (2002) described CoPs as a group with a problem or interest brought together to pool knowledge, suggesting that the need decided the longevity of the group. Bates (2014) suggested, most CoPs are spontaneous and transitory. However Wenger-Trayner (2015, n.p.) considered ‘Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly.’ indicating that groups are no longer regarded as informal. The ST sites are permanent and interaction is regular.

Wenger-Trayner (2015) added that ‘the concept [of CoP] has been adopted most readily by people in business because of the recognition that knowledge is a critical asset that needs to be managed strategically’. Kimble *et al.* (2001) had already suggested a planned structure was needed, as did any evolution of the CoP. Although for Wenger (1998, p.6) ‘workers organise their lives’ producing a design that suits them, Wenger-Trayner (2015) argue ‘some communities do self-organize and are very effective, but most communities need some cultivation to be sure the members get high value for their time’. On the other hand Kimble *et al.* (2001) suggested that ‘high value’ may be the outcome required by the company. Continuing the business theme, Kimble et al. (2001) suggested structure was needed because of changes caused by ‘outsourcing and smaller staffing levels’, adding that it [CoP] can ‘evolve from informal contact, to official grouping, to become the way members interact and work together’ (p225) and that groups could be linked in a chain or net. CoPs may have become more prescribed over time and internal to companies; rather than a way of extending knowledge to interested parties; and planned to be efficient in producing results. Zarb (2006) considers ‘many modern organisations depend on the effective deployment and continuous enhancement of the knowledge base to maintain a competitive edge’ (p.35). This suggests that CoPs are being regarded as a company tool. The ST sites do not belong to a company.

Wenger (1998) thought that CoP ‘sustains the processors ability to do their work’ and that ‘they [participants] are aware of their interdependence in making the job possible and the atmosphere pleasant’ (p.47).but Wenger *et al*. (2002) suggested the management of the knowledge generated needed to become more organised and evidence of learning and of expertise had to be demonstrated for it to be considered a CoP. A model with novices at the periphery and experts at the centre with the novices gaining knowledge as they work their way towards the central point, (centripetal movement) would support this idea. On this journey novices acquire ‘hard knowledge’; which ‘can be ‘structured, articulated and captured, can be: copied, codified and stored’ (Kimble *et al.*, 2001, p.221); and ‘soft knowledge’, which is ‘implicit and not easily articulated and divided into a product of social activity, and, internalised domain knowledge (skill expertise and experience which have become second nature)’ p220). Wubbels (2007) suggests that this movement from the outer position to the central position is ‘one of the most exciting ideas related to communities of practice’ (p. 226) however this implies that the process is not about gaining individual knowledge but learning how specific CoPs work and how to work effectively within them. Kimble *et al.* (2001, p.220) note that ‘soft knowledge is embodied in the day-to-day working practice in communities’ and ‘cannot be codified as hard knowledge and is retained as confidence in other members of the community’ (p223). CoP works by creating community ‘rules’ which novices learn in order to be able to participate, and in which experts are defined by approval of their contributions and competence.

The communities considered so far have been terrestrial and Wenger-Trayner (2015, n.p.) describe this type of CoP as having three elements:

- group with joint interests and therefore a ‘commitment’ and ‘shared competence’
- they must do things together, learning and building a reputation in the community
- they share and develop resources so that knowledge is dispersed

The findings chapters will show the extent to which ST communities fit these ideals; however an obstacle to their identification as a CoP is that ST sites are virtual and Wenger (1998) suggests that face-to-face meetings are needed to develop and maintain groups as CoPs even if members work apart at other times. The question is therefore can a web based setting work as a CoP?

2.3.2 CoP on the web as a VCoP

There are mixed feelings about CoP moving successfully to VCoP for example Zarb (2006) considers that physical meetings can increase participation and that 'the communities concerned may not have succeeded in generating the characteristics of a CoP in a solely virtual domain' (p. 10) adding that 'the key underlying characteristic of a CoP remains the interaction created by participation and the strength of learning relationships within it' (p. 11). Kimble *et al.*, (2001) wondered:

> how can participation be facilitated?, how does a group get set up and given a common sense of purpose? evolve from a need which is driven by members? Get a strong feeling of identity? Have its own terminology?'
>
> Kimble *et al.*, (2001, p.224)

and considered that it might be harder to be accepted as CoPs. These important questions assume that VCoPs will follow the same structure as terrestrial CoPs and would not develop independently. Zarb (2006) for example notes that in VCoP sometimes rival firms offer support to each other whereas this does not appear to be an expected, or necessarily welcome, outcome of CoP. For Zarb (2006) VCoP must be 'independent of specific organisations and also geographically dispersed' (p.11/12) The example sites chosen for study by Zarb (2006) use questions and answers, but appear to have developed under the same principle of 'expert' and 'novice' with appraisal of answers. Wenger *et al*., (2002) suggest that groups need leaders.

Engeström, (2007) suggested CoP, with the use of the apprentice/expert model by Wenger meant that '[CoP] is a fairly well banded local entity with clear boundaries and membership critera' (p19). On the other hand Gannon-Leary and Fontainha (2007) consider VCoP 'is a network of individuals who share a domain of interest about which they communicate online' (p.1) which is similar to CoP as described by Wenger-Trayner (2015). Gannon-Leary and Fontainha (2007) suggest that 'it is more likely that its [VCoP] main purpose is to increase the knowledge of participants', it 'shares resources (for example experiences, problems and solutions)' (p.2) and includes 'news and advice of academic interest' which increases the knowledge pool, but consider VCoP learning is more casual and members are less likely to undertake joint projects which are regarded as 'distributed research centre(s)'. The extent to which this occurs on ST websites can be seen in the findings chapters. Gannon-Leary and Fontainha (2007) consider that VCoPs will still have a hierarchical structure with experts and novices and that there must be goal setting via 'leadership which becomes more important as membership widens' (p. 6) because 'neo-apprentices in virtual CoPs may be wary of contributing because they feel what they have to say is not sufficiently worthy or weighty' (p. 6) suggesting that the VCoP will mimic the terrestrial CoP. On the other hand Fox (2005) compares the present use of the internet to that previously enjoyed by newspapers where 'clocked time and mapped space' (p.103) allows 'readers 'to be informed of different happenings in parallel with no links except that they are all news on the day in question. The regular reader is kept abreast of multiple threads' (p.103). He suggests that readers on virtual sites will have the same access experience and the same sense of belonging.

Fox also notes that the internet is not so easily controlled which could affect the use of traditional CoP where the need for structure is emphasised. Less rigidity could lead to a more fluid approach and therefore a new title is needed for VCoP which is not merely the result of company sections being more distant as noted by Kimble *et al.* (2001). Wubbels (2007) 'considers that CoP is possible because 'participants exchange their knowledge with each other and further their insights together' (p.228) but adds 'I doubt, however, if a situation of beginning teachers seeking help from Internet resources aligns with what Lave and Wenger meant by the community of practice metaphor'.(p. 229). Perhaps with CoP in mind, Zarb (2006) mentions the possible use of emoticons as 'a certain degree of emotion must be shared by the community' (p.34). These are available on ST site B but not on site A as the platform does not support them. Zarb (2006) also thinks that the value of knowledge stored makes it less likely that it will be shared however Pan *et al.* (2014) consider that the interaction that takes place in VCoP is a sharing process, unlike the expert to novice process of CoP which they describe as a 'one way process' (p. 61).

Other barriers to VCoP have also been suggested. Gannon-Leary and Fontainha (2007) suggest that language, lack of peer support, instability of membership, and varying rates of contribution by members may cause problems. Material in the findings chapters will reveal the situation on the ST websites. Murillo (2008) suggests that not all communities can become VCoP because some aspects cannot be adequately digitalised and that the nature of a virtual community makes detecting the essential CoP traits harder. Murillo (2008) added a second level, 'exemplary traits' to aid detection, however these were simply additions to make it more likely that a virtual community could be considered a CoP but did not override the need for all essential CoP characteristics to be present. Zhao and Bishop (2001) suggest that there must be differentiation between frequent and occasional participants.

So far the CoP and the VCoP only appear similar because both have groups of people with similar interests or needs that join together for mutual support and problem solving although both link the process to individuals being recognised by the community and acquiring status because of this. It appears that the VCoP lacks the rigidity of the CoP which has a tighter structure with members improving their standing by becoming approved by the experts at the centre. Much of the comment appears to regard VCoPs as a branch of CoP rather than an extension of CoP into a different medium with its own characteristics. Fox (2005) suggests the use of the internet as a base for learning and therefore as a CoP could ‘facilitate and enable new forms of imagined community’ (p.108).

Chiu *et al* (2006, p.1872) suggested ‘The proliferation of network access has facilitated the rapid growth of virtual communities’ and many, especially professional virtual communities, are used by individuals ‘for seeking knowledge to resolve problems at work’. Contrary to CoPs however, they suggest that for sharing of knowledge there must be recognition of the members as a ‘group-mate and there must be some kind of recognition received by the sharer’ (p.1878) Chiu *et al.* (2006) found that trust did not impact on the knowledge shared and considered that it could be due to ‘close and frequent interaction, fairness of exchanging knowledge and strong feelings towards the virtual community’ (p.1883), also noting that ‘there was no concrete reward system’ (p.1876) which differentiated VCoP from CoP.

Amin and Roberts (2008) considered that online communities were not knowledge led, and if learning took place it was as a result of members ‘foraging rather than engagement’ (p.363). on the other hand they do suggest that ‘relatively closed interest groups facing specific problems and consciously organised as knowledge communities’ (p.363) are a group where new knowledge may be generated. They suggest that ‘the idea that there is a fundamental difference between co-located and virtual communities and different forms of community should be reconsidered’. (p.367). reinforcing the idea that CoP and VCoP should be viewed from the same standpoint. A more fruitful approach may be shown by Wasko *et al.* (2009) who offer a different approach to these sites suggesting:

> Electronic networks of practice are computer-mediated social spaces where individuals working on similar problems self-organize to help each other and share knowledge, advice and perspectives about their occupational practice or common interest
>
> Wasko *et al.* (2009, p.254)

adding that the postings 'produce an on-line public good of knowledge, where all participants in the network can then access this knowledge regardless of their active participation in the network' (p.254). They also consider that management involved in terrestrial CoP who construct virtual spaces for collaboration and cannot understand why this does not result in a CoP do not understand 'the social and structural characteristics that underlie interactions and knowledge creations within active, sustainable electronic social networks' (p.255) and consider that 'the rapid growth of electronic social networks' and a 'new mode of value creation termed 'peer production' is a result of the increasing use of the internet'. These sites all share 'the critical public good characteristic of nonrivalry' which they suggest 'has fundamentally changed the characteristics of virtual communities within these networks'. Wasko *et al.,* (2009, p.255) consider that these websites have the following characteristics:

- they create electronic links between individuals regardless of physical location or personal acquaintances

- they Can support thousands of people

- individuals can engage in knowledge sharing, problem solving and learning through posting and responding to questions on professional advice, storytelling of personal experiences and debating relevant issues

- individuals gain access to new information, expertise and ideas that are often not available locally

Wasko *et al.* (2009) call these sites 'electronic networks of practice' (ENoP) and consider them to be similar to CoPs. However they do have differences. Posts are available for all members to read whether they have contributed or not. The number of participants may vary. Anyone who has access to the site can reply 'thus they create links between like-minded individuals who are willing and able to help' (p.257), unlike CoPs where assignments can be allocated hoping the group will work together to produce a positive result. ENoP, like CoPs, work with others to solve problems, but in ENoPs this is by posting a problem and receiving replies from other members. The medium means that replies are available to members and over time a bank of subjects will have been discussed or commented on. The cue for a reply is a question so there is no need to pre-empt questions, but questions will generally receive a rapid reply, unless no member knows the answer. As with CoP the potential knowledge of members ties them together, but .unlike CoP and VCoP in a business setting 'in the context of pure nonrivalry … those who do not contribute are not an issue or a problem to the membership' (p.258) adding:

> In an ENoP individuals who have a high degree of centrality and make up the critical mass are those who actively participate in posting and responding to others, thus creating multiple social ties and building the majority of the structural capital of the network.
>
> Wasko *et al.* (2009, p. 258)

suggesting that this critical mass sustains the websites. Ties are based on knowledge not physical meetings and Wasko *et al.* (2009, p.259) consider that the ties 'develop between the individual and the collective as a whole' and that 'those who post more have more resources and are more interested in the flourishing of the site'. Wasko *et al.* (2009) also suggest that this group forms a critical mass of members who respond to the other members whilst those who surround this central group both ask and answer questions. This does not fit with the ST websites where groups are homogeneous and all members ask and answer questions as equals. Wasko *et al.* (2009) also suggests there is a problem with those who do not post answers (p.263) and one of their key findings was 'that those individuals who made up the critical mass in this electronic network of practice were concerned with enhancing their reputations in the network' and were likely to have more experience, but no means of passing on the knowledge, adding 'when a local CoP is not available…ENoP may present a viable alternative for sustaining knowledge exchange' (p.264) It is however important to remember that as noted in Chapter One STs have a variety of backgrounds so there will be 'experts' in a wide range of fields, some of which are needed less often than others. This could reduce the number of responses made by individuals affecting both the critical mass theory and the idea that individuals are 'posting to enhance their reputations'.

It would appear that the features and the use of the ST websites is important in determining the type of community they have produced. The material in the findings chapters will be used to consider their placement and their strengths and weaknesses.

2.4 Gender

As the ST population is predominantly female there is the possibility that gender may be a contributory factor in the position of STs within the school. This final section will provide information about gender that can be related to the findings to consider this possibility.

Although a search for literature on gender at work produced many articles none appeared to relate to school support staff. 'Gender and work' produced one article: (Oh and Lewis, 2011) which noted that gender inequality is less noticeable in work in the science and technology sectors as more women enter this area. Chapter One revealed that around a quarter of STs were male with both genders receiving equal pay. Two other articles: Stier and Lewin-Epstein (2000) and Stier and Mandel (2009) concentrated on the effect employment has within the household suggesting that those working part time had less status in the home than those that work full time: ST jobs are categorised as full time when they relate to school opening times (38weeks) although may not be considered full time elsewhere. Household status may therefore be a misleading comparator for STs. Searches using ‘why do women work part time?’ and ‘part time work’ produced four useful articles (Fagan, 2001; Grönlund 2007; Higgins *et al.*, 2000; O’Connell *et al.,* 1989).

Whilst Higgins *et al.* (2000) noted that the majority of part time workers are women. Fagan (2001); considered that this assumes that men would not like part time work which ‘neglects the similarities between the sexes’ (p.239) adding that this relates to the labour market ‘interpretations of preference data often neglect the labour market and welfare state context in which individuals preferences are formed’ (p. 240). Nevertheless as ‘most part timers are women with dependent children’ (p.246) there is a majority of women for whom work has to take into account of family commitments All four of these articles tackle the problems created by this need. Higgins *et al.* (2000) suggest there are two types of work available: ‘career-orientated (managerial and professional) and earner (clerical and administrative and retail)’ (p.18). However the first question asked in their survey: ‘Is your job full time or part time?’(p.19) would create problems if asked of STs as noted above. Nevertheless the figures revealed by this question: 712 part time clerical and 117 part time career ‘validates claims that management and professional work is seldom available on a part time basis’ (p.21). Fagan (2001, p.241) considers that ‘once in part time work women give up hope of a career’ adding the caveat that it may be because the hours women want are simply not available (p. 243). There also appears to be a difference in attitude of colleagues: O’Connell *et al.* (1989) consider that career woman in part time roles feel overlooked and isolated from their work colleagues, whilst those who are earners feel supported by their peers. STs are isolated from others, but not from their peers if they are not lone workers.

ST work has been noted in Chapter One to have the advantage for those who have family commitments and this cannot be argued against as the literature suggests that women need part time work to enable them to fulfil other duties. Working in a school fits most neatly with childcare because it mirrors the rhythm of the school day and the holidays. However there are other factors that are important and it is the resonance with career women which can also apply to men that may be more important than gender in their choice of work.

- Higgins *et al.* (2000, p.28) note that: 'career women find their work conditions more stimulating than do women in clerical or administrative conditions' and 'part time work must also be made stimulating and rewarding' (p. 29)

- Fagan (2001, p.248) considers that '[for] part time women [who] describe their earnings as a supplementary job security and opportunities to use their abilities have become more important': adding that 'high status jobs have financial and intrinsic rewards (interesting work, responsibility, challenge, autonomy)' (p. 248) and also considers flexibility is important

- Grönlund (2007) regards freedom to control their work is a positive aspect of work

When gender overshadows other possibilities these important factors may be overlooked and may be an important issue in choice of jobs and as noted above may be more important than pay.

2.5 Conclusion

This chapter has shown the way factors affecting school support staff have affected STs. Aspects of marginalisation have been explored and related to an article concerning school nurses who have areas of similarity with STs. These aspects will be used with the comments of STs in the findings chapter to judge whether STs are a marginalised group. Information has been included about CoPs VCoPS and ENoPs and showed their strengths and weaknesses in business and network settings. These can be used with material from the findings chapter to understand the status of the technician websites. The literature relating to gender has not specifically mentioned school work, but has highlighted areas that may be more important to both men and women in the workplace.

The next chapter shows the approach used for this study.

Chapter 3: Methodology and methods

This study concerns school science technicians, a little understood group which cannot influence school-wide decisions. The aims are to reveal their professional daily life in schools and the nature of the virtual community of their professional websites.

The literature review chapters showed that while teachers, students and some researchers into practical science considered practical work worthwhile, it was scientific institutions and the employers of scientific staff who recognised the need for knowledgeable STs to provide the materials. The surveys reviewed (ASE, 1994, 2006, 2007a, 2009, 2010a (ASE, 2010a, was distributed in 2009 and predated the questionnaire conducted for this study); CLEAPSS, 2002, 2007, 2009; The Royal Society/ASE, 2001, 2002) provided some information about the work of STs, but the extent, complexity, variety and knowledge needed was not revealed. Furthermore the professional nature of the work was underplayed.

The literature also noted changes that have occurred in schools: the PFI programme which affected ST working conditions, and the reorganisation and redeployment of support staff suggested by research, the Labour government (1997-2010), and the present Liberal - Conservative coalition, has potential to affect their daily life.

Knowledge is therefore needed to ensure that STs have a voice when changes are being made that affect them. The most reliable source of this information is the ST and this account should be provided by technicians in their own words. STs can also provide material that reveals their work as little is known about STs. This can be used to consider other aspects of their life for example:

- it could be suggested that STs are marginalised as they are an isolated member of the school support staff. The literature review gives information about marginalisation and contains an example of another group, school nurses, that are considered marginalised

- STs are predominantly female therefore gender may be considered an issue, but other factors identified in the literature may be more important to STs in their working life

Data provided by STs can be explored to suggest whether or not STs are a marginalised group and consider whether gender as an issue.

It has been shown that as attendance at courses has become restricted and local council networking events have been abandoned STs have less opportunity to meet and exchange knowledge, but exchange of knowledge between professionals should be dynamic. This study aims to reveal the way that the professional websites that were set up to provide a means of communication now provide support, advice, opportunities to collaborate and informal training to STs. The way STs use their websites can be compared to those that characterise communities of practice to determine if ST websites can be described as a CoP.

This study was conceived as a way to give STs the opportunity to provide information: about their work; the knowledge that they bring to enhance practical science; to indicate how changes that have been introduced have affected them, and their use of their websites. This should result in: an increased recognition of the nature and significance of ST work in science;

the effect of changes on STs being anticipated, and the value of the websites acknowledged.

Data must be gathered about:

- the school science technician and their daily life and work
- STs views on changes that have been made to their work by factors including the single status agreement, reformation and PFI
- how STs lack of decision making power affects their work
- the way STs use of the websites as a means of communication, support and learning

This chapter explains the design chosen, the ontology and epistemology that informed the approach and the methodology that informed the selection of the methods used to gather the data. The websites provided a means of reaching science technicians and the use of websites as a research tool to collect data is an important aspect of this research. The position of the insider in research and the effect on the research are included.

3.1 The approach to the research

This section reviews and compares different paradigmatic stances in order to examine the benefit of the chosen approach.

3.1.1 The choice of the approach to the research

There are many different terms used to describe research designs (Bell, 2005; Danaher *et al.*, 2013; Clough and Nutbrown, 2008; Denscombe, 2002; Cohen *et al.*, 2007; Robson, 2002). Robson (2002, p.26) includes 'ethnography, action research and evaluation research', adding 'there is an attempt to isolate two broader strands [from those suggested] commonly labelled "post positivist" and "constructivist" as heirs respectively of the quantitative and qualitative traditions within social research' adding that 'It [constructivism] is also called "interpretive"' (p.27).

Positivist approaches use an hypothesis, scientific methods and conditions emulating 'natural sciences' where accuracy is characterised by: experiments; changing conditions one at a time; using controls, and producing results that can be replicated (Conole, 2012; Bryman, 2004; Cohen et al., 2007). Mies (1993) considers this creates a 'value-free – neutral, uninvolved approach of a non-reciprocal relationship between research subject and object' (p.67). Methods include surveys, structured interviews and non-participant observation. Numeric data and statistics produce data that confirms by deduction. The interpretivist approach assumes the participants construct their own view of the world and the methods used to explore a phenomenon include the use of surveys, unstructured or semi structured interviews, focus group discussions, case studies, observation and documents (Bazeley, 2002; Robson, 2002). Interpretivists consider that as sentient beings it is individuals, not society, that are the controlling feature and therefore researchers should interpret views obtained from individuals seeking insights rather than predictions of the world by the users (Robson, 2002). The problems associated with the interpretivist approach are noted in section 3.4 and will be reflected upon in chapter 9.

Only STs were selected to participate in the study: and from their numbers only those who belonged to the websites were invited to participate in the questionnaire. The sample was therefore purposive with respect to the ST population (Bazeley, 2002, LaCoursiere, 2003). The sample was not controlled therefore the data produced could not be relied upon to be statistically representative and could not be manipulated to draw statically valid generalisations. The quantitative data from the questionnaires formed only a small part of the data collected and was used for descriptive purposes only. The most important data: came from STs; was generated by STs, and therefore reported the STs' own voice. A small amount of additional data; for example technicians were given an opportunity to comment on their use of the websites; was requested as the research progressed.

The ontology and epistemology suggested that data was needed about science technicians, their work and their role, not only in the provision of practical science materials, but their other roles in the advancement of science in the school environment: including the help they give to teachers; their other duties in the science department, and the dissemination of their own knowledge to students. The data also needed to provide information to ascertain whether STs are a marginalised group, and to discover possible effects of gender. Information was also needed about ST use of their virtual community so that the characteristics could be compared with CoPs as this is an area that has not been considered or explored.

This research combines both quantitative and qualitative data, a mixed methods approach. Brannen (2005, p4) suggests that this 'may constitute a strategy in its own right or it may be subsumed within another research strategy'. The quantitative data from questionnaires forms an important part of the study and is woven into the narrative, but it is too small a portion of the overall data to be considered an equal part of the research and should therefore be incorporated into the interpretive paradigm. The use of different strategies to collect the data has allowed both descriptive and numerical data to be included which Brannen (2005) considers may be an advantage.

The various approaches and the paradigms behind them suggest an interpretive approach for this study. The reasons for this choice are based on a consideration of the ontology which suggests that:

- a realist approach would only repeat the data gathered using the empiricist epistemology employed by previous surveys

- what was required was an exploratory approach and an interpretive epistemology which allows the picture of reality to emerge from the data

The implications of this approach are considered in section 3.4.The methodology will reflect the inclusion of some quantitative data into a predominantly qualitative design.

3.1.2 Methodology and selection of the methods used

Methods relate to the outcomes required of the research. Clough and Nutbrown (2002, p.28) note the methodology ‘explain(s) and justif(ies) the particular methods used for the study’. There were three broad areas for which data was required:

- the ST and their work

- the effect on the ST of being unable to influence decisions

- the use of the websites by STs

The literature showed that:

- practicals were thought worthwhile, but the role of technicians was rarely mentioned

- technicians had only been studied positivistically. With little or no opportunity to influence the data collected, their daily life was unknown

- there had been no studies on the effect of whole school, government or policy decisions on STs or on the possibility of their marginalisation in the workplace

- there had been no studies on the way technicians use their professional websites or a consideration of the nature of the websites within the paradigm of CoPs

Data was required to compare this study with the quantitative results of the previous surveys as noted in the introduction to this chapter. A questionnaire was appropriate and was also used to collect data on the occupation of STs before they were employed in a school and to discover why they left their previous job. This data was not collected in previous surveys but provides knowledge that is needed to understand the source of STs and how this aids their work.

The questionnaire also collected information concerning ST qualifications to compare with previous surveys and with their present job titles. This was treated as qualitative data as the variety of jobs and job titles produced made assigning codes meaningless.

Information was also requested on the effect of the changes noted in Chapter Two. Dichotomous questions or questions with a limited choice of answers were used to provide this data and data concerning aspects of their unseen work to ensure that clear answers would be received for specific questions such as training teachers. The data from the questionnaire was used to complement the data from the websites and an interpretivist approach was used with the information to aid the exploration of the views of STs on the changes that are proposed to their working life and on hidden aspects of their work.

To allow technicians to voice their own opinions three open ended questions were included:

- reasons for leaving their previous job
- best and worst aspects of their work
- general comments

With the exception of these three questions the questionnaire was used solely for collecting data in a structured way on a few areas. The questionnaire was considered the most suitable way of collecting this data but formed only a small part of the data collected. It was designed to show if, and if so, how, the profile of technicians had altered. This provided a comparison with previous data and a means of triangulation. It was also used to produce firm opinions in some areas where change had been suggested. The other data needed was to be generated by technicians. Several methods were ruled out because of time or cost.

Moore (2011) suggests that it may be better to try to understand a small amount of material in great detail. However in-depth interviews, case studies and telephone interviews were all impractical. As a fellow technician my working day is similar to that of other technicians and there was no possibility of being released to meet technicians at their place of work even without the constraints of time, distance and cost. Telephone interviews were also unsuitable as even during breaks STs are likely to be interrupted by students or staff which would take priority. However the major issue is that the study of a small number of STs would undoubtedly increase sampling errors as, as has been shown in the literature, the work, responsibilities and hours allocatd to ST are infinitely variable and a small sample would be unlikely to be representative of the ST population. A larger sample was needed in order to reduce bias and perhaps allow generalisation within at least the STs who populated the websites. Focus groups would also be a non-representative sample and be impossible to arrange because as noted in ASE (2010a) there is no list of technicians available, technicians are widely distributed making it too costly, and time constraints would also apply. Postal surveys as used by CLEAPSS, (2002, 2007, 2009); ASE, (1994, 2006, 2007a, 2009); The Royal Society/ASE, (2001, 2002) may not have reached STs and would also have been too costly.

The major focus of the study suggested that data generated by STs in their own voice would be the best way to answer the questions posed, and this was available via their professional websites.

The websites provided access to approximately 600 STs at the time of data collection and gave more opportunity to generalise to the website population. The major part of the data collection was from these professional websites which were originally set up to provide a place for technicians to form a virtual meeting place. The nature of the websites, their characteristics and the specific nature of my relationship with the websites is detailed in section 3.1.3 and in section 3.4 where outsider/insider research and research in the virtual world are discussed. The data was entirely controlled by technicians and was naturally generated as part of their working lives and therefore reflected their work and their reaction to changes that affected them, giving insight into their world. This qualitative data put the views of technicians at the heart of the study and allowed them to speak in their own voice. Collecting the data from the websites over a period of two years and exploration and analysis of the data allowed hypotheses to appear. Although Cohen *et al.* (2007) suggest that qualitative research is individualistic; here an individual, isolated group from amongst school support staff is studied. Data was collected from individuals but the method used to extract the data has allowed group characteristics to emerge and gave an opportunity for individual opinions to be heard, both are needed to produce a rounded picture of science technicians.

As hypotheses were formed further data was thought useful. A request was posted on the websites for job descriptions to enrich the data on changes made to the work of technicians. When the data revealed the importance of the websites as a source of knowledge a request was posted to ask technicians for their views on the websites and how they used them to add a further dimension to the possibility of relating them to CoPs.

The methods chosen were: to use a questionnaire to provide some numerical data for this study using the websites as a source of participants; to use the websites to naturally generate data that would reveal the life of the technician using their own voice, and to request further information via the websites if needed.

Early adopters of internet research suggested its use as a search method (Robson, 2002; Denscombe 2002; Coomber, 1997; Mann and Stewart, 2000; Smith and Leigh, 1997; Bryman, 2004). Later the use of the internet to collect data was suggested (Clough and Nutbrown, 2002; Cohen et al., 2007). Smith and Leigh (1997, p.496) had already suggested that it could ‘offer new opportunities for research, examining questions previously too difficult to ask’ and DSS Research (2000, p.2) considered Internet surveys ‘can be used to augment or even replace mail surveys in certain circumstances'. In this study the internet was used to contact a difficult to reach group. Smith (1997) considered that surveys conducted digitally received an increased speed of response; but reported response numbers varied. The need to be comfortable with technology was thought to be a disadvantage; but by using the websites STs had already demonstrated a relaxed view towards the use of the internet. Smith (1997) also thought that there could be problems with layout and questionnaire length: the questionnaire used for this survey was short and had a simple layout. The problem of multiple entries and surveys not reaching the target audience is mentioned (Smith, 1997; Smith and Leigh, 1997), but this is not an issue with this survey where the respondents were self-selecting from a pool of known STs. As an insider the use of the internet in insider research is considered further in section 3.4.1.

The literature available was also useful for addressing ethical aspects of internet research (Smith, 1997; Smith and Leigh, 1997; Huff and Rosenberg, 1989; Mann and Stewart, 2000) and for highlighting different types of groups (Mann and Stewart, 2000) but problems raised such as, the authenticity of the participants, covertly collecting data, or discovering criminal activities did not fit this study. Details of the websites and their use in this study are considered in the next section. The comments of Mann and Stewart (2000) were used as a guide as this was the most useful source of advice at the time the data was collected.

3.1.3 The websites and their use as a source of data

All three websites available to STs were used in this study and each has its own characteristics. As noted further in section 3.4.2 this reduced some of the problems associated with an interpretivist approach by allowing comparison across the sites for triangulation (Unluer, 2012) and increasing the possibility of generalisabiltiy to the ST population using the websites.

Experience of the sites showed that they had evolved from their original purpose as a place for STs to meet, but this had occurred before the data collection and was therefore not something that was revealed by the data collected. The first site which had been available for approximately 8 years at the start of this research was primarily used for quick requests e.g. sources for items, or a method: the second being created when members of the first site requested a website for posting longer answers or more detailed information. These sites are closed to the general public: membership requires proof of eligibility. The third website is more recent and is also a closed site: although non-members can read news items posted on the front page they cannot read or add comments to posts. It has unique members and members in common with the other two sites. Not all STs belong to the websites which could make the data biased but this is balanced by:

- the extensive countrywide coverage which was confirmed by an examination of the profiles of members from the first and second websites (members of sites one and two have dual membership) and using the map indicating the location of members on the third site

- the profiles available showed there was a ratio of approximately 1:3 males to females which is in line with the estimated ratio of technicians in the UK (e.g. CLEAPSS, 2002)

- just over 31% were senior technicians or above indicating a range of ST grades were reached via the websites when participants requested for the questionnaire

- postal questionnaires, if passed on may have been directed towards the most senior ST

This suggests that the websites used were a suitable source of data.

As a technician, I am an insider, but to minimise the effect on the data firstly I excluded my own team and myself from the questionnaire. Secondly although I contributed and posted as normal to give and receive advice during this time, I have not included my contributions to discussions or help except where it was germane to the conclusion or final product. Section 3.4 contains more detail about outsider/insider research, and the steps I took to avoid and address bias because of this. However when collecting data no posts were made to specifically stimulate responses. All the data was generated by STs, and to avoid bias in the collection process caused by selectively collecting only part of the data (Unluer, 2012; Hooley *et al.,* 2012) all data was included

Specific posts were only made after data collection when job descriptions were requested and comments were sought on use of the sites. The reason for the request and the way responses would be used was included in the post. An e-mail was sent to the site moderators stating that I was researching STs and their roles and would like to use material from the site to inform the research before posts were made so there was no covert collection of data and my email address was available on my profile on the sites if anyone wished to be excluded. STs were fully informed about the collection, knew that they could send an email if they had any questions or if they did not want their posts included. STs were in charge of the use of their data.

Although Mann and Stewart (2000) consider problems can arise if participants' comments include controversial subjects the data on ST sites is professional and relates to their work (this is emphasised by the site moderators). Support groups for vulnerable or distressed groups were also specifically mentioned (p. 20) because of the potential harm that could result from the collection of such data The support offered by ST groups is aimed at professionals seeking professional advice for their work not to offer help and support to vulnerable members of society.

Mann and Stewart (2000) consider there can be power issues even in internet research, but I am just one member amongst the others. Subjects raised were decided by site members, and problem solving was a communal effort. As stated by the moderator ‘just ask, and the community will be behind you’. As my membership came long before the research many of the problems that face other researchers are not applicable to this study. This collaborative and supportive attitude may have helped with: obtaining participants for the questionnaire; requests for job descriptions: for comments on their perception of the websites, and their willingness to allow the use of quotes: but the data collected from the websites was generated entirely by technicians and did not require any technicians to modify their use of the site.

The ability to trace individuals is also considered a problem with internet research (Saunders *et al*, 2015). It would be possible to trace the origin of any email to a computer but not an individual as unattended machines could be used by anyone, especially at the time of this data collection when users could access computers using generic names and passwords, as I know from experience of setting up school computer networks during this period. Also, passwords only protect if individuals log off when moving away as a period of inactivity is required before it triggers automatic log off. Traceability is only possible to the same degree as any postal data which could be returned by anyone at an address.

Although Cohen *et al*. (2007, p. 236) suggest ‘sampling bias is a major concern for Internet-based surveys’ and different ways are employed to prevent multiple submissions and weed out duplicate entries, Coomber (1997) notes this also arises in non-internet surveys. This study uses websites that have vetted membership. Nevertheless other aspects of use of the internet as a source of data require reflection.

Nielsen (2006) suggested that only 1% of website members are active, 9% occasionally contribute and the rest are passive, I consider these websites and their use is different as they are professional not social websites and:

- STs posting to leave the website because they are no longer school science technicians have noted they valued the site but rarely needed to post because they found their answers in the archive: these would be active but not posting members

- others have stated they are posting queries because they could not find the answer in the archives so may be active searchers only posting when necessary

- the numbers who mainly search the archives is unknown but, they are not passive members

- questions sometimes only need one reply so STs may post only if they were the first to see the message, or post simultaneously

Nevertheless Nielson (2006) suggests that non-participatory members are passive which creates inequality between site members. Some technicians post more than others, perhaps because they have more technical experience which they share to give support and disseminate knowledge rather than exhibiting superiority.

Nielsen (2006, p.3) suggests those not actively participating ‘almost certainly differ from the 90% you never hear from’. This could be true but also applies to any data collection method that did not include every eligible member. The numbers contributing to some specific areas are shown in the findings chapters, of the rest, the answers and replies that had received more than one reply were totalled and the results show that 693 questions were raised and 1,793 replies were received. A similar number required only one reply, or received several answers within minutes giving the same advice (meaning the advice was probably given simultaneously by several people) suggesting a higher percentage of technicians actively use the site than Nielsen (2006) suggests is usual.

This section has defined the approach and used the methodology to choose the methods that will produce the data required for the study. The next section concerns the participants and the application of the methods chosen.

3.2 Sampling, the development and practical use of the questionnaire and data collected from the website

This section considers: the sampling method used to select participants; the preparation and practical use of the questionnaire, and the collection and handling of the data from the websites.

3.2.1 Selection of the ST sample

STs were the focus of this study. Cohen *et al*. (2007) list several methods of selecting participants based on ‘expense, time, accessibility [which] frequently prevent researchers from gaining information from the whole population’ (p.100) which are endorsed by others (Robson, 2002; Denscombe, 2002; Bell, 2005) their comments were used to consider the type of sample obtained.

The sample was not random because it only included STs who used the websites. This small study could not include all science technicians even if a list of technicians existed and the sample could not be initially random because the target group was STs and purposive or non-random initial selection was needed. Denscombe (2002, p. 147) suggests ‘for a small scale exercise it will be generally be an acceptable way of selecting a sample’ and Cohen *et al*. (2007) also note that it is a feature of qualitative research and fits the approach required although they think probability sampling has ‘less risk of bias’ (p.110).

The websites were a suitable source of STs and had advantages over postal surveys in cost and in ensuring that the survey reached STs: surveys delivered to a school with no named recipient easily go astray. With around 600 website members and with a target population of around 4,000 - 6,000 technicians in the UK this would reach at least 10% of the target population. A request for participants was posted on the websites. This increases bias, because only members of the websites would receive the request for participation, but would ensure the target group received the request. Although not asked on the questionnaire, the site has a section where STs can provide more details about themselves, which contains their names and it was possible to discover the gender ratio, which was 3:1 females to males, the same as in all other surveys except for ASE (2010a) which has a 4:1 ratio. This shows the sample is representative of the STs population as reported by other surveys, Mathy *et al*.(2003) consider showing representativeness can be a problem with internet research but consider that comparisons with surveys collected by other means shows reliability.

The post on the website explained the reason for the request and the email address to reply to if they wanted to participate. This was requested by the moderator to avoid overloading their website. Respondents were sent the questionnaire as an attachment. A survey website was not used because: these were not to my knowledge readily available or widely used at the time; I would still have used the website request method as STs did not have to go to another site to fill in the questionnaire; it reflected the spirit of mutual help evident on the websites, and encouraged participation This was reflected in the number of positive notes sent alongside the questionnaire when it was returned.

Cohen *et al*. (2007) suggest this approach could result in 'volunteer sampling' and increase bias, this is possible, but comparing the figure for the number of senior technicians on the sites (32%) with the number of senior technicians who responded to the questionnaire (38%) it would appear that the distribution of technician types available to volunteer and the distribution of those who volunteered was similar. Coomber (1997, paragraph 1.1) comments that 'The key issue that any survey research conducted via the Internet will have to contend with, as with non-Internet based surveys, is that of sampling bias' although Mathy *et al.* (2003) consider that respondents to traditional surveys are equally able to misrepresent themselves. The data received came from a range of ages, and length of service and other factors also suggested they were typical of the STs who used the websites. Responses related to issues such as the presence of a support group in their area would be valid whatever the status of the technician. As the problems will not be analysed statistically Robson (2002) considers non-probability sampling is a suitable approach.

An opportunity arose for some of my technicians to attend a course and they distributed twelve questionnaires adding another source of data (6). However this showed that this was not as effective as the internet as only two of those not collected at the meeting were returned. Those who attended the meeting and filled in questionnaires were a targeted convenience group with the required shared characteristics.

The sample is generalisable to technicians using the site and is at least a representative sample of all technicians (Denscombe, 2002; Mann and Stewart, 2000). 162 questionnaires were sent out via the websites and 142 were returned, this represents a 88% return rate, and would indicate a lack of sampling bias (Mathy *et al.,* 2003). It was 24% of the target population of the websites and represents between 2% and 4% of the approximate number of science technicians in the country. The amount of quantitative data suggests that no firm predictions can be made and that the concept of fuzzy predictions (Bassey, 2010) is more useful when drawing conclusions. The participants were a targeted group.

3.2.2 The development of the questionnaire

As a minor part of the data collection the questionnaire (See appendix 1) was kept as simple as possible and was used to provide demographic data for comparison with previous surveys and information in important areas that had not previously been considered. Questions relating to the remodelling of support staff, the present work of the technician in teaching students and training teachers and the willingness of technicians to continue to undertake these tasks were included to enhance data collected from the websites. Dichotomous answers were used as technicians may not consider this work as significant or worthy of recording. If this information had been available some changes suggested to the work expected of technicians might have been modified. Questions about the number of hours worked by technicians were included because changes made for economic reasons can affect ST work, for example a term time only contract means that STs can find it difficult to undertake some tasks such as stocktaking which require time to concentrate on the task without interruptions. The single status agreement has affected all support staff and questions were included so that the responses of those who had been through the process could be compared with those that had not. No research into this change appears to have been undertaken. As noted previously, only three unstructured questions were included. There were twenty eight questions about STs, their school and their work and six about ideas relating to changes anticipated in the work of support staff in schools at the time of the questionnaire. This was a self-completion survey.

When a request for the questionnaire was received the attachment sent included a letter giving more information about the reason for the research and stated that if they needed any more information about the study they could send me an email for clarification. It outlined the steps undertaken ensure the anonymity of the data for example the questionnaires would be separated from the email, data would be stored securely on a password protected computer and the anonymised paper copies would be kept in a locked file. STs were reminded that they could set up a new email account for the return if they wished; which would be appropriate for this research although Coomber (1997) notes that further means would be necessary for more sensitive research. STs could fill in the questionnaire at any time such as when they had a break at work for lunch, or they could access it at home by forwarding the questionnaire to their own email, or by logging into their school email from home. They were also reminded that they could withdraw at any time if they wished to do so.

The questionnaire was piloted by firstly inviting a small number of people from my school to check for clarity, and then ten members of one forum who had posted for their names to be removed were emailed privately to ask if they would act as pilot participants to fill in the form and add any comments. They would not be part of the main study as they would no longer receive the invitation to participate but would be able to comment upon the questions from a professional standpoint. The result of the initial pilot did not suggest any questions were unclear although this could of course have been because they were not too critical of the wording or understood the context as members of the technician group. However as a few participants emailed for clarification on the question regarding the number of classes at different key stages and as it produced a large range of answers this question was not used but the answers were recorded on the spreadsheet in case the data became useful. The questionnaire layout did not transfer correctly to some computers so it was modified and resent to ensure the questions and boxes aligned correctly.

The request for participants was posted in November 2009. Most returns were via e-mail: some were posted. There could have been duplicate returns but the combination of email address, age, hours worked, and type and length of previous employment should have made this obvious. No returns had these features in common although the possibility of duplication cannot be entirely ruled out in any survey unless the all surveys are in-person and conducted by the same interviewer.

It has been suggested that questions cannot be asked of the researcher when surveys are online. In this case a query could be emailed and answered if necessary. This shows an advantage over internet questionnaires that use survey providers where lack of understanding of a question could lead to a questionnaire being abandoned. This would affect the reliability and validity of the surveys unless the number of incomplete questionnaires or the reason for the failure of the questionnaire completion was known.

When printed out questionnaires had no identifying features attached, if the participant offered to answer further questions this was separated from the rest of the questionnaire. The questionnaire was posted simultaneously on all sites there was no way of knowing which site had been the source. I did not think this would be useful information as I considered that all sites were equal. The returned questionnaires from all sources (148:142 via the website; 6 from the convenience sample) indicated a wide range of ages, qualifications, length of service etc. amongst the replies. STs were not specifically asked to collect data from others. The convenience sample showed similar results to the larger sample from the websites. The websites provided a means of reaching science technicians as participants for the questionnaire, but they were also used as a source of data which allowed the voice of the technician to describe their work.

3.2.3 The collection and approach taken to the data from the websites

The data collected from the websites between 2009 and 2011 was the major source of qualitative data for this study, the structure and characteristics of the websites have been included in earlier sections of this chapter The websites provided an opportunity to study STs, their work and the effect of changes on their daily life and was a source of knowledge about their virtual world. The websites provided an opportunity for technicians to speak in the first person about their work. With no intervention of outsiders there is even less contact with me as the researcher than there would be even with an ethnographic study and the voice of the technician is entirely natural and without the bias that can be produced by questioning by a researcher The data is therefore honest and reliable.

As noted in section 3.1.3, and with reference to BERA (2004, 2011), permission was sought and technicians were informed about the data collection. The sample was non-random in the first instance, but the whole of the data available was collected therefore all technicians who posted during this time were included. Nobody asked to be excluded from the study. A limit had to be placed on data collection as the sites are dynamic and receive many posts each week. Material was collected over two school years as noted by Paechter (2013) this restricts the size of the data to a sample that allows some in depth analysis. It still produced thousands of emails which were initially stored on a password protected computer before data processing. As the data only needed to be collected from the sites this was a more straightforward process than for that collected via the questionnaire and details of the way the data was managed are given in section 3.3. In and Chee (2006) noted that in their research a threat that affects confirmability, which they consider is one indication of rigour, was that 'theoretical saturation' was required, that is the researcher must be assured that similar instances to those included are being repeated, which they suggest is difficult on asynchronised website responses. As all the data was collected and was completed at the end of the school year questions and comments could be assumed to have ended and all the data was in a saturated state. This applied to this study and that of Paechter (2013).

As the study progressed the websites became a further source of data. STs were contacted to request job descriptions when it became apparent that these would be useful when considering the changes being made to the work expected of STs and the types of work that were being included. Permission was sought and 25 job descriptions were received from different areas of the country.

The findings showed the way STs were using the websites and it became clear that this was an important area that needed to be included as it could reveal the nature of the use of the websites as a CoP. Following the Guidelines of BERA (2011) permission was again sought from the moderator who agreed to a post on the websites that would ask for more information from members, STs were again asked to participate in this study by contributing their personal thoughts on the use of the websites in their work as STs for inclusion in this study. Ten replies were received from technicians within a two week collection period.

In both these cases these were convenience samples, but still only included technicians.

The way in which the websites were used to collect data that was entirely and naturally generated by STs has been shown, as has the value of being able to collect further data as the study progressed. Once collected, the data had to be managed.

3.3 Managing the data

The quantitative data from the questionnaire was prepared for analysis whilst the qualitative data was collected. The qualitative material from the questionnaire and websites was then organised for reporting. Lastly the job descriptions and comments on the use of the websites were organised.

3.3.1 Managing the quantitative data

Questionnaires were given a unique number. Data was entered onto a prepared excel spreadsheet: comments about the best and worst aspects of their work were tabulated. Some demographic data was coded by number, former jobs were coded by science (s) or not science (n) with job descriptions being recorded in a separate column for reference. Data from the spreadsheet was then selected and filtered as required. Some data could be related to previous surveys whilst other data provided new information. Other information collected on the questionnaire including: piloting experiments; training teachers in the use of science equipment; thoughts on the single status agreement, and access to support and training were represented in tables. The data was used to provide information that related to the previous surveys and for descriptive reports. No specific types of analysis were used but percentages were included where it aided understanding.

3.3.2 Managing the qualitative data

Data collected from the websites (2009 and 2011) was sorted after the outline chapter headings for the findings had been decided because of the quantity of data produced. Notice was taken of BERA (2004, 2011) during the collection process and data management.

To anonymise the data collected and reveal any differences between the use of the sites, separate tables were made. The websites were labelled ‘A’ and ‘B’. ‘A’ was used for STs who used the original two websites. ‘B’ was used for other website. The number of posts made by each participant was then added to the appropriate table. The tables were then sorted by number of posts. The numbers involved suggested that the best way to code STs was to use a letter and number system for one site, and a number and letter system for the other. All STs who posted were included in the list, the list was then sorted in descending order of numbers of posts, which had the effect of randomising the names before the codes were applied. Each question and the answers were then placed in alphabetical order and the codes were used to identify the participants who contributed. The data was then sorted into broad categories to produce basic data sets. In essence the data generated its own sets because it was easily distinguishable. The categories chosen were: biology; chemistry; physics; general preparation queries; other work; jobs; single status; remodelling, and ‘other’. Word documents were created for each section and each email coded and placed in the appropriate document and printed.

The rest of the process was completed manually. The printout was cut into sections, containing one question and its answers. The first sort was into topics for example microbiology, photosynthesis etc. Sub sections were then isolated and the number of questions related to specific topics, the number of replies received and whether they were comments or advice were tabled. The amount of data generated meant not all data could be included in the study, so representative samples of topics which illustrated various aspects of the work of technicians were selected for each section. The questions and the comments on that topic were used to provide a description to accompany the table. Paechter (2013) described the use of data collected in this way, where the distance from the events means that the researcher cannot interact with the data as they could if postings were live 'emphasises the researcher's separation from the events and helps to make the familiar strange' (p.83) as time is compressed, and the resulting threads are complete, Paechter (2013) suggests this brings 'a different sort of intensity to the researcher's relationship with the community'

3.3.3 Managing the remaining data

Small amounts of other data were also collected which consisted of:

- job descriptions, which were placed on a spreadsheet so that the variety could be seen

- responses to the request for comments on the use of the websites, which were used to produce a narrative

- the best and worst aspects of the job, were placed in tables so that comments could be made

3.3.4 Ethics

Reference to ethics has been included throughout this chapter. Reference was made initially to BERA Ethical Guidelines (2004) and later BERA (2011) was consulted for guidance. To ensure that ethical issues that related to the internet were also included the chapter on ethics in Mann and Stewart (2000) and other comments (Smith, 1997; Smith and Leigh, 1997; Huff and Rosenberg, 1989) were noted and included. Care was taken throughout the research to adhere to guidelines relating to the responsibility to the participants as noted in BERA (2011) and the possibility of withdrawal at any stage was explained. Data was stored in password protected areas and data including the data which was used to provide the narrative was anonymised.

3.4 Insider research and issues of the interpretivist approach

3.4.1 Insider research in the terrestrial and virtual worlds

This section looks at the insider from different perspectives.

3.4.1.1 The insider in the terrestrial world

Outsider research is a positivist approach where the researcher observes but stands apart from the object of study and is considered neutral. Insider research such as this study occurs when the researcher is part of the group being researched and an interpretivist approach is taken (Bell, 2005; Hanson, 2013; Mercer, 2007; Rooney, 2005; Humphrey, 2013).

Insiders have advantages: initial entry is easier (Paechter (2013), and behaviour is unaltered as the shock of an outsider is avoided. Insider knowledge means that the internal mores of the group being studied are known, but a disadvantage is that these may not be recognised as unusual and therefore remain unquestioned or unchallenged. Knowledge could cause bias, and questioning may be biased towards the known (Mercer, 2007; Unluer, 2012). Unluer (2012, p.6) suggests ‘develop[ing] myopia’ and ‘prior experiences not [being] explained' are also issues. Participants are readily available giving insiders more flexibility. Mercer (2007) considers that knowledge may be advantageous but it also suggested insiders may be more uncomfortable when interviewing or observing acquaintances and superiors (Bell, 2005; Mercer, 2007; Hanson 2013; Humphrey, 2013) which suggests any insider advantage may be lost as sensitive issues may be avoided introducing bias. Mercer (2007) noted that the relationship was different when interviewing known and unknown participants, as were responses, for example the truth may be tempered by fear that their thoughts could be unfavourably revealed, conversely Unluer (2012) suggests that insiders are more likely to be told; and to recognise; the truth. Participants may also have expectations that cannot be fulfilled (Bell, 2005; Paechter, 2013) and material might be disclosed which is ethically compromising for the researcher (TLRP, n.d.). Other problems such as; 'role duality'; missing 'the big picture'; being expected to know what the participant means, and misinterpretation (Unluer, 2012) may also be disadvantages. However Mercer (2007) also suggests that it is necessary to be an outsider to be neutral but inside/outsider should not be viewed as a distinct division but as the two poles of a continuum. Mercer (2007), having modified the approach taken on site two of a study and noted that the results were 'remarkably alike' concluded 'I am still unsure about the extent to which different degrees of insiderness (or outsiderness) affect research processes and findings' (p.14). Paechter (2013, p.75) suggests: 'insider positioning also necessitates the observation of oneself and one's relation to the research process; in this way research makes outsiders of us' something also noted by TLRP (n.d.).

These comments relate to the terrestrial world, however this research was conducted within a virtual environment and although the issues noted above may apply. The 'insider' has taken on a new persona and new ways of working have emerged.

3.4.1.2 The insider in the virtual world

Although the internet has been used for many years as a resource for seeking and retrieving literature, (Robson; 2002; Denscombe, 2002; Bell, 2005, Cohen *et al.*, 2007) the internet is becoming increasingly regarded as a new source of data collection (Jones, 1999; Mann and Stewart, 2000; James and Busher, 2009; Hooley *et al.*, 2012; Boellstorf *et al.*, 2012; Durand Thomas *et al.,* 2000; Moore, 2011; Paechter, 2013; Taylor, 2011). It releases both the researcher and the researched from the need for physical presence by for example using e-interviews (James and Busher, 2009). This research moves in another direction: the observation of internet based groups. This could be considered to be a virtual ethnography, although Boellstorff *et al.,* (2012) who are more concerned with game based worlds such as World of Warcraft and Minecraft argue against this. However there are issues raised in the literature when the internet is used as a way to study groups and the researcher becomes an insider in a virtual world.

The difficulty of knowing when to enter a terrestrial space has been noted (Moore, 2012, Humphrey, 2013). In virtual space it is easy to search the internet for groups and lurk without taking part, an outsider position and a positivist approach. The ethics of such an approach have been questioned (Mann and Stewart 2000). If researchers wish to engage with the group they may join and post after lurking, this approach can cause difficulties (Hooley, 2012; Jones, 1999; Boellstorf *et al.,* 2012) and as with terrestrial researchers virtual researchers may need to consider what they 'say' to the group as an outsider who wishes to become an insider (Moore, 20012).

One thing that sets this research apart from many other studies that use the internet is my relationship with other STs which began long before the study so I was already an established insider. Paechter (2013) had a similar relationship and can be used as a touchstone.

The research of Paechter (2013) is the only research that I have found that has a similar starting point as this study. I was already an active member and Paechter (2013) joined a group long before researching it: regarding her position as ‘a partial insider’. The site was not professional and the subject was sensitive, which may have resulted in this definition. Both data collections took place with no attempt to influence the data by making specific postings. This is a subtly different use to that created between website members and an opportunist researcher using the internet as a covert source of data: or researchers who only join or contribute to sites in order to gather data without having a long term commitment to the group. Paechter (2013) as a previous, and continuing participant of a site describes herself as ‘an insider and a researcher, but not an insider researcher’ (pp.75, 76) which would distinguish the use of the site by long term members. Both this study and the work of Paechter (2013) approach website use from the stance of a person inside the group where membership came before, and was independent of, the study. This use of the site avoids some of the pitfalls associated with insider research: insider knowledge did not affect the data as no questions were asked at the time of collection and all data was collected. Sensitive data was not posted on the professional websites. There was no specific interaction to bias questions or answers therefore the relationship did not change and the data was therefore neutral to this effect.

3.4.2 Issues with the interpretivstic approach

The factors considered in this section will be used in Chapter Nine to reflect on the limitations of the study.

Rigour

Cope (2014, p.89) suggests that ‘the perspectives of quantitative research are rigour and validity, and the perspectives of qualitative research are credibility and trustworthiness’ and whilst Shenton (2004, p.63) considers that ‘credibility, transferability dependability and confirmability’ are more suitable for qualitative research, for In and Chee (2006, p.2) ‘confidence in the truth of data’ is required. Although they relate this to the analysis of transcripts, which were not part of this study: the data used was the authentic voice of STs. Rigour requires accurate accounts of the methods and the analysis used in the study and these have been included in this chapter Validity requires information concerning the data collection, triangulation and valid respondents: details of these elements have been also been included. This research was qualitative with a quantitative element subsumed within it. Therefore the categories suggested by Shenton (2004) are used in this section.

Credibility

Rooney (2005) suggests that the positivist approach to accuracy (validity) with the researcher taking a detached, neutral or outsider view of the researched to avoid influencing the data has been modified ‘to include factors such as credibility, believability and reliability’ (p.3) and that interpretivism ‘rest[s] on the common epistemological premise that truths or meanings do not exist independently but are created by the human mind on an individual personal level’. Cope (2014) refers to the credibility of the data. The data used in this research has been generated by the STs without any influence and is an accurate record of their comments. The possibility of verifying the work with participants is suggested which would be useful in a terrestrial setting or interviews or other ways of generating data such as extended emailing (James and Busher, 2009) but would not be useful for this data. However the data presented produces a picture of the work of STs and their virtual world, which is also considered by Cope (2014) as an indication of credibility. Mercer (2007) suggests credibility with the subjects is a positive aspect of insider research

It has been suggested (Shenton and Hay-Gibson, 2009) that the use of ‘well-established research methods’ (p.29) aids credibility. This study uses a questionnaire, which is a well-established method. The use of the internet to collect data as in this study is less usual, but was also used by Paechter (2013). The data comes from a closed site therefore the participants are credible. Matzger (2007, p.2098) regards this as ‘the believability of some information or its source’

Trustworthiness

Shenton (2004) suggests research should:

> provide sufficient detail of the context of the fieldwork for a reader to be able to decide whether the prevailing environment is similar to another situation with which he or she is familiar and whether the findings can justifiably be applied to the other settings
>
> (Shenton, 2004, p.63)

The context of the research, the source of the data and details of the process used have been included.

Shenton and Hay-Gibson (2009) note that the problem with this concept [trustworthiness] is that readers may treat ‘with undue suspicion any research whose findings surprise them’ (p.24) although this can be because the researchers may not ‘recognise the type of information of value to the reader’.

Reliability

The reliability of the internet as a source of data has been questioned and It has been suggested (Coomber, 1997) that those who fill in online questionnaires may not give truthful responses. Reasons have been given to show that the data collected is reliable. The use of the websites allowed technicians, who are hard to reach support staff, to have their voice heard when paper based surveys have been shown to have limited success. The data generated on the websites was not used to produce a snapshot, which could give false results: but was gathered for two years and the wide range of topics enabled a clearer picture of the range of the work undertaken to emerge. The topics were generated entirely by technicians and there was no intervention to lead the content they are therefore authentic accounts of technician activities over that period. The value of the websites as a source of data for an insider is revealed. Shenton and Hay-Gibson (2009) also note that widening the literature beyond the field can aid reliability, whist also noting that this should be a robust link. The literature used has been widened to include nursing where parallels could be drawn to STs, and to the use of a website in a similar manner to this study from an insider with a congruent background (Paechter, 2013)

Triangulation

Robson (2002, p.104) describes this as ‘coming at the same thing from a different angle’. It is suggested that using different methods of data collection provides a means of triangulation and includes the use of literature in this process (Cope, 2014; Shenton, 2004). ‘Prolonged engagement’ (Cope, 2014, p.90) is also considered suitable. This study includes the results of other surveys and the data is collected from different websites which have some members in common, but also have distinct members. I also have prolonged engagement with STs and with the websites.

Bias

Bias can arise because all the available data has not been collected. In quantitative research this could be due to the way the sample was chosen which inadvertently excluded those with knowledge of this other data. This could also apply in qualitative research, especially if small numbers of participants are involved which are unrepresentative of the group being studied. This would be true of this research if only a small sample of STs were involved. Although participants are limited to those who are members of the websites; except for the small convenience sample; triangulation with previous studies and reference to ST profiles on the websites shows they are representative of the ST population. Pigott *et al.* (2013) note that bias can be caused by the omitting of data collected from the report. The data from one question on the questionnaire was not used and the reason has been noted, exemplar material has been used in chapters 4-7 to illustrate specific aspects from a number of comparable examples available. Pigott *et al.* (2013) consider that this is acceptable and ‘any resulting bias is likely to be minimal’ (p.426) However all data has been tabled or if of less importance its existence has been acknowledged, for example the total figure for questions requiring only one reply has been noted. For Pigott *et al.*. (2013) this is a valid approach. Where views contrary to other opinions have been present in the data collected they have been included in the examples used.

Bias may be introduced in other ways as asking questions may bias the response given, as shown by the sketch in Yes Prime Minister - The Ministerial Broadcast (G0ZZJXw4MTA, 2012) where the result of a questions is clearly shown to depend upon the approach taken before the question is asked.

3.5 Conclusion

This chapter has shown the design and methodology that determined the methods used for this research. It has explained the methods and the reason for their use. The gathering of the data from the websites has been discussed and the reasons for using this approach have been given. Areas such as reliability and trustworthiness have been included and ethics have been considered throughout the chapter.

Chapter 4: The profile of the science technician

Chapter One showed that practical work was valued but that the need for science technicians to prepare the materials for practical work was rarely acknowledged. The exceptions were the employers who regarded the development of practical expertise as an important part of science education in schools. Despite this positive acknowledgement, the voice of the science technician, even, to a certain extent, in the case of the surveys (ASE, 1994; 2010a; Royal Society, 2001, CLEAPSS, 2002) remains silent. More specifically, there remain gaps in our understanding of the true nature of their work. As a result, the expertise which is needed to carry out the job and the way the job is considered within the broader category of support staff is underestimated.

As a way to fill this gap in our knowledge and understanding, this chapter provides evidence about the school science technician using data from the survey; from the websites, and from job descriptions. Although some information concerning the survey and the management of data from the websites has already been given this introductory section includes more information about the STs using the websites to increase knowledge about them and increase the validity of the evidence.

The information relates only to STs who posted questions or answers during the collection period (participants). Other STs who were registered on the site are not included because they were not actively participating by posting questions or replies at this time (non-participants). There appeared to be no significant differences between participants and non-participants with reference to their job title, gender, location, or how long they had been a member of a site. Information on the age of the STs was not included on the sites.

At the time of the survey 38 participating STs were members of both sites (A and B). This group had a range of job titles and there was no particular difference between STs with dual membership and STs who belonged to only one site. During the time of the collection of the data, 368 technicians posted questions or answers to questions; site A had 223 participating members and site B had 145 participating members.

Some participating STs posted more often than others. Of the ten highest posters on site ‘A’, nine were senior technicians or higher and one was a science technician. For the ten highest posters on site ‘B’, eight were senior technicians or higher and two were science technicians. Both groups were made up of six males and four females. As the majority of technicians are female this could suggest that the male voice is disproportionately represented but could have been a result of the type of questions asked during the collection period. Three technicians were in the group of highest posters on both sites. Other posters were also very active, posting more than fifty times during the collection period. table 4.1 shows the number and type of technicians in this group.

Table 4.1

Number of Participants who posted more than fifty posts but were not in the top ten posters						
Site	Technician	Biology technician	Chemistry technician	Physics technician	Senior technician	Lead/chief technician
Site A	18	0	4	3	12	2
Site B	17	4	6	2	12	2

Site ‘A’ appears to have a smaller number of members with over 50 posts than site ‘B’. The quality of the posts was not assessed because the nature of the reply varied according to the subject of the question. However as would be expected of a professional website, the replies were of a professional nature.

Site ‘A’ was created in 2004, site B was created in 2008. Table 4.2 shows the year that participating technicians had joined the websites.

Table 4.2

The year that technicians who participated joined the websites							
Year	2004	2005	2006	2007	2008	2009	2010
Site A	43	24	18	32	44	38	25
Site B	-	-	-	-	96	38	33

The large number joining site ‘B’ in 2008 was partly as a result of the existence of the new site being posted on site ‘A’. There was no significant difference between the number of posts made and the length of time that the technicians had been a member of the site. Apart from the difference in the numbers with more than 50 posts which could be due to the larger number of active participants on site A the websites appear to be similar.

4.1 Demographic data about science technicians

This section provides information about the STs provided by the 145 STs who submitted replies to the survey and by those who participated on the websites. This information is important as it provides evidence to show that there are gaps in the knowledge needed to understand who the ST is.

4.1.1 STs as an ageing profession

Previous surveys have shown that STs are an ageing population. Table 4.3 adds to this information by combining age and job titles from the survey.

Table 4.3

Table to show the age and job titles of STs				
Job titles of Technician	Age of Technician			
	<24	25-34	35-45	46+
Chief Technician				5 (100%)
Senior Technician		2 (4%)	5 (10%)	45 (87%)
Technician	4(5%)	12(14%)	29 (33%)	43 (49%)
Total as a percentage	4%	7%	22%	79%

Of the 88 STs who described themselves as technicians 21 had specific areas of responsibility stating they were biology (11) chemistry (6) or physics (4) technicians. The majority (18) worked with two other technicians and experience suggests that this means that there was a technician for each subject, biology, chemistry and physics in the school. Of this group 10 were aged over 46+ years (47%) and 6 were aged 35-45 years (21%), 2 were aged 25-34 years and 1 was aged under 24 years. This is similar pattern to that of the technician group rather than that of the senior group.

Replies to the question on the survey asking how many STs worked in their school showed that sixteen technicians worked alone. Of these STs none were aged under 24 years, three were aged 25-34 years (18%), five were aged 35-45 years (31%) and 8 were aged over 45 years (50%). The group of lone technicians is small but they show a similar pattern in age distribution to the larger survey: the majority of STs being aged over 35 years and the highest proportion being aged over 46 years. Surprisingly five technicians had a senior title, this also reflects the number of senior technicians in the rest of the survey, but as noted in Chapter Two this is usually an indication of supervision of other technicians. A possible explanation is that as these STs had all worked in the school for over ten years, the school used to have more technicians.

This lack of younger entrants was noted on the websites by STs 7d, 12b, and 14i.

- ST 12b commented: 'due to the scarcity of jobs for new graduates there may be a few youngsters who join, but they don't stay long'

- ST14i added 'when one [younger applicant] applied they were discounted because it was felt they would use the job as something to do until a better one came up'

which supports the view of 12b.

As with previous surveys this survey indicated that young people are in the minority showing that only 12% of the respondents were aged under 35 years, in all previous surveys around 30% were aged under 40 years, with the exception of the latest (ASE 2010a) survey where the figure had dropped to under 20%. The peak age for STs showed a shift from being aged 35-45 years (2002) to being aged 51-60 years (2010a) this survey using a different age range showed that the majority of STs were aged over 46 years. This indicates that the ST population is ageing and there is little recruitment from the younger age groups. This questionnaire showed that 64% of STs were aged over 46 years.

The previous surveys noted in chapter One (CLEAPSS, 2002, 2007, 2009; ASE, 1994, 2006, 2007a, 2007b, 2009, 2010a) have shown STs as an ageing workforce with a lack of younger people in the profession which is confirmed in this survey. However using a slightly different age range the lack of younger entrants is shown to be amongst the aged under 35years, not those under 31 years of age as might be suggested by the earlier figures.

The figures in the older surveys can only be regarded as an indication as STs were not specifically asked about their job titles. It is therefore possible that the surveys were completed by STs who were the most senior and perhaps the oldest in the department which may have caused bias. The Royal Society/ ASE (2001) asked for the survey to be given to the senior technician but participants were not asked to confirm that this was the case. This survey asked the respondents for their job title and this showed that around a third the job titles of respondents was senior or above. This is important information as, as shown in table 4.1, the majority of seniors who responded to this survey were in the 46+ age group. However, nearly two thirds of the respondents were technicians. The results showed that 49% were aged 46+ years, 33% were aged 35-45 years, 7% were aged 25-34 years and 4% were under 24 years of age. These figures are similar to the figures of previous surveys. This survey shows that the population is still ageing as suggested by previous surveys, but also that there is a hidden demographic which shows that there are very few senior or chief technicians aged under 46 years.

The websites did not contain the ages of STs, but table 4.4 overleaf shows the job titles of participating technicians on sites A and B. This shows that there was little difference in the percentages of the participants on websites 'A' and 'B'; except for the numbers of specialist technicians. The percentage of chief technicians is the same as that in table 4.3. However the figure for senior technicians is lower and that for technicians is higher. A comparison of the results of the survey and those of the participating members of websites

‘A’ and ‘B’ showed the survey had a lower percentage of replies from technicians and an increased percentage of replies from senior technicians. A possible explanation is that as table 4.4 reflects the use of the websites the difference could be due to participation, with a greater number of technicians requesting advice on the websites.

Table 4.4

The job titles of the participating technicians on websites A and B.						
Title	Technician	Biology technician	Chemistry technician	Physics technician	Senior technician	Lead/chief technician
Site A	124 (55%)	10 (4%)	11 (5%)	14 (6%)	50 (22%)	14 (6%)
Site B	76 (46%)	20 (12%)	18 (11%)	10 (6%)	34 (20%)	9 (5%)

website ‘A’ 223 participating members, website ‘B’ 167 participating members

4.1.2 Previous employment of technicians

Since previous surveys did not seek information about STs’ previous employment, the survey in this study addressed this gap. This information is important as it establishes the origin of STs so that more can be known about who the ST is, their knowledge and their expertise. For this reason STs were asked if they had had a previous job, and if so, what that job was. The results are shown in table 4.5 overleaf. Table 4.3 has shown that there were only 4 STs aged under 24 years, two of these had a previous job, (food microbiology and a temporary job in administration). Of the 13 STs aged 25-34 years seven had a previous job, five of which were science based (microbiology, pharmaceutical research, horticulture, health, environmental chemist). For those STs aged 35-45 years (34 STs) and those STs aged 46+

years (92 STs) the figures show that most STs who completed the questionnaire had had a previous job.

Table 4.5

Percentage of technicians who had a previous job				
Age range	<24	25-34	35-45	46+
Percentage	50%	62%	94%	93%

STs were also asked in the survey why they left that job. They were given two examples of reasons: ‘family commitments’ and ‘wanted a change’ with the option of adding another reason if they wished to do so. The reason was to find out how many found their previous work was not a job most suited to their family life. Because although STs were not asked about their previous work in previous surveys, these surveys suggested this was a possible reason many women became STs. Table 4.6 shows the results.

Table 4.6

Reason given by STs for leaving their previous job			
Reason for leaving job	Number of technicians citing this reason	Percentage of technicians who had a previous job	Percentage of total workforce
Redundancy	12	10%	8%
Semi-retirement	2	2%	1%
Family reasons	79	62%	53%
Wanted a change	12	9%	8%
Other (a range of answers given)	23	18%	15%
no previous job	18	-	12%

Table 4.6 shows that over half of the technicians who answered the question cited ‘family reasons’ as the reason they left their previous job with some technicians specifically stating on their survey (4, 6, 23, 46, 56) that this was due to pregnancy or that school hours were important factors. Technicians also commented on this aspect on the websites stating for example that:

- ‘fulltime, all year round employment was not an option’ (16i)

- ‘as is the case with many other techs when I started the job it suited my personal circumstances…children of school age’ (o1)

- ‘when my youngest reached school age I replied to an advert for a lab tech in a school and have been here ever since. I used to work in [a laboratory in industry]’ (12b)

- ‘stayed at home until daughter went to school [previous job in industry] got a job at nearby secondary school so I’d have the holidays’ (7d)

- ‘I originally took this job so that I could have holidays with my children’ (15i)

One ST noted ‘I accepted the low wage because it suited me to have the school holidays at home with my children’ (13i). The issue of the salary associated with the job is considered further in Chapter Seven.

Other reasons given included ‘moving house’ (64, 9), ‘the previous post was a temporary job’ (49, 92, 119) and ‘for more sociable hours’ (73, 80) one ST (83) suggested at the time they moved ‘it was easy to change jobs’(83).

Table 4.6 also revealed that 12% of STs who responded to the questionnaire stated that redundancy (10%) or semi-retirement (2%) was their reason for leaving their previous posts. Of these technicians, 7 had been in post for less than 6 years and only one of these had a previous job title that was not indicative of an obviously science based job.

Experience had suggested that technicians tended to stay in post for a number of years. Table 4.7 shows the length of time the percentage of STs who returned the survey have worked in schools.

Table 4.7

Years working in school and the percentage of technicians in that range								
Years worked in school	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40
Percentage of STs	24%	18%	22%	15%	7%	5%	2%	3%

This shows that technicians are likely to remain in post for some time with a drop in numbers after 20 years. Technicians (d1, 7a, 8a, s2, 24c, 10c), all female, commented on the website that even though they no longer needed the holidays for childcare they had become used to the longer breaks and therefore remained working as STs. Retention of STs is useful because STs will be more able to anticipate requests with knowledge of the syllabus. It could be suggested that this may stifle innovation, but Chapter Five shows STs work to improve and invent practical activities to give students the best possible experience of practical work, aiding the advancement of science as a dynamic subject.

The previous job titles supplied by STs indicated the type of work they undertook. Table 4.8 shows the number of technicians who previously worked in science and cited 'family reasons' as their reason for leaving. The figures show that a large percentage of technicians who had been working in school between six and twenty five years had cited 'family reasons' for the reason they left their previous science based job.

Table 4.8

Number of technicians who cited 'family reasons' as the reason why they left their previous job and who previously worked in science								
Years in school	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40
Number of technicians	11	19	18	16	9	0	0	1
Percentage of Technicians	57%	90%	90%	100%	100%	0%	0%	50%

As women constitute the majority of STs it could be considered that gender is an important issue, and comments above suggest this is a possibility as the need for childcare makes working in a school attractive as it allows time off during the school holidays.

Science work in laboratories has in my experience not been family friendly until fairly recently when part time and job share became available:

- a former medical laboratory scientist (5a) noted that they worked in a school as it fitted in with child care

Others commented on the convenience of the holidays stating, for example:

- 'it suits them with school term dates for their children's sake' (g5)

- 'I started here simply because it was the only interesting job I could get that fitted in with my children's school hours' (11b)

- 11b also added that 'the only recruits in all the time I have been here have been mothers with working partners'

Nevertheless the majority of STs have worked in science and may have a preference for work that is scientific, and although working in a school is useful other factors may also be important. To gather information in this area a question on the survey asked STs to state the best and worst aspects of their work. Apart from asking the technicians to think about the positive and negative aspects in the questionnaire there were no other prompts. Tables 4.9 and 4.10 on the next pages show the results: and it can be seen that there was more variety in the negative aspects of the job where some aspects were noted by several technicians. These included: lack of organisation amongst teachers; lack of recognition of the complexity and the amount of work done, and the views of teachers outside the department on the role of the technician. These comments suggest that technicians find aspects that diminish the professional nature of their work dissatisfying.

Table 4.9

Best aspects of the job	
Reason given	Number
Trying new practicals	28
Helping students when possible	20
Helping teachers with new practicals	9
Research	9
HOD	1
Freedom to include additional experiments	4
Can extend/ rewrite experiments	5
Flexibility/ planning own day etc.	22
Using science skills	4
Interesting	2
worthwhile	3
holidays	8
Being part of a dedicated team and committed team helping students	22
variety	53
appreciation	5
All of it	1
Classroom demos	1
Respect and appreciation from science teachers	3

Table 4.10

Worst aspects of the job	
Reason given	number
Lack of communication	8
Not having status of teaching staff	8
Dealing with staff	11
Lack of training, not knowing enough	2
School politics	2
Solitary working, loneliness	1
Practicals not being done	3
pay	8
Frustration at lack of practical skills in teachers	1
Lack of appreciation for complexity of work done	17
Lack of appreciation for amount of work done on a higher level	16
none	3
Taking big pracs to distant labs	1
Long periods with nothing to do	1
Forced time off	1
photocopying	4
Disorganised teachers	27
Teachers inability to value equipment	9
Journey to work	1
Lack of time	15
Sorting out worksheets	5
Impression of teachers outside the dept. who think we only photocopy and wash up	18
Lack of space – prep room and labs	1
Badly behaved pupils	2
Washing up	9
Petty vandalism and graffiti	3
No recognition for work done	14
Delivering cover work when teacher is away	1
Juggling small budget	1
lack of career prospects	1
Treated as PA by teachers	10

4.1.3 The qualifications of technicians

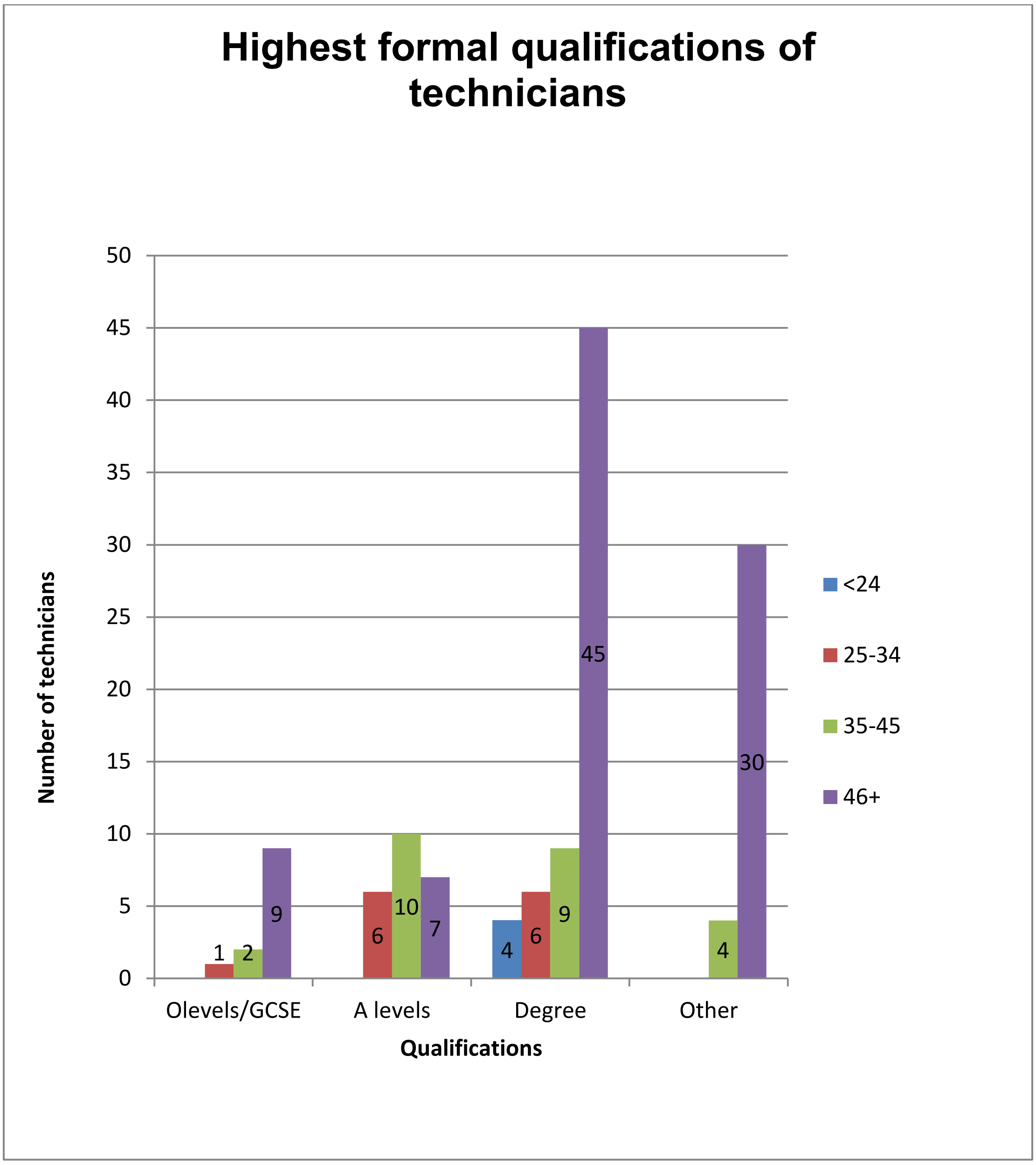
Although the numbers of technicians who work in school who have previously worked in science is high, previous surveys have expressed doubts about the knowledge of STs suggesting that their qualifications are not relevant, or of a high enough level. For this reason STs were asked to state their qualifications as a way of comparing the participants of this study with those of previous studies. In doing so the evidence in this section also sheds light on the relationship between the qualifications of STs, the qualifications expected for the job and the expertise actually required at each level of responsibility.

The survey asked technicians about their qualifications and the results of the highest qualification noted by individual STs are shown in chart 4.1 overleaf.

Of the twelve technicians whose highest qualifications were ‘O’ levels or GCSE nine were aged 45+ years, all had been working as STs for over ten years and three were senior technicians (1 male, 2 female) Of the twenty four technicians whose highest qualification was ‘A’ levels ten had worked in schools for over ten years.

Most job descriptions at the time of collection specified that at least ‘A’ levels in a science subject were required. Nearly half of the STs who responded had a degree with over 70% having a degree or ’other’ qualification.

Chart 4.1



Nearly half of the STs who responded had a degree with over 70% having a degree or 'other' qualification. Conversations I have had with technicians at meetings suggest that it was common for STs to have worked in medical laboratories before taking up posts in schools. They would have selected 'other' in this survey because at the time they were employed in schools, which can be deduced from their length of time in post at the time of the survey there was no degree offered in this discipline. Qualifications were monitored by the Institute of Medical Laboratory Sciences (Now the Institute of Biomedical Sciences) which provided the training route and the accreditation. The Associate qualification was the HNC in medical laboratory subjects and was equivalent to a degree in a science subject plus one year working in a medical laboratory (the criteria used at the time for the granting of associate membership for those who entered the profession with a degree in an appropriate area). The Fellowship qualification, which would be obtained in their chosen discipline within medical laboratory work, is comparable to a masters qualification but would have been recorded as 'other'.

Until fairly recently part time work in medical laboratories was rare therefore work as a school science technician, which fitted well with childcare and was science based was an attractive option and was the route taken by myself and other STs with a background in medical laboratory work with whom I have spoken. A typical comment was 'I gave up my job as a MLSO in a hospital for a school job that I could work around my daughter when she started school' (14i).

STs therefore appear to be well qualified for their work, but Chapter One has shown that their work is not well known. Without knowledge of the true nature of their role and responsibilities and the expertise they bring with them from their previous employment, the qualifications needed to perform their role cannot be appreciated. It may also have resulted in little need to determine what STs do and what scientific understanding is needed to undertake the work. When completing the survey, 17 technicians specifically stated that they considered that this lack of knowledge of the work of the technician was one of the worst aspects of their job with comments such as:

- 'difficult senior managers who have no idea [about the work]' (66)

- ‘dealing with senior management who has no idea what our job involves’ (73)
- ‘lack of respect from management’ (76)
- ‘lack of understanding from management and the rest of the staff about what we actually do’ (87)

Comments were also made on the websites about the lack of knowledge about the job, and two comments taken from website ‘A’ illustrate the problem that arises through lack of knowledge of the work undertaken:

> Senior management don’t actually appreciate/understand/know what we do. When the last chemistry tech left I commented that it would be hard to find a replacement. The response was – oh, do you think so? Why is that then? Surely someone with a bit of science background could do it.
>
> Technician 8j
>
> and
>
> When I said I was retiring, but would stay on for a while to show the new person the ropes the answer was – oh that doesn’t matter surely you don’t have to know much to be a lab tech, just how to wash up test tubes- anyone can do that
>
> Technician 7j

suggesting that the level of knowledge required at each level of responsibility is underestimated. This can lead to the assumption that STs are unqualified staff as shown by the quotes (8j, 7j).

The suggested structure of the qualifications needed with four levels produced by the ASE (2010b) and shown in Chapter One (table 1.4) is reproduced here in a simplified form in table 4.11 and shows their views on the qualifications are considered necessary to undertake the work.

Table 4.11

Table of qualifications suggested by ASE for STs	
Level	Qualification required
Level 1 (NCC) or Assistant Technician	NVQ level 1 which is equivalent to GCSE, basic literacy and numeracy or BTEC.
Level 2 (NCC) or Technician level	NVQ level 2 which is equivalent to BTEC or 1'A' level
Level 3 (NCC) or Senior Technician	NVQ level 3 which is equivalent to City and Guilds level three, or 2+ 'A' levels.
Level 4 (NCC) or Team Leader Technician	NVQ level 4 which is equivalent to a foundation degree or HNC.

None of the work undertaken by STs is considered to need a degree: yet 70% have a degree or equivalent, and over 90% have 'A' levels.

It could be considered that although STs have higher qualifications, these are not needed for their role. The work required of STs and detailed in their job descriptions should match the work required with the grade allocated to the post. The work should also be reflected in the position of STs in the single status agreement and therefore in their pay scales. The next section gives information in these areas.

4.2 Job descriptions, pay and the single status agreement

4.2.1 Job descriptions of STs

A request for job descriptions was posted on the websites in 2011 and 25 job descriptions which came from different areas of England including London, East Anglia, the North East, the South West and the Midlands were received. Examination of the 25 job descriptions showed that they contained a mixture of 83 different tasks and that tasks were randomly allocated to grades. Although the job descriptions have not been included to preserve anonymity of the STs who supplied them, table 4.12 overleaf shows 24 tasks that appeared at least 7 of the job descriptions, the grade in which they appeared and the number of times that task appeared in each grade. The total number of job descriptions received for each level appears in brackets. It shows the difficulty of producing a job description without a good knowledge of the work required of the ST and of the knowledge needed by the ST to perform the tasks.

The table also shows that not all the tasks relate to prep room work. CLEAPSS (2002) suggests that tasks such as paperwork for coursework and trips, keeping departmental records, and photocopying that are undertaken by administration staff or teachers in other departments should not be included in ST job descriptions. Most of these items were included in more than one job description: 7 included photocopying. This not to imply that STs never do these tasks, but to include them as part of their duties can have a detrimental effect on their real work, which is to use their expertise to give the best possible experience of practical work to students and to enable teachers to concentrate on teaching.

Table 4.12

The most common inclusions in technician job descriptions				
	Grade, level and the number of job descriptions received for each level			Total
	Technician Level 2 (11)	Senior technician Level 3 (11)	Principal Technician Level 4 (3)	25
Prepare equipment	11	10	1	22
Maintain equipment	10	10	2	22
Identify and report H&S issues to create and maintain environment	8	9	3	20
Catalogue resources undertake audits	9	8	2	19
Design equipment	9	7	2	18
Monitor and manage stocks within an agreed budget	6	8	2	16
Check/maintain/setup ICT equipment	8	5	3	16
Provide specialist advice and guidance to service users including non-specialist teachers	7	7	1	15
Admin stationary/books/invoices/data	7	5	1	13
Local purchases	6	5	1	12
Contribute to recommendations towards budget planning	4	6	1	11
Equipment safe for use, chemicals labelled etc.	5	5	1	11
Assist in development of lesson/work plans	3	6	1	10
Undertake repairs/modifications or arrange for others to do so	6	3	1	10
Support pupils in the classroom	5	4		9
The post holder will be expected to take part in relevant training	6	3		9
Disposal of waste	3	5	1	9
Trial experiments	4	5		9
Responsible for safe storage of chemicals	3	4	1	8
Handle money	3	3	2	8
Cleaning laboratories	5	3		8
Assist teachers with demonstrations in lessons where this is required	4	3		7
Prepare solutions	5	2		7
Photocopying	5	2		7

Fifteen job descriptions required technicians to ‘provide specialist advice and guidance to service users including non-specialist teachers’. If the qualifications for technicians and senior technicians only have ‘A’ levels as suggested in table 4.11 this would not equip them to provide specialist advice. However as shown in chart 4.1 the majority of STs do have qualifications which exceed those set out in the levels used to determine their salary and therefore have the knowledge needed to provide this guidance. This requirement relies on a supply of STs with higher qualifications than are considered necessary to do the work not as suggested earlier in section 4.1.4, ‘a bit of science’ (8j) or someone who can ‘wash test tubes’ (7j).

Nine job descriptions required the technician ‘to support students in the classroom’. Three specified that this should be for practical work, one specified both practical and classroom work. The use of the word ‘classroom’ to mean ‘laboratory’ is, in my experience common parlance for those not in the school science department. I think therefore the job descriptions refer to work outside the ‘prep room’ and use ‘practical’ and ‘classroom’ to distinguish between practical and theoretical work in the laboratory. STs may be willing to go into the laboratory and table 4.13 overleaf shows the number of STs who will work in the laboratory under a number of scenarios

The results show only a third of STs would supervise students in the laboratory, although approximately two thirds would go into the laboratory for other reasons. However some STs also taught students. 18% of STs said they taught individual students, one (135) stating that this was for sixth form chemistry. 18% taught small sixth form groups, one (42) stating that they taught specific skills using knowledge from previous work, and another (97) noted that this was for ‘A’ level biology and chemistry.

Table 4.13

Scenarios under which STs would go into the laboratory						
	yes		no		blank	
	number	%	number	%	number	%
As another adult*	99	68	46	32	0	0
Look after specific aspects**	90	62	50	34	5	3
Demonstrate experiments***	91	63	49	34	5	3
Supervise small groups of children****	53	37	91	63	1	<1

ST added the following comments to their answers

*'rarely' (12, 38)

**'only to teacher in prep room' (12), 'occasionally' (72)

***'for cover teacher if too scary for teacher' (107) 'maybe' (27)

****'only A2 projects' (56), 'v rarely' (12, 32), 'transition for year 6' (12)

Items such as designing and preparing equipment, providing advice, and budgeting and local purchases are applied inconsistently, appearing in level two (science technician) and level three (senior laboratory technician) jobs. The inclusion in more than one level means that science technicians could be expected to work at the higher level whilst being paid at the lower level. The next section considers aspects of pay.

4.2.2 Aspects of pay

Job descriptions usually had an indication of the wage band but for some this related to local council scales and therefore of little use to STs outside the area. The title of the post had little correspondence with a particular band, range of tasks or salary, suggesting a degree of confusion about which task should be allocated to which level. Some job descriptions noted the *pro rata* payment, whilst others did not state whether the amount quoted would be the salary received or the 52 week equivalent. This could suggest that the post was more highly paid. For example one job quoted the salary that would be received for a 37 hour 52 week contact (£17872) and the reduced salary for the actual job (£13178) although the actual hours to be worked were not stated. A second example from the same data set showed that the £19427-£23473 salary was reduced to £17185 - £20765 for the 37 hour term time +1 week. Technicians have commented on their pay on the website stating

- 'I love my job but I work for the money, it's a means to an end for me so I can afford to live, I don't work for pin money, most people don't'. (14a)

- 'for some we are the sole wage earner for various reasons. I see the low wages and the inability of technicians to make it a living wage a huge threat to us as a body, thereby losing good hardworking well qualified people' (g5)

Others (p1, x1, 2a, 8a) commented that the wage was making the job untenable.

Contracts of all support staff vary both between and within schools, Questions regularly appear on the websites from technicians asking how they can work out what their salary should be (21g, 16b, 14a) because the lack of uniformity means individuals need to perform their own calculation. There is a formula that is noted in CLEAPSS (2009) which can be used, but it does not aid those who wish to know how much holiday pay is included, whether or not they are paid for all bank holidays or just a portion or the effect this has on sick pay. It may appear that this could be easily solved by consulting those in charge of salaries, but experience suggests this is an area where they are also unsure of the answer. To illustrate the problem STs were asked to provide details of the hours they worked per week and the number of weeks they worked per year and table 4.14 overleaf shows the number of weeks worked per year, the number of technicians in that group and their average hours per week. The figures have been averaged only where STs in the group worked roughly the same number of hours because it is important that the wide variation can be seen. Part time ST hours are shown in bold

The evidence in the table shows the variation in the number of weeks per year worked by technicians. These can be explained as follows:

- figures below 38 weeks may indicate that the school may not follow the usual 38 week pattern of state schools or that the ST does not work all the weeks when the school is open

- 38 weeks or above apply to a range of school types including academies. 38 week contracts mean that the science technician is employed only for the weeks the school is open to students

- 39 weeks usually means that they also work on teacher training days, and anything above that means they are working when there are no students in school and teachers are not expected to attend

Table 4.14

The variation in hours of technician contracts		
Number of weeks per year	Number of respondents in this category	Number of hours worked per week by the respondent to this study
29	2	1x34. 1x35
33	1	37.5
33.5	1	37.5
34	1	37
35	3	**1x12,** 1x34.5, 1x37
36	3	40, 37, 35
37	3	2x37, 1x30
38	16	**1x15, 1x20, 1x22,**the average of the rest of STs in this group was 35.6
39	36	**1x15,** 7x30, the average of the rest of the STs in this group was 35.3
40	20	Average 35
41	4	**1x20**, 1x37, 1x40, 1x32
42	11	Average 36.6
43.4	2	34.5
44	5	4x37, 1x41.5
46	3	2x35, 1x37,
47	2	1x37, 1x37.5
48	1	44
52	24	35

The number of hours also varied.

- 30 hours a week: STs are only employed for the school day.
- 35 hours: STs may be present for 30 minutes at each end of the day or 1 hour after school. Time is needed to clear laboratories at the end of the day and replenish them for the morning. Time in the morning may be needed to prepare materials that cannot be prepared in advance such as the microbiology experiments

Hours above the average normal working week of 37.5 hours are a result of the technician working longer than expected on the days when the school is open which is reduced when averaged over the whole year. Some or all of these extra hours are given to the technician in the form of extra weeks, for example the technician may have a 42 week contract. The technician may be allowed to use the hours of these extra weeks to enable them to work longer hours during the time the school is open. This can benefit both the technician and the school as the technician can use the extra time as necessary for example to set up large practical exams after school for the following morning or clear away after an afternoon exam but still be free during the school holidays.

The disadvantage is that this semi structured work pattern can be varied at will which makes it easy for a school to change contracts and reduce hours when a technician leaves. Website evidence from technicians (25i, 1j, p1, c2, 8a, 11a, 24c, 7d, d1, w1, s2, k3).) shows that:

- when technicians have left they have not been replaced

- 52 week 37 hour contracts have been reduced in weeks and/ or hours

- term time plus teacher training days have been reduced to term time only

- full time (meaning full time when the school is open) have been reduced to part time posts

Without knowledge of the work undertaken by STs there is little idea of the consequences that these changes will have on practical work in the science department which affects the ability of the technician to complete their work within the time available without doing unpaid overtime. It was noted in Chapter One that 70% of STs work overtime.

4.2.3 The Single status agreement

Lack of knowledge has also noticeable when regrading STs in the single status agreement. This is considered in more detail in Chapter Seven however as this should reflect their level and their pay two comments are included here to show that the lack of knowledge also affects ST grades in other ways.

One technician stated:

> The use of chemicals' appears at grade 7. Anyone any ideas then as to how I do my job??? My new grade is 5, and the word "senior" isn't in my job title.
>
> Technician I2

Another technician who previously had also had a science based job and had responsibility for other STs commented:

> Out of curiosity I had a look and have discovered that I am only on a grade 3 pay scale (technician) I have worked in education for over 10 years now for its convenient working hours with a family, and in ignorance, just accepted low pay as a fact of life.
>
> Technician 17h

This section has used job descriptions to show that the work expected of STs varies considerably and jobs are not grade specific. This makes it difficult for technicians to compare their roles. The variation in the number of hours and the number of weeks worked has been shown. This is also an issue, not only because it makes it difficult for STs to ensure they are receiving the correct payment for the work done, but also as noted by STs, it makes it easier for hours to be varied when STs leave. Lack of knowledge of the work has also affected their position within the new single status agreement.

Although STs have been shown to be well qualified, as with teachers the opportunity to meet and receive training is important for personal development and updating knowledge. The final section of this chapter shows the findings on training opportunities provided by the survey and introduces the use of the ST websites as a source of training and knowledge.

The final section is about training and support for technicians.

4.3 Training and support for technicians

Technicians bring knowledge to their work, but as with other professionals in school they need training to keep up to date with the latest health and safety issues and with changes to the curriculum content. They also need to learn new techniques or refresh their memory on aspects of their work. For example, the Single Status Agreement (SSA) suggests that chemicals are handled ‘but hazardous materials are only occasionally used’. Chapter Five will show that this is an underestimation of the type of chemicals encountered by technicians. The SSA also states that chemicals need to be handled ‘according to health and safety procedures’, but does not specify how this knowledge is to be obtained by the ST.

The training needed by technicians is not the same as that needed by teachers because, for example, technicians handle chemicals at a more dangerous concentration than are usually supplied to laboratories and the quantities are larger. STs also need to know the way apparatus used in the laboratories works, the safe disposal of waste products, problems with experiments encountered by other STs and need a place to work together to solve problems, address accidents and depending upon the situation, pass information onto teachers. Data about training needs was collected through the questionnaire specifically to discover whether STs had the opportunity to attend or join a support group in their area and if they were encouraged to attend courses. Table 4.15 shows how many technicians had these opportunities

Table 4.15

STs with access to two specific sources of information						
	Yes		No		Blank	
	Number	%	Number	%	Number	%
Are you encouraged to attend courses?	101	70	35	24	9	6
Do you have a support group in your area?	57	39	86	59	2	1

70% of technicians who took part in the questionnaire (2009) were encouraged to attend courses. However more recent postings on the website (2010) gave a different picture and indicated that technicians may now be less likely to be encouraged to attend courses.

Typical comments included;

- 'CLEAPSS do seem to be running more courses, but funding will be an issue.' (14b)
- 'No courses allowed at the moment, even though it won't cost them because of the bursary' (2b)
- 'They really don't like us going on courses' (9h)
- 'I have filled out the paperwork to go on a course but it is very likely I will not be allowed to go' (3a)

Technicians may therefore find that attending training courses is closed to them even if it is advertised. Local groups could provide training but nearly 60% of technicians had no access to a group which means that STs who work alone have no opportunity to meet with other technicians to discuss their work. One noted:

> Over the years I noticed with the decline of the GLC and other local authorities there was less and less contact and support for technicians and little opportunity for networking and discussing problems.
>
> Technician (4a)

There are other barriers to attending courses. If STs work in a school because it fits in with the school day they may only be able to attend courses that start and finish within that timeframe. This limits the distance that can be travelled and the length of course that can be attended. Pressure of work may also affect the ability of technicians to attend courses. A typical comment was 'I am a lone tech, no chance of attending any courses ever, plus we are only technicians, sadly'. (26b). Technicians have therefore lost or have reduced access to two sources of training and support. However STs now have another means of communication, that is their professional websites. The use of the websites as a means of training and support emerged from the research and the evidence of its value is shown in the next chapters where the ways in which the websites replace this loss and provide a substitute for the training and support that used to be available by attending meetings will be revealed.

The type of community generated by STs will be considered in Chapter Eight and further research in this area will be noted in Chapter Nine. One of the advantages of the use of the websites as a source of material was that it was possible to post on the site to ask for clarification on the thoughts of STs on their use of the sites.

4.4 Conclusion

This chapter began with demographic details about STs. Age and gender were included which could be compared with previous surveys. Further information was added to give more information about STs including: their previous employment; their qualifications and their opinion on the best and worst aspects of their job. Job descriptions and aspects that affect their daily life were then included. Finally their training opportunities were considered and their use of their websites was introduced. The next chapter concerns the use of their virtual community in their daily life.

Chapter 5: The use of the virtual community in the work of the science technician in the preparation of practical work.

Chapter Four gave information about STs using demographic data obtained via the survey to compare that provided by previous surveys reported in Chapter One, providing an opportunity for triangulation. Survey and website material was used to reveal: the qualifications of STs; their previous work, and the attraction of working in schools over their previous employment. The effect of the lack of knowledge of their work on the perceptions of the qualifications needed to undertake their work (ASE, 2010b), on their job descriptions and the hours they are offered were also included. Details were also provided about STs who were actively participating on the websites at the time of the data collection which introduced their virtual community. This was linked to their access to conventional training and support was noted and comments made by technicians about their access to courses were included.

The survey produced valuable data some of which could be compared with that of previous surveys. It provided evidence to suggest that the website population is representative of STs and other data added to the present knowledge of STs. However the websites provided an opportunity, as an insider with access to this 'hidden' world, to provide a deeper understanding of STs and as STs controlled the subjects discussed on the sites the material is an authentic account of the science technician at work. This chapter will draw from the 'virtual' voice of STs to explore and make visible the invisible or hidden work of the technician and will show the level of expertise needed by technicians to prepare practical work.

As noted in Chapter Four, at the time of the survey:

- 30% of participating STs were not encouraged to attend courses
- comments by STs suggested they would like to attend such events
- only 39% had access to a support group in their area

Attendance at courses not only provides training but also provides an opportunity to meet fellow STs. The lack of the chance to meet severely limits the help, advice and support that can be given by one ST to another. As well as providing insight into the work of STs, the role of the websites in providing an alternative channel of communication and collaboration between STs when help and advice is needed for practical work will aid the classification of the sites as a variation of a community of practice.

This chapter shows evidence of the way in which STs use the websites by showing examples of the professional discussions that take place. In this chapter the total numbers of STs who have contributed to the particular subjects used as examples (e.g. microbiology) are given. Where reference is made to specific questions and replies within this area the ST(s) concerned have been identified. As space has limited the areas within the subjects that can be included not all the questions and replies contributed to the specific areas used as examples and these STs have therefore not been specifically identified as they have not contributed to the discussions used. As it has been shown that many STs previously worked in medical laboratories experience suggests that two text books that may have been part of their training, Baker *et al.* (1970) and Gillian and Dodds (1972), along with specific courses relating to their qualifications and their specific work within medical laboratories may have been a source of some of their knowledge STs from other science backgrounds may similarly draw upon knowledge gained via their own professional bodies. CLEAPSS (2013) provides HazCcards to which STs may refer and also provides a helpline for subscribing schools. I have drawn own experience when indicating the work undertaken by pupils at each key stage in the following sections.

5.1 The use of the website as a means of collaboration between technicians.

A question about the safety or suitability of a particular experiment or the way to approach a particular practical might produce many solutions. These could include alternative experiments, warnings about problems that could occur or specific details of ways of reducing risk during preparation. This type of question is used in this section to illustrate the complexity of the work and the value of the sites. Although there is some commonality between the different areas of science, examples from each of the three disciplines, biology, chemistry and physics, have been used to allow the differences in the problems posed to be readily identified.

Technicians are indicated by their designated number as explained in Chapter Three, and for this section their grade is indicated by T (technician) S (senior technician) C (chief or team leader technician) in brackets after their number. This is so that the grades of questioner and the respondent(s) can be seen.

5.1.1 Preparing practicals for biology

The use of living organisms in biology in my experience can result in a lack of predictability of outcomes in experiments. At the time of this study the curriculum at Key Stage 3 (KS3) covered included topics such as: growth and development; respiration; the spread of disease and the environment. KS4 included topics such as: homeostasis; advanced work with plants; aspects of animal behaviour, and enzymes. KS5 included cell mitosis and advanced enzyme work such as the effect of inhibitors. The type and complexity of the practical work increases as students progress for instance at key stage 3 the presence of starch in a leaf may be tested and the test may be repeated on food materials: at key stage 4 the digestion of starch by an enzyme and the passage of the product (glucose) through visking tubing is studied.

Posts included a wide range of subjects including osmosis, dissection, and lung capacity and microbiology has been selected to illustrate the work of the ST in biology because the potential dangers show the way in which STs work together to ensure safety is maintained whilst still providing valuable experience for students.

5.1.1.1 The work involved in the preparation of microbiology practicals

Practical work appears in microbiology modules at key stages 3 (KS3) KS4 and KS5. Table 5.1 overleaf shows that twenty two questions were asked about microbiology. The majority of the questions were about the preparation of the basic microbiology practical and these are used in the narrative to explain the processes involved. Some questions posted contained queries about areas outside of the preparation of the standard plates. These are included to show the range of knowledge needed to ensure that practical work with bacteria is safe for students. It also shows the way in which STs work together on the websites, bringing evidence to classify the type of community that has been formed.

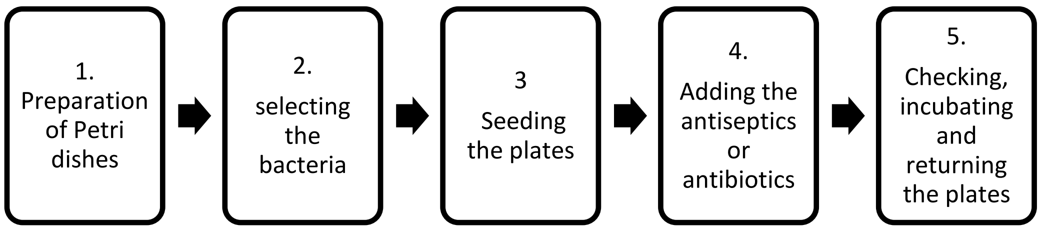
Table 5.1

Total number of questions related to microbiology			
Number of questions	replies	Advice given	Methods suggested
22	84	70	27

One object of microbiological practical work at KS3 and KS4 is to show control of bacterial growth. I have produced Figure 5.1 to show the basic stages in the preparation of a microbiological practical and issues that were raised that relate to these stages,

Figure 5.1

The stages in the preparation of a standard microbiology practical



1. The preparation of plates (Petri dishes) – Bacteria are grown on nutrient agar (standard agar plus nutrients which encourage general bacterial growth). In microbiology laboratories various nutrient mixes encourage the growth of specific bacteria in schools standard commercially produced nutrient agar is usually used.

Questions included:

- the best concentration to use (a4 (T)) answered by u3 (S), i2 (C), j2 (T), e1 (S)

- the type of medium required for specific bacteria (s2 (S) answered by i2 (C), f3 (T), t1 (T)

- the possibility of buying in plates due to lack of facilities (l3 (T), although the reply to the last question (q1 (T) pointed out that 'the problem of disposal would still need solving'

This element shows knowledge being sought from STs with more expertise in a particular area

2. Selecting the bacteria –Threads in the website discussion show questions about varieties of bacteria. A robust but non-pathogenic bacterium which grows easily is required. The bacteria that were thought most suitable were: an *E.Coli* variant (three senior (2a, g7, u2) and four technicians (g6, f3, q1, t1)) and *M. luteus,* (five senior technicians, (r1 ,g11, a2, g9) . Both grow easily in at room temperature. The merits of the *E. coli* variant: safe, but produces rather uninteresting colonies and no colour, and of *M. luteus*: safe, yellow colonies and easy to see, were discussed. The opinion of these STs was that although *M. luteus* is easier for the students to see and count, it may not have the same association with disease as the use of the *E. coli variant.* This, although harmless, would be equated with the *E. coli* strain that causes food poisoning. Using a bacterium that encourages student to relate their practical work with real life situations can encourage students to link their studies with food hygiene. This is an example of STs pooling their knowledge to enhance and advance practical work

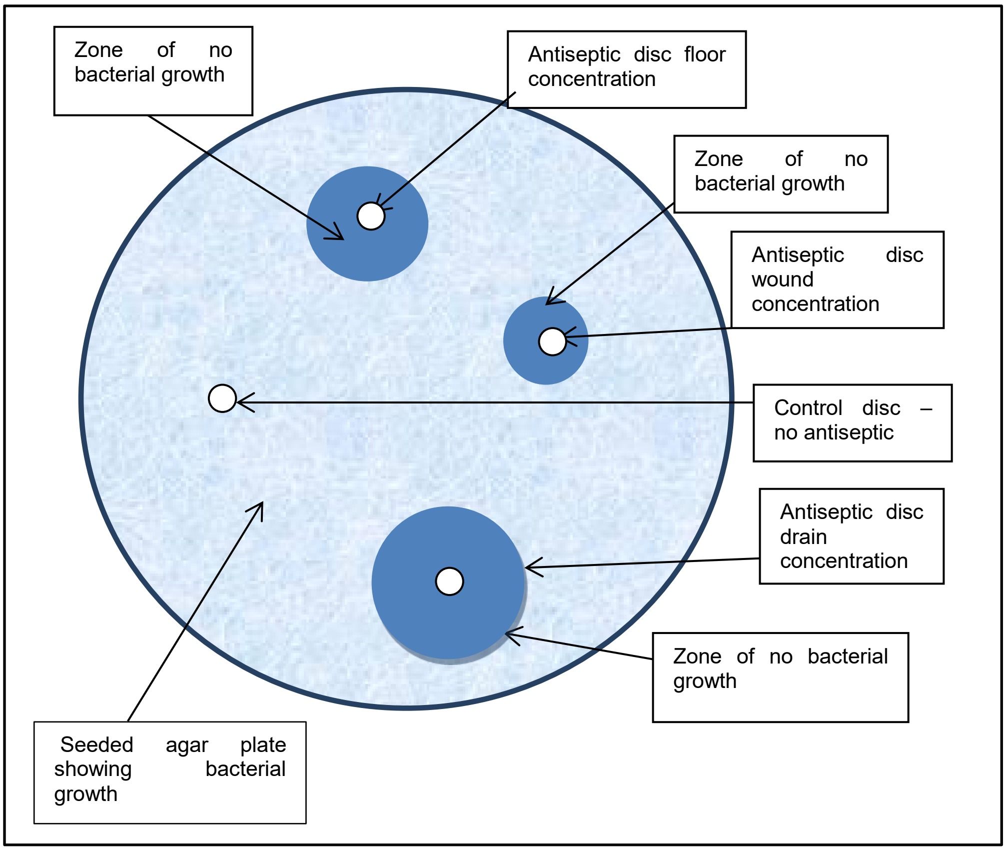
3. Seeding the plates – A standard technique used in microbiology laboratories, which requires either a small amount of the bacteria of choice to be added the cooled agar before pouring the plate, or applying a thin layer of bacteria in liquid agar to an already poured plate. The bacteria form a 'bacterial lawn' giving an even distribution over the whole surface. Both techniques need skill to ensure the correct temperatures and aseptic techniques are used throughout these processes. These tasks are completed in the prep room and the technical expertise needed is therefore invisible to others. The production of the plates can take up to an hour from the start to the delivery of the plates to the laboratory. This does not include any time spent in discussing problems or seeking advice from fellow technicians via the websites. A question relating to the preparation of seeded for the first lessons of the day.(question 18t (T) replies from 1h (T), 21h (T), 2a (S))arose because bacteria start to multiply as soon as they are added to the medium therefore plates must be used fairly promptly. A delay can result in bacterial growth being too rapid to be contained by the applied antibiotic discs and therefore no clear zones appear. Using their previous knowledge STs concluded that the class would have to wait for their plates as they could not be prepared and left overnight. Technicians have to know about bacterial growth to produce suitable safe plates for the experimentation.

4. Adding the antiseptics or antibiotics –Students transfer either commercially produced antibiotic discs, or discs soaked in solutions such as antiseptics, to the plates. One set of questions on each site related to sources of antibiotic discs, and blank discs to which solutions could be applied. Questions were raised by four technicians 10a (T), 6e (T), n3 (T), j1 (T) and answered by five technicians (25e, 3f, 10a, m3, g12) and three senior technicians (4j, h2, g2). The savings that could be made by preparing discs for use with antiseptics by using a hole-punch and chromatography paper were discussed by two technicians (q1 (T), m3 (T)) and one senior technician (g2 (S)) within the context of money saving measures.

5. Checking, incubating and returning the plates - after adding the discs students have to label and then seal the plates using tape strips. The plates are checked in the prep room. A question about the sealing of plates (9b, (T)) produced the most replies on the website (eight technicians (25e, 21a, 14b, 26b, 13c, 9d, 13d 1h) and six senior technicians(2a, 12d, 51e, 3g, 2h, 13i,)) who used previous knowledge of microbiological methods to discuss this problem as although instructions emphasise that only four small pieces of sellotape should be used, students often seal all the way round producing anaerobic conditions. Bacteria that grow under anaerobic conditions are more likely to be pathogenic and therefore a possible health and safety risk if students opened the plates. The health and safety issue was further debated by five technicians (8a, 11a, 13d, 14b, 9d,) and five senior technicians(2a, 11a, 2b, 19b 3g) and although technicians (8a (T), 19b (S) 9d (T)) thought that as incubation was at room temperature and the plates remained unopened when viewed by the students this was not a great risk, other technicians (2a (S), 11a (S) 3g (S)) suggested that if the rule for applying the sellotape was not followed there was no guarantee that the plates would not be opened. It was decided that for safety, technicians should reseal the plates using the correct technique to avoid problems. This is an example of technicians collaborating via the website to decide upon a course of action to ensure student safety.

Even though some experiments suggest using temperatures including body temperature plates are incubated at room temperature. STs use room temperature for incubation; as it lessens the risk of the growth of bacteria that may have been accidentally introduced that are pathogenic to humans and which therefore grow well at body temperature. No questions regarding this aspect appeared during the collection of this data but experience of previous questions shows that STs will use their previous knowledge to pass on this information to those not trained in microbiological techniques. STs also monitor the plates during growth to prevent the bacteria overwhelming the small amount of antiseptic or antibiotic present and colonising the whole plate and may also have to decide whether it is better to suspend growth at the outset or to risk leaving the plates out over the weekend if the plates are produced late in the week as the optimum incubation time is usually 2-3 days. I have produced Figure 5.2 to show a successful result of an experiment.

Figure 5.2 – A stylised result of a successful microbiology experiment that investigated a range of concentrations of an antiseptic (KS3)



The websites also served to solve an array of other questions related to microbiology including:

1. Sometimes textbooks still suggest growing random ‘wild’ bacteria - from sources such as soil and fingers to see what appears on the plates. Questions were asked (t1 (T), x1 (T), g18 (T)) concerning growing bacteria from soil. Technicians (d1 (S), h3 (T)) thought that it might be banned, but if still allowed anyone doing this needed to be very aware of health and safety considerations. Technicians who had worked in related fields (d2 (S), h3 (T), g2 (T)) were able to point out possible problems that could arise because of the risk of inadvertently growing potentially harmful bacteria. These concerns were passed on to teachers wishing to use these practicals. The advantages of using controlled practicals using antibiotics and antiseptics instead of allowing students to collect random samples that could potentially grow dangerous bacterial colonies were discussed. STs (p1 (C), a3 (S), g4 (S), g12 (T)) referred to previous knowledge about possible rogue bacteria which could cause problems if grown inadvertently. This information was discussed and could be retained or retrieved from the archives in order to inform and assist teachers planning bacterial experiments.

2. Antibacterial handwashes – The increasing use of antibacterial handwashes has resulted in experiments with handwashes and mouthwashes appearing in textbooks. Questions were asked (8a (T), 25b (T) (18c (S) s2 (S), concerning the use of these products which appeared ineffective against the usual bacteria used by STs to produce bacterial lawns. STs who had previous knowledge of microbiology 12a (S), 14b (T), 26b (T)) experimented with possible substitutes to solve this problem and reported to the group that *B. subtilis* was a good bacterium to use. A list of solutions which worked with *M. luteus* or *E. coli* was also made available as these are the ones usually used in microbiology practical work and would save the expense of buying in specific supplies for this experiment. Technicians (2a (S), 8a (T)) provided an alternative experiment for KS3 using various dilutions of Dettol which consistently produced a suitable pattern of results. This shows the way in which the websites facilitated collaboration between STs to produce viable practical work in schools

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Microbiological work requires a high level of knowledge of specialist techniques including selecting bacteria, the aseptic production of bacterial lawns, and of incubation temperatures in a school setting. Some of the replies drew on previous knowledge of microbiological techniques outside the school environment to provide useful and applicable information for technicians. This specialised knowledge also assisted in ensuring that safety was maintained during microbiological work in the laboratory. Technicians sourced the materials for experiments and also found ways to cut costs. Technicians (8a (T), 11a (T), 5e (S), 7d (S)) also commented that they explained microbiological techniques to the teachers, and some had produced information to supplement that found in textbooks so that students used the correct methods.

Microbiology is an area where previous knowledge is an essential resource. This query also shows the amount of knowledge needed to produce a safe and effective practical. Microbiology practicals may take students 30-40 minutes to complete but require a lot more technician time to produce. In Chapter Four it was suggested that there were a large number of technicians who had previously worked in medical laboratories. Microbiology is one of the four areas of this work and this could be a source of the knowledge that is available to STs via the websites.

The next section gives examples of the work of STs in chemistry.

5.1.2 Preparing practicals for chemistry

Chemistry deals with the composition structure and properties of matter and in my experience it is generally less capricious than biology. Chemistry practicals at KS3 cover: acids and alkalis; metals and their reaction with acids, and other areas are introduced. This work is extended at KS4 and other concepts and practical techniques are presented. At KS5 work is more advanced. The work of STs in chemistry may be considered by those outside their profession to be simply a matter of following instructions given by a teacher or found in textbooks as noted in a comment in Chapter Four. This is not the case. The preparation of experiments for student use or for demonstrations requires STs to have a high degree of practical knowledge. As would be expected many chemistry questions raised on the websites relate to the production of solutions, molarity, and safe handling. As a consequence only one answer may be required. The following paragraphs contain a summary derived from these questions.

Questions posed on the websites showed STs need specific knowledge to deal safely with chemicals which are dangerous at the concentrations at which they are found in the prep room and have to be reduced to safe levels for use in the school laboratories. General questions on dilutions were posed by eight STs (6a (T), 19a (T), 14b (S), 4d (T), n1 (T), x1 (T) m2 (T), h3 (T)) and replies were made by ten STs (11a (S), 10b (T), 19e (T), 19h (T), 3j (T), 4g (S), r1 (S), a2 (S) b2 (S), k2 (S)) some of these answered more than one query. Evidence from job descriptions (table 4.12) show that STs at all levels are expected to know how to prepare solutions and the hazards involved in that process. This will include basic knowledge such as: whether to add acid to water or water to acid when diluting concentrated acid; that when diluting sulfuric acid it is important that the receiving container is kept cold as possible by surrounding it with cold water as this process produces a considerable amount of heat, and diluting hydrochloric acid should be undertaken in a fume cupboard. A similar situation arises with alkalis, for example preparing sodium hydroxide solutions of even moderate molarity produces a considerable amount of heat which could surprise the unwary. These are in my experience areas where previous knowledge of working in laboratories is invaluable.

Solutions delivered to the laboratory are expected to be suitable for the key stage for which they are intended. Instructions may simply state 'dilute acid' should be used, and assume the technician will know that the actual concentration permitted for the age of the students concerned and will supply the correct concentration. Questions were asked about concentrations by seven STs (x1 (T), 24e (T) 12f (T), 17e (T), s2 (S) w3 (S), g4 (S)) and answered by seven STs (2a (S), 14a (S), 25a (T), 13g (S), 12f (S), r3 (S), o2 (S)). Again some answered more than one query. STs need to have knowledge of the safe preparation of a wide variety of solutions, and it appears that much of the knowledge about common chemicals comes from their previous work some posts on the websites when such matters are discussed (e.g. posts by 2a (S), 13a (T), 3g (S), p1 (T)) have on occasions confirmed this in their replies. CLEAPSS is also an invaluable source of information via HazCards, the website and telephone. However this does rely on the ST realising that there is an issue, and the school subscribing to the service.

As noted in Chapter Four not all STs have access to course or a local group for less common chemicals advice is sought from CLEAPSS (n.d.a)and also from the websites where it is likely that another technician has the expertise necessary or will give a CLEAPSS' HazCard number so that the information can be found. For example a query (2a) on the dilution of hydrogen peroxide using its molarity (this is often written as a dilution concentration in volume (e.g. 20 vol.) produced a reference (by 14a) to the appropriate HazCard where the information could be found

Previous knowledge and the recognition that there may be a need to take extra care with some chemicals is important: for example knowing that some acids require care, technicians will consult before diluting unfamiliar acids (e.g. 4d (T)). This has been shown by the number of questions asked by

STs. Also by knowing that anhydrous copper sulfate gives out heat when being hydrated STs will look up anhydrous calcium chloride to check the precautions necessary when making a solution of this chemical (e.g 19e). This suggests that the type of work undertaken by technicians relies on their skill in chemistry which may have been acquired elsewhere: and on the use of the website community to supplement that knowledge. The flame test practical which illustrates the use of the site to modify and confirm practical procedure has been chosen to reveal the role of the technician in chemistry.

5.1.2.1 The flame test practical

Flame tests are used to identify specific metal ions such as potassium, sodium, and calcium which produce a coloured flame. A small amount of the metal salt collected on a wire loop is burnt in a Bunsen flame and the colour observed. The best salts are chlorides, but if the salt supplied is not a chloride this is produced by dipping the wire first in concentrated hydrochloric acid then into the powder. Heating the wire after dipping in concentrated hydrochloric acid is used to remove residual salt from the loop. Three questions were about flame tests (table 5.2).

Table 5.2

Questions related to flame tests			
Number of questions	Replies	Advice given	Methods suggested
3	6	5	1

The use of the method outlined above with younger students was queried (N3 (T)) because they should not use concentrated acid at their key stage. It was recommended that the chloride salts were bought to eliminate the need for concentrated acid (R3 (T)) and the use of soaked wooden splints instead of wire loops to collect the sample was suggested (L2 (T)). Technicians used advice from the site to modify the practical for this younger age.

Using spray bottles containing metal chlorides dissolved in 70% alcohol to spray the solution into a Bunsen flame to produce impressive coloured flames has become more widespread as it is demonstrated to teachers on their training courses. However technicians (5a (T), 11a (T)) noted that students had been allowed to use the spray bottles. Advice was sought via the websites to check practical procedure and the opinion was that it was important that teachers were reminded that this was for demonstration only because of the risk of fire if the solution was either spilled or aimed at the bench rather than into the air .(14a (T), 16a (C), 16g (T)), in this example questions were asked and answered by technician grades with the exception of one response (16a (C)) although again the answers could have been supplied by experts in the field of chemistry whose salary point was that of a technician, as noted in Chapter Four.

5.1.3 Preparing practicals for physics

Physics is the study of matter and energy. Although physics appears straightforward, there are many areas where assistance from those with more knowledge is needed. KS3 includes electricity, light, sound, and the universe. KS4 studies aspects of the electromagnetic spectrum, forces and expands on areas already visited. KS5 builds on work already covered. A forces experiment where adaptation of an experiment is shown is used to illustrate work in physics.

5.1.3.1 Refining experiments for forces

This concept is developed throughout all key stages, beginning with work on streamlining and parachutes and progressing to speed and collisions. Table 5.4 shows that twenty one questions related to queries about forces.

The demonstration of streamlining by dropping shapes into a container of liquid, usually wallpaper paste and timing their descent is a popular class experiment but can be messy because of the liquid used and unproductive if time is wasted because the students prepare the shapes.

Table 5.3

Questions related to forces			
Number of questions	Replies	Advice given	Methods suggested
21	48	39	12

Technicians have suggested improvements to the experiment. (x1 (T), d1 (S), m1 (S) g1 (S), d2 (S), f3 (T)) The wallpaper paste has been replaced with bubble bath which is easier to handle and has the advantage of not containing fungicide. Using 'own brand' bubble bath also means it is considerably cheaper. The use of 2 litre carbonated drinks bottles with the neck removed in place of the measuring cylinders suggested in textbooks allows larger shapes to be used which increases the differences observed.

Collaboration between the technicians noted above resulted in the following recommendations:

- arrange as a circus
- shapes should be made in advance from the same mass of plasticine with a string and a loop attached to each one to aid removal from the liquid

- containers should be sellotaped to a retort stand and clamp to avoid spillage
- the loop of string should be placed round the clamp to aid shape removal from the liquid and the shape should be placed in a small beaker between use

Preformed shapes with constant mass are advantageous as class results could be tabulated and extension work on the analysis of the results included in the lesson. Although this prevents students making their own shapes, changing the shape results in the inclusion of the liquid in the plasticine which then has to be thrown away and wastes resources as noted by (d1 (S)). It can also result in a narrower range of shapes being used as students would rarely have enough time in a lesson to produce the number available in a circus and class results could not be produced (d1 (S)). This is an example of technicians working together to improve an experiment and enhance the learning process of the students whilst also cutting costs.

This section has shown that technicians collaborate to modify experiments to improve practical work and to reduce costs. The value of expert advice from other technicians has been revealed.

Selected aspects of the work of STs have been described in detail. This detail is important as it shows the complexity and the challenging nature of the work of STs and the way that STs work together to pool their extensive practical knowledge to enhance practical science in schools and ensure that it is safe. The value of having technicians who have previously knowledge of electronics is shown by the ability of the site to answer queries such as the failure of multimeters to read mA (w3 (S)), which relates to the internal quick blow fuse inside being blown by students, and confirming that an experiment that needed a particular gauge of wire that appeared unobtainable (19c (T)) contained a typological error (4a (T)).

It has demonstrated the role played by the sites as a replacement for informal discussions and more formal training that would be available at general meetings and shown:

- they are places where technicians can work together to discuss a topic
- they produce material that can cover many aspects of a subject which can be accessed in the archives of the sites by other STs

This information can be used in Chapter Eight to consider if and how the websites can be deemed a community of practice.

5.2 Other questions posed on the websites

This section contains information about the queries posed that need only a few replies.

5.2.1 The range of questions asked

Table 5.4 (p.164) shows a range of questions, the subject into which the questions fit, the technician(s) who replied to the question, and their title. Most of the subjects selected from site A were from the original area as this is still the place where questions that require short answers are usually, but not always, posted. Site B has no such division.

The questions used in section 5.1 were chosen as they illustrated the variety of technical questions asked during the data collection period. The table shows that the majority of postings were from technicians, whilst the majority of replies were from senior technicians.

When compiling the table those technicians who stated that they were biology, chemistry or physics technicians were included in the ‘technician’ column. This is because despite their expertise in a particular area they are usually paid as technicians and not as senior technicians. However the replies from these groups are subject-specific, suggesting that they have significant knowledge of their own specialist subject.

The subjects of the queries suggests that technicians may be using the websites to ask for advice that may previously been obtainable informally at training courses because there would be an opportunity to network with other technicians during breaks in the more structured part of a meeting, or at a local level if a technician group was available.

Table 5.4

Table to show a selection of queries illustrating the range of questions asked						
Query	Subject			Replies from		
T=technician S= senior tech	Biology	Chemistry	Physics	Chief technician	Senior technician	technician
From site A						
Clamps (T)		✓			14g	
Acid/base titrations (T)		✓		23f	19b, 9j	
Bunsen burners (T)		✓			10j, 5b	
Bromine water (S)		✓			5e	
Conductive putty (T)			✓			11j
Cloud chambers (S)			✓		22b	
Chromatography (T)	✓				2a	
Clock reaction (temp) (S)		✓			2a, 12a	11c
Dry ice source (T)			✓		1a	2j
Equilibrium (T)		✓				11c
Lactose (T)	✓				24c, 8a	
Ferro fluid (T)			✓		2b,5f	
Lava lamp (T)			✓			15d
Muscle fibres (T)	✓				2a	
Potassium permanganate (S)		✓	✓		2h,5e	
Potato osmosis (T)	✓				2a	2f, 19d
Reaction times (T)	✓				20i	17f
Thermite reaction (S)		✓			2b, 14j	
Full range UI (S)		✓				11c
From site B						
Axolotl (T)	✓				f3,m2,z2	
Apple browning (S)	✓				b3,f3, d1	
Bunsen tubing (T)		✓			p1	
Gelatine (S)	✓				v2, o1	
Glucose concentration for colourimetry (S)		✓			z2, b2	
Iron in cereals (T)		✓			m3	
Methane bubbles (T)		✓			g11,o3,w1	
Newton scales(S)			✓		g10,	j2,w1
Oxygen+hydrogen rocket (T)			✓	g3	g10, g11	
Source of oolitic limestone (T)		✓			o3	
Periscopes (T)			✓			x1 v2
Rhubarb in school grounds (S)	✓				f3, g10	
Stopclocks (T)	✓	✓	✓		g7,	j2, e4
Iodine clock reagents (T)		✓			g7	q3
Screaming jelly baby		✓				w1, j2
Variable resistors (T)			✓			m1
Terrapins-keeping (S)	✓				d1, g11	m2
UI range 1-14 (T)						d3
Woodlice (S)					u2	u1, q3

5.2.2 Examples of questions generating more replies

Questions may receive more replies because there may be a number of ways of tackling a problem. One example of this is the testing of fume cupboards. Although this may be available as a course, or part of a course, technicians are finding that this source of information is not always accessible as has been noted in chapter four. A question was posted on the second part of site A by 11j (senior technician). This resulted in two initial responses from technicians 21d (team leader) and 16b (technician) who gave general advice. A further query from the initial poster resulted in replies from 1e, 10e, and 13d (technicians) to clarify the process and a summary was provided by 4a (technician). This example shows the way that the sites can be used to provide the training that would be provided at a meeting or course where this was one of the topics covered.

Another post concerned the problem of eating and drinking in the laboratories (11a, (S)) where six replies from a mix of technicians and senior technicians (4a (S), f4 (S), g1 (T), o3 (S), n3 (T), m3 (T), g3 (S)) were posted. In both of the cases above technicians gave examples of the way this problem had been overcome in their particular prep room or school although comments posted for the latter query included one which noted

> As far as we are concerned it is a bit of a nightmare as it is almost impossible to stop them using it as … well a form room, they can't understand why it is not a good idea and they argue that it is their classroom.
>
> Senior technician (2a).

On the other hand posts can also provide practical help:

- a question was asked by u2 (senior Technician) concerning the best way to dispense chemicals to a class. Replies were received from g1 and g16 (technicians) and o3, f1 and d1 (senior technicians). This is a question that could have been part of a course on handling chemicals

- Another question concerned the reaction of an enzyme and egg white posted by 19i (senior technician). Replies were received from five technicians (2j, 13a, 12c, 5e (senior technicians) and 3a (technician) which gave advice and alternative method which gave better results. A course on practical work with enzymes would be needed to provide the practical information given by technicians

Other examples included:

- the practicality of dissecting eyes was queried (13d (T)). STs (g8 (T), m1(T), n3 (T), o2 (S), l3 (S), s1 (T)) gave possible sources, costs and practical advice about the dissection

- A question on the production and use of Jones' reagent, (j3 (T)) received four replies (o1(T), g6 (S), t2 (S), p3 (S)). These included two timely warnings which pointed out the danger of this reagent which has corrosive oxidising and toxic properties and suggested that it was not suitable for school use

As noted earlier, the title 'technician' is a salary distinction and does not mean that all the questions were asked by less experienced technicians, but it does show that the majority of answers in this section were posted by those with senior titles.

These questions and answers also show that as well as giving support to fellow technicians the websites also provide some training. For example the answer to the question on bromine water given by 5e (S) gave detailed instruction on the method to use and the health and safety issues that needed to be addressed The answer to the muscle fibre question by 2a (S) gave information on a good source of fibres and a way of easily measuring the contraction. Posts such as a source of a particular chemical, or item (e.g. oolitic limestone (11a (T)) or a concentration that will give good results (e.g. potato osmosis (n3 (T)) represent the needs of the STs for replies to problems.

Not all questions received a reply on the sites. Sometimes replies are sent directly to the questioner, especially if related to exams. Others have no answer for example a question (g20 (S)) asking for 'a range of different protein concentrations that would give a range of different shades of purple when biuret was added to $2cm^3$ samples' is not a known experiment, and unless anyone had actually done it before the only way to do this would be trial and error.

5.3 Conclusion

The evidence provided by using a selected range of practical experiments which STs prepare as part of science teaching shows that apparently simple tasks across all three sciences may contain hidden problems that require a breadth of understanding that has not been recognised as necessary by previous studies: which have focused more heavily on the superficial and the visible aspects of technicians' work. Responses show the amount and quality of informal training that is given to technicians by technicians with more experience in particular areas. This also reveals that technicians use knowledge they have gained in industry or in public sector laboratories in their work in schools. The examples chosen show the variety of skills needed and demonstrates the way in which the sites function as:

- a source of knowledge for less experienced technicians or those working outside their particular area of skill

- a place where new ideas can be discussed

- an opportunity to pass on processes or experiments that work

- a source of health and safety advice

The queries in this section were asked and answered by a mixture of team leader or chief technicians, senior technicians and technicians but as has been shown in Chapter Four, titles indicate the salary point and do not necessarily indicate the level of experience of knowledge of the technician. Although not all questions posted during the data collection needed a number of replies or the discussions shown in this section the range and scope of the questions relating to practical work and the knowledge needed by STs in their preparation of materials for practical work has been shown.

Previously, individuals relied on meeting with other technicians on training courses or at technician meetings for such knowledge to be disseminated. Now that training courses are less accessible to technicians, the virtual community provides a place where this invaluable knowledge can be accessed by technicians who may need to prepare practicals which are outside their area of expertise. The variety and complexity of the questions asked illustrates the value of the sites as a means of easy communication between technicians that are mainly isolated or one of only a few in their own school but who have an enormous amount of experience between them that is willingly shared to aid other technicians and therefore practical work in schools. The examples given also reveal that the sites have an advantage over a meeting as the question can be posed when it arises and receive a speedy reply. It therefore does not rely on the availability of a course at the right time. This shows one way in which the sites are a valuable resource for STs.

The invisible areas such as the development of practical work have been shown, but areas including their cost saving and their care in aspects of health and safety are largely invisible to those outside the prep room and these and other hidden aspects of their work are the subject of Chapter Six.

Chapter 6: The hidden work undertaken by the technician and ST views on the value of the websites

Chapter Five explored the work of STs in the preparation of materials for practical work showing the knowledge required to solve problems that arise in the course of their work, to improve the learning experience of students and to support teachers. The examples showed the way the websites were used as a virtual community by STs to aid this aspect of their work. This chapter shows other aspects of the work of STs. Lack of acknowledgement of these tasks results in the degree of expertise needed to perform these tasks being underestimated and the extent to which technicians use knowledge gained elsewhere or provided by other technicians being unappreciated. It also shows the amount of time that technicians spend on these unseen tasks which although unidentified increase the workload and extend the role. As in Chapter Five the material used in this chapter was controlled by the technicians and is therefore their authentic voice. This chapter is not divided by science subject but by four areas that have been selected to illustrate the invisible work of the technician:

6.1 Working with experiments

This section shows the way in which technicians work to check experiments which supports teachers by ensuring practical work is a positive experience for both teachers and students and therefore advances science. STs also develop practical work which enhance the experience of students and shows the professionalism of STs. However as these aspects have not been formally recognised the time involved is not considered when technician hours are being calculated.

As noted in the comments on the best and worst aspects of their job, (Chapter Four, Table 4.13) technicians regard trying new practicals as the second best aspect which was only surpassed by the variety of the job. In the survey 92% of STs stated that they piloted experiments with 97% of this group stating that if they commented adversely the experiment would be modified: this suggests that teachers take note of the views of technicians in this area. Analysis of the technicians who did not pilot experiments showed no difference between this group and the other STs in areas of age, qualifications, length of time in schools or the number of technicians in the school. Piloting experiments may therefore be a personal choice. The development of an experiment is used to illustrate this work

6.1.1 Developing new experiments

Initially Information was posted by 14b (T) about an experiment which suggested that a camcorder and different coloured seeds could be used to discover which colours attracted birds to a feeding table. This is related to food chains where the colour, shape or size of seeds or animals for example increase or decrease the possibility of being eaten. In the initial experiment, real birds and real seeds were used to conduct the experiment. The results of the post are noted in table 6.1 the title 'worm survival' relates to the name of the experiment produced by technicians from the initial information:

Table 6.1

The development of the Worm survival experiment			
Initial post	Replies	Ideas	Result
Use of camcorder to record bird preferences	12	6	Method sheet produced - 8 copies requested

This discussion took place between:

- four technicians (4a 26d, 9f, 1h) who were specifically employed as biology technicians, but were therefore graded as technicians
- one physics technician (4a (T)), who gave advice on the original proposal and possible cost reduction
- seven senior technicians. (2a,12a, 19b, 23d, 5e 25i 9j)

This shows a range of expertise is available which is an advantage of the websites.

Although the idea was attractive, technicians (2a (S), 5e (S), 4a (T)) thought that the cost of the equipment was high and it was thought to be hard to justify, but technicians (2a (S), 9j (S), 26d (T)) also noted that their teachers had asked if this practical was possible because they had encountered it a meeting or had been told about it. It was suggested an alternative idea might be to place seeds on the ground and see if birds were attracted, but this would be difficult to arrange within a school day, and at other times all the seeds could be eaten and no preference discovered. Ideas suggested the use of coloured string and coloured paper to show that some colours would be more easily seen. One senior technician (2a) developed the idea further using different coloured spaghetti pieces and a grassed area of the school so that students could study the way that colour could affect the survival of a worm where the spaghetti worms replaced the seeds of the original experiment and the students searched for the worms and noted which colour they could see more easily. Copies of the method were made available via the website and technicians that requested the method stated that their teachers were happy with the alternative. This shows the way in which technicians co-operate together via the websites to produce alternative experiments and shows the amount of work undertaken by technicians which remains unseen even to those within the department who are only aware of the result. It also shows the way that technicians also benefit from the collaboration.

Experiments are also modified, for example a post by ST 4b (T) on a website noted that ultraviolet lamps are being discouraged in schools Table 6.2 shows the number of STs involved in the discussions

Table 6.2

The use of the ultraviolet lamp in an experiment using sun cream			
Initial post	Replies	Ideas	Result
Use of ultra violet lamps	12	6	Alternative methods were suggested

The results of the discussion that followed produced a modified experiment which shows the way in which the websites are a useful way of passing on information and of developing solutions. Of the twelve technicians who took part in this discussion:

- three were physics technicians (4a, 9a, 15c)
- five were biology technicians (9f, 26d. 11g, 1h, 14b)
- four were senior technicians (3a, 2a, 12a, 18c)

This example shows technicians working together and using their joint knowledge via the websites to find an alternative method when an original method may no longer be acceptable in schools. This again shows the advantage of being able to reach a wide range of expertise.

6.1.2 Piloting exam work

Practical exams at both AS and A2 level requires considerable technician time and expertise to ensure that students have the best opportunity possible to obtain good marks. Technicians obtain the materials, pilot the experiments and determine the best way to provide the materials required. Exam boards give schools contact e-mails for queries concerning exams, these are not always helpful, receiving replies such as *'it has worked for us'* (4a (T)) STs may therefore post queries on the websites for advice. A senior technician posted:

> some practicals are not only horrendous equipment-wise but the cost of the chemicals in some cases is horrendous, OK for 2 sittings but not for whole classes of up to 80 students
>
> (z2)

One ST (11a (S)) suggested 'I really do feel that the exam boards should have experienced technician advisors for the practical work for the three sciences'. STs could use their knowledge of the preparation of practical exams to prevent some of the problems that STs encounter including the availability of materials and experiments that do not work as expected. For example:

6.1.2.1 Availability of materials

one 'A' level exam required variegated pelargonium leaves. The variegated leaves were needed as the students were required to test both areas from the same leaf. However these plants were not available at the time of the exam. This problem resulted in nine replies:

- five from technicians (z1, q3, l2, j3. a7)
- four from senior technicians (f3, v2, e2, d1)

Using this information, technicians found an alternative leaf and passed on this information via the extra secure website for others to see.

One technician (7a) commented that one experiment needed 5 thermometers per student, and there were over 60 students taking the exam at the same time.

Another (j3) noted ‘Last year over the course of a week of practicals I washed up 3000 test tubes and then you have to add in all the other glassware’.

A third (2a) added that for one practical each student (there were 45) required 10 small squares of an exact size that had to be cut from egg boxes or similar material to be used in boiling tubes: which required a considerable amount of technician time.

In one case when the amount of apple required for an experiment was calculated (technicians thought that each student would require the pulp from approximately two apples for the experiment) a technician (k1) posted that canned apple pulp was a suitable replacement for fresh apple.

6.1.2.2 Experiments that do not work as expected

Technicians trial exam experiments, and every year there are a number of queries about the results as sometimes experiments do not work, give ambiguous results or the instructions are incomplete when given to the technician. STs use the extra secure area of the websites to confirm results or seek advice in order to ensure that the correct results can be reproduced by the students providing they follow the instructions.

Technicians also have to calculate exactly how much solution will be needed how much equipment will be required and set up the practicals. Examples of photographs of the results are shown in the appendix.

The preparation and setting up of successful exam work takes many hours of careful planning from the initial receipt of the paperwork to the arranging of the laboratory and also requires teachers and technicians to work closely together to minimise stress for students.

6.1.3 Working with teachers

In the survey 22 technicians considered that being part of a dedicated team was one of the best aspects of the job, (table 4.10). One ST (53) commented that 'being part of a very good team' was a positive aspect of their work. Technicians and teachers work together to make sure that students have the best possible experience of science. Teachers have ultimate control over the practical work undertaken by the students, but technicians provide technical knowledge to complement the knowledge of the teacher in deciding which practicals are worthwhile, by highlighting what, if any, modifications are needed, reporting results of their trials and discussing potential problems with practical work. 48% of technicians who took part in the survey play a part in the planning of lessons. A soap making practical is an example. The textbook method used a concentrated alkali solution (4M sodium hydroxide) when students at the intended key stage usually only routinely use up to 1M sodium hydroxide. This resulted in discussions on the website between:

- four senior technicians (d1, a2, d2, g2)
- two technicians (y2, o1)
- two chemistry technicians (k2, r3)

These concluded that weaker solutions would not work, but that teachers should be informed of the problem so that they could decide if the practical should be used with all classes. A worksheet was produced which emphasised the precautions needed and was made available to other technicians. The survey showed 88% of STs had had to dissuade a teacher from doing a practical. In 95% of cases the teacher took the advice of the ST.

STs explain practicals to science teachers working outside their area and provide help and advice to trainee science teachers and science teachers who are new to teaching or to the school. The survey showed 86% of STs stated that they would give teachers training in the use of equipment (Question 16) or show them new experiments. This number included technicians, senior technicians and lead/chief technicians. This does not undermine the professional training given by more experienced teachers in the department but is a convenient way for teachers to try out an experiment or obtain advice during their allocated preparation time. STs are available during lesson times when other teaching staff may be occupied in the laboratories and shows one of the ways in which STs work with teachers in the science department.

STs may also be involved in planning practical activities when schemes of work are written. This is important to ensure that materials are obtainable and the practical work suggested can be accommodated in the time available. For example, textbooks suggest that cloning plants using cauliflower is a suitable practical activity. The viability of this experiment was debated by fourteen technicians:

- eight senior technicians (d1, i1, g2, p2, z2, s2, h2, y3)
- six technicians (which included specialist biology technicians) (8a, k1, i2, e2, b3, m3)

The reasons for the debate were: it requires skilled aseptic techniques; has a low success rate in the school laboratory, and it is unlikely to produce any visible results within the average six week timeslot allocated to each science module. Additionally as terms are around six to seven weeks long, there could be no-one to look after the plantlets if all technicians are on term time only contracts. It was suggested (d1 (S)) that taking cuttings was a good alternative that could be related to commercial cloning techniques by showing pupils the apparatus used in the process. Armed with the information gained from such discussions, technicians can inform teachers of any problems and offer an alternative approach to this section of the module. This shows the value of the websites and the way in which teachers and technicians work together on practical aspects of science work.

It is also useful for technicians to be involved in the development of schemes of work as this aids STs own organisation and planning process as it means they can start to prepare equipment and test and modify new practicals in good time.

Two examples of postings in this area are:

- a request for ideas for testing carbonated soft drinks: six technicians made suggestions including measurements of viscosity and fizziness (4a (S)) and more advanced analysis of sugar content (10a (T), 12d (S) 1j(S), 2a (S))

- possibilities for class sets of balls for a density experiment: five possibilities were suggested by four physics technicians (m3, m1,v2, m2) and one senior technician (x1)

The work of STs which has been outlined above shows that technicians are using their expertise to enhance the learning of students and has noted that STs regard this as one of the best aspects of their job.

When describing the best aspects of their job STs specifically included the following comments:

- ‘the delivery of well-built practicals that enhance learning and developing practicals that allow pupils to see science’ (3)
- ‘rewriting experiments’ (17)
- ‘developing experiments’ (51)
- ‘working on experiments to make them work better’ (91)

These comments suggest that STs enjoy using their knowledge and expertise to improve science experiments in schools.

6.2 Planning the work of the technician

This section contains material illustrating the planning process that has to be undertaken by technicians each week when providing practical materials to the laboratories and the variety of methods they use. This is important as it shows the nature of the workload of the technician and the way technicians organise their work to ensure the equipment and materials are provided to the laboratory for practical work. This area covered a wide range of topics and is reported as a descriptive account.

Twenty two STs considered that being in charge of their own workload was one of the best aspects of the job, specific comments included:

- ‘flexibility’ (22)
- ‘planning own day’ (54)
- ‘autonomy – I can organise my own day’ (63)
- ‘managing own workload’ (64)
- ‘Independent working’ (109)
- ‘being my own boss’ (100)

This also suggests that STs think that their work is not controlled by others and that they plan their own work.

This is an important aspect of the work and can be considered when considering why ST work is attractive when the pay is low.

6.2.1 The need to plan

Technicians supply resources for science teachers and in large schools technicians could be required to prepare over thirty different practicals in each school day where there are three double lessons: and more if some single lessons are also included in the timetable. Therefore STs need to be able to see from their charts what lessons they have to prepare for each day and if more than one teacher requires the same practical simultaneously. Technicians have to ensure that they have adequate supplies of materials when a number of classes are undertaking the same practical work in close succession, and that items that need advance preparation, such as the soaking or sprouting of beans are ready when required. Technicians therefore need a method to collect requests from teachers.

6.2.2 Collecting requests

Posts asking for examples and the variety of replies posted suggests that there is no universal method that works for all schools: some STs (11a, e1, f3) receive individual slips of paper for each day or each week from teachers; some have large whiteboards where they, or the teachers, write their requests (g1, g3); some use a diary system (p1, x1), and others use an electronic system (f1, g2). The amount of advance notice required varies from a deadline of Thursday or Friday for the next week (d1, f1, l2) to one or two days (l3, q2, v2). All methods rely on the co-operation of teachers to keep to the system to avoid unplanned work for the technicians or the possibility of the practical work being unavailable if items need to be prepared in advance, such as a large amount of a solution or seeds or garlic roots have to be grown. Comments such as:

- ‘no “can I just have…” in passing in the corridor’ (d1)

- ‘there seems to be a body of teachers who think we can put together anything without notice’ (e2)

suggest that sometimes teachers forget the need for technicians to have advance warning of their needs: ‘teachers not realising how long a job takes’ (104) was considered one of the worst aspects of the job.

6.2.3 Providing practical materials

STs decide amongst themselves how the work will be distributed. Some divide by subject or key stage (g2, e3) others simply work systematically through the requests for each session (d1, g13). Preparation takes place whilst previous lessons are being undertaken in the laboratory and material is distributed during break times. This distribution process is the visible result of the work of the technician, the rest remains unseen and the work involved is unknown.

This shows that STs; whose job is to produce the materials needed for lessons; work as a member of the science team to produce the practical materials needed, but that this occurs independently of the teaching staff. It also shows that although the work of STs is commissioned, by teachers,

teachers do not oversee the actual process of providing materials needed for practical work. It also shows why STs cannot be timetabled to work in the laboratory as their variable workload means that the practical work for the next classes cannot be prepared.

The preparation of materials for practical work may also involve checking for any health and safety issues as noted previously.

6.3 Health and safety advice given by technicians

The health and safety of pupils and staff is important and technicians use: their previous knowledge; material provided by CLEAPSS (2013) in the form of 'HazCards' and information requested and given by other technicians via the websites to keep up to date with safety issues. 84% of technicians who responded to the survey gave health and safety advice to teachers. A number of posts were made about health and safety on the websites as shown in table 6.3.

Table 6.3

Questions relating to health and safety			
Number of questions	Replies	Advice given	Approaches suggested
49	102	83	25

Reports of incidents and 'near misses' posted on the website are a valuable source of information. Issues of health and safety in the visible work of the technician have been highlighted in Chapter Five where the need to understand the potential dangers in areas such as microbiology have been noted. This section illustrates dangers associated with chemicals and advice related to areas reported by other technicians.

6.3.1 Chemicals

Chapter Five included ways in which technicians work together via the websites to ensure the safety of students in the laboratory and indicated the knowledge necessary to prepare the required solutions at the correct concentration and with appropriate labels. However technicians also need to have knowledge of the storage of chemicals and the disposal of waste from experiments. On the other hand although The Home Office (n.d.) advice suggests that STs should monitor chemicals, and their job descriptions may include this activity (table 4.12) this activity only appears at team leader level of the ASE table, a position that has been shown to rarely reached by STs. Nevertheless STs do undertake this task. Posts on the website suggest that STs are most likely to guided by their previous knowledge and by CLEAPSS (n.d.b) guidelines, if the school is a member.

6.3.2. Chemical storage and disposal of residues

Chemical storage is an important to maintain safety for those working in the science department and for the rest of the school. Incorrect storage, which can be caused by the design of the storage facilities in the science department, can result in manageable incidents becoming major events (personal experience). CLEAPSS (n.d.b) and experience of chemical storage in other laboratories suggests chemicals in schools are ideally stored in two separate places. The first being a separate chemical store with integrated gas and water facilities large enough to allow the preparation of solutions for laboratory work. It can be located within the science department, but to avoid technicians being excessively exposed to chemicals it should not be the prep room where technicians spend most of their time. This store ideally contains mainly solid materials and diluted acids, should be well ventilated and locked when not in use. The second should be a locked outside store where various chemicals such as bulk supplies of concentrated acids, other inorganic solutions and liquid organic substances are kept.

Table 6.4 shows the number of problems that were posted about chemical stores. These often related to new buildings where there was no outside storage provision and the internal chemical store was inadequate in terms of ventilation or size or both.

Table 6.4

Questions about chemical storage			
Number of questions	Replies	Advice given	Approaches suggested
8	11	9	2

Comments noted that:

- ‘the architects made no provision for cylinders or radioactive sources’ (5a)
- ‘all chemicals including cylinders and radioactive sources are to be stored in the [main] prep room’ (8c).

Replies were received from six technicians (5a, 8c, 9d, 1a, 14a, 4a) and five senior technicians (5b, 22a, 18a 12a, 2h) with advice and references for literature on the storage of radioactive materials.

The problems with the buildings were noted in Chapter Two where information on the PFI building programme was included. This inadequacy can be seen quite easily when technicians have to store ammonia and concentrated hydrochloric acid in close proximity and ventilation is poor. The white crystals of ammonium chloride which form when vapours of these two chemicals mix and can be seen on the outside of bottles and on surfaces in the store. The problem revealed by the presence of the visible crystals suggests that there could be potential danger from fumes from chemicals which are less visible. Technicians (5c, 3g) stated that they would have brought these problems to the attention of the builders during the design process if they had been consulted. STs (4d, 5a) commented that they had told others in the school who were involved with the consultation, but this has not resulted in any changes. This suggests that the need for adequate ventilation and safe and adequate storage for chemicals has not been considered, perhaps because the nature of the work of the technician has not been understood and it was not known that technicians handle noxious and dangerous chemicals.

Specific questions were asked about the shelf life of some chemicals after an Ofsted inspector had queried the age of some chemicals and suggested that stock that had not been used for five years should be discarded. This was viewed pragmatically by technicians, who pointed out that these chemicals were once in the syllabus and would, in all likelihood be required in the future and therefore if they were not prone to deterioration they should be kept for possible future use. Technicians (2a (S), 11a (S)10b (T)) have posted on websites that they have recently used up containers of chemicals that had pre-decimal price labels which had not deteriorated and had worked perfectly.

However STs also have to manage the storage of the solutions used for practical work in the laboratory. This consists of the comparatively small volumes of solutions used in everyday practical work, frequently used solutions such as molar acid and alkali solutions which are produced and stored in larger containers of 20-25 litres, and solutions prepared in quantity exams. Technicians have to work closely with teachers when practical exam work is planned to ensure that the large quantities of solution will be available, and that the planned times will be close enough to prevent any possible deterioration of the solutions. An example is the ‘disappearing cross’ experiment which times the rate of appearance of ‘cloudiness’ in various ratios of hydrochloric acid and sodium thiosulphate which obscures a cross drawn on a piece of paper under a conical flask has been used for exam work. This can use over 20 litres of sodium thiosulphate and a similar volume of hydrochloric acid if several classes need to complete the practical at the same time. This has to be made in one batch for continuity so that if the experiment is conducted over several lessons, the student will be using exactly the same concentration. Queries concerning the production of the large quantities needed for this practical were asked by three technicians (j1, i2, g7) and three senior technicians (g3, k2, d1) and two chemistry technicians (q3, i1) replied. Methods were suggested for making these, including the use of tall rubbish bins to contain the required amount. This would be acceptable for this exam as although the concentration needs to be suitable for the experiment, the exact concentration is less important than the need for sufficient volume to complete the experiment. For ‘A’ level practical exams solutions need to be accurate within the range specified by the exam board and slightly different concentrations are needed for successive groups. Again each group must have enough of their particular solution to repeat each experiment for the maximum number of times allowed by the examining board. STs have to calculate these amounts to ensure sufficient solution will be available for students.

When experiments have been completed the results have to be discarded. Questions were also asked concerning the disposal of residue from experiments. This occurs across all key stages. Although many experiments produce residual materials sometimes these can be recycled, for example an experiment involving the effect of acid on marble chips which produces carbon dioxide does not use up the chips which can be washed and reused. The action of acid on metal usually results in waste consisting of unreacted metal which can also be washed and reused. Recycling of this kind helps reduce the cost of experiments. Sometimes the product can be reused.

The section concerning chemical storage illustrates part of the sometimes very challenging work of the technician. Dealing with chemicals is an expected part of the work of STs but considering the lack of training opportunities as shown in Chapter Four the knowledge needed may depend upon: their previous knowledge; access to CLEAPSS, and the knowledge and advice that is given by technicians to technicians via the websites. This information exchange shows the value of the websites and the way that they allow technicians to communicate with each other when the opportunities for training and professional development are diminished. This knowledge is important to avoid accidents and warn others of potential dangers.

6.3.3 Health and safety issues reported by technicians on the websites

Technicians also report incidents and ‘near misses’ that have happened in their own schools on the website so that other technicians become aware of potential dangers. The health and safety of students and staff is important and technicians use their previous knowledge and collaborate to find ways of solving problems.

Posts in this area included the problems that occur when collecting materials from laboratories at the end of practical sessions. This is a particular issue when equipment and solutions are left scattered around the laboratory because insufficient time has been allowed for returning items correctly at the end of a lesson. Replies to the survey noted that:

> 'seeing the mess left after a practical' (63)
>
> 'cleaning up pointless messy experiments' (105)

were some of the worst aspects of the job.

At KS3 this is unlikely to be a safety issue, but at higher key stages and especially at KS5 students occasionally use concentrated acids. Sometimes students decant the concentrated acid into unmarked beakers; which they should not do; and leave the residual acid: in unmarked beakers in mixed trays of beakers; amongst other equipment; or elsewhere in the laboratory. This has resulted in 'near miss' situations when concentrated sulfuric acid has been left in such a situation and the acid has been poured down the sink and the beaker has been placed in a bowl of warm washing up water. Senior technicians (d1, g2, 2a) posted warnings on separate occasions on this issue. As previously noted this is a dangerous acid that requires care when being diluted and could have a serious reaction with any chemical in the u bend of the sink and in the bowl of warm water. Sulfuric acid is colourless and odourless and as it would not be expected that students would leave this in an unmarked beaker; or that a teacher would let them do so; it is unlikely that technicians would be wearing goggles or gloves which are always worn when dealing with concentrated acids as the technician would assume that the liquid was water. Luckily there have been no serious accidents recorded, but the potential is there.

Allergic reaction to nuts is well known and sometimes food materials are used in science as a source of energy (burning food) or for DNA extraction (soft fruit such as kiwi).

Two main areas were flagged up where allergic reactions were possible. These are shown in table 6.5.

Table6.5

Comments on food allergies			
Allergies for	Problem	Replies	Alternatives suggested
Burning foods	Peanuts	12	6
DNA extraction	Kiwi and strawberries	5	2

Eleven senior technicians (d1, z2, g1, i1, b2, d2, g2, a3, t2, b4, g9), and six technicians, including two chemistry technicians replied (c4, d3, f3, c1, e2, k2). Peanut allergy is well documented however the high fat content made nuts an ideal source of a high energy food for the burning foods experiment it may still be requested and STs have to be aware of this issue. The need to avoid the use of some breakfast cereals for other food tests because they also contain nuts was also highlighted (c4). Alternative sources were offered such as crisps and various types of savoury biscuits, although technicians (d1, z2) used the websites to remind others of the potential of these snack biscuits to drip fat and cause burns. The increasing popularity of the extraction of DNA from fruit has been noted. Kiwi is used as a suitable source, but allergy to kiwi and to strawberries has been reported.(d3) Technicians have suggested that peas or onions are suitable alternatives, with peas being favoured because of the lack of smell.

6.4 Managing the budget for the science department

The size of the science department budget varies from £1500 (16a) to £30,000 (9d) which may depend upon the size of the school, or less commonly on the areas covered by the budget. Technicians who responded to questions posted on the website indicated that although the HOD signed the off orders technicians played a large part in the balancing of the budget. Technicians sometimes noted that their school required the money to be spent several months before the end of the school accounts year (2a, 16c, 3a) This causes problems for science departments as sometimes material for exam work and items for practical work such as hearts, sweets and maggots need to be purchased during the time the accounts are closed. Most, but not all, finance departments will allow some money to be retained for this purpose. The involvement of technicians in the procurement process is divided into three sections: buying equipment; choosing suppliers, and local shopping.

6.4.1 Buying equipment

When buying equipment the quality of items is sometimes important, but sometimes robustness is also valuable. For example one type of beaker supplied was very strong and inexpensive but the scale did not survive the dishwasher. The relative value of beakers with scales over the sturdy beakers was debated by four senior technicians (d1, f1, a2, g4)and four technicians (b1, r3, s1, n3) and it was concluded that these robust beakers would be suitable for any experiments when the scale was not required and would therefore be a reasonable purchase.

Sometimes plastic versions of equipment are available which are less liable to be broken. Measuring cylinders, because of their shape are easy to knock over and plastic measuring cylinders are a possible alternative. However they are not clear plastic so are less easy to read than glass cylinders. Clear plastic cylinders are available, but tend to be made of a more brittle plastic so do not last as long. The opinion was that plastic would be suitable for most occasions but glass ones would be needed for more accurate measurement and when plastic was unsuitable. One question concerning the replacement of glass burettes with plastic burettes (f1) received a number of replies which covered various areas including:

- the lack of a meniscus: the curve found on the surface of a liquid in a container where it touches the container the bottom of the meniscus is used to take accurate readings of the volume of the liquid which is most important at KS5

- staining when the plastic burette is used with coloured solutions such as potassium permanganate

- plastic burettes cannot be used with organic liquids were also problems which has to be weighed against the robustness of plastic

Technicians (a2, h1, c1, s3) noted these problems, and as most titration work is confined to year 11 and KS5 glass burettes were considered more useful than plastic versions. A problem noted with glass burettes is the tendency for the tap to seize and the advantage of buying glass burettes with replaceable tap ends was noted by three technicians (r1, k2, b3). This is important as it has now become common for textbooks to suggest sodium hydroxide is placed in the burette rather than in the conical flask. This increases the risk of seizure of the tap which therefore makes the burette useless. However it was also noted that these replacements are made of nylon and students and teachers have noticed that these new tips can cause air gaps to form between the body and the tip. Technicians (a2, h1, c1) suggested that inversion followed by tapping usually remedied this problem.

Similar debates occurred with other items such as balances and microscopes where there are many different makes. Expert advice from technicians with specific knowledge in these areas (e.g. 4a, 9a, 15c, 22d, m1, m2,(physics) and 3b, 14b, 1h, 21h, d1, h3 (biology)) was sought with regard to expensive electrical items and other specialised equipment. The websites allow technician community to consult with each other even when they cannot actually meet.

6.4.2 Choosing suppliers

Technicians who are in charge of most if not all of the budget choose the companies that they use. There are three or four main companies and around six or seven others who regularly send catalogues to schools. Technicians are careful to seek out the best deals, sometimes posting on the websites to alert others of bargains available. Questions about a company are often posted on the websites when new companies send out flyers to find out if they have been used by other technicians and discover their worth in areas such as reliability, product quality and speed of delivery. A favourable review will probably increase orders to the company. Comments may suggest that a company is good for some things, or that ‘you get what you pay for’ (2a) and technicians may then decide what items are worth trying and which may be better bought from other sources. Website postings suggest that companies which have no minimum order to avoid delivery charges are favoured over those who have minimum spends as occasionally technicians need to buy something quickly without sending in a large order. Sometimes technicians post about advice they have received from technical departments of companies Rapid electronics has been particularly praised for their advice and this provides another source of advice for technicians and makes the company more attractive. This shows the use of the website to evaluate suppliers of materials in order to save the department money and to advise other STs of another source of expert advice.

6.4.3 Local shopping

One of the items in job descriptions of technicians is that they will shop locally for items needed for practicals. This means items that are perishable, food, plants etc. and for other items such as containers or items from bargain shops. Technicians will often see and buy items that will be of use, but four senior technicians (9d, 3a, 22g, 7a) and three technicians (17f, 24c, 4c) noted that they are having increasing difficulty in claiming for these items. Some have petty cash (h1, k1, r1) which they can use and which is topped up when it becomes depleted whilst other have to supply itemised receipts (u2, g3, s3, b1) where the exact reason for the item on a receipt needs to be stated which is a source of amusement as some purchases such as chocolate biscuits (for a digestion experiment) and crisps (used for burning foods) and sugar cubes and boiled sweets (for a rock experiment) will still look suspiciously like treats for technicians. A further problem is the expectation that technicians will shop in their own time and it has been noted that a suggestion that the shopper should be allowed to leave early in order to complete this task was not well received (2a).

6.5 ST views on the value of their websites

It had been seen that STs use their websites for a variety of purposes. This final section reports the comments of STs that appeared spontaneously on the websites, and on comments that were received by posting a request for STs to consider the value they placed on the sites.

6.5.1 Comments on the help with practical exams

As already noted A level practical exams, can cause problems and unlike ordinary practical work, technicians cannot substitute another practical which they know works. STs have also have little time in which to solve problems. The extra secure areas of the websites are invaluable when an answer to a problem is required.

> 'exam (ISA) help is invaluable if one just does not work for me it is great to ask for help and get it within a few hours' (4a)

> 'I've been helped with many queries to do with ISAs' (s1)

> 'I use the site for ISAs because I always have problems every year' (10c)

.

6.5.2 Communication with other technicians

Technicians also value the sites as an opportunity to reach out to other technicians. Comments made included:

> 'I work in a rural area so networking with other schools is a once a term activity and I feel that I know the people on the site much better than those in the surrounding area' (11a)

> 'the community aspect is helpful too as there's not always another technician in a school to ask for help' (k1)

> 'school science technicians often work alone or in small groups. Having access to others doing the same job all over the UK makes me feel part of a profession that is part of the process that enthuses children about

science. This is a great feeling and not one which can be achieved in isolation' (2a)

Loneliness is something that technicians may experience because they are busy when the rest of the science department and other support staff meet at break times. Technician comments show that the support available via the websites is invaluable.

6.5.3 Support

'the support is fantastic and makes you feel that everyone just wants to give both moral and technical support when they can' (11a)

'moral support is also invaluable as we techs often feel that we are the odd ones out in the school [others] really don't understand the problems and frustrations. I can vent my angst on here and know that everyone understands' (3a)

'the existence of a friendly community atmosphere which encourages quality discussion, exchange of knowledge, information and best practice within the group' (k1)

'clear support that is offered to colleagues who find themselves in any particular difficulties' (f1)

'the help and support would be difficult to find elsewhere' (14b)

'the forums have been like having a group of friends to talk things through with – it can be lonely as a tech as there are so few of us in a school.' (19a)

'I can pass on my experience to those new to the job which is also very satisfying' (8a) ‘it is important to share knowledge’ (4a)

‘helping other techs by answering their queries as well as getting answers to mine’ (11a)

‘information sharing and sharing my own specialist knowledge’ (k1)

These comments show the value of the professional websites available to technicians as a tool which allows the dissemination of knowledge and a pool of problem solving experts to aid practical work in science.

‘one of the most delightful aspects is the support network that emerges for people doing the same job mostly working on their own or in very small groups. I can spend my whole day not talking to a soul, but I know my virtual friends are out there if I need to get in touch with them’ (12a)

‘as a lone worker I would not like to be without this extra tool in my tool box’ (16b)

‘I can’t imagine technician life without it’ (1a)

‘helps me manage difficult situations’ (d1)

‘the community is very understanding and supporting of each other. This is particularly valuable in this time of recession when less money is available for technician training’ (19b)

I use the site often as I am a lone tech. I find it sometimes gives me the reassurance of having someone to ask and not feel foolish’ (23c))

‘I tend to lurk on the forum, reading but not commenting I find it is a good way to pick up tips’ (16g)

These comments show that the site is valued for answering questions, provides training and is probably superior to courses in some respects as it is immediate and available as required. It could be argued that the comments came from those who use the sites, but technicians (8a, 12a, 7g, 9h) have noted that their HOD has asked them to pose a question, and technicians who have found alternative employment often state that the sites have been valuable even though they have not needed to post as they found the answer in the archive. These comments will be used to consider the role of the websites as a community of practice.

6.6 Conclusion

This chapter has given insight into some of the invisible tasks carried out by STs, such as their work in piloting experiments and providing teachers with information about the results. STs explain practicals to teachers if necessary and collaborate with teachers when schemes of work are being planned.

It also shows that STs consider that they plan their own work and make sure that practicals are delivered to the laboratories as required using their previous knowledge and knowledge obtained via their professional websites. STs are responsible for the correct storage and labelling of chemicals, the correct disposal of any waste products and the maintenance and updating of health and safety information in their domain and passing on information as necessary to teachers. However as these aspects of the work of the technician are invisible they are unacknowledged and therefore the value of this work is unknown. This affects the perception of the work of science technicians by those wishing to reform school support staff, and those who assessed the work of the technician when implementing the single status agreement. The chapter has shown the value of the websites as a source of knowledge, help and advice and as a means of collaboration between technicians to enhance the science experience of students. The next chapter shows the views of technicians on the effect of school wide changes on the technician workforce and their willingness to comply with the proposed changes.

Chapter 7: The effect on STs of the remodelling agenda, single status agreement, the PFI building programme and the views of STs on their status and the control of their work.

In order to aid the understanding of STs and their work Chapter Four provided: demographic information about STs who participated in the surveys; about the users of the websites during the time of data collection; the employment of STs, and the support and training available to them. Chapter Five explored the work of STs in the preparation of practical work and Chapter Six gave examples of the unexpected, unknown or 'hidden' work of STs. This chapter shows the way that global changes to school support staff have affected STs and reveals their opinions on the impact of these changes on their status and the control of their work. Tabled material originates from the survey conducted for this study: data from the website which was controlled by STs provides descriptive material.

The chapter is divided into four sections: selected aspects of the remodelling agenda; the effect of the single status agreement on technicians; the views of STs on changes to their conditions of work, and evidence of the effect of the PFI building programme on the working environment of the ST. This data has been chosen because it provides information to answer the second research question, ‘how do changes to school structure and organisation affect the work of the science technician’.

7.1 The effect of remodelling on the work of the science technician

The lack of understanding of the work of the technician means that research reports into workforce reform (Hutchings *et al*., 2009) and workforce development (DfES, 2002a, 2003a) utilise limited information upon which to consider the effect of their proposed changes on the science technician, or mention to what extent science technicians are included, or excluded in the proposed changes. As members of the school support staff STs are included in the proposals by default, but not actively included. For example it is noted in Chapter One section 1.3.1 that CLEAPSS (2009) suggests that SMT might like to increase the use of STs in the classroom without suggesting how this could be assimilated within their current work. In this section the authentic voice of STs is used to show their thoughts on the changes.

7.1.1 The views of technicians on selected aspects of the remodelling process

Remodelling envisages a greater role for support staff in the classroom (DfES, 2002a, 2003a; Hutchings *et al.,* 2009). STs are not excluded and it is therefore possible that the ST role could be remodelled to include working in the laboratories. The difficulties that this would cause if working in the classroom were to become a formalised and timetabled arrangement has been mentioned in Chapter Four in connection with job descriptions. The views of STs were not sought by those envisaging this change.

Although technicians spend most of their time working in the prep room comments on the website showed that STs sometimes go into the laboratories. Chapter Four, table 4.12 showed that some STs already do this in a range of suggested contexts. However this table also suggests that STs may be more specific about when they will go into the laboratory. For example STs may volunteer to go into a lesson because a potentially dangerous chemical is being used e.g. 4M sodium hydroxide when making soap, a practical mentioned in Chapter Six.

Further analysis of the data showed that:

- 31 STs who participated in the survey would undertake all four scenarios

- 23 would not undertake any laboratory work

- 1 ST would only work with small groups

- 21 STs who stated that they would not go into the laboratory to become another adult, would go in to look after specific aspects such as controlling the use of delicate apparatus and of these 21, 19 would demonstrate equipment

The results and the comments made by technicians reported in Chapter Four suggest that some technicians may be willing to help when their skills and knowledge are required. This emphasises the difference between the role of STs who occasionally go into the laboratory and TAs who are timetabled to be present in the lesson: and between the work of STs which is mainly to provide the practical materials and science teachers who teach the lesson. It also shows that STs do not want to work as another pair of hands as this is not, in their opinion, the true role of STs (2a, d1, h1, 4a, 8a).

When STs who took part in the survey had the opportunity to indicate when they would go into the laboratory:

- over 30% would not go into the laboratory under any of the situations suggested in the survey
- over 60% would not work with small groups of children
- some STs would be prepared to work in the laboratory under all the scenarios suggested
- others were more specific about the type of task they were prepared to undertake

This suggests that although it may be thought that STs would go into the laboratory (DfES, 2002a, 2003a; Hutchings et al, 2009) STs consider that they can decide if and when they are prepared to do this. To emphasis this website responses to a posting about working in the laboratory (3a) revealed that technicians using the sites may think that this role is more suited to teaching assistants (25a, 19b, 17c, 24c, 7f): one technician suggested that their role was ‘to support the teacher, not the students’ (25a).

One ST (12) commented on their survey that they would be prepared ‘[to demonstrate] to teachers in the prep room’ which could indicate that technicians may be more willing to help the teacher master the demonstration and perform the experiment to the class rather than demonstrating the experiment to the students for the teacher.

To emphasise this point:

- nearly half the technicians surveyed (48%) stated that they gave teachers advice about health and safety (Q22) and explained the science behind experiments if asked (Q17)
- 86% will give teachers training in the use of equipment (Q16) or show teachers experiments with which the teacher is not familiar

Additionally comments on the websites showed that technicians will also be available to help if necessary if the teacher wanted to try out an experiment before using it in class (25a, 19b, 17c, 11a). Although this aspect of ST work is not explored by other reports or surveys; this role as an advisor is important as it gives teachers confidence in practical work. This can result in more practical work for students and advances science by enthusing students. However the availability of the technician to help teachers does depend upon STs being in the prep room and available to help teachers who are free when their fellow teachers are busy teaching. This opportunity would be reduced if STs were expected to also work in the laboratories.

7.1.2 Willingness to take science lessons or to take on more teaching responsibilities

To consider further the role of the ST in the laboratory, the survey asked STs if they ever taught students. Table 7.1 overleaf shows that of the participating STs:

- 19% will teach whole classes: although this could involve explaining a particular part of the lesson; such as the production and use of algal balls, or demonstrating techniques that STs have used in previous jobs

- 19% will teach small groups: perhaps using their knowledge of experimental work to help students plan coursework

- 15% will help individual students: perhaps helping sixth formers with their projects or giving them an opportunity to enhance their practical skills

- whilst some technicians would undertake all three roles and others would undertake some of the tasks, most would not do any of them

Table 7.1

Technicians undertaking teaching		
	Yes	No
Individual students	27*	118
Small groups	27**	118
Whole classes	21***	124

The following qualifying comments were added to the answers by STs:

* ‘Year 6 only’ (13) ‘individual sixth form chemistry’ (135)

** ‘sixth form students’ (58)

*** ‘A level chemistry’ (97), ‘With teacher supervision’ (1)

‘not chemistry’ (112)

This suggests that at the moment STs decide whether or not they will participate in teaching. Such work does not replace or undermine the role of the teacher but uses the expertise of the technician to increase the knowledge available to the students. Most STs who would teach had been technicians for over ten years suggesting that they were happy to remain as technicians rather than using the experience as a way into teaching. The answers given to posts about occasional teaching (2a, 8c, 4a, 5a, 8c) suggest that this is something individual technicians undertake because their previous work was in a particular area and they can offer their expertise to the students. Respondent 42 stated that they used previous knowledge to help students.

However, if the possibility of support staff being asked to take classes becomes more likely, then technicians may be asked to formalise their teaching of science to students, One technician commented ‘if I wanted to become a teacher I would have done so’ (2a). This could be a pay issue because STs would not be paid as a teacher, but could also be that STs like to work in the prep room because they consider they are their own boss. This was regarded as one of the best aspects of the work.

To probe this point further, STs were asked to consider their response to a range of situations that could arise as a result of the remodelling process. Table 7.2 overleaf shows that only 28% would take on more teaching.

Table 7.2

Technician response to possible changes caused by the development of other support staff roles						
Task	Yes		No		Blanks	
	number	%	number	%	number	%
Take on more teaching	41	28	90	62	14	10
Become an advanced teaching assistant if the post involved an increase in salary	54	37	76	52	15	10
Train LSAs or TAs so they could take the lesson	66	46	62	43	17	11
Would you do this even if they were paid more than you* (n=66 from previous question)	46	70	20	30	.	
Would you help a TA/cover supervisor etc. in the lesson if it was necessary to ensure learning took place**	78	54	51	35	16	11

Of the 28% who would take on more teaching:

eleven (20, 21, 57, 61, 75, 86, 93, 97, 106, 112, 143) previously stated that they taught whole classes

ten (20, 21, 57, 61, 75, 80, 86, 97, 112, 143) taught small groups

nine (20, 57, 61, 86, 93, 97, 106, 112, 143) taught individual students

This suggests that although some STs would undertake some types of teaching or support others do not want more teaching commitments. However it also shows that some STs who do not do any teaching at the moment would consider doing so.

The answers given in table 7.2 show a complex response to this issue of development of support staff roles at the time of the survey. Whilst only a third of technicians would take on more teaching as part of their present workload, a higher percentage would take on this role by becoming an advanced teaching assistant (a title used at the time of the questionnaire) if they were paid more to do so, even though it would have involved a change of job. 19 of those who initially would not take on more teaching would do so if they were paid more. Of those who initially said they would take on more teaching, 6 would not become an advanced teaching assistant even if it increased their salary as at the time of the survey it would have involved a change of job.

7.1.3 Willingness to train or help TAs or cover supervisors to enable them to take science lessons

The remodelling of school support staff has resulted in the development of cover supervisors who supervise classes where the teacher is absent for a short time. At the time the questionnaire was distributed in 2009 this post was not a well-established and my experience suggested that the perception amongst STs was that cover supervisors would be expected to teach the class and that TAs would be expected to take on more teaching after gaining HTLA status. Questions were therefore asked about the help STs would give to TAs and to cover supervisors.

If TAs were expected to take on more science teaching nearly half (46%) of STs who replied would give them training however a third of this number would not do so if the TA was paid more than the ST. Although one ST (38) commented on the questionnaire that they would ‘do this for a teacher and would therefore also do so for a TA’ which suggests that this is something decided by individual technicians.

However because TAs or cover supervisors do not necessarily have a science background the questionnaire also asked STs if they would help the TA or cover supervisor if this was necessary to ensure that learning took place. 54% of STs who responded would do so. This is important because if a cover supervisor needed clarification about the answer to a question in the text book or the explanation of a phenomenon given in the text book was not understood by students it would be easier to ask for advice from STs than to disturb another science teacher who would be busy teaching their own class. This is also in my experience an occasion where STs will not only give the TA or cover supervisor help, but will go into the classroom to offer explanations to students if necessary. However some STs added a qualification specifically stating that they would:

‘sort out books, but not practical’ (12),

‘only books, not practicals (15)

practicals should be carried out by a qualified teacher’ (18),

‘if real teacher asked me’ (27)

‘in certain circumstances’ (42)

‘only if no practical involved’ (72)

‘not practical’ (107)

Other STs did not indicate whether or not they would put the same restriction on the help that they would provide.

The questionnaire did not specifically ask what kind of help would be offered as at the time it was not known if the role of the cover supervisor in science or the HTLA would include undertaking practical work with the class. Nevertheless website comments on the topic indicated that STs who replied would confine their help to science theory: consulting the HOD if practical work had been included in cover work before help was given because of health and safety implications. Similar comments were made on all websites (1a, 2a, 10a, 14a, 12b, 9c, 24c, k1, d2, g2, u2). When replying to this question on the survey, some STs qualified their answers indicating they would help with theory but not practical (72, 15, 8): others (34, 134), suggested that they would do this if they thought the LSA was competent or the usual teacher or head of department asked them to do it. The problem appeared to be that their concern was not with the LSAs or cover supervisors *per se*, but that there could be health and safety issues. There was no difference between percentage of technicians and the percentage of senior technicians who responded positively to the questions.

7.1.4 The effect of remodelling on the status of technicians

When STs posted on the websites they used the term ‘status’ to describe their perception of their position in the school. ‘Status’ was therefore used in the survey to establish the perception of the technician to the way they might be affected by remodelling in their own specific circumstances. Status is an issue that may have been considered for many years with respect to teachers and support staff. However as has been shown, the role of the ST is unknown for reasons that include lack of visibility and of a voice. STs are on the periphery of any discussions or ignored. However STs regard themselves as being in charge of their own work pattern: and as long as they produce the practical work for the classes, the way they do this is decided by STs. Whether this is deliberate marginalisation of STs, and whether STs consider they are marginalised and if so, in what way, will be considered in Chapter Eight. For this reason this section concerns only the views on STs about their status. Technicians were asked if they thought the effect of the remodelling process would enhance, diminish or cause no change to their status in schools. Table 7.3 overleaf shows the results. These show the majority of technicians felt that there would be no change to their status. However of those STs who thought their status would change, over two thirds thought that their status would be diminished.

Table 7.3

The perceived possible change in status if remodelling of support staff takes place				
	Enhanced	Diminished	Stay the same	Don't know
Number of technicians	16	36	71	22

The comments on the websites and those added to the survey suggest that the amount of assistance provided by STs to teachers and to cover supervisors is determined by the ST.

This section has shown that although the concept of STs having a greater role in the laboratory as a result of the remodelling of support staff is compelling: not all STs regard this as part of their job; some STs who already worked in the laboratory did not want to become another adult, and some preferred to use their professional skills to demonstrate experiments or to safeguard delicate apparatus. Some STs were prepared to help support staff if it was necessary to ensure learning took place and although most technicians did not think remodelling would affect their status, approximately two thirds of those that expected a change thought their status would be diminished.

7.2. The effect of the single status agreement

The literature showed that the adoption of the 'single status' agreement for all council workers has affected technicians, showing that this process worked well for only for those whose jobs were familiar to the evaluators, being less successful where jobs were not understood (Butt and Lance, 2005). STs have been disadvantaged because they are one of the groups which are less well understood. This is likely to affect most STs as schools such as academies may also adopt the local authority scales for their support staff. This section considers: the views of STs on the effect of single status; on the perception of their role; on the ‘single status’ process, and on ST pay scales.

At the time of data collection (2009-2011) under half (42%) of the technicians worked in a county which had introduced the single status agreement and at present (2014) there are still a few areas where the process has not been completed. However all technicians were aware that the process would eventually affect their county.

7.2.1 The effect on the perception of the status of science technicians within the school

Technicians were asked for their views on the effect of the ‘single status’ agreement on the perception of others on their status. Table 7.4 overleaf shows the results. Half of all technicians who responded to this question thought that their status was or would be unaffected, but a larger number of those who had been affected by the changes thought that their status had been diminished.

The number of responses from technicians who had been through the ‘single status’ was small but the comments noted in the next section may indicate possible reasons for this perception.

Table7.4

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Views on changes in status related to the effect of single status implementation								
Category of technician	Enhanced status		Diminished status		Stay the same		Don't know	
	Number	%	Number	%	Number	%	Number	%
Technicians who considered they had been affected by single status agreement	2	9	7	31	10	45	3	13
Technicians who considered they had not been affected by single status agreement	1	6	4	24	10	58	2	12
Technicians who had not been through single status agreement	8	14	14	24	29	50	7	12

7.2.2 Views of STs on the single status agreement process

Comments made by technicians on their experiences of the single status process on the questionnaire or on the websites show the opinions of technicians on the regrading process. STs 3a, 13a, 22a, 12b, 16b, 10d added their region which showed that technicians who worked in counties that completed their evaluation early such as Sussex were more likely to have received an increase in grade whilst STs whose counties completed the process later were likely to find the results were less generous towards them. When considering this diversity, one technician noted '[I] thought the idea was for the whole thing to be countrywide. There is nothing fair in the system' (22a). Posts about regrading appeared periodically as the evaluation process continued and the number of technicians who commented that they had received a pay cut increased as it progressed.

A typical comment was:

> Welcome to the cold reality of support staff. Technicians are paid on the same scale as LSAs and often less than office staff. Passing exams and gaining qualifications does not mean you get more pay
>
> (technician 22i).

Technicians (18c, 14d, 23h) noted the difficulties they faced in obtaining a higher grade by asking for a reappraisal. Whilst some technicians suggested making a list of all the jobs they do and presenting that at the regrading interview to show they had many tasks that fitted into the higher grade (5b, 9c, 15f). Others (2a, 7d, 5e, 3g, 19i) warned against this suggesting that the list may not be used to enhance their grade, but to define their duties at their present grade as it is stated that some duties at the higher level can be incorporated at a lower level.

At one point technicians considered that as the problem with grading was caused by the lack of understanding of the role and the answer was to only undertake the work noted on the grades allocated as 'the pay reflects the role not the person' (7b). Technicians would therefore be fulfilling all the work at the grade allocated but it would soon become obvious if this grade did not reflect all the work they had previously been doing. However, technicians thought this would be difficult. It has been shown in Chapters Five and Six that technicians are keen to ensure that students receive the best practical work possible and that the work that students do is safe. Technicians therefore felt that they were unable to change their situation as their true role is unknown (2a, 3a, 4a, 11a).

7.2.3 The effect of the 'single status' on pay scales and work

Grading also affected their pay scales. When STs were told their pay point and therefore their grade they also received a chart which showed the work that was regarded as suitable for that grade. The result of not allocating the correct grade for the work required has resulted in contradictions in the work expected and the work that should be undertaken.

One example is supervision: theoretically, there should be a technician in the department who can undertake the supervision of other STs. However the situation can arise when no-one in the technician team should be supervising others because either: all technicians have been allocated the same lower grade; or nobody has been allocated a grade that is high enough to include supervision of other STs. STs who work alone are also affected: it has already been noted lone STs are expected by implication to undertake tasks such as diluting chemicals unsupervised, but may not have been allocated the higher grade necessary to do this because they have no one to supervise. Hidden tasks such as being in charge of the budget should also only appear in higher grades. Although not allocating a sufficiently high grade for the expected work saves money, the allocation could also be due to insufficient knowledge of the work of the technician. Two comments by technicians indicate their views of this problem:

- whilst I understand the frustration felt by techs about their lowly status I am afraid that we are the only ones bothered about it. Management are not interested in what we think

ST (3a)

- I mentioned in my appraisal that expressions of appreciation from senior management were non existent

ST (g1) '

It also leads to other adverse comments for example:

- [I] asked what was needed to be made a senior and the answer given was – "restructure the technicians" (but I am a lone worker so can't do that) if I wanted more money I would have to become a cover supervisor

  ST (h1).

- All the science techs in my county have had a pay cut made because techs score poorly in some factors (e.g. number of people supervised etc.). This also included the area concerning 'knowledge and skills' required and the level given is consistent with 'working at a basic level involving a limited range of tests that can be carried out after a brief induction' other areas are also considered to be undertaken at a low level

  ST (k1)

However, STs have also posted about other issues and the next section gives details of some changes made to the working conditions of STs, the views of STs on their management and the effect of this situation which means that STs have no means to communicate the issues to those who can influence changes.

7.3 Views of STs on their interaction with senior management, performance management, and changes to their working conditions

Concentration on the visible workforce and forgetting the others leaves a significant group of the school workforce with no voice: meaning that the experience needed to carry out their work, and the way the job is considered within the broader context of support staff is underestimated. In section 7.2.3

STs (3a, g1) considered that their senior management did not appreciate the work of STs. Other STs commented:

- ‘[science] teaching staff say thank you, senior management on the other hand never have and probably never will’ (21b)

- ‘SLT never come near the prep room’ (a4)

- ‘of course SMT should come and say thank you for the effort we put in, but that never happens (2b commenting on extra work done for the annual open evening for prospective parents).

This section includes comments made by technicians to show the way in which the lack of understanding of the work of the technician has resulted in some changes that may be counterproductive to management expectations. The material used was generated by STs and therefore reflects their thoughts. Areas chosen are: the views of technicians on senior management and examples of the consequences of the isolation of science technicians from the decision processes; examples of the development of a division between teaching and support staff as a result of management decisions which change working conditions, and the introduction of performance management.

7.3.1 The effects of the isolation of science technicians from decision processes

The literature has shown that science technicians are isolated from the majority of school staff because they may be physically isolated: and because technicians are busy at break times when other staff can meet.

Technicians also accept they are invisible to others in the school. For example, it was noted on a website:

> many technicians who work hard for the school, staff and its pupils can often become invisible the harder they work. If you do not cause a problem and get the work done the school is happy and no one ever really gives you a second thought
>
> ST (3a).

Comments about the lack of communication included:

- ‘SLT don’t even come near the prep room’ (a4)
- ‘I resent the fact that there was no consultation [over a particular change] or even the manners to point [the change] out to us’ (16c)
- ‘communications about changes are sent via a letter, or email’ (2a)
- ‘in a nice world managers should consult with their workforce to reach an agreement together’ (2f)
- ‘not to be consulted is, I think, insulting’ (5g)

Only two posts on this subject on the websites indicated that technicians had any formal meetings with the SMT that related to future plans for the school development plan (u1, k3). This suggests that little can be known about the effect of changes on STs when decisions are being made. Financial issues are used to illustrate the problem.

It has been noted in Chapter Six that STs may have budget responsibilities. 18 technicians posted comments about changes that have been made to financial arrangements without taking the needs of science into account and which have created difficulties. The changes have been described as ‘frustrating’(f1) and examples include:

- ‘the need to order only via the finance office, so bargains that are available online may be missed’ (o3, g10, g8, p1)

- ‘the need to get quotes when the best source has already been found’ (p1)

- ‘having to sit with the accounts clerk to add all the items to the school system otherwise they cannot be ordered’ (d1)

Three technicians (k2, v2, m3) noted that lack of understanding of the work of the science department had resulted in departments losing facilities for payment, and only finance staff were allowed to handle money. STs regarded this system as a sign of a lack of trust making ordering more convoluted.

The job descriptions used in Chapter Four, showed local shopping is usually written into ST job descriptions. Posts from STs noted that formerly this only required the presentation of the receipt to receive payment or had petty cash (p1, g2, u1, g10, h1, k1, r1). Technicians reported a range of changes. Some had to write the experiment on the receipt (p1, u1, m3, v2, j2), with some needing to write exactly why it was needed (u2, g3, s3 b1). An example would be the need to buy chocolate chip cookies because the experiment required the chocolate to be extracted. Others had to have the money paid into their bank account (g10, s1). Three STs (k2, g2, u2) noted they had to personally pay for internet items and then claim the money back. Technicians stated that they did not see why they should subsidise the school, for example:

- ‘we do not provide loans to the school’ (c1)

- ‘staff provide the money or they buy items themselves’ (t1)

- ‘purchasing may be in my job description, but not the financing’ (m1).

- ‘It cost me £30 a week and I did not get the money back until the end of the month. I suggested that the teachers did their own shopping and they went mad [commenting] why should they spend their own money and shop in their own time?’ (k1)

- Another stated ‘ no float, so we have to make purchases from our own money and claim it back, this can take a week or two’ (w3)

As many items bought are perishable, STs (z2, g6, d1, a2, 2a) reported that finance now purchase these weekly using a supermarket delivery service STs have to check the practicals for the whole of the next week to see what will be needed and in some cases such as the purchase of hearts for dissection, (a class dissection usually needs between 10 and 15 hearts) hope that the number required will be available (a2), One ST was pleased that they no longer had to shop:

> that finance has all the responsibility [and that] my recent job evaluation states that I do not have financial responsibility, finance do
>
> ST (d3).

This illustrates the difficulties that arise when technicians cannot to communicate with SMT when changes are being made either to the science department or to areas such as finance and ST needs are not understood. However other changes have also been made which have caused differences between teaching and support staff to become more obvious.

7.3.2 The development of a division between teaching and support staff

As the postings were controlled by the technicians, there were comments that reflected changes implemented by school management that emphasise the division between support staff and teachers in the workplace.

The procedures in the event of snow also showed a difference of attitude towards teachers and support staff. 21 STs posted comments about these procedures. Support staff were expected to come in for a variety of reasons: to man the phones (z1); to provide a crèche for pupils as a service to parents (a2), or to help site staff (m3, 2a, b4, d12); but teaching staff were told to stay at home. Support staff were told they would only be paid If the school was officially closed, and even then those who lived close enough were to walk in. The isolation and invisibility of science technicians was apparent when the decision to close was caused by sudden snowfall during the school day. One technician noted that when heavy snow fell during the day and the school decided to close, only teaching staff were told, and STs found out only when a member of the SMT came into science to look for a photocopier to photocopy some more notices to hand out to teachers (d1). Another technician stated that they only found out that the school was closing when they ‘bumped into a teacher who was collecting their handbag from the department’ (a2). The expectation amongst teachers that support staff would be in even if they were not was illustrated by a post (d1) that stated that when the school reopened after a ‘snow day’ teachers were complaining they had the wrong practical in their classroom. Which they did as it was obviously for the day before when the school was closed. One post noted that support staff that did not get in had to explain why not (g2).

Ways of recording hours worked beyond STs normal hours produced a number of posts (15) and the problem appears to be that historically technicians have managed their own time, because of the need for flexibility. ‘Flexibility’ was noted as one of the best aspects of the job in the survey. Until recently this was accepted as a necessary part of the work of the ST and monitored informally by the HOD. One ST stated:

- ‘as long as the work is done and I am there when needed I keep my own hours and in return I stay late when necessary’ (j2)

However schools appear to have changed the attitude towards the way support staff and teachers are monitored and this has resulted in comments on the website that reflect a much more rigorous approach to timekeeping, such as:

- ‘school support staff have to sign in and out, teaching staff do not – we all know it is really done to make sure we work our full time’ (o3)

- ‘every second of our time has to be accounted for’ (2a).

It was also noted that extra hours worked are treated differently ‘[we have] flexitime, but only if the exact start and finish time were noted’ (y2, d1) ‘Any extra time accrued has to be taken within one month and booked in advance with permission from everyone above us’ (2a,). Others noted that those whose contracts were longer than 38 weeks had to detail when they did the extra time and get permission before they did it (y2, d1, o3, f3, q3, g10, 2a). STs noted that this was difficult if the time was worked when the HOD was not available (u2, j2, g10). The micro management of hours worked also reduces the inclination of technicians to undertake shopping for experiments although this is routinely a part of their job description as already noted, technicians posted:

- ‘I agree that shopping may be part of the duties of the technician but not if it has to be done in their own time’ (w1)

- ‘we are not trusted to go out during school hours’(a2)

- ‘I used to go shopping in my lunchtime, but not any more … I’m not using my own time on it’ (n1).

A technician with the appropriate business qualification commented:

> Management cannot make you shop in your own time and if you shop during your own time they should give you the time back, also they can order you to shop in school time, but you need to be told what other jobs you should not do because of the loss of this time in school.
>
> ST (d2)

The implication is that management do not trust STs, and although STs need to be flexible, deviation from their expected hours is viewed with suspicion.

Other posts related to staff leaving at the end of term. Support staff were expected to remain (u2, b2, a3) after teachers had been allowed to leave.

The issues used to illustrate this section may appear to be minor grievances, to outsiders, but the number of comments posted on the websites show that these are important issues to science technicians. The scenarios illustrate that although STs think of themselves as a recognised member of the school they are likely to be forgotten when important information is distributed in unusual but not unpredictable circumstances and are constantly monitored in a Taylor (1911) like way to ensure that all their hours are accounted whilst the need for flexibility is underestimated.

However these are not the only areas where STs have made comments on their interaction with senior management: the introduction of performance management has also resulted in postings.

7.3.3 The introduction of performance management

During the time of the survey in 2009 and the initial collection of data, performance management was not an obvious issue for STs. However, postings began to appear late in the collection process and as this seemed to be an important issue a further request to use the data was posted. The comments used are from sites A and B as both had postings on this subject.

During the postings, one ST commented:

> human nature being what it is, an increase of a pay point is likely to be linked to a successful appraisal, if the process is transparent and can be seen to be fair, however there is also potential for a problem if that is not the case
>
> ST (19i).

Other posts reflect various aspects of the process starting with the line manager, who will be responsible for the management. Whilst some STs are managed by their head of department others are managed by a range of other staff:

- '[my] line manager is the business manager' (1c)

- 'my line manager, the director of support staff services, actually knows very little about what I do' (f2)

- ‘the head of IT is my line manger he knows nothing about my job’ (8a)

- ‘my line manager is the head’s PA, who has never even been in the science department’ (12b)

Lack of knowledge of the work would make appraisal difficult and may not instil trust in the process. STs commented: ‘It needs to be done by someone who understands the role’ (7b) another added:

> There is nothing like getting out and about and finding out what your employees do and what contribution they make. Sitting in an office…trying to think up new goals to set at the next performance management does not get results
>
> technician (15c)

Other STs have posted that they have never had a review. Comments included:

- ‘no appraisal for more than 10 years’ (l1)
- ‘been here 21 years and not had a performance management – what would be the point?’ (o1)

- ‘never had a review in 4 years’ (11d)

When one ST(12b) posted that they ‘needed to come up with three targets, two challenging and one standard’, a reply suggested ‘you might want to look at personal goals for your own improvement’ (15c) but another cautioned that approach:

> - I tried to put in jobs that I do anyway such as updating the chemical storage [in line with the new regulations] but the head of corporate management didn’t like them
>
> ST(11d)

Less seriously another suggested that their targets would be:

- ‘get to the end of the week, get to the end of the term, get to the end of the year’ (3a).

However when this question was posted on another site the reply posted stated:

- ‘business managers should do this, they are paid on the management grade’ (I1)

Some STs appear to regard the process as fruitless with comments including:

- ‘I think the time could be better spent’ (2b)

- ‘the process doesn’t suit many support jobs in education and has been lifted from banking or insurance’ (4p)

For others it appeared a futile process commenting that:

- ‘I had my review and got just enough points for a pay rise – needs to be moderated by head and is not likely to be approved – and will 75p a day be worth it?’ (12b)

- ‘[we are] on a pay freeze, so targets have stayed the same for 3 years’ (j1)

Others regarded it with a degree of suspicion or feel there is little point in the review:

- ‘I feel it will be used to keep salaries low’ (x1)

- ‘like many techs I have been at the top of my scale for years with no prospect of moving up to the next scale. If the main reason is to determine pay rises there seems little point in me having one at all’ (I1)

Other posts queried the motives for the process, some thought it was simply a way of increasing their workload, one stated: ‘I don’t need a form to sign every year to encourage me to work harder’ (a3).

Others thought this was the motive for the review:

- ‘Once on the top grade you have to exceed expectations for whichever aspect has been highlighted without any prospect of financial reward’ (4f)

- ‘I can’t see the point as once on the top grade you can’t get another penny’ (g3)

- ‘there is nowhere to go, so they should not expect more as they are not paying for it’ (d1)

One ST returned to the subject of the single status agreement stating that:

> The local paper put a list of occupations for the grades given [single status agreement] grade 2 where most techs appear to have been placed is equivalent to a post room attendant and a mobile toilet cleaner. Grade 3 equals an office worker and a yard hand why should they expect more from us?
>
> ST (2a).

Whilst another suggested reviews:

> used to be what courses we wanted to go on and praising what people have already achieved and has now turned into a punishment, i.e. a capability exercise
>
> ST (f1).

> Some STs were more reflective and suggested causes for the present situation:If the system is used to motivate, reward and train staff then it works well, but in most cases involving support staff it is a paper exercise so management can say yes we have an appraisal system for our support staff, so we value them – LOL [laughs out loud]
>
> ST (g15).

Others blamed other factors such as lack of understanding of the role of the ST:

> we will never get anywhere whilst everyone outside the school (and maybe sometimes inside) thinks support staff = people who work in classrooms alongside teachers
>
> ST (2a)

and the lack of a proper career structure

> it is difficult to have performance management when you have no career structure. What are you working towards with nowhere to progress to? I do my job well so nothing else, unless I go out of my role completely
>
> ST (15c).

Continuing the theme of lack of understanding another commented that

> the only time I've ever heard of this being a useful process in a job that is difficult to define (like ours) it was used by both sides to produce a REAL job descriptions meaning jobs that ONLY you can do and without which things would grind to a halt.
>
> ST (g13).

The post by one ST emphasised the wide range of tasks undertaken by STs: ‘example – can you tell me what your job entails? Erm - everything?’ (26f). Another argued that:

> one of the difficulties is assessing the contribution made by the technician to the education of the student, it would probably need an extended period of time without support to realise the importance of the role
>
> ST (d2)

It would appear that the introduction of performance management has not been viewed positively by those STs who contributed to the discussion and, as a result of the performance management process one technician suggested that:

> ‘we feel we have used all our goodwill up and now have none left’ (g2).

Lack of understanding of the role has caused problems with performance management. It has also caused problems in their work environment

7.4 The unexpected effects of the Private Finance Initiative (PFI) building programme on the working environment of the technician

This section outlines the changes to the working environment of science technicians in new buildings. Launched in 1992, PFI is the government initiative for updating schools which has resulted in rebuilds rather than refurbishment.

Some problems such as the flooring in corridors being slippery when wet has been mentioned in postings by technicians (2a, 13c, 21a,12c). It creates an increased hazard in science as flooring in laboratories and prep rooms is non slip and it is easy to forget this when materials are being moved or carried in corridors.

Chapter Two revealed that some prep rooms are located between laboratories however these prep rooms have opening windows and daylight. Other prep rooms have been placed in the centre of the building and having no windows they lack natural light and ventilation. Technicians who were being moved into new buildings posted questions asking if there were any important points to consider, a comment suggesting: an opening window is essential in a prep room' (3a) is not flippant. An opening window allows increased ventilation in case of a spillage of noxious chemicals. Lack of ventilation in chemical stores has been noted in postings on the website (g1, x1, c3, g3). This is a serious issue and has resulted in the need to call out the emergency services to deal with an incident that would otherwise have been a job that an experienced technician could have handled (personal experience).

Prep room temperatures have also been mentioned (g1, c3, m3, y3) especially in under-ventilated rooms, but there is no legislation that deals with areas that are too hot and technicians (d1, x1) have posted that requests to investigate the lack of ventilation have resulted in no action being taken. Technicians also commented upon the lack of room (d1, c3, y3, g13) adding that space for storage in laboratories was not a substitute as classes have to be disturbed if the equipment has to be retrieved during lesson time.

Technicians (d1, c3, g2) stated that they were not able to influence the design and without any idea of the work undertaken in prep rooms the design was whatever the architects decided was needed and resulted in:

- ‘prep rooms being furnished with more hand washing basins than there are technicians to use them’ (d1),
- ‘with too few gas or electric sockets for efficient working’ (a3)
- ‘with water supplies inadequately distributed around the room’ (d1)

One technician commented that they had managed to persuade the builders that a gas tap was needed in the prep room, only to find that it had been placed directly underneath a heat sensor (w1).

Communication with science technicians would have lessened the problems encountered and would have made the prep rooms a better environment in which to work.

7.5 Conclusion

This chapter contains material about school-wide factors that affect science technicians. Their willingness to undertake tasks that were regarded as possible extensions to their present role was shown using data collected from the questionnaire and from the websites.

The next chapter links material from the literature and material from Chapters Four-Seven and discuss the findings.

Chapter 8: Discussion of the findings

The data produced by this study has provided the ST with an opportunity to actively participate in the production of a picture of their daily life using their authentic voice. It links the findings of this study to points raised in the literature reviews, Chapters One and Two, from which the questions, aims and objectives of the study emerged.

8.1 The science technician and their work

Chapter One explored the perception of practical work held by science teachers, scientists and by those researching practical science in schools showing that the role of STs in practical preparation is rarely mentioned. The lack of literature relating to school science technicians was also noted.

Although some surveys had been undertaken as noted in Chapter One that could be used to provide an overview of the information available about STs and their work at the time of the study, these studies viewed the science technician and their work through the lens of an outsider which showed the limitations of this approach. More specifically it revealed gaps in our understanding of the nature of the daily life and work of STs and as a result the expertise needed to carry out the job was underestimated. This section discusses points raised in Chapter One with reference to this study which used the authentic words of technicians who posted on the website: and a questionnaire produced using the lens of an insider.

8.1.1 The age of STs

The surveys previously produced contained data about the age of STs suggesting:

- most technicians were aged over 50 years
- the population was ageing
- recruitment was low in STs aged under 30 years
- a new source of recruits; the semi-retired and the redundant; was suggested

The modified ages used in this study showed that:

- most technicians (88%) were aged over 35 years
- the population was ageing
- recruitment was low in STs aged under 35 years
- some retired and redundant people were recruited and appeared to have science based qualifications

To explore the lack of younger recruits further, the figures produced in the previous surveys showed the reduction in younger entrants: 31% (ASE, 1994); 28% (The Royal Society/ASE, 2001); 18% (ASE, 2010a). This study showed that 12% of the technicians who responded were aged under 35 years. suggesting that the job is no longer attracting the same number of younger entrants.

Previous surveys did not ask if STs had a previous job, or the nature of that job. This survey revealed that over 90% of technicians aged over 35 years had a previous job (table 4.5) and a high percentage of STs had previously had a science based job (table 4.8). From experience and from speaking to other technicians it is known that there were few part time or job share opportunities in laboratories until such work patterns became commonplace in other spheres and this could be one reason for the plentiful supply of STs for schools in the past. The increase in availability of suitable work in laboratories may be one factor that reduces the attractiveness of school work.

The lack of younger entrants, and the high percentage of older technicians; 64% of STs in this study were aged over 45 years; in ASE (2010a) 43% were aged over 50 years ; points to a developing crisis similar to that recognised in the teaching profession. Unless recruitment increases the figures suggest that by the mid-2020s retirement of STs the number of technicians could be halved. ASE (2010a) reported an increase in applications from the retired and the redundant. This study shows 9% of STs in this category. This source provides recruits with science knowledge but these STs may not be a long term solution: those who have retired may leave after a few years and; those previously made redundant may find work in a laboratory - unless they are encouraged to remain as STs. Stability is important in the prep room: STs become attuned to the needs of individual teachers; can draw on previous knowledge of work schemes to anticipate requests if teachers forget to submit their requests, and can give advice to new teachers on practicals used in the department. This study asked how long the ST had worked in schools. 40% of technicians had stayed for over six years, showing that STs remain in post for some time providing stability of practical provision for the science department. Although many of the comments on the best aspects of their work (Chapter Four, table 4.13) suggest that STs like their work, other reasons: lack of alternative employment in an area, or that STs like, or have got used to, having longer holidays are also possible reasons for STs staying in schools.

By using an outsider view to produce information about STs and their work only a partial picture emerged. The seriousness of the problem has not been recognised and steps have not been taken to reappraise the recruitment of STs. This study, by using the voice of the technician and an insider approach has added more detail: suggesting reasons for the decline in numbers entering the profession and arguing why recruitment from the retired and the redundant may not replace recruitment from younger groups.

8.1.2 Qualifications of STs

The range of tasks expected of STs in Chapter One (tables 1.5, 1.6.) and in the findings chapters show that prior knowledge of science is important for STs. Previous surveys showed a reluctance to recognise the knowledge already possessed by technicians (The Royal Society/ASE, 2001; CLEAPSS, 2002; ASE, 1994) dismissing its value by suggesting that the qualifications might be in the wrong field or could be insufficient for the work involved (CLEAPSS,2009). This attitude was also recognised by Barley and Bechky (2004) and Lewis and Gospel (2011) who suggested it is the result a different value being placed on academic study and practical acumen. ASE (2010a) suggested 70% of STs had a degree or technical qualification, but did not ask about their previous work to establish the value of the qualification to their present post. In this study 70% of technicians who participated had a degree or HNC qualification and the previous occupation of most STs indicated that a science qualification would be needed for that post.

The ASE (2010b) requirements for technicians at various levels as previously noted in Chapter One (table 1.4) suggested that:

Level 1 technicians require only basic level qualification

level 2 technicians require 1 ‘A’ level.

level 3 needs 2 ‘A’ levels.

level 4 requires a foundation degree.

making it difficult to understand why the qualifications are considered insufficient when a degree is not required at any level.

The findings showed many technicians are graded at level 2 and should not need a degree to undertake their work. However the range of tasks expected as seen in Chapter One (tables 1.5, 1.6.) suggests that prior knowledge of a range of science techniques is needed by STs and a single ‘A’ level is unlikely to be sufficient. As ASE produced surveys and the table the reason for the disparity could be that the complexity of the work and the amount of knowledge needed is not understood or has not been recognised because an outsider approach has been used to collect data on a group whose daily life and work is unknown. This has been shown by comments of STs and of school management in the findings chapters. Using the voice of STs and an insider approach has shown the complexity of their job and the skills and knowledge that is needed for their work.

Qualifications are also important to understand why technicians work in a school. Only this survey showed that almost all technicians aged above 35 years had had a previous job with just over half of the participating STs stating it was for family reasons. The findings showed that 100% of those who had worked in schools for between 16 and 25 years, and 90% of those who had worked in schools for 6-15 years had left their previous post for family reasons. However amongst those who had worked in schools for less than five years only 57% had worked in science. Inclusion of data about the previous job suggests one reason why schools were previously able to attract highly qualified staff and did not need to provide basic training was because they were more family friendly than laboratories. The reduction of participants who had worked less than 5 years in schools who cited 'family reasons' could suggest that laboratories are becoming more family friendly, reducing this source of trained scientists to work in the prep room: although other factors could also affect this choice: the wages; the effect of the single status agreement, and the lack of access to training all received a number of negative comments on the website. These findings suggest the idea that schools will always be able to attract staff with a science background to work as STs because schools are family friendly environment may be optimistic.

8.1.3 Wages, and job descriptions

Wages which are low compared to the work expected could also affect the decision to become a school science technician. The Royal Society/ASE (2001) noted that technicians commented on their low pay. It is considered that wages can be kept artificially low because the appeal of working in a school attracts to technicians with higher qualifications than those specified (ASE, 2010a). The school is advantaged if the low qualifications expected can justify the low wages offered as this would save the school money, but is only sustainable if there is a supply of technicians who are willing and able to accept the low wages in return for a family friendly environment. The reduction in entrants suggests that this may no longer be the case. The literature showed that in ASE (1994) only 33% of STs were the main wage earner, but in ASE (2010a) this figure had risen to 44%.

Although technicians were not specifically asked about their pay in this study comments on the websites showed that STs:

- worked as ‘a means to an end’
- thought the job was no longer a source of ‘pin money’
- STs also added that for sole wage earners the job was ‘untenable’ and was not a ‘living wage’

Keeping the wages low whilst still being able to recruit staff that are more qualified than stated in the job profile (although in truth the higher qualifications are essential to be able to undertake the work) only works when the wages earned by the ST are not critical, that is they are neither the main nor an essential second source of income. As suggested by ASE (2010a) and noted in ST comments; low pay is tolerated in exchange for the family friendly holidays associated with working in a school. Therefore schools manage to recruit highly qualified staff whilst offering low pay. Comments by technicians on the websites suggested that for some, pay is now a critical issue. This may override the attractiveness of term time working as well as deterring younger applicants. The low level of pay suggests low level qualifications are needed so training should be minimal. If they can no longer recruit highly qualified staff schools may either have to pay more to get the STs they need or provide suitable training. However the training will have to include the visible and the invisible tasks of STs.

8.1.4 Tasks undertaken by science technicians

8.1.4.1 Practical work

As technicians are isolated from other school staff and their work is largely unknown different lists of tasks expected of STs have been produced by previous surveys. Two were reproduced in Chapter One (tables 1.5, 1.6). The long list of tasks produced by The Royal Society (2001) did not differentiate or prioritise the tasks or their relative importance or frequency, not noting for example that ‘check[ing] first aid kits’ would be a less frequent task than ‘delivering equipment to rooms’. Tasks listed by Busher and Blease (2000) showed teachers were more likely to relate the significance of tasks to the impact they had on their own work rather than the impact on the work of the technician. The list produced by CLEAPSS (2002); although more realistic about the range of tasks undertaken by science technicians; could suggest that the work should be expected of all STs. Therefore STs on level 2 (ASE, 2010b) as they work alone or do not supervise enough staff could be expected to undertake all these tasks: including dealing with hazardous chemicals such as bromine with only one ‘A’ level which could be in biology. Whilst at present technicians are far more qualified than this and can undertake these tasks, as the demographics change this may no longer be true. The lists of tasks in the job descriptions collected for this study were not helpful, showing that tasks were allocated randomly between ST grades, suggesting confusion exists about which tasks should be attached to which grades and that grade contents are infinitely variable. As personal experience and the comments made by STs suggest that STs rarely have a hand over period with the previous ST generic lists are unhelpful and reference to the tasks actually required is needed. As Chapter One has shown that lists produced by outsiders are unsuitable and job descriptions have shown that jobs are allocated randomly to grades. A basic list prepared by STs for STs is needed rather than a list produced by others outside the profession. The science curriculum has a degree of correlation across the country therefore a basic framework of tasks usually expected to be undertaken by technicians could be produced. Any particular needs could be added as long as they fitted the tasks listed in the SSA for the level envisaged for the job.

The findings chapters showed that ST work extends beyond the delivering of a few items to the laboratory for practicals; keeping laboratories tidy, and washing up. It showed that ST work includes: the delivery of the materials needed for practicals; piloting experiments to ensure they would be safe and effective; refining and inventing practicals; producing worksheets; preparing solutions for laboratory use; using previous knowledge to reduce concentrations from the potentially dangerous levels STs handle to the levels suitable for student use; knowing the concentrations to use for each key stage, and making equipment. The preparation for microbiology practical gave an example of the amount of work that can be generated by a seemingly simple experiment. Any or all of these skills could be required in a set of practicals needed in a single school day and is the only visible part of this work is the delivery of the materials to the laboratory.

A practical that runs smoothly with no problems is the goal of technicians but does not show the amount of work involved or the skill and knowledge required. However to those outside the prep room it does suggest that the work is easier than it is because they have no idea of the work that goes on out of sight. Previous research has concentrated on ways of controlling STs, without consulting STs. STs have no voice because although they were the subject of the previous surveys their contribution was passive. This study has allowed their contribution to science in schools to be acknowledged.

8.1.4.2 Other work

Other work undertaken by STs such as: health and safety; budgeting: where describing their involvement as 'keeping financial records' (The Royal Society, 2001, pp. 37-38) has been shown to inadequately describe their role; giving advice and training to teachers and students; demonstrating equipment, and the planning of their workload require a range of skills that are not seen or understood even by some members of the science team. Although The Royal Society/ASE (2001) suggests that the help teachers can expect depends on highly trained staff, and ASE (2010a) notes the increase of tasks: these tasks go unrecognised. Without a means to communicate the complexity to others ST work appears less multifaceted than it is. The role of STs in these invisible areas has been shown in this study and their contribution noted. However the visible tasks technicians undertake as part of the science team if they have the time can weaken their status. These tasks may include: collecting or photocopying items that are needed quickly, as noted in STs comments on the best and worst aspects of their work, (Chapter Four, table 4.9 and 4.10); finding students in the department when they should be elsewhere, and filing items. This helps inside the department but gives the impression to outsiders that technicians are the science admin staff. STs therefore appear to be judged upon their visible tasks, whilst their expertise is hidden. This affects the view that others have of their work and leads to it being underestimated.

8.1.5 Gender and STs

Previous surveys have established that the profession is predominantly female. The ratio of females to males was 3:1 in all but one survey (ASE, 2010a note a ratio of 4:1). It has therefore already been established beyond reasonable doubt that it is a predominately female workforce. It was also considered unlikely to alter (ASE, 2010a). Although the initial survey for this study did not ask for gender information it was possible to establish the gender of the participating STs: some added information to their survey, that identified them as female: others were members of one website which had this information, and an email was sent to the few remaining asking for the information. In this survey 80% of the respondents were female. This is similar to other surveys (The Royal society/ASE, (2001), 76%; ASE (2010a),78%). Respondents were asked for their job titles therefore it was possible to ascertain the gender of senior technicians. The results showed 24% were male and 78% were female suggesting that the ratio was similar to that found in the ST population as a whole.

The issue of gender and STs is complex: the work is not gender specific, and the ratio of males to females is similar at technician and at senior levels, suggesting that males are not being selectively promoted. However the ratio points to a female bias at all levels which may not be considered usual for science based work. However as females have traditionally taken on the role of childcare it is reasonable to suggest that females are more likely to take jobs that suit their other commitments. This has been demonstrated in this survey by the reasons given by STs for working in a school. One aspect that distinguishes school work and other work is that it naturally fits with school days and school holidays. This means that many factors which affect 'working time preference' issues (Fagan, 2001) in other part time work for those with family commitments such as the need to make arrangements for childcare during school holidays, or vying for time off during school holidays with others, do not apply.

The ratio of the highest posters on the website showed a change in the ratio from 3:1 to 2:3. However this could be due to many variables; for example at least one of the male posters has a wealth of knowledge in physics and often provides sources for obscure components and makes very detailed comments.

Although gender may be a reason for working in a school it is a distraction to focus on gender as this hides the true issue that I think underlies the reasons for the poor pay:

- STs comments have established that STs feel they are invisible and that management do not know what they do

- the ASE, by producing guidelines that have very low expectations of the qualifications needed to undertake ST work have suggested that the work is not professional

- the result is management regard the work as something anyone can do.This has been shown in comments made by SMTs which have been reported by STs

- the pay reflects that belief

There is no gender bias in the pay received as it is low for all STs, it is coincidental that more females with science qualifications want to work in schools as STs because it fits with their other commitments. Therefore:

- Although the qualifications of STs are higher, the convenience means they are prepared to work in schools for the low pay

- Schools can therefore recruit from a pool of people who are overqualified according to the low expectations of the qualifications needed for the work as set out by the ASE

- However the qualifications held mean that STs can perform all the tasks needed even though this requires working at a higher level than their pay suggests

- this results in management; who do not understand the role; thinking that the work is low level and justifies the low pay

It is the lack of understanding of the work that has resulted in the low pay, and the lack of family friendly science jobs that has allowed schools to recruit trained STs. Causes of the lack of younger recruits could include the increase in family friendly science work outside schools, and as noted in comments by STs, the need to earn a living wage.

However Grönlund, (2007) noted that it is the flexibility within work that determines whether the job is considered good or bad. At present STs comments on the positive aspects of their work suggest that this is an important issue for STs. As other factors in the working life of STs become more pressing: the effect of the single status agreement the need for a living wage, and removal of the flexibility may make work in schools less attractive and this could be true for either gender.

8.2 Other factors that affect STs

Chapter Two showed how issues that included all support staff: remodelling, and the single status agreement have affected STs. It has been shown that STs have had little opportunity to reveal how such changes have affected them or to discuss the way they could be affected by future changes. STs have revealed their views which suggest that the lack of opportunity to be part of the decision making processes concerning changes to their work and environment has had a negative effect on science technicians.

8.2.1 Remodelling, the single status agreement and PFI

8.2.1.1The effect of remodelling on science technicians

The aim of remodelling was to raise standards and reduce the workload of teachers (DfES,2003f, Bach *et al.*, 2006) and suggested that STs could work in the classroom (i.e. the laboratory in science) and take on more teaching without understanding their present role or consulting with STs. Over a third of the job descriptions used in this study included working in the classroom: some including both practical and theory lessons. This ignores the variable workload of STs and the effect this could have on other lessons which would not be prepared.

The data showed that 68% of technicians will go into the laboratory but individual STs decide what tasks they will undertake. Posts indicated that technicians thought going into the laboratory blurred the boundaries between STs and TAs and remodelling will only increase their workload. Hutchings *et al.* (2009) suggested that expectations by support staff that remodelling would increase progression or pay were unfounded which supports this concern.

Remodelling also suggested that support staff should take on more teaching, with teachers only being needed to undertake expert teaching (Hammersley-Fletcher and Lowe, 2006; Bach *et al.,* 2006). STs with science qualifications could be asked to teach science. Previous surveys did not ask STs if they ever taught. This study showed most STs do not do this at present and do not want to teach in the future. One ST suggested that if they wanted to teach they ‘would have become a teacher’. Without knowledge of the work of

STs it could be assumed STs would teach because they are members of the support staff. However most technicians do not think this should be part of their work.

To expand on this idea technicians were asked if they would train TAs or cover supervisors, to take the lesson. Of those who responded positively most would do so even if TAs were paid more. Additionally when technicians were asked if they would train others if it was necessary to ensure learning took place the figure increased to just over half indicating that STs want students to learn. However if TAs or cover supervisors were expected to take practical lessons most STs responded that unless specifically asked by the HOD they would not do this because of health and safety issues.

Therefore although STs do not want to teach over half the STs would be prepared to give any necessary training to allow TAs or cover supervisors to take the class, as long as practical work was not involved.

Although most ST felt that their status will remain the same after remodelling, nearly two thirds of those who thought their status would change thought it would be diminished.

8.2.1.2 The effect of the single status agreement

Evidence mainly from website comments suggests that the SSA which was used to implement the joint national agreement has had a profound and divisive effect on support staff including STs. The literature shows that the Hay (2005) method designed for office workers was used for all staff: and relied on headteachers to inform the county councils of any discrepancies between the new grade allocated for the job and the work undertaken. It resulted in many support staff in all categories being placed on grades that were lower than they thought acceptable. Postings showed the angst felt by technicians who recognised that their only course of action was to work to the letter of their grade but their loyalty to the students made this impossible. Technicians who commented on the websites felt exploited but had no means to communicate this.

This process has had a very serious effect on technicians who feel that they cannot alter what they do to match their new grade without adversely affecting the education of the students. Although the process started some time ago and SMTs and even teachers may think it is now in the past: I think this is an area that still affects many support staff. A larger study would give a more comprehensive view of the feelings of STs, and an extension into other support staff groups may also reveal why the process affected some members of support staff more than others. It also affected the job descriptions of STs as the job families devised using Hay (2005) have little resemblance to ST work in the prep room, but have many desirable features if STs are expected to work with students in the laboratory: or undertake general administration tasks. Asking present STs about their work would produce a more realistic job description.

8.2.1.3 The effects of the PFI building

PFI building has caused problems in accommodation. Even when asked for an opinion; which posts suggest was unusual; attempts to change the plans had been unsuccessful: making the working conditions worse than in old buildings. Problems may have been avoided if STs had been consulted at an early stage. So far there have been no reviews of the adequacy of the new buildings and without a voice STs are working in conditions that they consider to be unsatisfactory.

8.2.2 Hours given to STs

STs are employed for a range of different hours as noted in Chapter One. ASE (1994, p.15) provided a confusing explanation for ‘full time’ noting 60% of technicians are ‘full time’ but 35% are ‘available throughout the year’ suggesting that ‘full time’ is not a 52 week contract. This study also showed a wide range of hours. With a mixture of full time (52 weeks) Full time (38 weeks) and a range of extra weeks added, without knowledge of the work actually undertaken hours can be randomly cut to save money. Technicians posted stating the hours attached to the job had been cut without any consultation when technicians left or STs had been given hours to share instead of another ST being employed, but these were rarely equivalent to the hours lost. The Royal Society/ASE (2001) noted without comment that nearly 70% of STs work overtime, which for nearly 20% is not paid for or for which time is given in lieu. This suggests that STs are not being allocated enough permanent hours to do all their work.

Without knowledge of the work of STs it could also be assumed that technicians only need to work when the school is open, not realising that tasks such as stocktaking are more easily accomplished when the department is empty. It has been noted in Chapter Four section 4.2.2 that when STs leave:

- full time (52 weeks) is reduced to term time only with perhaps another week or two added
- term time only is reduced to part time
- part time is not replaced

Not having a template for hours needed in a range of situations: size of school; number of lessons per day; amount of sixth form work, for example means that hours are randomly allocated and gives the impression that STs are not professionals and are in fact easily replaced.

8.2.3 Training and development

STs are now being included in appraisal and continuous professional development (CPD) processes in schools. ASE (2010a) notes that less than 50% of STs thought the process was worthwhile. In Chapter One Jarvis *et al.* (2008, p.37) suggested that ‘technicians did not have high career expectations’ which might suggest this negative attitude. However STs have commented on the website that they think these appraisals are a waste of their time and are designed solely to increase their workload. Their reasoning was that they are at the top of their scale and unable to progress. A progression route which recognised other skills instead of the need to supervise other technicians could make STs view the process more positively. The Royal Society/ASE (2001) suggested the lack of a career structure deterred younger applicants.

CPD should give technicians the opportunity to describe their training needs resulting in access to training and development. STs postings revealed that as training was either not available or could not be accessed because of cost the CPD process was not useful. The Royal Society/ASE (2001) considered that STs comments that BTEC courses were inappropriate was because their content was too academic without considering that it was below STs present qualifications. Jarvis *et al.* (2008, p.37) noted that there was less satisfaction after STs had been on a course. As STs have noted that there is little chance of advancement even with extra qualifications, this could be the cause of the dissatisfaction. As noted in the findings STs consider that their work is not understood therefore when objectives are given during annual reviews that require training. SMTs do not understand that, like teachers, fellow professionals are the best source of this training. In-house training as recommended by Garret *et al.* (2007) is unsuitable because others in the school have no idea of the complexity of the work. Combining the training of teachers and technicians would be of little value as the needs of the two groups are different. As recruitment of trained STs is falling the issue of training needs urgent consideration because trained technicians may no longer be available to schools. It has been has shown in the findings that technicians want to be trained by other technicians: such courses have been produced for other professions and similar approach is needed for STs.

8.2.4 Control of STs

In Chapter One CLEAPSS (2009) noted that STs were not supervised and The Royal Society/ASE (2001) noted that SMT knew little about STs and their work. Chapter Four showed that STs consider that they work independently because as long as practicals are delivered to the laboratories as required nobody questions their work. They consider they are their own boss: regarding these as some of the best aspects of their job. However posts made by STs on the websites show attempts have been made by SMTs to make technicians more demonstrably accountable for their time by adopting a Taylor (1911) style approach. This has suggested to STs especially those whose contracts are longer than 38 weeks that they are not trusted: resulting in a deterioration of the relationship between SMTs and technicians. It ensures that STs can prove they have worked all their hours, but forgets the extra work that technicians undertake which includes the unpaid overtime already noted and shopping for items. STs have posted that they are now reluctant to shop in their own time or anywhere but locally, meaning that some fresh materials are only available if teachers get their own items. STs may also be less inclined to stay late to prepare for functions such as open evenings.

Comments from STs have shown that making changes without knowledge of the work of STs can cause problems. It is suggested in Chapter Two that a visit from SMTs to the prep room or preferably a shadowing of the work for a week would establish the need for flexibility in ST hours. It would also assure SMT that technicians were not only completing all the hours paid for but would also make obvious the many hours that were given for free by STs and improve communication between SMTs and STs.

It could be considered that STs are a marginalised group and the next section considers this possibility.

8.3 The marginalisation of STs

Technicians as one of the forgotten members of the support staff of schools need to have their voice heard when decisions are made about support staff work that affects them. The findings show the need for technicians to be included in discussions relevant to their work and their daily life. Although in Chapter One and Two the division of school staff into teaching staff and support staff can be seen, until recently the division was acknowledged but not overtly demonstrated. Several posts on the website have shown that the division has now become more obvious with seemingly minor changes having served to increase differences. Chapter Two has shown areas where STs can be equated with the position of school nurses which include: their work being unknown and undervalued; being considered by other staff as having a menial role; feeling that they are invisible, and that their views were not sought. Smith, (2004) suggests this makes school nurses a marginalised group. Nevertheless unlike the nurses STs do not feel they are made a scapegoat.

In many areas cited by others: Harsløf, (2002) - working hours; Boychuk Duchscher and Cowin (2000) - being the inferior partner in an hierarchy; Bailey (2000) – the effect of mandatory change; Simmons *et al*. (2014) – employers developing the workforce in ways that suits their needs, and Jenson (2000) – being shut out of areas where they would like to be included could suggest that STs are marginalised. However STs have ways of explaining their position by suggesting it is caused by: the isolation of their workspace; being busy when other staff are free, and being not understood, rather than being deliberately excluded. More importantly perhaps are the answers produced concerning the best aspects of their job which included: planning own day; trying new practicals, and modifying others; flexibility; variety, and being respected and appreciated by science teachers. Responses which suggest they use similar strategies to those that Durand Thomas *et al.* (2000) suggested are used by nurses in hospitals as noted in Chapter Two. By considering their work could not be undertaken by those who ignore them and regarding their job as one which uses their science skills *and* enhances the learning of students they make their work have meaning and therefore give their daily life purpose. This approach would allow STs to value themselves as important members of the science team, and regard the lack of being included the result of lack of knowledge of their work rather than deliberate marginalisation by those outside the department.

The lack of a strong definition noted by authors: Bailey, (2000); Jenson, (2000); Danaher *et al.*, (2013) allows ‘marginalisation’ to be used freely. This allows a wide variety of groups to be included. Messiou (2006) considered that those being marginalised may not recognise their position and to outsiders STs may appear to be a marginalised group which does not recognise they are marginalised. Although STs may resonate with some aspects of marginalisation: being invisible; not being included; being undervalued; not being understood, and not being able to access training, STs argue that this is due to the lack of knowledge about their work, and can justify this stance because they consider one of the best aspects of their work is being a respected part of the science team. STs also find their relative isolation can have advantages for example they can plan their own day and decide their level of involvement in the laboratory and with students. This may change as more control is exercised over STs, but at present this appears to be passive marginalisation caused by lack of knowledge rather than a deliberate act by SMT.

Smith (2004, p.315) suggests that nurses should be 'joining your professional organisation' to overcome isolation adding that it 'also provides [increased] education [and[resources' STs have a virtual community within which they connect with other STs. The next section considers the status of their websites and provides information that will be used to determine if their websites are communities of practice.

8.4 Defining the ST websites as communities of practice

The voice of the technician has been revealed through the medium of the websites by material naturally generated by technicians. This section notes the way that STs use their websites and considers whether the ST websites are a community of practice (CoP) or a variant of that concept.

8.4.1 The websites as conventional CoPs

Chapter Two noted that communities of practice were originally terrestrial and initially modelled on the structure of apprenticeships (Wenger, 1998). The structure was therefore learning based with those on the periphery moving towards the centre as their increasing knowledge integrated them more fully into the community. Experts are situated at the centre. This suggests a structure that has a hierarchy. The ST websites were originally created to provide a point of contact between STs but as can be seen from the findings they are now multi-faceted creations that fulfil the needs of STs in their professional life: it is a meeting place, but not a general chat room, topics being confined to subjects that relate to the work of STs; opinions are sought, but the contribution of every technician is treated with respect and there is no hierarchical structure with STs moving to a central position by learning from those at the centre. Therefore it would appear that ST websites lack some of the characteristics of CoPs.

Further thoughts on CoPs resulted in the idea that their function was to bring together a group to solve a particular problem; therefore the group would be transient, only existing until the problem was solved. Bates (2014) suggested most CoPs are spontaneous and transitory. Although the findings show that ST websites do solve problems: there is no deliberate formation of a group; ST websites are long lived, and the contributors to a particular issue are self-selected and fluid. Wenger-Trayner (2015, n.p.) considered that groups may be more permanent, but retain the student and master approach. The websites provide a pool of STs and advice is sought from the whole pool rather than a problem being given to selected members as in a business setting. This suggests that a conventional CoP does not represent the use of the websites by STs because although knowledge is shared, the topics are random and follow no specific path and the website offers a variety of information. Websites are used for quick answers to questions such as the source of a particular chemical and for longer explanations such as the setting up of complicated experiments. Although collaboration occurs, for example when experiments are being devised as Shown in Chapter Five the membership is always self-selecting.

It has been seen that it is less likely that STs will be allowed to attend training events. These offer technicians both a chance to gain knowledge in specific areas and a place where technicians can meet and exchange knowledge on a variety of subjects from new techniques to the best source of test tubes. The websites offer the opportunity to recreate the training course with the advantage that it is available to STs at any time.

Although it would appear that the ST sites lack many of the characteristics of conventional CoPs Wenger-Trayner (2015, n.p.) suggest CoPs have three elements:

- joint interests and therefore a 'commitment' and 'shared competence
- they must do things together, learning and building a reputation in the community
- they share and develop resources so that knowledge is dispersed

which do appear relevant to the STs websites. However the business aspect is also emphasised: Wenger-Trayner (2015) comment that using a CoP allows knowledge to be managed; Kimble et al. (2001); suggest it was an efficient way of producing results, and Zarb (2006) thought it maintained a competitive edge. Terrestrial CoPs are therefore regarded as a company tool and the suggestion by Wenger (1998) that face-to-face meetings are needed to develop and maintain groups as CoPs suggests that CoPs cannot represent ST websites.

8.4.2 CoP on the web as a Virtual CoP

ST communities exist in the virtual world and the possibility of Virtual CoPs has been noted in Chapter Two where the difficulties of the CoP transferring to the VCoP have been expressed: Wenger *et al*. (2002) Zarb (2006) and Engeström (2007) note the need for leaders and the apprentice/expert model; Kimble *et al.* (2001) emphasise the need for physical contact, and Gannon-Leary and Fontainha (2007) consider that VCoPs need the same hierarchical structure as CoPs to maintain the community. This suggests that the VCoP is regarded as direct transfer of terrestrial CoP into a virtual world. Amin and Roberts (2008) support this by noting that although new knowledge may be generated within virtual groups CoP and VCoP should be viewed from the same standpoint. Differences are noted by Chiu *et al.* (2006) who note strong ties to the virtual community exist: and by Fox (2005) who suggests that a virtual site can allow easy access at a time suitable to the participant and could represent a new form of community. These observations could include the ST websites. However they do not entirely match the ST websites as the presence of novices and experts is still regarded as an important feature of the VCoP. Therefore the VCoP also appears to be an unsuitable model for ST websites,

The final possibility, the Electronic Network of Practice (ENoP) is a newer and better model for ST websites.

8.4.3 CoP on the web as an Electronic Network of Practice

The definition of ENoP as:

> computer-mediated social spaces where individuals working on similar problems self-organize to help each other and share knowledge, advice and perspectives about their occupational practice or common interest
>
> Wasko *et al.* (2009, p.254)

suggests that many of the older concepts that apply to business CoPs have been replaced by others that are more fitted to online communities. This allows for the different approach taken by STs to be regarded as a community but allows for the non-traditional outcomes: for example all information on a subject is available to all members regardless of their active participation in a subject. Wasko *et al.* (2009) also recognise that the construction of the community is different suggesting that 'peer production' is a suitable term for these communities which are different from the CoP and their online counterpart the VCoP. Wasko *et al.* (2009) consider that these websites: link people who may be physically distant from each other; support more people than would be possible in a CoP setting; all participants can share in problem solving, learning discussion and debate, and have access knowledge and expertise which is not limited to local sources.

They also have significant differences with CoPs: any participant can post a query; posts are available for all members to read whether they have contributed or not; anyone who has access to the site can post or reply so the participants are linked to a wide range of possible sources of information. ENoPs work by posting a problem and receiving replies from other members.

It would appear that the features and use of the ST websites is important in determining the type of community it has produced. The material in the findings chapters will be used to consider their placement as an ENoP. Table 8.1 overleaf links the comments concerning ENoP in Chapter Two to the findings.

Table 8.1

Table to show congruence between ENoP and ST websites			
Area	Characteristic	ENoP	ST website
As a way of communication	Not restricted by location	✓	✓
	Many members	✓sites may require registration to participate	✓ but restricted to STs
	Can replace other sources of knowledge	✓	✓for example when STs now work alone
	Any members can read replies whether they have contributed or not	✓sites may also have archives	✓plus archives are also available to all
	No restriction in participation	✓	✓
	Available at any time	✓	✓
	Swift replies	✓and anyone can reply	✓and anyone can reply
As a way of providing support			
	In specific areas	✓sites may be subject specific	✓examples are: sources of chemicals, safety issues, warnings
	Experts in specific areas	This depends on the site and its purpose	✓there are experts available in many areas
	Possibility of a range of answers	✓	✓the right answer for a specific situation can be chosen from the range provided
	Anything can be posted	Depends on the site	Anything relating to their work and daily life can be posted
As a source of knowledge			
	Opportunity for informal training	A characteristic noted in ENoPs	✓often additional information is given that clarifies the answer and provides informal training
	Archival material collects all comments on a specific post together	Possibly depends on the site	✓this makes searching by topic an easy way to find all comments on a particular subject
	Rewarding to respondents	It is noted in Chapter Two that the expert may become more prominent and increase their status when postings receive a positive response	✓STs have commented that they find passing on knowledge rewarding, all STs are equal, none receive extra status
	Tied together by potential knowledge not physical meetings	✓	✓
	Have a critical mass of members who respond	✓	✓some may post more than others, but do not form a critical mass

Source of ENoP information Wasko *et al.,*(2009) However aspects of the ENoP do not fit the ST websites exactly: Wasko *et al.* (2009) suggest that as with ST websites, non- contribution is not an issue but regard this as a result of a critical mass of respondents who sustain the site providing the knowledge and the interest in maintaining the site and gaining a reputation. However it has been shown that STs have a variety of backgrounds and their particular expertise may be needed less frequently; therefore the critical mass theory may not apply.

This could be another variant of the CoP: A Professional ENoP. There is no central area to aspire to as with a CoP. ST websites are a place for teamworking which may suggest a link with VCoPs, but is not the result of STs being chosen to participate. Those who post more are not 'approved' by STs as suggested for ENoP. As professionals of equal standing, a Professional community (PENoP) as a different kind of CoP may have been created.

8.5 Technicians and their daily life

The evidence brought forward could give the impression that technicians are unhappy in their work. However despite being unable to influence decisions, technicians in school are a stable group suggesting STs like their work, although other influences: no alternative jobs available; or the need for school holidays are possible. When asked, 'variety' was the most commonly cited positive reason (55 STs) followed by 'trying out new practicals' (28 STs) and 'flexibility' (22 STs) these suggest independence from those who know little about their work. The negative aspects 'Disorganised teachers' (27 STs) was cited most frequently followed by 'lack of appreciation for the complexity of the work done' (17 STs) and 'for the amount of work done on a higher level' (16 STS) show a lack of knowledge and a failure to appreciate that it is a professional job. It would appear there is a need for STs work to be appreciated and that their flexibility should be valued.

8.6 Conclusion

This chapter has related the findings of the study to the literature chapters. Gender and marginalisation have been considered and a variation of the ENoP model of communities has been suggested as the best fit for the ST website communities. Finally the reasons why technicians like their job and aspects that are less attractive have been included which show that being a technician in school can be rewarding despite the difficulties encountered.

The final chapter includes recommendations based on the findings, suggesting areas for further research and acknowledgement of the limitations of the research.

Chapter 9 Conclusion

This chapter refers back to the aims of the study and includes: reflections on being an insider; on the study; the research process; limitations; contribution to knowledge, and recommendations and possibilities for future research.

It has been seen that STs are not prominent in schools which is a result of their location and work pattern, not a desire to remain aloof. Nevertheless this isolation has resulted in their main work being hidden with only the delivery of the final result being seen. The knowledge and qualifications needed to undertake the work are also unknown and their significance is underestimated making STs vulnerable to changes that adversely affect their work even though practical work is considered an important part of the science curriculum. The study provided greater understanding of their work and their contribution to the advancement of science in schools and revealed their use of their professional websites.

9.1 Research question one:

‘To what extent and in what ways are qualified science technicians significant staff in the advancement of science in schools?’

Searches for literature about school science technicians showed only limited references to STs. Previous surveys allowed triangulation but appeared to have used an outsider approach which had not revealed the daily life of STs, The aim of this study was to advance knowledge about STs and to establish the current position of the science technician within the school workforce as a provider of practical materials for science. To illustrate this, two areas from Chapter Eight are used.

9.1.1 Age

This study collected data about the age of STs showing this is still an important issue. Triangulation showed that these ST were as representative of the ST population as previous surveys. To advance knowledge questions were included to show whether STs had had a previous job and if so, what it was and why they left. This showed a high proportion had held a scientific post. Insider knowledge suggested that many had held posts in medical laboratories. A number cited ‘family reasons’ for leaving their previous job. Lower numbers amongst younger respondents suggested that this source of STs was diminishing. The recruitment of retirees or those made redundant from industry appears to be the expected source for technicians to replace the younger, mostly female technicians who now seem less attracted to working in schools. The recognition of the ageing workforce has yet to be confronted.

9.1.2 Gender

Gender might be considered a reason for the low wages and for this reason gender; although not included in the original survey; was established. Triangulation showed that the gender ratio was similar to the respondents in previous surveys strengthening the representativeness and reliability of the data produced.

However in Chapter Eight it is argued that gender; which as noted in Chapter Two is a commonly suggested reason for low wages; is probably not the most important factor. Findings suggest that it is the result of a combination of a lack of:

- understanding about the work of STs
- information about the qualifications needed by STs to undertake their work
- recognition that the disparity between the qualifications suggested by ASE (2010b) and those held by applicants may be caused by the advantage of having school holidays

that has allowed schools to recruit highly qualified scientists.

The findings in Chapters Four to Seven have increased knowledge about STs and their work by showing how:

- apparently simple requests for practicals require a great deal of expertise; much of which is the result of experience and knowledge gained as a result of their previous employment
- ST work includes other areas such as: health and safety; budgeting, and providing training to teachers in practical work
- The hidden aspects are either unknown or the amount of time and expertise needed is not understood

These are significant features of technicians' work which need to be recognised when decisions are made about technicians' employment and deployment.

9.2. Research question two:

'How do changes to school structure and organisation affect the work of science technicians?'

With changes being implemented which affect STs it is important to understand the role of the ST. This survey revealed that both external policy changes; remodelling and SSA; and internal changes have affected STs without the consequences being recognised.

9.3 Research Question three:

'In what ways does the virtual community of their professional websites aid science technicians?'

The use of the websites has been demonstrated throughout the findings chapters. The websites provide a dynamic and exciting platform offering STs a meeting place that provides an alternative to the informal meetings that used to take place at training sessions, and a source of accessible knowledge from fellow STs with a wide range of experience. This increases the possibility of finding an answer to a problem. The archives provide a source of knowledge that can be accessed at any time.

9.4 Limitations of the study

This is a small study limited by cost and by time. The study had to be fitted around my work. There was no possibility of being able to visit technicians at their workplace or conduct face to face interviews as our work patterns would coincide and school support staff have no opportunity to take time off except in very exceptional circumstances. Access was therefore limited. Without a list of technicians available there was no chance of creating a probability sample and the respondents were therefore a self-selecting convenience sample. The lack of gender information could have been a problem, but was remedied by returning to the original data as noted in Chapter Three. This was an advantage of using the ST websites to ask for participants.

Triangulation with previous surveys showed that the STs were similar in age and gender to those in previous samples. This survey produced valid data about the ST which was the target group which was verifiable and was a representative sample of STs. There was enough data for this study.

Case studies may have produced more detailed descriptions of a few individuals, but would be less likely to be representative of the ST population because of the diversity of the work. A larger study could incorporate views on the value of practical work.

The websites were a suitable source of STs. The profiles on sites A and B showed that the sites had similar populations with a range of grades represented on both sites. The survey represented the views of STs at the time they replied.

The data produced by STs represented the authentic voice of the technician at the time of collection. Collecting the data for two years was a suitable time, and as it continued to the end of the second school year it can be considered that all available data on any subject posted had been collected. However a second two year period would inevitably have included different subjects.

There is little previous literature on STs and this study concentrates on science technicians. The opinions of teachers or SMTs were not sought. The literature suggests teachers tend to view the work of technicians through the lens of their own needs. Further research could include other groups.

In a study where the researcher is close to the participants the possibility of bias is important and was considered in Chapter Three. The literature review contained support for practical science, and alternative views. All surveys about STs in this country that were found were included except those which duplicated most of the content of another, where any additions were noted where appropriate. Comments from STs; support statements; views of others, and alternative conclusions have been included. All the data gathered, with the exception of six questionnaires came from STs who used the websites therefore only STs who were members and also posted questions or comments or requested the questionnaire were included, but the results are representative of the STs who use the websites. All the data was collected. The selection of data for inclusion was chosen to illustrate a variety of aspects of the work of STs. Inclusion of data was limited by size of the finished document. This could introduce bias, but queries that required only one answer were reported as a total, and further queries and the number of replies were included in a table.

The quantitative data was not a probability sample but was used mainly to supplement the qualitative data except for demographic details. The data was not suitable for drawing statistical conclusions. A larger survey would produce data that could be used in this way but with no list would be difficult to produce. Postal requests might not reach STs.

9.4.1 Generalisability

Generalisability refers to the ‘degree to which the results can be generalized to the wider population, cases or situations’ (Cohen *et al.* 2007, p136). To be generalisable into the ST population a larger survey would be needed so that predictions could be made. There were small numbers in this study the survey was not randomised but a self-selecting group and the lack of probability sampling would severely limit generalisation. A larger study could include data from STs who were not members of the websites to determine whether their views were similar to those who were members. The findings would not be generalisable outside the ST environment.

9.4.2 Transferability

Transferability refers to the possibility of applying the findings to another situation. The thick description provides the possibility for readers of the survey to compare the results with a suitably similar situation. However the transferability may be limited by other factors. Therefore the results may be transferrable to other STs but care would be needed to ensure similarity.

The findings concerning the use of the website may not be transferable because it does not conform to a traditional CoP although the concept of the website may be a useful model to explore. Further discussion of the transferability of website practice as seen in this research is in section 9.6.2 where I argue that websites may be useable as a form of ENOP or PENOP for other groups e.g. those used in this research.

9.5 Implications of the findings

9.5.1 About STs

The age of STs, has still not been addressed. Except for those who had worked in schools for less than five years, a very high percentage of STs had cited family reasons for leaving their previous job. As the variety of working patterns, flexi time etc. increases in laboratories, laboratories may be becoming more family friendly therefore reducing the attractiveness of schools as a place to work for those with families. With an ageing population the potential lack of the highly qualified technicians needed to produce the age appropriate materials that allow practical work to be undertaken satisfactorily and safely may restrict practical science in schools.

9.5.2 Reforming and remodelling

The literature in Chapter Two showed that assumptions had been made about the role of STs without seeking their opinion on an extension of their role. Most technicians do not want this. Furthermore it showed that STs go into the laboratory for specific reasons: looking after specific equipment, or demonstrating an experiment to the class, which shows their expertise. STs were asked for their views on remodelling. Around half of the STs who answered this question thought it would not affect their status: 69% of those who thought it would have an effect thought their status would diminish. This is important as one of the findings was that STs regard their ability to regulate their own work as a positive asset. Diminution of this could make the work less attractive. This study showed that the level of unhappiness caused by the SSA has been underestimated. Comments on the website showed this was an ongoing problem at the time of data collection with many technicians feeling they were unappreciated and their work underestimated 'Lack of appreciation' was regarded as one of the worst aspects of the job.

9.6 Recommendations for future Research

9.6.1 The need for a larger study.

There is a research opportunity in this area for a larger study of STs to discover if the results of the small study are replicated in the whole of the ST community. This small study has shown that there are areas that could be explored in more detail. As this is the first study that has explored the work of the ST as an insider there is scope to extend this into a larger study. There is also a possibility of including other staff/interested parties. However it would be important to establish that they were knowledgeable about the ST role so they could provide informed comment as the literature has shown that little is known about STs.

The age of STs has been noted but has not been addressed by other surveys. The seriousness of the problem and the percentage of STs who are close to retirement needs to be studied.

Lack of recruits is an issue as the traditional source of STs; females with family commitments; are no longer being attracted to ST work. The reason may seem obvious and related to gender, but this study suggests that the main reason may be that:

- the work of STs is unknown and underestimated
- the qualifications suggested by ASE (2010a) are too low
- consequently the wages offered are equally low
- STs comments on the low pay, and the increase of family friendly employment have decreased the desirability of school work

A comparison between the advantages of school work and those now available to female scientists in industry may suggest ways that schools could again attract the female scientists they need to work as STs. If the best source of new STs is from amongst retirees, then a way of attracting those with science knowledge and developing their skills must be a priority.

At present STs are well qualified, however if STs are recruited from those with fewer qualifications a course needs to be developed specifically for STs. The need for training has been touched upon by previous studies, (ASE 1994, 2010a; The Royal Society/ASE, 2001; CLEAPSS, 2002) but a planned and accredited course designed to meet the needs of new STs has never materialised. The course needs to take into consideration the complex tasks that STs carry out and recognise that STs work in schools because it fits in with their other commitments. A mix of online and practical work could be suitable. STs who took part in the study, and those who were quoted in CLEAPSS (2002), stated that STs would like to receive training from other STs. There is a need to develop training for technicians in delivering courses.

9.6.2 The use of the websites by science technicians

The use of the websites has been shown as a powerful tool for STs. and gave a true portrait of their work and their opinions on matters that affect it.

However the use of the website appears to have resulted in the development of a site which gives STs easy access to support and knowledge from fellow professionals. This does not appear to fit perfectly with any of the present concepts of CoPs including those in the virtual world. It lacks the centre and periphery model; there are no formal groupings to work on a specific problem; no leader for specific areas, and although some members may be more likely to post on specific queries all can contribute and all posts are regarded as equal. Enhancement of reputation is not the object of replies which is still a requirement of VCoPs and ENoPs. The use of the website has enabled STs to work together even if they cannot meet and the result has been the development of a virtual community that benefits technicians, and the schools in which they work. It does however require access to the internet, and for STs to know of its existence and consider it a positive asset. As these are professional websites an appropriate acronym might be a PENoP.

Why the websites have emerged in this way is an interesting conundrum. They work as a help desk, a place for problem solving for collaboration and for mutual and unconditional support. This model would appear to have applications outside of the ST websites; nurses for example may find such a website useful and one could be developed using the examples shown in this research: but as has been noted attempts to deliberately set up CoPs in the virtual world have had limited success and reproduction of these ST websites might not work. Research into this area could be useful for a number of other groups.

9.7 Reflections on the research

9.7.1 Researching using an interpretivist paradigm as an Insider

My experience of practical science in school was the reason I decided to pursue a career in science and allowed me to feel confident in the use of equipment from my first day in a real laboratory. My insider knowledge has a variety of origins: as a consumer of school science; a practical scientist using the knowledge I gained as a student; a trainer; and a technician in schools. I regard practical work as a very important element of school science for those who wish to pursue a practical science career, which could have influenced the research.

Chapter Three contains a section on insider research and the interpretivist approach and considers some of the issues that arise. However there were advantages. The survey contained questions which may not have been included by outsiders: the effect of the SSA, and whether STs trained teachers for example. The survey questions were chosen to answer particular questions that my insider knowledge suggested were important: other duties such as filing were excluded as these were considered unimportant in the context of this study. In this respect the questionnaire may be considered biased towards certain areas and missing items included in other surveys in Chapter One. Insider knowledge suggested the questions included were ones which needed to be specifically asked to show the true work of STs. The data collected via the questionnaire had only three open questions. There was close involvement as a member of the websites and some surveys were returned with positive comments. There could have been biased replies on the survey, but no more than in any other survey collection method. The source of participants ensured they were all STs and a suitable sample was used. Being a long term member reduced the possibility of the

Hawthorne effect (Mayo, 1933) affecting the results. Some of the disadvantages of interpretivist approach relate to interviews and the bias caused by the presence of a researcher and the way questions are asked. No interviews were used. As the websites were virtual and all the questionnaires were completed in my absence many of the issues such as feeling uncomfortable about answering or asking questions face-to-face which can affect interpretation were eliminated. I had been an active member of the sites for a long time and was therefore known to the site members. This may have increased response rates both in the original request and for subsequent data making being an insider an advantage.

All posts to the websites were collected for two years. There was no selective collection which could have introduced bias at this stage. The postings made during the collection period were generated by STs. I did not query any replies or ask for any further information during the collection period. Therefore the data collected was the authentic voice of the STs who contributed. An issue with being an insider with access to additional data after the collection period was the temptation to include more data as interesting topics appeared: this was resisted.

Interpreting the data could have resulted in bias, especially as an insider. However for each subject used in the findings chapters all the data available was included as were negative comments from STs. As the entire website data was collected there were no questions that could receive less honest replies from this source. By using the voice of STs the topics used were chosen by STs, this removed some bias. Although some choice had to be made when illustrating practical work, experience of topics that had been discussed on previous occasions was used to choose items that were typical rather than occasional topics. This introduced some bias, but was necessary in this small study.

Paechter (2013) had a similar longstanding relationship with the group she researched and labelled herself as an insider and a researcher to distinguish herself from opportunist researchers who only join to collect data. This seems a suitable label for those whose membership predates the research.

9.7.2 Reflections on being a researcher

9.7.2.1 Researching part-time

Not being able to research the subject as a full time student placed many limitations on the process. Working as a science technician in a school was helpful as it allowed data to be obtained about STs from their closed websites,

Using an interpretivist approach has limitations as already noted. For this research it was important to reveal the work of the ST and their feelings about issues that affected them. However I also found that being an insider and close to the subject of study can make it easy to forget that it was necessary to justify conclusions that appeared obvious.

9.7.2.2 The research process.

The aim of this thesis was firstly to provide information about STs so that their work could be understood: a second aim that emerged during the research was to show the way in which the websites were used by STs. The process needed to achieve these aims was learnt during the research process.

Framing the question was difficult because little literature was available about STs upon which to build this study. Consequently the framing of the questions underwent changes during the research process. There appeared to be little engagement with STs and consequently the nature of their work was unknown. Advice was sought from my then supervisor and initially the questions were framed to consider why this was the case: A considerable amount of time was therefore spent gathering data and writing chapters concerning the changes occurring in schools: all which were ultimately abandoned because I felt that the ST was being subsumed in an attempt to fit STs work into this frame rather than STs being the subject of the study. This showed me that:

- the framing of the research questions must reflect the subject of the study

- it is important to ensure that the data and the literature actually fit the research being undertaken and not to an ideology that may not be the best approach to the research question

The questions were reframed to reflect the aims of the thesis: to show the daily life of the ST; issues that affect them, and their use of their websites: the approach taken was changed to use an interpretivist paradigm.

Being an insider meant that the questions on the questionnaire were shaped to produce the answers required. At the time my knowledge suggested that gender was not an issue, so this question was not included. However when this knowledge was required being an insider made it possible to remedy this omission at a later date. In other circumstances this may have been more difficult and therefore in future I would make sure that data such as gender was included if mentioned in literature related to the study.

The data from the website was collected from its natural setting and was therefore not shaped by questioning at the time of collection. However the large quantity of qualitative data produced was initially stored as complete postings. Not planning the sort process until the data had been collected was probably not the best approach and in hindsight I should have prepared a experimental frame when a small amount of data was available for sorting.

The websites produced data for the thesis: but also revealed the way the website was used by STS. This was an unexpected finding and therefore not part of the original study, showing that research can develop in other ways and suggest other paths which can be explored.

9.8 Contribution to Knowledge

Aim of the research was to produce a study of STs:

- to show why they are an essential member of the science team in the advancement of science in schools

- to establish the effect of changes within the workforce on STs

- to show the value of the professional closed websites to STs

- to show the use of the websites by STs

9.8.1 Knowledge of STs

This study has provided information:

- on the daily life of STs
-
- that showed that providing the materials that enable students to experience practical work in schools is a professional job

- the job is complex and requires more than SMT comments '[that it only requires] a bit of science background' (reported by ST 8j) and 'you (STs) don't need to know much to be a lab tech, just how to wash up test tubes, anyone can do that' (reported by ST 7j) suggest

- that STs advance science in schools by a range of means such as: using their previous knowledge to promote science; to extend, develop and improve the experience of practical work; to encourage teachers to become confident using unfamiliar practicals, and to ensure safety

Chapter Eight discussed the findings that add knowledge to these areas. It has also shown that their daily life has facets that advance science noting that some STs will go into the laboratory and explain aspects of science and of their previous work, which could inspire students. STs may also explain aspects of science to teachers, provide teachers with an opportunity to practise experiments giving them confidence in the laboratory and ensure that health and safety is maintained. Some STs have also shown that they undertake other tasks such as: ordering materials for science, keeping costs down and freeing up HODs to concentrate on other areas, and piloting experiments before they are included in the curriculum, reporting results where they consider there may be problems.

Understanding the attitude of STs to their job, the areas they like and those that are less positive, has shown that although others may think they are marginalised, STs consider that this allows them to ‘be their own boss’ and arrange their working life as they wish. This gives them flexibility. STs also suggest that those who ignore them could not do their job and concentrate on the positive aspects such as the variety.

9.8.2 Knowledge of the effect of wider changes on STs

Although it was suggested that STs, should take an active role during lessons opinion on this extension of their role was not sought. It was shown that most technicians do not want to do this. This study was the first to seek the opinions of STs on the SSA: showing that it has caused unhappiness with many technicians.

9.8.3 Knowledge of the websites

The websites were used as a source of data about the daily life of STs, providing detail about:

- the work of the ST
- their opinions on aspects of their work
- the effect that outside changes such as the SSA had had on their lives

this has contributed to knowledge about STs

However although the initial use of the websites was as a means of collecting data, a picture of the way that STs used their sites emerged. The sites have proved to be a dynamic place where a different type of CoP has developed and is an area that should be explored as it could prove valuable for other groups.

9.9 Final thoughts

Although practical work as part of science education is considered important: by students; teachers; some researchers into science education, and users of science, the role of the ST has been underestimated and their knowledge unrecognised. STs provide the materials for practical science; their visible work; but the skill needed to produce those materials is hidden making their work appear easy. Their other contributions to the advancement of science; improvement and development of practicals; the preparation of exam work; the training of teachers; their contribution to health and safety, and the expertise they gained in other jobs that they pass on to inspire students is unknown. By understanding the daily life and the work done by STs they can be supported and changes that are made that adversely affect their working conditions can be avoided. By recognising the knowledge needed and developing a suitable pay scale for STs the decline in recruits from younger ages may be halted and the loss of STs reversed to protect practical work in schools.

The websites available to STs support their work and their use the sites appears to have produced a different way of working in a virtual community which might benefit other groups, although more research would be needed in this area.

This study has revealed that technicians like their job, the relative independence and the ability to solve problems. The use of the website has enabled STs to work together and the result has been the development of a virtual community that benefits not only the technicians, but the schools in which they work. The positive aspects that encourage STs to work in schools will need to be maintained to ensure that STs are available to produce practical materials for school science.

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Appendices

Appendix 1 questionnaire for science technicians

This first section is about you and your school

1. Which of the key stages are taught at your school?

Key stage 3

Key stage 4

A levels or equivalent

Other (please describe)

2. How many classes in each key stage are there at your school?
3. How many science technicians are there at your school?
4. What is your age? <24

25-34

35-45

46+

5. What is your highest qualification?

'O' levels/ GCSE

'A' levels

Degree

Other

6. How long have you worked in schools?
7. How many hours do you work each week?
8. How many weeks a year do you work?
9. What is your point on the pay scale?
10. Did you have another job before you came to work in schools?

(if 'yes' go to question 11, if not go to question 12)

11. What was this post?

12. Why did you leave?

(family commitments? ☐

wanted a change? ☐

other – please state) ☐

What is your job title? ____

This next section is about your job

13. What is the best aspect of your job? ☐

14. What is the worst aspect of your job? ☐

	yes	no
15. Do you pilot experiments and report results?	☐	☐
16. If you commented adversely, would the experiment be modified or abandoned?	☐	☐
17. Do you explain the science behind experiments to teachers?	☐	☐

18. Do you ever help in the laboratory during practical experiments?

Do you	Yes	No
Become another adult in the laboratory and provide general help		
Look after specific aspects, such as making sure experiments are conducted safely		
Demonstrate experiments		
Supervise small groups of children		

19. Do you ever teach?

	Yes	No
Individual pupils		
Small groups		
Whole classes		

	Yes	No
20. Do you play a part in the planning of lessons?	☐	☐
21. Do you train teachers in the use of science equipment?	☐	☐
22. Do you give health and safety advice to teachers?	☐	☐
23. Have you ever had to dissuade a teacher from doing a practical?	☐	☐
24. Did they take your advice?	☐	☐
25. Do you have a support group in your area?	☐	☐
26. Are you encouraged to attend courses?	☐	☐
27. Has your authority introduced the single status agreement?	☐	☐
28. If yes, has this affected your pay/status?	☐	☐

If your status has been affected, could you explain how?

This final section is concerned with the latest ideas on support staff in schools.

The ideas appear to suggest that the role of the LSA and the TA will be enhanced, they will have greater recognition in schools and a properly structured qualification route with progression to management status or qualified teacher status. There does not appear to be a similar path for technicians, and the content of the courses proposed suggests that the examining boards had the TAs and LSAs in mind when the content was formulated.

. There are several documents on the DfES website and on www.teachernet.gov.uk/management/remodelling if you would like to read them.

A. If these changes occur do you think your status will be:

enhanced,	☐
diminished	☐
stay the same	☐

	Yes	No
B. Would you take on more teaching?	☐	☐
C. Would you become an advanced teaching assistant if the post involved an increase in salary?	☐	☐
D. Would you give LSAs or TAs training so that they could take the lesson?	☐	☐
E. Would you do this even if they were paid more than you?	☐	☐
F. Would you be prepared to help a TA/cover supervisor etc in the lesson if it was necessary to ensure learning took place? (for example if they were taking a lesson for a teacher who was absent.)	☐	☐

Please add your own comments or expand on your answers if you wish and if you would be willing to answer any further questions, could you add an address to which you would like any further questions sent?

Thanks for your participation.

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Information Sheet to accompany the questionnaire

Thank you for offering to take part in this research project

Before you take part please read the information provided here, and please ask if you would like any further information. There is no compulsion to take part, and no penalty if you decide not to do so, there is no need to give a reason. You may withdraw at any time.

The working title is :

School Science Technicians in Role Transition within Policy, Curricular and Labour Process Contexts

The research concerns the role of the science technician and the changes that are occurring in education including the remodelling of the support staff role and investigation the possible effects of this, the changes in the content of the science curriculum, in policy and in the requirements of the labour of the future may have. There needs to be a clear picture of the current profile of technicians and the work they do and this portion of the work is an attempt to show how this has changed from the state reported by CLEAPSS, the RSC and my own work Barker (2004). This questionnaire will form part of the research into the role of the science technician, providing some basic information so that any changes in the profile of the technician can be noted, and their work can be placed in context when aligning it with roles of other support staff.

This research will, I hope show how important technicians are, not only for the continuation of practical work for all state school pupils, but also that they hold a very important place in the preservation of the type of education that all state educated pupils receive. Although taking part may not lead to any noticeable benefits, hopefully it may prove to be useful in the long term.

Filling in the questionnaire is entirely voluntary and you can leave out any questions you do not wish to answer, and you can withdraw at any time.

If you feel that you do not wish colleagues to know that you do not want to fill in the questionnaire, simply return a blank form.

In order to make your questionnaire anonymous you may wish to set up a separate e-mail account from which to send the completed form, Yahoo amongst other sites will allow you to do this, then only you will know your true identity. Even if you agree to participate in further aspects you will still be able to use this new address to preserve anonymity if you wish.

The material will be kept strictly confidential, there will be no way of identifying individuals as the questionnaire will be allocated a unique but random number and only at this stage will they be stored on the computer for analysis. The questionnaires will only be read by me and answers will be aggregated when the results are analysed so that an individual response will be unknowable. The data may be used to construct an 'average technician' profile.

The information collected will form part of my research and as such will be assessed, and may be used as information for articles; however individuals will not be identifiable in either case. You are welcome to see the final version of the thesis and/ or any articles that may develop from it.

Appendix 2 photographs of labs set up for A level exams

chemistry

Biology

Appendix 3 glossary and abbreviations

ASE –Stands for The Association for Science Education a membership only body that provides information to its members concerning science. A regular magazine and journal are produced. There are various levels of subscription rates. The lowest being for technicians and NQTs. Technicians have been informed that they can only receive the magazine for their subscription level.

CLEAPSS – This used to be the abbreviation for the Consortium of Local Education Authorities for the Provision of Science Services. Due to inclusion of design technology and a change in the position of the education section of Local Authorities CLEAPSS has now been registered as a Trade Mark and is no longer an acronym.

CoP – community of practice a group that is brought together to perform a specific task, it is transient and designed for a specific function although in some cases it may have a degree of longevity. With a central area and a periphery members move from the outside to the centre as they gain experience of the way the community works. It has been likened to an apprenticeship model.

CPD – Acronym for continuous professional development which is part of the appraisal system used for all staff. This should relate to the training needs of the individual, and show how these can be met.

EMPA – and A2 practical exams which are marked externally.

ENoP – An electronic network of practice this has a less structured model, but it is still suggested that there are leaders and followers, with leaders enhancing their status by approval of their contributions

Gratnell storage system – Consists of a rack that varies in height which has runners for trays. Components can be stored on these trays and class sets of items, such as 15 ray boxes can be kept together for ease of use. The racks themselves may be fitted with wheels so they can be moved around.

HazCards – These are a series of cards that have been produced by CLEAPSS and supplied to those who buy into the CLEAPSS service. They contain information about the common chemicals used in schools and any hazards that need to be highlighted. They also contain first aid procedures in case of accident.

HOD – This is the Head of Department, in this case, Head of Science.

HTLA – this the abbreviation used for 'Higher Level Teaching Assistants and was generally used for teaching assistants who had had specific training, or produced a suitable portfolio to allow them to work at a higher level than a teaching assistant. Amongst other tasks they could undertake at the time of the survey was the supervision of classes.

ISA – These are the 'AS and A2 practical science exams that are marked internally.

Laboratory – This term is used to refer to the place where the teachers deliver science lessons not the workplace of the science technicians which is the prep room.

HNC – (Higher National Certificate) This qualification usually relates to vocational qualifications and nowadays is considered roughly equivalent to a first year university course. At the time when many technicians in this study took these courses (mostly technicians working in medical laboratories) there was no degree course in this area and HNC replaced the original associate qualification. A degree plus one year of medical lab work or the HNC were the basic entry requirement for registration as an associate member and for enrolment for the fellowship exam.

ONC– Ordinary National Certificate equivalent to A levels. This was taken by those working as juniors in a medical laboratory who entered the profession without A levels and was considered an important first step in medical laboratory work.

PFI – The private finance initiative in which private capital is used in the case of schools to provide 'new builds' to replace school buildings that were considered to be outdated. The company owns and runs the building on their terms and also provide a number of services to the school such as site supervision for all of which they receive for a fixed number of years.

Practicals – This term is often used as a generic term for practical work of all kinds to distinguish it from theory as in 'which practicals are included for year 8 forces unit' or 'practicals are being prepared for the afternoon lessons'. It is also used interchangeably with 'practical work' undertaken by students and context usually indicates what is meant.

Practical work – This is usually used to describe the work students do in the laboratory as opposed to the preparation for practical work undertaken by technicians, although this is used interchangeably with practicals, the context usually signifies whether the work of students is indicated as in 'year 9 found the practical work hard this afternoon' or 'what practical work is being used by 10ABC this afternoon'.

Prep room – This is the place where technicians spend most of their time, it may be one room, or may be several different rooms which may be divided by subject, or by use, for example there may be one room with a fume cupboard with a chemical store attached where solutions are made and stored and another room generally used for non-chemical preparation, or there may be one prep room for each subject.

SCORE – The Science Community Representing Education who describe themselves as 'A collaboration of organisations working together on science education' (SCORE, 2011, p.1).

SMT – The senior management team in schools, which consists of deputy heads and associate heads. They sit between the headteacher (and the business manager if present in the school) and the middle management.

SSA – The single status agreement which was designed to place all council workers, and in schools in academies which also use the council pay scales, to ensure that equal jobs receive equal pay. The process required a high level of understanding of individual jobs in order for a satisfactory outcome to be achieved.

ST – Science technician.

STEM – The Science, Technology, Engineering and Maths (STEM) projects of the Nuffield Foundation.

SWG – Standard wire gauge, a measurement used to determine the diameter of a particular wire. It has been superseded (1964) by the use of cross sectional areas in mm^2 but is still used for some wire, and is still found on reels in schools where reels of wire may last for a long time.

TA – Teaching Assistant, this term is used here for all support staff whose job it is to work in the classroom or laboratory.

TECHNICIAN – This term is used to mean science technician unless the type of technician is not clear, when ‘science technician’ is used.

VCoP – virtual community of practice. A CoP operating in a virtual place.