Why chemistry teaching? A narrative approach

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Institute of Education

PhD Thesis

Alexander J Dawes

Declaration

I, Alexander James Dawes, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

The narrative approach used in this study is a complement to larger scale quantitative studies into teacher recruitment and suggests that chemistry teachers' relationship with the subject and prior teaching experience can have a large part to play in them entering the profession, whilst the influence of their own teachers is more nuanced than the wider literature suggests. There have been recent international concerns over teacher recruitment and attrition rates, especially in mathematics and the physical sciences. Much has been written about the recruitment of student teachers and the reasons people give for going into teaching, but little on the broader context of these people's lives and the complex influences on their career decisions. This study concerns eight current UK chemistry teachers and their stories of becoming teachers. These are told through interviews and examine twin research areas: namely, the key influences on becoming a teacher, and what can be learned about teacher recruitment from considering the narratives of teachers at different points in their careers. Two analytic lenses were used for these eight narratives: a broadly inductive thematic analysis and a broadly deductive analysis, using the psychoanalytical idea of the defended participant and attempting to 'read between the lines'. These lenses were used to both exemplify and challenge each other, providing triangulation of interpretation. Results align with that of the broader literature that family background and interest in, and utility of, studying chemistry influence career life decisions, but that some people experience moments where their career trajectory changes towards teaching whereas others followed a smooth path towards this end. Particularly influential appears to be prior teaching experience which led to changes of trajectory for some of the participants in this study. The narrative approach used complements current perspectives on teaching recruitment as it seeks to consider the wider picture of a person's life and, through a defended participant perspective, exposes influences that may not have been obvious to the participants themselves.

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Acknowledgements

I would like to thank my parents and sister very much for supporting me throughout the doctoral process, something quite lengthy when undertaken part time; they were full of useful advice, especially when encouraging me to take on the challenge originally and for sticking in there when there seemed to be an overwhelming amount to get done. My aunt Helen, an anthropologist, has also been a useful source of wisdom, particularly about undertaking qualitative research, something quite foreign to a physical scientist like me, even long into her own retirement.

My supervisor, Ruth, and co-supervisor, Ralph, have been permanently positive, friendly and encouraging and I struck it lucky having access to two experts who possess different perspectives on things; we made a great team and I enjoyed and valued our conversations (even when I had rushed straight to the IoE from school and it didn't seem like it). Your support, especially when school was trying, has been immeasurable.

I owe a debt of gratitude to the large number of people I met at the 2014 ESERA[1] summer school in Turkey, for showing me that educational research comes in all shapes and sizes and that what I was attempting to do in my fledgling research project was of interest others. I valued my subsequent Danish visit hugely where I had the opportunity to share some of my ideas with the extremely welcoming Science Education faculty in Copenhagen, and to learn from their expertise. I would like to thank Professor Lars Ulriksen particularly for his very thoughtful advice on analysing my collected data.

Finally, I would also like to thank my colleagues, particularly Liz, at school over the past twenty years as well as my students, without whom teaching itself would not

[1] European Science Education Research Association

have been such a positive influence on my life, and this thesis would not have been started let alone completed.

There was one particular chemistry teacher who was just brilliant, inspirational, whose strongest piece of advice was, whatever you do, don't become a teacher!

Jonathan, Chemistry teacher for thirty years

He was a really good teacher. I remember the first lesson and he was right, if you're not prepared to work then I'm not prepared to work either. The door's there. Leave, I'm not bothered. We were all like, whoa, who's this person?

Claire, Chemistry teacher for five years

When my friend and I were young, we said what is the least favourite thing that you could end up doing, and we decided chemistry teacher; and that made us laugh with great hilarity.

Sonia, Chemistry teacher for twenty-five years

1 Introduction

When I finished my finals at university, I swore I would never do another written examination in my life, something I have adhered to since that day in 1995. However, after teaching for around ten years, I felt the desire to study formally again so I enrolled in a part-time Masters degree in Science Education. I largely enjoyed this course although it revealed a new world to me, moving from my previous comfort zone, doing calculations and constructing organic chemistry mechanisms, to writing essays and referencing sources. Having avoided all essay writing subjects assiduously at school, my MA studies helped me develop new skills and widen the breadth of my knowledge, within science education, something I had (shamefully) not engaged with seriously during my teacher training. After a few years of being part of other research projects as a teacher researcher, I decided to apply for my own doctoral studies, the PhD I had never applied for whilst I was an undergraduate.

As I discuss in chapter 2, my initial research interests centred around the classroom and my own teaching of chemistry. I had used participant observation with some of my own year eleven[2] students, to try and improve my teaching of the concept of amount (in moles) and subsequently was involved in other research about how students understand chemical equilibria (Wheeldon, Atkinson, Dawes, & Levinson, 2012). In my research, I was very keen to stay close to the academic subject with which I associate so strongly and am confident with (which is interesting considering what is to follow in this thesis) and carry out what I had assumed would be quantitative research as I had always felt most comfortable with numbers and statistics.

I have always seen myself as a science/chemistry teacher rather than a teacher which does reflect this affinity with the subject. It has always struck me how the academic interests of my colleagues vary so much, not only in how closely we

[2] 15-16 year-old students in England and Wales

seem to identify with our subjects, but also what it is about them that appeals. For every theoretician, happy to derive thermodynamic equations from first principles, there is an experimentalist who is always planning to show the students another demonstration they have read about.

As my career progressed I became Head of Chemistry at my school, as well as taking on other roles particularly with some of the high achieving students; I also acted as a mentor to both new chemistry teachers as well as student teachers and I found it very interesting talking to them about their backgrounds and reasons for coming into teaching. Even then it was obvious that some trainee teachers were entering the profession for intrinsic reasons, such as love of the subject, or more extrinsic ones which might be financial or because of childcare demands or even the global financial downturn and consequent job insecurity.

One of the driving forces behind my taking on doctoral studies was the wish to learn something new and as my research became steadily more qualitative, eventually moving towards narratives, I moved further and further away from my comfort zone but was learning all the time. Becoming an expert was never realistic, but I have learnt about qualitative research, sociology, psychology, narrative analysis as well as considering many new ideas and concepts.

My attendance at the ESERA doctoral summer school in Turkey in 2014 helped me consider many of these ideas and others, often ones that were a long way from my own experience. By the end of the trip I had had some fascinating conversations, been exposed to many new ideas and even had the confidence to argue my case in areas of chemistry education I felt passionate about. One of the things that struck me most strongly was that I was one of the only full time teachers attending the summer school and was discussing matters of the classroom with many people who had not taught extensively or indeed at all. I realised that there must be a place for teacher researchers within educational research; in my twenty years in the classroom much has changed, and is still changing, which can be hard to appreciate from the outside.

Being a participant in my own study has been a vital part of my research as my own life story is the central thread of this piece of work. This has added complication but also the freedom to consider how other people's stories relate to my own. I have thoroughly enjoyed thinking about why people might study chemistry and become teachers, both of which have percolated into interesting discussions I have had at school, with colleagues and students.

In this thesis, I would like to present the work I have carried out and the following chapters will begin with the background, where I discuss my interest in the need for teachers of subjects like chemistry and introduce the wider issues around teacher recruitment. Following this, in my literature review, I summarise key research findings that have influenced my study and how I have carried it out. The methodology chapter considers how I carried out my interviews and narrative research in more detail. I have combined my analysis and discussion as I wish to give my reader the context of the narrative threads I am considering whilst presenting them, drawing conclusions and comparing and contrasting them. Finally, I consider the implications of my research as well as limitations and areas for potential further study.

2 Background

2.1 Introduction

Through my own MA study on how students take algorithmic approaches to moles calculations, and my ongoing career as a chemistry teacher, I took part as a teacher-researcher in a research project about students' modelling of chemical equilibrium (Wheeldon et al., 2012). Initially in my doctoral studies I was attracted towards looking at a specific topic like equilibrium in the classroom and examining how well students could learn it and how one might teach it more effectively. I focused my reading on equilibrium, as a chemical concept, and how it has been taught to students in different parts of the world.

On joining the Royal Society of Chemistry (RSC), I was asked to write a short article for their readers' magazine about equilibria and I invited anyone interested in my research to get in touch with me. I was pleasantly surprised by a response from almost thirty RSC members with widely ranging backgrounds and opinions to share about equilibrium. As an initial pilot investigation, I decided I would interview a sample of my respondents, to try to get a feel for how important chemical concepts like equilibria might be to them in their current life.

I had never conducted an interview before, but it seemed sensible to start with a semi-structured style, sufficiently structured to support me, a novice interviewer, and relaxed enough to allow a more natural conversation between us. I began by carrying out a mock interview with my supervisor and I was surprised by how difficult interviewing is, especially over the phone, where you do not have the benefit of body language cues to gauge reaction to a certain question. Shuy (2003) suggests that face-to-face interviews are often more suitable than telephone interviews especially if deeper and self-generated answers are sought; it is difficult to have these kinds of interactions over the telephone especially with strangers. Initially I felt that I had not given my supervisor enough thinking time after asking a question and then did not follow up an interesting response in the

way I could have. Where I asked a closed question, I could have asked something more open and allowed the interviewee to introduce wider issues to the mix that I might not have considered.

I developed a set of prompt sheets to help me with this semi-structured approach, which I used in another trial interview with one of my respondents, a Chemistry Professor with whom I had done work experience as a seventeen-year-old student. I had decided to try to have a broad conversation about the interviewees' backgrounds and current occupation, if any, leading to how learning or teaching concepts such as equilibria might have influenced this. The second interview went well although again I did not feel that I had got out of him the kinds of responses I might have; I was nervous throughout and found it hard to think on my feet to ask pertinent follow up questions, but tended to stick to my pre-prepared questions and therefore failing to have as conversational an interview as possible.

My confidence increased when I took on the next interview with the first person I did not know personally. I found it friendly and purposeful probably because my interviewees had volunteered and had an interest in what we were discussing. Volunteering can be seen as sign that a person may hold a very strong view within the group you are interested in (Arksey & Knight, 1999) so may present a skewed perspective from a particular sample, but that was not necessarily a bad thing in an exploratory set of interviews. The subject of this interview, a chemistry teaching fellow at a UK university, made some very telling remarks about the nature of chemistry and chemistry students, centring on the difference between a good student and a good chemist. We started talking about her educational background, and I soon realised what she does now and what she has observed in her students is of greater interest to me than specific chemical concepts that she may have studied and now teaches. Through my attempts to have a conversation with these participants I gathered much wider data than I had originally aimed for and this made me consider approaches that try to do this, which led me in turn to begin to consider a narrative methodology.

This interview also made me think about the subject chemistry and the processes undertaken and developed by those that study it. Does studying concepts such as equilibria develop specific skills in a person and, if so, are any of these skills useful outside of the laboratory? I made the decision to focus on this aspect for the rest of my pilot interviews. My next two interviewees were not selected at random; my research focus was now on skills, both those required for a role and where one might have acquired them from, so I decided to look at two contrasting subjects and interview a 21-year-old chemistry student about to graduate and an 88-year-old retired industrial chemist.

I suspected these two respondents would have very different tales to tell and therefore would be right for an initial exploratory study. They could both prove to be very interesting and help me decide on the direction I would head in my main study. Both these interviews were carried out in a very friendly spirit with interested and motivated interviewees and I felt I was developing an interviewer confidence to leave silences and ask relevant follow up questions that might allow a richer response into an area of interest.

These three interviews, taken together, led to a key development in my research. I realised quickly that all three people, despite completely different careers, ages and backgrounds, were all discussing the key skills required in their day to day work which they were not presenting as relating to chemistry directly. People skills, organisation and problem solving were talked about but no sign of what might appear, at face value, to be chemistry specific skills. I mentioned this to one of them and he expressed surprise that he had done so, and then took time to rationalise this. My other primary observation from my three exploratory interviews was that they all operate within a community rather than independently, with their colleagues, students and laboratory assistants and being able to operate within this community and that this was a very important part of their daily life at work. This led me to focus some reading onto situated learning and various authors who have looked at how learning takes place within communities, particularly the work of Lave and Wenger (1991), whose communities of practice are groups of people who share a craft and/or a profession.

I decided to interview the older retired industrial chemist again, as I wanted to try to probe further some of the specific chemistry he had carried out in the laboratory over his fifty-year career and to ascertain where he had learnt to do what he did, as he had left school and begun work at sixteen. This second interview was more skilfully handled by me and allowed me to draw out a lot more detail about the community he participated in at work, as well as details of the analytical experiments he carried out. He described the women he learnt the initial techniques from, who were skilled but without extensive chemical knowledge and how he asked questions of the qualified chemists there about why things changed colour or why they were doing what they were doing. This raised an interesting question about how we discern skills from knowledge; to carry out a titration accurately one would require certain chemical knowledge as well as an ability to manipulate equipment in a reproducible way. However, it was clear from my interviewee that he considered the manipulation of the glassware separate from an ability to rationalise the results in terms of chemical theory.

Giddens (1984) describes a flute maker and his apprentice and where the apprentice becomes the master when he can discern the sound of the flute for himself correctly. My interviewee seemed to acknowledge that he eventually mastered carrying out titrations and using these results to draw a conclusion, but he found it difficult to see himself in the same light as the 'qualified chemists' he had mentioned when he began working as a young man. It was a pleasure to speak to such an enthusiastic and interesting man; despite him seeing himself as in some ways an inferior chemist relative to the experts he so respected, he seemed to fit my own view of a chemist, who had spent a lifetime in a laboratory doing experiments and analysis. No doubt that says something about both my and his views of what makes a chemist, which led me to ponder this very question as part of my developing set of research questions.

To expand this line of enquiry, I decided to interview a friend who is a pharmacist working in a hospital trust. Obviously, we have a relationship different from my other interviewees, but I felt that so long as I acknowledged this and was upfront

about any potential bias it would still be relevant to interview him. It was striking to see my friend go into a professional mode I had not seen him operate in before; we had not discussed his work in this manner previously and I felt that he took my interview seriously. In trying to probe the nature of chemistry it was instructive to interview a pharmacist. On the one hand, a pharmacy graduate will probably have studied the same subjects at school as a chemistry graduate and initial university topics studied would be similar. Nevertheless, the similarities and differences between the responses from him compared with my other interviewees were of great interest. He continuously referred to a community of professionals, where their work used a shared background and technical vocabulary to carry out their disparate roles. He said the training for participating within this community had begun in first year of university, which differs hugely from those who studied chemistry, although this is not at all surprising as he was essentially being trained for a specific career path rather than in an academic discipline with a less clearly defined progression post-undergraduate study.

This raised the question for me of what the nature of chemistry is, and reminded me of a way of viewing science put forward by Layton (1993) as firstly 'the cathedral' representing scientific knowledge and theories like chemical equilibria; secondly 'the quarry' representing science as a resource to search and use for something useful as my retired interviewee might have whilst doing analysis; or thirdly 'the company store' representing workshops for science where research is done strategically towards a particular application as might be the case in the pharmaceutical industry. Many people, not just science graduates, view science with awe and regard the cathedral of scientific theory as high status and give it due deference. However, many of these graduates are mining and trading their knowledge and skill, using science as a quarry or perhaps as a company store; alternatively, they may well be using different aspects of what they have learnt in all three ways, dependent on the situation.

My initial research presented me with a dichotomy between perception of the subject and actual day-to-day use of it. I decided to pursue this idea further and consider decisions we all make, in terms of what to study, when to stop studying

a formal curriculum and what to do with our lives once we have left school or university or finished a qualification. These decisions form part of our individual trajectories which I wanted to examine more closely. Do we make these decisions in terms of the direct utility of, say, a chemistry degree opening particular career doors or for wider reasons of interest and intrinsic value?

Research into the undergraduate experience of mathematicians by Margaret Brown and colleagues has suggested that most students do not feel a strong commitment to their subject (Smith & Cooke, 2011). Few of the undergraduates in their study had any passion for mathematics; rather, they felt that the usefulness of mathematics did not meet early aspirations; their degree was seen as a means to an end and driven by the need to hold credentials (Brown, 2003). These views are similar to those held by chemistry students thirty years previously (Zinberg, 1971, pp. 294-295) where findings point to disenchantment, disillusionment and apathy among science undergraduates:

> There is no beauty in Chemistry but it is easier to get a job in science. Everybody has got the dread picture of working in a laboratory for the rest of their life, in some backwater, testing soap powder or something.

In their study of around a thousand UK arts and science (chemistry, physics, history and languages specifically) undergraduate students, Smith and Cooke (2011) asked participants to indicate the main reasons for their choice of university and course.

> The location of the university and its academic reputation were the main reasons given by all students for their choice of university, regardless of subject specialism. Secondary choices tended to be based on the Open Day visit and the course content, the most frequently stated reason for studying a course at university was an interest in the subject (over 80% of respondents) followed by success in the subject at school (45%) and then by career interests (28%). However, the percentage of chemistry students giving interest in the subject as a reason for joining a course was lower than for the three other disciplines (p. 311-312).

Considering the above, science undergraduates in this study showed a much stronger identification with their subject than the Arts students:

18% of chemistry students and 38% of physics students in the survey strongly agreed with the statement 'I like to think of myself as a scientist'. No historians and just 4% of linguists strongly agreed with their discipline's equivalent statement (p. 313).

The authors went on to comment that a relative lack of career direction among the arts students contrasted with the scientists, 'who were much more instrumental in their choice of degree programme and in its relationship to their subsequent career' (p. 320). Conclusions seem to indicate that students appear to be drawn towards arts subjects earlier than those towards science subjects but that the science students seemed to have a more definite idea as to career path once they had decided to follow this route. Although I was initially surprised that chemistry students showed the lowest rating for interest in the subject out of the four subjects studied, this does in fact tally with the chemistry students' view of themselves as scientists and on a career trajectory. This synchronises well with a feeling I had when I was at school, and now promulgate as a chemistry teacher, that studying the subject is a safe bet for employment options in the future.

I was particularly taken with the parallel drawn by the authors between linguist and scientist undergraduates in terms of wanting to 'use their language' or 'use their chemistry'. I very much wanted to use the chemistry I had learnt, in the future, when I was coming to the end of my undergraduate studies and having to contemplate applying for jobs or further study. The obvious progression to postgraduate chemistry study was scuppered by my pervading sense of not being 'academic' enough for PhD studies in chemistry. A combination of comparison with more academically successful friends and insecurity in my own achievements relative to the status of the 'cathedral' of chemical theory led me to not pursuing the obvious path. Nevertheless, I did not want to lose my interest in the subject or waste all the effort I had put into studying it to a high level, so my attention turned to teaching.

I asked one of my interviewees, who was about to graduate in chemistry and to embark upon a PGCE[3], why he had chosen to do this and he responded:

I've always had an interest in teaching I think and always had an interest in working with people. For me, the main aspect of it is, when you look at a young person, they have two main figures in their life, their parents, in most cases or guardian/carer and then their teachers. So, I think you have a massive part to play which I find very exciting. And I do really like chemistry, although I've decided not to carry it on, I really do enjoy it and think that the skills it does provide are important so I want to have a part of passing it on.

These interviews and some self-reflection of some of my own big life decisions led to the next shift of research focus. The above chemistry student echoed my own feelings about 'not carrying on chemistry' and going into teaching instead, something which speaks volumes about how we both view chemistry teaching as outside of chemistry itself. It also circles back neatly into my previous thoughts about what makes a chemist a chemist. To narrow down my research focus to something more realistic and manageable I decided to look at these big life decisions, particularly the decision to study chemistry at university and the decision to then teach. From a look at the literature on teacher recruitment and retention around the world, particularly the meta-analyses of Borman and Dowling (2008) in the US and the more recent international comparative study by Heinz (2015), there are many large scale quantitative studies with questionnaires filled out by current/ex teachers and student teachers, but few that attempt to look at a more nuanced picture of individuals' lives and the influences on big life decisions such as going into teaching. In the context of teacher shortages in many parts of the world, including the UK, especially in subjects like the physical sciences, I decided to try to consider the question of 'why do chemists go into teaching?'

Realistically, as a full-time teacher in one school and without easy access to large numbers of teachers or student teachers, I decided to focus on the choices of a small group of chemistry teachers that teach at my school. There are obvious

[3] Post Graduate Certificate in Education (PGCE): most common qualification to teach in a state school in the UK

advantages to this decision in terms of logistics and it gave me people to talk to who already had a positive relationship with me and an interest in what I was doing. This did not come without inevitable bias and power relationships, which I will discuss in more detail later in section 4.2.6. Nevertheless, I thought that these potential issues did not outweigh the positives, so long as I considered how they might influence what I was being told. For example, teaching colleagues from my school probably have a clear idea in their own minds of how they perceive my relationship with chemistry and therefore they may wish to present a portrayal of their relationship in a more positive light because of this. I therefore needed to exercise some caution when analysing what was said to me in any interviews with teachers I know well.

I decided that the best way to examine these life decisions was through exploring narratives, where I would attempt to consider the influences on the colleague's life which they felt had affected their decision-making process, such as their family or peers. This allowed me to use a similar conversational interview technique I had begun to develop in my pilot interviews but, if anything, attempt to be even less structured than I was then. I was looking for a story from my interviewees, even if it was one that they had not expressed before or would again.

My first challenge was to consider my own narrative, which inevitably would colour every interview that I participated in. Narrative research involves a dialogue with the story teller (Bochner, 2001) and one tries to make matches with one's own lived experiences so as to make appropriate and empathic responses. The advantages here are obvious, in making the experience pleasant for both interviewee and interviewer and in finding areas of commonality or difference which can highlight aspects of the story being told. However, on the flip side, there is always the danger of distortion, of my seeing parallels with my own story and imposing that upon theirs. By choosing this method of data gathering, I was inviting some co-construction and I should not shy away from this but rather acknowledge it where I saw it.

I attempted to commit thoughts about my own story to paper at various times during my research and this illustrated one hugely important point about narratives; every time I considered my story it had changed since the previous time – every time we tell a story we are viewing it from a different perspective and in my own case I had been doing a lot of thinking in this area so my interpretations of my own story, and therefore the story itself in my head, evolved as time went on, despite the events depicted being unchanged, but of course being recalled through changing lenses with different foci. As I will discuss later, this influenced my decision to only interview each of the main study participants once.

Emerging from my own story and that of my early participants was the influence of key players mentioned above such as inspirational chemistry teachers or parents, but also psychological defences of decisions made regarding chemistry. I was taken by the UPMAP[4] project into uptake of mathematics and physics in the UK where narrative style interviews were carried out seeking to understand why some students continued studying these subjects and others did not (Rodd, Mujtaba, & Reiss, 2010). Also influential has been the work of Holmegaard (Holmegaard, 2012, 2015; Holmegaard, Madsen, & Ulriksen, 2012a, 2012b, 2014, 2015; Ulriksen, Holmegaard, & Madsen, 2013) who has looked at Danish secondary school students' decisions whether to continue studying science and mathematics at school and beyond. Her use of narratives to learn about students' choices, by considering trajectories retrospectively, has helped broaden my methodological knowledge and has stimulated my own thinking about life decisions.

My focus on these big decisions that we all make in our lives, albeit within the narrow confines of people who are currently chemistry teachers in the UK, is of interest itself, but I wish to situate it within a much larger debate, that of science, technology, engineering and mathematics (STEM) education and its importance around the world. I will discuss aspects of this debate in the next section,

[4] Understanding Participation rates in post-16 Mathematics And Physics (UPMAP). Ongoing project carried out at UCL, Institute of Education, London

concluding in the research questions that I shall attempt to address in my own study, within the field of STEM teacher recruitment.

2.2 STEM and Chemistry

There has been a long running debate around the world about the increasing importance of science, technology, engineering and mathematics (STEM) education and how this fits in with individuals' and indeed whole countries' ability to prosper in a global economy. My interest lies within chemistry education, but this is only a part of what we know about the wider sciences which are themselves situated within the sphere of STEM education where much of the international debate is framed. However, we should not lose sight of the fact that the term itself is couched in terms of global competitiveness and prosperity (Hutchinson, 2012; The Royal Society, 2009); whereas, for an individual such as myself, going into chemistry teaching had more to do with an intellectual fascination with our subject than any instrumental term such as STEM and its perceived effect on a nation's economy.

Chemistry is a central STEM subject, but this has epistemological implications as integrating chemistry knowledge and mathematical knowledge is problematic. When studying equilibria in a quantitative way, for example in calculating the value of an equilibrium constant, approaching this as a mathematician may lead to considering a balanced chemical equation as mere algebra, but its chemical meaning is subtler; the number of atoms of each element will be the same on each side of the chemical equation, but the total amount of reactant and product may or may not be affecting how one calculates Kc[5]. There is a dichotomy between the way chemistry is seen, subsumed within the STEM umbrella, for studying for the purposes of a global market and fascination about the subject for its own sake and distinct from mathematics or physics.

Therefore, it is important for me to consider this debate before considering it from the perspective of chemistry and chemistry teachers. Watt, Richardson, and Pietsch (2007) compare and contrast the situation between the USA and Australia: participation in the sciences and mathematics in secondary and tertiary education has exponentially declined in the USA over the past two

[5] Equilibrium constant in terms of reactant/product concentrations

decades, to the point where there is grave concern about the viability of these disciplines to sustain economic growth and development (Jacobs, 2005). A similar concern exists in Australia, and elsewhere, where there is an increasing decline in STEM participation and educational attainment (Dow, 2003).

UK public spending has declined in real terms since the economic downturn in 2008, but one area where it is claimed that spending has been sustained or even increased is in the supply of new scientists. Taken together, the UK government's proposals to develop the nation's scientific skills base largely lie in increasing the supply of young people into the STEM professions either through attracting well qualified people into teaching, increasing the science content of the National Curriculum in schools or reforming the curriculum, such as encouraging schools to enter more students for 'triple science'[6] so as to encourage able young people to remain in the 'science stream' and subsequently study the subject at university (Smith & Gorard, 2011).

Parallel to the debate about STEM education itself is that of teacher recruitment and retention. The links between the two are a little subtler than might be thought initially. Teachers of STEM subjects, such as chemistry, are usually required for students to become proficient in these subjects; however, if the national agenda is for these students to become 'STEM professionals', how can we reconcile this with attracting them to teach? One might argue that teaching chemistry is, of course, a STEM profession but whether that is acknowledged by STEM students is a different matter. I have been asked many times by my own students over the past twenty years about why I became a teacher when I held a chemistry degree; their implication being that becoming a teacher might be in some way selling myself short, certainly in their eyes in purely financial terms. My students often seem to value utility above all else and may not appreciate the reality of teacher salaries versus other STEM professions, but this view of teaching, the UK at least, being a 'last resort' may well feed into decisions that undergraduates may

[6] UK (except Scottish) students sit their GCSE (General Certificate of Secondary Education) examinations when they are 16 years old, after two years of study. Nationally, most students sit for two awards ('double science') but some sit Biology, Chemistry and Physics as three separate awards ('triple science')

make when they graduate, despite teacher salaries comparing favourably with, say, post-doctoral science researchers. In their research considering cross-national student expectations of becoming a teacher, Park and Byun (2015) argue that both the economic and social status of teaching, within a country, can influence individuals' decision to teach more strongly than their own background status. Using 2006 PISA[7] data from 23 OECD countries, as well as a measure of teachers' social status around the world given by the global index of teacher status established by Dolton and Marcenaro-Gutierrez (2013), they concluded that both these factors do affect the likelihood of a young person going into teaching, but that the social status of teachers has not received nearly as much attention in the literature compared with economic status. Although interesting, this research must be seen in the context of examining academically successful fifteen-year-old students only; many students who become teachers subsequently would not have been able to say this aged 15, myself included, so we should we wary of definite conclusions here, a point conceded by the authors.

There is a potential crisis in many countries around the world in terms of future teaching numbers. In Sweden (Lindqvist, Nordänger, & Carlsson, 2014) this shortfall could reach twenty percent by 2020. Teachers leaving the profession within the first five years is a huge problem in countries like Sweden, the USA and the UK (30-50%), but interestingly far less so in France and Germany (around 5%). Moreau (2015), in her comparison of career choices between England and France, comments that French secondary school teachers identified with the academic side of their job more than their English equivalents, as befits a school system where their roles are more aligned with the curriculum and relatively free of the pastoral demands a British teacher will face. She highlights concerns expressed by UK teachers that around half of them had considered leaving the profession due to stress (NUT, 2008), something far lower, although recently increasing to around a quarter (Fotinos & Horenstein, 2012), in France.

[7] The Programme for International Student Assessment (PISA) is a worldwide study by the Organisation for Economic Co-operation and Development (OECD) in member and non-member nations of 15-year-old school pupils' scholastic performance on mathematics, science, and reading.

The lack of enthusiasm by STEM graduates for a teaching career in some countries may be a direct result of the general shortage in STEM professionals, increasing the number and type of high-status and lucrative career options available to graduates in those fields, thereby exacerbating the difficulties of attracting new graduates and career switchers into a career teaching in STEM subjects (Harris & Jensz, 2006). If other STEM careers are seen as more desirable, and at the heart of national agendas, then a lack of qualified teachers to potentially inspire the next generation is a likely consequence.

I would like to consider the debate from three angles: the need for STEM education; the viability of teaching as a career for a STEM student and finally teacher recruitment.

2.2.1 The need for STEM education

If you read the press or the rhetoric from politicians such as Tony Blair, Gordon Brown or Barack Obama over the past ten years or so, you may well be convinced the UK and the US are facing a crisis. There has been a perceived failure to adequately recruit, train and retain professional scientists in the UK and this has led to huge government investment, as well as shake ups to the education system, such as Curriculum 2000[8] and a push for 15-16 year olds to study more science. This concern is echoed across Europe (Convert, 2005; Haas, 2005) and the rest of the developed world and demonstrated by large-scale projects including Relevance of Science Education (ROSE) (Jenkins & Pell, 2006) and Interests and Recruitment in Science (IRIS) (Henriksen, Dillon, & Ryder, 2015; Sjøberg & Schreiner, 2010), as well as much academic research exploring student participation in the sciences (Hipkins & Bolstad, 2005; Holmegaard et al., 2015; Regan & DeWitt, 2015).

However, this long running international debate is somewhat more complex than the headlines might suggest. As Osborne and Dillon (2008) point out, the discourse centres on the recruitment of young people on to STEM courses and not on the demand for STEM workers. Do these students have attractive and valuable (to their national economy) jobs waiting for them at the end of their course of choice? It appears that the curriculum, particularly in schools, has been dissected, and criticised, but less attention has been devoted to the experiences of undergraduate scientists and how these feed into a life trajectory leading to a career as a professional scientist or technician.

In the UK, research carried out by Smith (2010, p. 288) into university applications and acceptances, she noted that there is:

> little evidence of a 'swing' away from science subjects or that the sciences overall have failed to keep up with the rapid increase in the number of students studying at university.

[8] In 2000 students were expected to study four subjects at Advanced-Subsidiary level (AS) at 16/17 years of age, leading to three Advanced (A) levels at 17/18 years; numbers studying mathematics and the sciences nationally have increased in the intervening years.

What has happened instead is some change in the type of science courses that students opt to study.

Moreover, some of the subjects that fall within the STEM banner are recruiting more students than initially apply; in the UK, students can accept a place on a degree course they did not initially apply for via a system called 'Clearing' and therefore subjects like chemistry, mathematics and engineering have been net recruiters over the past twenty years. Smith calls this situation a paradox where subjects noted as important to the nation's economic wellbeing are given extra funding for more places, but are filling many of these vacancies with students who did not originally want to study them. The shift in popularity has been towards more applied subjects such as psychology, sports science and environmental science. Panizzon, Corrigan, Forgasz, and Hopkins (2015) report very similar trends in Australia where an increased range of subjects available for study in schools in the 1990s and early 2000s generated more competition between subjects within the same cohort.

Another big issue with the STEM debate is the ambiguity over the term itself. In Australia technology in schools is not mentioned in terms of STEM; within universities, health programmes such as medicine and nursing are included with architecture and agriculture; and yet medicine and health science occupations are not always included as 'STEM professions'. In large swathes of the STEM debate the term is being used to describe different groups and that the real issue is that there may well be gaps in the STEM workforce, as well as areas of competition for jobs, but these are hidden within the rhetoric of overall STEM shortages.

Despite the above politicised, and possibly skewed debate, there remains a need for STEM graduates. Numbers studying subjects such as chemistry have remained stable in the UK, but placed within the context of increased total student numbers and an approximately constant proportion of the national cohort reading science subjects, including applied sciences such as psychology, numbers have not kept pace in the core school sciences of biology, chemistry and physics. I would not advocate pushing more students into these subjects if they are not

suited to them, for the sake of quotas, but I would advocate an analysis of specific career trajectories and the suitability of current graduates to fulfil these roles, to expose where the shortfalls are.

2.2.2 The viability of teaching as a career for STEM students

Even if the number of students taking the sciences from school onto higher education has not increased significantly over the past twenty years, numbers taking Advanced level sciences in the UK have increased again after previously declining (Osborne, Simon, & Collins, 2003). Government statistics show that the national percentage of A level chemistry entries in England and Wales rose from 5.5% in 2001 to 7.3% in 2013 (Truss, 2013). The most common explanation for the previous decrease was that there was increased choice for students, similar to the discourse expressed above in Australia, both at school and in higher education in an era where participation was increasing rapidly. However, with an economic downturn affecting much of the post-industrial world, many students in schools perceived that getting a job with a degree would not be as straightforward as it once was. Some students took the view that 'traditional' A levels and an 'academic' degree course such as chemistry might be a prudent course of action to try and secure a job three years down the line (Hoyle, 2016).

In my experience, very few students at school express any desire to teach and those that have expressed it to me almost always wish to be primary school teachers. Nevertheless, some of my ex-students are now secondary school teachers of a variety of subjects including chemistry. However, those currently employed as chemistry teachers have reached this point via academic disciplines, some like me via chemistry but others via engineering, biochemistry or forensic sciences. These contrasting backgrounds will, inevitably, influence how these teachers frame their identities with respect to chemistry and how they defend themselves against it.

Irrespective of the rights and wrongs of the somewhat complex STEM debate, all countries require well qualified and motivated teachers to educate the next generation of students. Teaching has always been a popular and viable career choice for science graduates, although when I was an undergraduate in the early 1990s there was a feeling that a teacher certification could be a soft option for some who had not excelled academically.

To me, the important thing about teacher recruitment is to demonstrate not only that teaching is a viable career choice for science graduates, but that this viability is not pre-determined by degree class or A-level grades, but rather by an individual suitability or, at least, this having more emphasis than academic factors such as degree class. This personal view is slightly at odds with Park and Byun (2015) who argue that attracting high-achieving students into the teaching profession can create a 'virtuous circle' (Carnoy, Gove, & Marshall, 2007) where well qualified students become better prepared, in terms of subject knowledge, when they become teachers and capable of delivering a more demanding curriculum. I agree with this perspective in terms of a minimum subject knowledge and understanding required to teach, say, chemistry at GCSE or A level, but once this level is reached I would argue that other personal teaching qualities are more important, such as empathy, patience and an understanding of how children learn. Mitchell and Lambert (2015, p. 1) go further and suggest that the educational purpose of subject knowledge has been separated from 'teachers' concerns with pedagogy, performance and the child's experience' and they advocate that training teachers develop a balance of their subject and education via the concept of curriculum and curriculum making, something that is not currently the case in the UK where the balance lies more with being a skilled classroom technician.

Nevertheless, Park and Byun (2015) make a telling comment about research into teaching motivations which is largely focused on students undergoing teacher training and not where a desire to teach may develop from in younger students, which they suggest is in sharp contrast to the literature on scientists (Maple & Stage, 1991; Xie & Shauman, 2003), which 'highlights the critical role of students' expectations in high schools for their science careers' (Park & Byun, 2015, p. 526). Not only this but that the social status of teachers, as an influence of motivation to teach, is not as well studied internationally as their equivalent economic status. In some countries thought to be educationally successful, in terms of PISA or TIMSS[9],

[9] The Trends in International Mathematics and Science Study (TIMSS) is a series of international assessments of the mathematics and science knowledge of students around the world

the social status of teachers is high. In Finland teaching is consistently the most admired profession (Sahlberg, 2012), before doctors, architects and lawyers; research and experience both suggest one factor trumps all others: excellent teachers and consequently only the most qualified are able to become teachers in Finland and entry onto teacher training is very competitive and normally some prior experience is required, which is similar to the situation in Singapore. In contrast, in the UK teachers were historically respected but less so now (Macbeath, 2012) where long hours beyond those in the workplace have been partly responsible for acting as a disincentive to teacher recruitment.

Watt et al. (2007) suggest that in each of mathematics, ICT and science, the highest rated motivations for choosing a teaching career were perceived teaching abilities, the desire to make a social contribution, to shape the future of students, and the intrinsic value of teaching as a career. Positive individual prior teaching and learning experiences were also quite highly rated, suggesting that to attract quality teachers in these subjects it is important to provide these experiences for the next generation of scientists and potential teachers. Any of us may make a teaching career decision for sound or altruistic reasons, such as wanting to benefit society or help secure the next generation of scientists, but it could still prove to be the wrong one personally. For me, an interest in chemistry was very important, so it will be interesting to see if my gathered narratives agree with Watt's research or, at least, offer a view into the bigger picture of these choices in the context of their wider life which a narrative approach offers over surveys (Riessman, 2008).

From a UK perspective, recent governments have tried to push teacher recruitment, particularly in shortage subjects. My research is all about investigating the myriad of factors that have influenced the participants' decision to teach. How successful these government initiatives have been cannot be measured by my research methods, but any influence of various schemes such as teacher training fees being waived, initial bonuses for teachers of certain subjects or entering the profession through new routes, previously unavailable,

such as Teach First or the Graduate Teaching Programme (GTP)[10] might be detectable from what the participants say. I received a small bursary for training to teach science in 1995/6 that others in non-shortage subjects did not receive. I cannot say that this cheque influenced my decision to teach, as it was a complete surprise to me when I received it! Dolton and Chung (2004) consider financial incentives used in the UK, such as the one I received in 1996, so called 'golden hellos' of £4000 used in 1998 in shortage subjects (mathematics, science and modern languages) and schemes in London in 2003 to give housing loans to teachers in the capital. They conclude that despite financial incentives, the 'profitability' of becoming a teacher varied according to gender (positive for women; negative for men) but that the net present value of earnings of becoming a teacher compared with an alternative occupation had fallen in the preceding ten years (Dolton & Chung, 2004, p. 99).

Nevertheless, teaching remains a viable option for a STEM graduate, and one taken up by many people of all ages and from differing backgrounds. Although most chemistry teachers have graduated in the subject, as I mentioned earlier, some have studied biochemistry, forensic science or chemical engineering and so it is important to recognise this within the overarching banner of STEM education.

[10] Now called School Direct, both are employment routes into teaching

2.2.3 Teacher recruitment and retention

The problem of teacher retention, and consequently teacher recruitment, is especially pressing among beginning teachers, with an estimated 30 to 50% drop-out rate of teachers within five years of qualification in England (Burghes, 2009). There has been a lively debate in the USA about teacher retention and attrition rates. Clandinin, Downey, and Schaefer (2014) carried out a large study into teacher attrition in the US where up to fifty percent of new teachers leave the profession within five years, a figure even higher in urban settings. The situation in Canada mirrors that in the US and proves very costly in terms of recruitment, training teachers and covering classes which do not have a teacher. Despite these statistics there seems little consensus on why teacher attrition rates are so high. Schaefer, Long, and Clandinin (2012) found that most recent studies focused on:

- Demographics;
- Life situations;
- Dispositions of individual teachers;
- Quality of particular teaching contexts.

This is a very large range of factors to be considering. Recent studies frame 'teacher resilience' as critical to teachers remaining in the profession (Jones & Youngs, 2012). This problem is complex, Hong (2012) discusses how teachers' values, self-efficacy, beliefs and emotions are nurtured or hindered due to the school they work in and the classroom environments within them. For example, where the support mechanisms are robust from other staff or administration, staff developed better self-efficacy and were more likely to stay in the profession. Analyses suggested that teachers within early and middle career phases of their professional lives were more likely to retain their sense of resilience than those in late careers (Gu & Day, 2013). I have certainly seen, at first hand, teachers worn down by the profession's physical, mental and emotional demands towards the end of their careers and looking to retire early.

In her International meta-analysis, Heinz (2015) considers student teachers' career motivations and levels of commitment to teaching. She suggests that research

shows that teachers are no longer 'instruments' that act towards student achievement utilising a certain knowledge, but 'intelligent agents' whose practice 'remains forever rooted in personality and experience' (Goodson, 1994; Kagan, 1992, p. 163). Heinz argues that by understanding the motivations of student teachers and what attracts them to teach in the first place, one can plan initial teacher training and wider education policy more effectively. The wider literature, including the large US meta-analysis by Brookhart and Freeman (1992), suggests that there are three main sources of motivations influencing the decision to enter initial teacher training, intrinsic, altruistic and extrinsic reasons.

Intrinsic motivations include factors such as the enjoyment of teaching, job satisfaction, creativity and an interest in chosen teaching subject(s). Studies around the world have shown these factors as the most influential, including various UK studies (Reid & Caudwell, 1997; Thornton, Bricheno, & Reid, 2002). Valentine (1934) had already cited subject favouritism as a major drive to go into teaching and much more recent research by Younger, Brindley, Pedder, and Hagger (2004) identified the subject as one of the major factors in the decision to teach, but as the authors say:

> This apparent homogeneity of response carries with it a complexity of constructions of subject and teaching. For some trainees, it was the perceived intrinsic value of the subject itself, and the opportunity to continue working within the subject area, which drew them to teaching. For others, however, an additional dimension to the 'love of the subject' was the desire to share their own enthusiasm and pleasure in the area with others, to communicate ways of seeing the world through different lenses (page 248).

Altruistic reasons for going into teaching include a sense that teaching is useful and socially worthwhile and that going into the profession will contribute on an individual level to young people but also to society as a whole. Valentine (1934) and Tudhope (1944) both suggested that caring for children was an important justification given by UK teachers to their decision to go into education, albeit a long time ago. Richardson and Watt (2006) considered several altruistic motivation factors affecting Australian teachers which they call "social utility values" which they perceive can allow them to make a positive difference to

society. Much worldwide research in this area considers gender differences (Clarke, 2009; Drudy, Martin, O'Flynn, & Woods, 2005) and teachers from minority backgrounds (King, 1993; Lortie, 1975/2002; Su, 1997). This research suggests that the altruistic desire to work with children appears more prevalent in women and that an awareness of current inequalities within existing educational and social institutions can lead some students from minority backgrounds to seek the role, as an agent of change.

Extrinsic reasons to go into teaching include 'aspects of the job which are not inherent in the work itself, such as status of the profession, levels of pay, holidays as well as job security, transferability, and flexibility' (Heinz, 2015, p. 267). Most of the international studies Heinz considers do not report teachers placing extrinsic factors as highly as intrinsic or altruistic ones. However, teachers may well prioritise other reasons to teach when they present these to an external audience, as may befit their identity as a caring and knowledgeable teacher. I am seeking to examine, in my research, these big, undeniably complex, life decisions and how we present them to ourselves and others; this presentation will depend on many factors. Lortie (1975/2002, p. 30) argues that teachers may underplay the influence of material benefits 'as a result of normative pressures, which require teachers to emphasise more their dedication and service role', something I must be careful to consider when analysing what my teachers tell me in interview.

Outside of the three categories of motivation discussed above, the literature identifies other influential factors (Heinz, 2015) including student teachers' teaching-ability related beliefs, their prior teaching and learning experiences, the potential influence of family members and others and the impact of socio-cultural factors, such as cultural, religious or ethnic identity. Of interest to me is the idea prevalent in the international literature (Brookhart & Freeman, 1992; Heinz, 2013; Lortie, 1975/2002; Richardson & Watt, 2006; Watt & Richardson, 2007; Younger et al., 2004) that high levels of confidence in their own teaching ability relate mostly to the confidence in their subject knowledge and/or character traits they observed in their own best teachers. According to Younger et al. (2004, p. 250) the most commonly cited teacher qualities were 'their enthusiasm, strong

interpersonal skills, energy, and ability to generate confidence in pupils'. Confidence in one's own subject knowledge and teaching ability does not necessarily equate to success as a teacher, but I wish to see if my research supports such a view.

Many studies cite prior experience of teaching and learning as a positive influence upon the decision to train to teach. However as Heinz (2015, p. 270) discusses in her meta-analysis only two studies so far identify student teachers' previous experience as teachers as an influential source of career motivation, namely that of Younger et al. (2004) in the UK and her own research in Ireland (Heinz, 2011, 2013). These teacher experiences include work experience at university, overseas working or participation in such schemes as Teaching English as a Foreign Language (TEFL).

Thirdly, studies around the world show that there can be a strong influence by family members on the decision to become teachers. Interestingly these influences vary and can be both positive and negative. In Ireland (Drudy et al., 2005) 61.7% of the respondents had a close relative who was a teacher and the authors concluded that having a relative in the profession will act in a positive way in promoting the ideas of teaching. In contrast, other studies show a lower parental influence, such as Valentine (1934) in the UK, Book and Freeman (1986) in the US and Yaakub (1990) in Malaysia where family influence seems to be far lower in the influences' pecking order. In Australia Richardson and Watt (2006) suggest that, in fact, having teachers in the family can act against going into the profession. In my own experience teachers give both positive and negative impressions of the job and it does not surprise me that some young people might be attracted towards the profession by family members and equally others might be dissuaded from considering it. The status, working conditions and pay of teachers varies from country to country, so I might expect family influence to depend on the country under discussion, but more than that, it comes down to the specific family under discussion. The influence of our parents may well be direct, but I would expect much of it to be subtle. This is something that is worth considering when I carry out my own interviews.

In their comprehensive meta-analysis of US teacher career trajectory research, Borman and Dowling (2008) suggest that the evidence shows the odds of teachers with a graduate degree leaving the profession were somewhat greater than those without, and those holding a science or maths undergraduate degree were approximately twice as likely to leave compared to those with other degrees. The literature seems to also suggest that teacher attrition increased after five to six years of service and that science and maths teachers were more likely to leave than other teaching specialisations. The authors suggest that personal characteristics of teachers, including their backgrounds and qualifications are important predictors of teacher turnover. Research seems to suggest that many student teachers enter their training with particular career aspirations, linked to their motivation to teach, and discrepancies between these and the reality of training and the job itself can lead to teacher attrition (Heinz, 2011; Lin, Shi, Wang, Zhang, & Hui, 2012; Manuel & Hughes, 2006). If we can understand the motivations for training to teach more clearly, then teacher training and newly qualified teacher schemes could and should align themselves with these, whilst addressing the tension between these aspirations and the reality in the classroom, as called for by Heinz (2013) and Priyadharshini and Robinson-Pant (2003).

Acknowledged to be the most significant development (Heinz, 2015) regarding students teachers' motivation to teach has been the design of the Factors Influencing Teaching Choice (FIT-Choice) scales by Watt & Richardson (2007, 2008), which have been used in many international studies. However, much of the research published in this area has considered teachers as a homogenous group without consideration of sub-categories such as primary versus secondary teachers, socio-economic background or age. Findings published have often considered gender but not these other categories. Another issue is that of opportunity; for many people deciding to teach may not be as simple as something they have intrinsic, altruistic or extrinsic motivation for, but rather an opportunity that presents itself according to market forces with an individuals' 'choice of teaching over other available occupations' (Guarino, Santibanez, & Daley, 2006, p. 175).

Schaefer and Clandinin (2011, p. 277) suggest that much of the literature published about teacher attrition relied on instruments, surveys and interviews designed to elucidate why teachers were leaving the profession leading to factors, trends and tendencies, which 'sand away the larger contexts of their lives'. In their narrative study into early career teachers, the researchers did not ask directly why they left teaching but instead talked to them about their lives which produced long engaging conversations. Schaefer and Clandinin (2011) used the strategy of Narrative Inquiry (Clandinin, 2006) where social and cultural influences are considered not only as occasions for critical exposure but resources to be used. Whilst research using the FIT-Choice survey does include one open-ended item asking participants to "briefly state their main reason(s) for choosing to become a teacher" (Watt & Richardson, 2007), a narrative approach has something to offer here to examine the sub-categories mentioned above, as well as situate their motivations within the wider context of the participants lives.

According to Lindqvist et al. (2014) potential teacher shortage in some countries, such as Sweden will reach twenty percent by 2020. Strategies employed by countries are to increase teacher recruitment numbers using schemes such as Teach First in the UK or Teach for America in the US. However findings show that the major problem for schools is not teacher recruitment, it appears as if many of the newly qualified teachers choose not to go into teaching at all or leave after a few years (Ingersoll, 2003, 2007). Teaching has higher rates of turnover compared with higher-status occupations (professors), similar to comparable ones (nursing) and lower than some lower-status ones (clerical workers). The proportion that seems to drop out often seems to correlate with the number of years in the profession yielding a U-shaped dependence where younger and older teachers are more likely to leave the profession. Quantitative studies in the USA suggest 40-50% of the graduated teachers are still working as teachers within five years after graduation and we find a similar story in the UK. The matter of teacher attrition is, of course, not just a matter of raw numbers; perhaps the debate should be considering the characteristics of people who become long term teachers and hence how to attract the kinds of people who are more likely

to remain within the profession. Also we should look at who leaves teaching, as there is some evidence that schools tend to lose the more skilled then their less skilled teachers (Ronfeldt, Loeb, & Wyckoff, 2013). On this theme, Borman and Dowling (2008) comment that:

> The schools do seem to lose more experienced teachers and teachers with high-demand science and math degrees. On balance, then, there is somewhat more evidence suggesting that it is the more talented rather than the less talented teachers – those who are better trained, more experienced, and more highly skilled – who tend to be lost to turnover with greater frequency. However, this finding is equivocal because the evidence is somewhat mixed and because these various teacher qualifications are imperfect indicators of teacher quality (page 396).

Most research on teacher attrition is 'one shot' rather than considered as a process over time. Lindqvist et al. (2014) take a very different approach and consider 87 Swedish teachers over nineteen years. In their study, some of the teachers seem 'premeditated' to leave – they express no inclination to seriously enter the profession. The analysis of the longitudinal data here suggests that career decisions may not be as rational as we often seem to suppose. Rationality does not recognise that people create and re-create goals over the course of time or that individuals do not have one stable goal but often operate with a variety of possible outcomes. This ties in with the renegotiated identities discussed by Holmegaard (2012) where narratives are continuously retold and revised according to the experiences of the student concerned and hence their changing decisions regarding subject studies. We all renegotiate our identities as time passes and present a defended account if we are asked about it. The use of such defences is based on the work of the psychologist, Melanie Klein (Segal, 2012; Waddell, 2002) which I will discuss in more detail in section 3.6.

The case of teachers of mathematics and the physical sciences, within the UK, has long been considered by various learned societies to be of major concern. There have been shortfalls in the recruitment of science and mathematics teachers for over thirty years. The Royal Society presented the cumulative shortfall of science and mathematics teachers (Taylor, Martin, & Wilsdon, 2010) and by

2010, there had been under-recruitment of physics teachers for 25 years, and the Institute of Physics estimated that 1,000 physics teachers a year for the next 15 years would be required to address this. ACME[11] has indicated that secondary schools have a shortage of 5,500 specialist mathematics teachers in England (ACME, 2014). The Department for Education Workforce Census data for England shows that the number of physics teachers with no relevant post A level qualification in physics is 37% and increasing. For chemistry and mathematics, the number of non-subject specialist teachers remains consistently high, at around 25%. Research (Husbands & Pearce, 2012) indicates that it is teacher competence that has the greatest effect on student achievement and that subject specialist degree-qualified teachers in chemistry positively affect pupil progression. With many chemistry teachers coming from a biochemical or engineering background, this idea of teacher competence is an interesting one, as such teachers will bring different contexts and examples to the classroom compared to straight chemistry graduates. In my experience, biochemistry graduates tend to prefer to teach the organic chemistry side of the Advanced level chemistry course, but this does not necessarily mean they teach the physical or inorganic portions less effectively.

I see teaching differently now, with many years of experience, to how I did as a student teacher. My own retention within the profession, or anyone else's, is extremely complex to consider with a myriad of different factors interacting. Nevertheless, the perspective of current practitioners on becoming a teacher may shed some light upon wider retention issues even though this is not my primary interest.

[11] Advisory Committee on Mathematics Education

2.3 Research Questions

My research interests have developed from very specific classroom and pedagogic matters relating to the teaching of chemical concepts such as the mole and chemical equilibria to a broader view on transferable skills developed by/through chemical education and how these manifest themselves day to day in a person's life. This focus on skills and the practice of a 'chemist' led me to the realisation that our current practice, in whichever sphere of our life we are considering, comes at a point of an evolving trajectory as viewed at a particular time. As a practising chemistry teacher, the trajectories of other current chemistry teachers are of interest to me and many offer insights more widely to the recruitment of other STEM subject teachers internationally.

This interest in career trajectories is augmented by my commitment to narrative research methods, which seem to me to be an ideal vehicle with which to explore them considering the complexity of each story. I intend to examine the following questions throughout the main body of the following chapters:

What are the key influences on the trajectories of people who become chemistry teachers?

What can we learn about chemistry teacher recruitment from considering the narratives of chemistry teachers at different stages of their careers?

3 Literature Review

3.1 Introduction

In the preceding background chapter, I have discussed how my research has evolved into a narrative study of chemistry teacher career trajectories. In this chapter I examine themes underpinning my work: identity, choice, practice and chemistry and chemists, as well as the defended self.

As we are all a product of a multitude of internal and external influences, identity is an important term to define, discuss and consider in terms of how it may influence us to make choices in our lives. I am particularly interested in two life choices, to study chemistry and to subsequently become a teacher. All the participants in my study are teachers and therefore work within a particular community, so attempting to understand the practice of chemistry and/or a teaching must be important when I look at choosing this subject or career. I will also look at the academic subject of chemistry and whether seeing ourselves as a chemist is important in terms of choice or practice and finally consider the idea of the defended participant and what that can reveal regarding these choices.

3.2 Identity

Identity is a complex and problematic term, much considered by philosophers and in the wider literature, including within the educational field and, more narrowly, the field of teachers and teacher education. Beliefs in some kind of core-self have been challenged – is it possible to remain the same person when so much of our body, biochemically, has altered? Nietzsche, argued against the idea of a core-self but considers people as a combination of different forces and drives, something that Freud utilises in his development of psychoanalysis (Freud, 1964). In more recent times, memory, aligned with our desires, intentions, beliefs and temperaments have been considered to combine into some kind of personal identity (Parfit, 1984). Current debates refer to the idea that identity is constructed and that it is developed and shaped by our relations with external factors; can other people therefore shape our identity?

Olsen (2008, p. 139) gives his take on teacher identity: 'I view identity as a label, really, for the collection of influences and effects from immediate contexts, prior constructs of self, social positioning, and meaning systems (each itself a fluid influence and all together an ever-changing construct) that become intertwined inside the flow of activity as a teacher simultaneously reacts to and negotiates given contexts and human relationships at given moments.' This label is useful as a starting point in considering people who are all chemistry teachers as it is considered in terms of relations with external factors, but specific to my area of interest. It therefore facilitates my investigation into the influences and situations affecting the participants throughout their lives, but captured at a particular point in time and strongly influenced by recent events.

Rather than immersing myself in the history and tradition of what is a complex and disputed term, I will use this working definition to focus my discussion onto recent educational thinking regarding identity and how it can change. Whilst considering teacher identity in their overview of the literature, Beauchamp and Thomas (2009), concede that the concept of identity is hard to define; it has been used in many different fields for a variety of purposes. Teacher education literature 'seems to agree that identity is dynamic, and that a teacher's identity

shifts over time under the influence of a range of factors both internal to the individual, such as emotion, and external to the individual, such as job and life experiences in particular contexts' (Beauchamp & Thomas, 2009, p. 177). I can see how my own identity has shifted, inevitably perhaps as I have aged, from that of a student of chemistry to a teacher of chemistry and more latterly a mentor to younger chemistry teachers. Although I feel like the same person, my relationship with chemistry has shifted and different responsibilities in my job have changed how I have seen my students, my colleagues and even the institution for which I work. The identity perceived of me, the interviewer, by the participants at the point of time of our interview gives a context against which they will present their own identity in the form of stories.

As I have decided to conduct my research using narrative techniques, it is important to acknowledge that many scholars consider us to live in a world pervaded by stories (Bruner, 1986, 1990; Polkinghorne, 1996). Smith and Sparkes (2008) discuss different perspectives on the narration of self and identity and cite Nelson (2001, p. 106) who argues that selves and 'identities are complicated narrative constructions consisting of a fluid and continual interaction of the many stories and fragments of stories that are created around the things that appear most important, from either the first – or the third – person perspective, about a person's life over time'.

The stories that the participants have to tell are interesting as is how they communicate with me and my own narrative. Sfard and Prusak (2005, p. 18) suggest that the significant narratives about a person can be split into two subgroups: actual identity, consisting of stories about how things are, and designated identity, consisting of narratives presenting a state of affairs which, for one reason or another, may be the case, if not now, then in the future. Designated identities give direction to how one acts and can influence one's deeds, sometimes in ways that escape any rationalisation. For example, a primary school teacher may present themselves as a science teacher, but in fact lack the confidence to teach beyond presenting facts gathered from a textbook, rather than attempting to explain the underlying ideas, a situation researched by

Canipe (2016) in her narrative work with primary school teachers in the US. This does not invalidate their description of themselves as a science teacher but they may not choose to designate themselves in this way in conversation with a high school physics teacher.

Sfard and Prusak (2005) do not consider these designated identities to be either 'inborn or entirely immutable', but created from narratives that can be found around them; they are not the sole authorship of the individual telling the story but may be co-authored by the people to whom the story is told or recycled from other narratives. Therefore, stories about others can act as sources for our own identity. I might look back through my decisions and see an actual identity as an academic chemist, but my designated identity shifted at university from this to that of an educationalist when I considered myself unfit for science PhD studies.

The field of narrative identity has become broader and less clearly defined over the past few decades. Smith and Sparkes (2008) suggest that one area of commonality is that identities are shaped by a larger socio-cultural interdependence – we are all in the world – and we relate to this world. Identity can, and has been, theorised in different ways. Smith and Sparkes (2008) present five such perspectives, the psychosocial, the intersubjective, the storied resource, the dialogic and the performance perspectives. These approaches are by no means definitive and researchers are not bound by any of them specifically but, nevertheless, they provide a useful introduction to understanding different theoretical approaches to narrative identity.

The psychosocial approach does not deny that social interaction and socio-cultural factors are important, but places the individual above the social; experiences are largely personal and identities can be considered to be an 'internalised life story that develops over time through self-reflection' (Smith & Sparkes, 2008, p. 9). For researchers such as McAdams (1996, 2001) stories are internal entities, being made and unmade, and discovered through sharing with others, perhaps in an interview.

The inter-subjective approach has a less individualistic focus than the psychosocial approach, where narrative identities are developed through interaction between 'events, imagination, significant others, routines and habits, and the structure of the soliloquy that forms a person's self-narrative' (Ezzy, 1998). We experience the world around us and we understand ourselves within the context of that world and we cannot extricate this understanding from this context.

Researchers who subscribe to the storied resource perspective on narrative identities, in contrast to those who see the individual mind as something that interacts with society, view people as immersed in society. An identity is thus something produced where a speaker orients themselves against others, as part of the community in which they operate and may not exist outside of these relationships (Somers, 1994). Using this perspective, we all construct identities for ourselves where we draw on larger resources from our social world but in ways unique to us and our particular circumstances.

Dialogic narratives are not viewed as a route into internal identity, but in terms of relations with others. Identity can therefore be seen as a process that is both the outcome of, and the input to, dialogue between participants. This resonates with a narrative approach where identity is described as a process of interactive storytelling by Sims (2005) who suggests that the process of identity work is a combination of writing one's own story, being written about by others and of seeking to write oneself into the stories of others (Beech, 2011).

From a performance perspective, in contrast to the preceding perspectives, the individual's self or identity becomes something performed or done rather than something they have (Smith & Sparkes, 2008, p. 25). If language is used to construct the self, and speech is social, then we must perform these with/to others and therefore identities are not inside our heads but are achieved through stories.

These five perspectives on narrative identities serve to try to illustrate the difficulty in pinning down what we mean by the self or identity, as they consider the balance from a largely internal perspective to a wholly social one. I find it hard to

expel the idea of the individual but concede that, counter to what I might have thought when I started to use the word 'identity', our shifting identities are influenced by the cultural milieu we find ourselves in and who we speak to about ourselves.

In this research, I will be using two contrasting approaches in analysing the data set, one a narrative approach and one using a sense of the defended participant to analyse what is said to me about life decisions.

From a theoretical point of view, I have decided to consider these narratives as a storied resource. I will consider the participants in terms of their orientation to me and our shared contexts, either the community of teachers as a whole or the community within the school I teach at. The extent to which this illustrates a sense of individual identity versus a social construction with me will be an interesting discussion point as my research proceeds, as my position as a Head of Department is well known to the participants, even to those who do not work at my school. This inter-psychological approach is my attempt to take a big picture view of these stories and to consider how external factors have interacted with, and influenced, the identity of the protagonist and hence life decisions that they may have made. This approach considers the sense of identity as being a thick cultural effect construct where the social nature of the narrative is revealed to me, a fellow chemistry teacher, in a shared space.

Counter to this inter-psychological approach, analysing the data with via the defended self could be seen as applying an intra-psychological lens through which to view it. This lens will help me attempt to decipher actual identifies from designated identities, using narratives to illuminate them. If any of the participants feel the need to defend their choices or opinions, this may reveal much about how they see themselves in relation to me or the profession more widely. These defences are a way of dealing with the world, and its challenges, by a core self. By considering this thin individual identity, I can consider the developing chemist and chemistry teacher identities of the participants and corroborate as well as challenge that told from an inter-psychological view.

Analysing the gathered data in two contrasting ways, with a different theoretical position on the concept of identity, will enable me to locate areas of commonality as well as potentially use these two analytic approaches to challenge each other. This will allow me to examine career trajectories more thoughtfully especially where influences are subtle or even counter to the literal story being told in a similar way to when students have told me they wish to pursue medicine and present this in pure terms of helping people when, in fact, the narrative is far more complex and encompasses their family, their school and a mix of aspirations, which can be revealed by asking them if they would consider nursing or occupational therapy in lieu of medicine.

3.3 Choice

At the heart of my research is the idea of choice, particularly to study chemistry in post-compulsory education and to subsequently become a teacher. These two decisions are not the result of two independent choices but are because of many other choices and circumstances throughout our lives and I suggest are far more complex than any of us realise at the time.

Within the career guidance community, there were thought to be three dominant competing theories of career decision making (Hodkinson & Sparkes, 1997), trait theory, the developmental model, and social learning theory. Trait theory has people matched to placements based on personality, skills or interests. The developmental model argues that there are stages to pass through in making a 'good' career decision, once somebody has developed certain abilities and maturity. Thirdly, social learning theory addressed the interaction of social and cultural factors which become entangled with a person's identity, however it considered these as external forces as opposed to an integral part of making the decisions themselves. All three models present this decision-making process as rational and planned. This view has been criticised in the literature (Baumgardner, 1982; Miller, 1983) as this idea of planned decision making bears little relation to the more real processes where 'lucky breaks' or circumstances, such as my work experience at seventeen with a chemistry professor who attended my childhood athletics club, come together to influence things.

Hodkinson and Sparkes (1997), in their research with young people they interviewed, found that they were both rational and pragmatic in making career decisions, rather than pre-planned and systematic, and so decisions were context-related and could not be separated from family background, culture and life history of the person concerned. Therefore, the authors suggest that career decisions, 'can only be understood in terms of the life histories of those who make them, wherein identity has evolved through interaction with significant others and with the culture in which the subject has lived and is living' (Hodkinson & Sparkes, 1997, p. 33).

Bourdieu (1977) considers a person's beliefs and ideas to be influenced by social networks and cultural traditions and that 'habitus', a system of embodied dispositions, tendencies that organise the ways in which individuals perceive the social world around them and react to it, derives from an interaction between these traditions and identity. Stakeholders, such as young people, employers, parents and teachers can provide economic (where opportunities could be provided that cost money, say school trips), social (network of contacts who may be able to provide advantage such as a school's "old boys' network"), cultural (family norms, items owned or institutionalised capital such as qualifications) or symbolic capital (individual recognition within a particular culture, for example having attended an elite university) to the decision making process. I will consider some of Bourdieu's ideas in more detail in section 3.4.

Viewing the participants in this research and their stories in a thick inter-psychological way relies on the way in which their identity interacts with these traditions. And they serve as a backdrop against which defences may be made defending the self against threats when viewing matters in a thin intra-psychological way so I may defend choices I have made in terms of an affinity with or an avoidance of chemistry but my upbringing has strongly influenced the importance I place on the subject. Therefore, despite being viewed from different perspectives, these cultural traditions are important, as is how I and the participants perceive them. I will consider the interaction between culture and identity in the next section and how these may influence the decision-making process.

3.3.1 Culture, identity and decision making

Bauman (1999) suggests that the term 'culture' has been used within three separate contexts, each connoting a different concept. As a hierarchical concept, culture, whether inherited or acquired, is possessed by a human being and is detachable; it can be transmitted by an institution such as the school we attended. In its second meaning, culture is used to account for the apparent differences between groups of people, the so called differential concept. Key in this concept is the assumption that human beings are not entirely determined by their genotype, which Kaplan (1965, p. 960) uses to define culture as something that 'does not appear to be explainable by an appeal to either genetic or panhuman psychic traits'. The generic concept of culture in some ways acts as the corollary to the differential concept which packages humankind into unrelated, self-sufficient groups. In its simplest terms, it considers culture to be those features of all mankind and of mankind only. Thus, according to White and Murdock (1959), 'the culture of mankind in actuality is a one, a single system; all the so-called cultures are merely distinguishable portions of a single fabric'.

However one defines culture, the possibility of this definition is rooted in a particular vision of the world (Bauman, 2003) that is directed by three tacit, yet axiomatically accepted, premises. Firstly, that human beings are essentially incomplete and not self-sufficient and a process takes place, after birth, with other human beings called humanisation. Second, this process is essentially a learning process, split into the acquisition of knowledge and the repressing of animal predispositions. Third, learning is just one side of the relation, the other of which is teaching. Bauman (2003, p. 3) considers that 'the completion of the humanisation process, therefore, requires teachers and a system of – formal and informal – education'.

For Bruner (1996, p. 3) evolution of the mind is linked to development of a way of life where 'reality' is represented by a 'symbolism shared by members of a cultural community in which a technical-social life is both organised and construed in terms of that symbolism'. This mode is shared by a community, but also conserved, elaborated upon and passed on to succeeding generations who continue to

maintain the culture's identity and way of life. Individuals are also shaped by this mode, assigning meaning to things in different settings on different occasions. This meaning making is in the mind but has its origins and significance in the culture in which it is created. Life in culture is, then, an interplay between versions of the world that people form under its institutions' sways and the versions of it that are products of their individual histories. Thus, education cannot be an island, but part of the continent of culture as its institutions must surely influence us all; as Bruner (1996, p. 24) observes, 'we all carry with us habits of thought and taste fostered in some nearly forgotten classroom by a certain teacher'. For participants in this research, how we see ourselves as a chemist or as a teacher will have been influenced by the institutions whose communities we have found ourselves part of, our own schools, our universities as well as our places of work.

Whilst lives and selves are partly narrative constructions, made coherent through the 'biographical work' that links events into life (and family) histories, they are also 'locally informed and organised' (Bottero, 2015, p. 553) grounded in concrete, material situations, and produced out of the ordinary procedures, tasks and local requirements (Gubrium & Holstein, 1994) within the institutions and communities we find ourselves situated in. Therefore, to consider life choices, it is essential to consider life in culture, and I will do this using both the inter- and intra-psychological approaches mentioned above.

The nature of decision making is complex and many approaches can, and have been, taken to try to understand these choices including a consideration of personality types, products of socio-economic factors, self-efficacy theory, intrinsic and extrinsic motivation, attribution theory and expectancy-value theory. Eccles and Wigfield (2002, p. 68) claim that 'individuals' choice, persistence and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity'. In their model, identity forms expectations and values and affects achievement-related choices, such as career choices (Eccles, 2009). Personal identity includes self-image, values and goals and the identity they think they may hold in the future. Students' social or collective identities are about how they see themselves in terms of social

categories and how they express membership to these categories through symbols and activities. Young people use stereotypes as tools in their identity work and they have their own perceptions of each stereotype which, in turn, are influenced by parents, peers and other socialisers.

Bøe, Henriksen, Lyons, and Schreiner (2011) have considered international research into science options through the lens of the Eccles model of achievement-related choices (Eccles et al., 1983; Eccles & Wigfield, 2002). This theoretical expectancy model of achievement-related choices and behaviours predicted that people select those achievement-related activities (such as school and university courses) that they think they can master and that have value to them (Eccles, 2006). Within the model, task value is grouped into four broad categories: interest value (how much enjoyment you derive from engaging in that particular task/activity), utility value (the instrumental value of the task or activity for enabling you to fulfil a separate goal), attainment value (the link between the task or activity and one's sense of self or personal or social identity) and cost (what must be given up by making that choice or potential negative experiences that might be consequential).

The Eccles model (Eccles et al., 1983) links achievement-related beliefs, outcomes and goals to interpretive systems like casual attributions, to the input of socialisers (parents, teachers, siblings, pees and the media) to various social-role related beliefs, to self-perceptions and self-concept, and to one's perceptions of various tasks, behaviours and activities themselves. Of particular interest to Eccles is that of family demographics and she claims that 'both parents' education level and family income have a positive impact on parents' expectations regarding both their children's immediate school success and long-term educational prospects' (Davis-Kean, Malanchuk, Peck, & Eccles, 2003; Eccles, 2006, pp. 669-670).

Bøe et al. (2011, p. 81) predict that people select those activities for which they feel most efficacious (or for which they have the highest expectations of success). What influences these intra-individual hierarchies of expectations of success? Parents, teachers and peers tell people what they are good at, often with little

information on which to base such conclusions (Eccles, 2006), based on stereotype and other socially constructed belief system. Subjective task value is the value individuals attach to the various achievement-related options they believe are available to them, which Eccles suggests is directly related to personal and collective/social identities and the identity formation processes underlying the emergence of these identities. Therefore, I needed to try to find out, in my teachers' narratives, how the participants felt about their own expectations of success in chemistry and/or teaching, within their own family and social situation. Although expectations for success and personal efficacy do predict occupational choice, they are not the only predictors.

Evidence suggests that positive expectations are a necessary but not sufficient predictor of occupational choice. Believing that one can succeed at an occupation is critical to one's decision to enter that field but it also depends on the value one attaches to various occupational characteristics. I believed, quite without empirical evidence, that I could succeed as an accountant but I did not value the potential lifestyle I perceived it would bring me; I had been told that I would be good at it by parents, peers and teachers and I had the necessary qualifications but, despite never having done any accountancy, I perceived it as dull and this did not fit with my designated identity; whereas teaching where I could work with young people and retain a sense of a chemical identity, fitted far better.

I would like to narrow down my discussion of the decision-making process to the choice to study STEM subjects and subsequently to teach.

3.3.2 Choosing to study STEM subjects

Much has been written about young people's relationships to, and participation in, STEM subjects, a central issue affecting chemistry take up in schools and universities and the subsequent recruitment of chemistry teachers. As I briefly discussed above, Bøe et al. (2011) have used the Eccles model and considered five aspects from the model and their relationship with STEM subjects and careers:

1. Interest-enjoyment value

   This is frequently cited as a reason for educational choices. Interest in school science seems to decline with age, although interest in science per se may stay quite high (Häussler & Hoffmann, 2000). School science, in terms of the curriculum or demands placed on students, therefore appears to be unable to meet the students' personal interest in science related topics. I recognise this apparent decline in interest in school science as students progress through secondary school, from the bright eyed year seven[12] students excited by Bunsen burners and all new ideas, to year eleven students often overwhelmed by the curriculum, something recognised internationally particularly in western Europe (van Griethuijsen et al., 2015). Some students seem to lose their interest altogether, but so often it is the academic demand of the subject that appears to have caused this rather than an interest in science itself; the crucial period seems to be between 10 and 14 years of age (Bennett & Hogarth, 2009; Osborne et al., 2003) and van Griethuijsen et al. (2015) suggest a key determinant is whether the young person holds a view that science can act positively to help solve real world problems or not, something the authors assert is strongly influenced by the child's teachers. Critical curriculum decision points vary in different countries e.g. in the UK GCSE choices are made at fourteen years of age and A level choice is made at sixteen, where students go from approximately ten subjects studied to four.

2. Attainment value

[12] Secondary schools in England and Wales start at year 7, when the students are eleven years of age, through to year 13 (eighteen years old)

How well does a subject/course fit in with a person's identity? Students may accept or reject a subject if it matches a self-identity or does not. Attainment value is strongly linked to whether a person can identify positively or not with a subject area. Some students have an image of a typical science student as hard-working and intelligent but also boring and socially-awkward – this may not fit with their assumed identity. Szu, Osborne, and Patterson (2016, p. 2), when considering the image of science and scientists, comment that science in popular media has been 'shown to influence public science knowledge, the interest of students in science careers, and how the public engages with science'. Following the popular crime drama series CSI: Crime Scene Investigation, universities around the United States reported a dramatic rise in interest in forensic science, sometimes dubbed the "CSI-effect" (Houck, 2006). Research highlights how the media can represent scientists in both good and bad light but representations as an 'evil genius' or slightly nerdy are still common (Szu et al., 2016). I recognise this idea of nerdy scientists/science students from my own school days, university days and career in teaching; some view it as a badge of honour, others as something to be avoided. My own assumed identity was in no way threatened by being thought of in this way and it is not now.

3. Utility value

   Utility value concerns how helpful an educational choice is in reaching our other goals, such as career goals (Eccles et al., 1983). Short-term goals may also include some utility value e.g. wanting to study the same course as a friend. Some courses have the sciences acting as a gatekeeper for example medicine or dentistry but they can also act to keep options open for some students (Broman & Simon, 2015); there can also be disincentives towards studying them as they are considered 'hard' and if overall mark average is the final determinant of outcome it may be better to study something 'easier' like psychology. It has been interesting to note changing attitudes within my own students over the past fifteen years or so, as university opportunities were widened considerably in the UK. I observed a decline in numbers studying chemistry, excluding where it acts as a gatekeeper to medicine or veterinary

science, as students seemed to view it as very difficult which has been backed up by UK research comparing subjects at A level (Coe, Searle, Barmby, Jones, & Higgins, 2008). However, in recent years, with an economic decline in the UK, there has been a rising perception that a job will be hard to come by after university and studying a subject like chemistry may make them more competitive when they graduate, something considered by Smith (2010) in her analysis of changing patterns of participation in Higher Education (HE) science courses over the past twenty years.

4. Relative cost

   Negative aspects of one choice relative to another e.g. more effort to do maths than economics. The physical sciences are generally perceived to have higher costs than most other subjects, due to their relative difficulty (Coe et al., 2008). Also anxiety can influence a student's view of physics (Sahin, Caliskan, & Dilek, 2015) or chemistry (Bowen, 1999), something which has been shown to have a strong gender effect, particularly in physics, where women exhibited much higher levels of science anxiety compared to men (Bryant et al., 2013). I am particularly interested in this aspect of anxiety as defended participants may well use the perceived cost of a subject to justify a decision they have made.

5. Expectation of success

   Students will evaluate chances of succeeding with each option – physical sciences are seen to be challenging, so they will have a lower chance of success. This, of course, is influenced by how success looks to an individual and their designated identity. If I did have an assumed identity as an academic chemist when I started university, my expectation of success decreased sufficiently for my designated identity to move away from that towards areas where my expectation of success was higher.

Bøe et al. (2011) conclude by suggesting that teachers are key actors in the efforts to increase participation in STEM education and careers. The Eccles model identifies and maps the components that affect young people's educational choices. However, there is a call to move towards more qualitative research that explores how the students themselves handle and make meanings of their

choices (Holmegaard et al., 2015). Research has been carried out since 2000, addressing this meaning making, looking at how students' identities relate to their choice of education. A key finding is that for the students it is not only a question about what they want to study but also of who they wish to become i.e. of constructing an attractive identity. Narrative psychology is far from a field fully characterised and Ulriksen et al. (2013) suggest meaning making is understood as a way of structuring the world. Through narratives, complex experiences of the world are fixed into a sense of coherence and causality, in terms of what caused these happenings and experiences and why. For Holmegaard et al. (2015, p. 35) a central question, then, is how this meaning making takes place and the authors argue it is 'both embedded in the cultural context and constructed in relation to the individuals' own and their surroundings' sense of the individual's self'. As I discussed previously, individuals cannot freely invent narratives that are not recognisable in terms of these two central aspects; the culture that surrounds them and other people they know and meet.

We understand our lives as a single progressive story, and our identities develop over time (Polkinghorne, 1988). The Eccles model originally implied a one-way only development towards a particular outcome (Eccles et al., 1983) but more recently it has evolved to imply a two-way process where experiences continuously feed into decisions we may make (Eccles & Wigfield, 2002). This is further evidence for the need to try to consider the whole picture in my research rather than view people's decision making processes simply in a linear way. There is no limit to how varied and fluid our narratives can appear and 'the notion of identity, on the one hand must be understood as possessing a culturally embedded stability, but on the other hand as constantly changing, flowing backwards and forwards, a continuous process in which we keep on working to retell ourselves' (Holmegaard et al., 2015, p. 36). I found it interesting that in their study, the phrase 'I always' which indicates a choice that is well-reasoned, motivated, and stable was used sometimes by students in their choice-narratives, but was constructed retrospectively in the sense that students used it even when their choice-narrative had dramatically changed over time (Holmegaard et al., 2012a).

Most people would regard subject or career choice a responsibility of the individual and the students' narratives discussed by Holmegaard et al. (2015) show that choice-narratives are constantly tried out and (re)negotiated within the students' social relationships where they are informed, adjusted and revised according to how friends and family may view these narratives and whether or not they think they suit the individual concerned. Holmegaard (2015) divides research into this continuous and dynamic process into three categories of students' choices of higher education:

Rational choice: people making different decisions share a common set of cognitive skills that are thus reflected in the similar ways they make decisions (Hastie & Dawes, 2010). This assumes that students are capable of making informed choices based on what they expect to gain, and that they choose what to study to maximise their potential to participate in, say, a career in the future.

Social inclusion: directs systems towards increasing the uptake of a student population with a wider social distribution into higher education. These approaches are based on the work of Bourdieu (1986) and how students with non-traditional backgrounds may not be able to access routes into higher education as efficiently as those from traditional ones. This has included research into gender and more specifically women in science and engineering (Brickhouse, Lowery, & Schultz, 2000; Tonso, 2006).

Interest-based choice: where research sees choice in terms of expressions of students' interests or how 'students construct and perform their identities and handle aspirations while drawing on culturally-accepted ways of making choices' (Holmegaard, 2015, p. 1456).

This study by Holmegaard (2015) shows how students' science interest was far from the only aspiration they based their choice-narrative on. Instead, combinations of different interests were adjusted and negotiated in relation to each other, which agrees with separate research from Oslo in Norway (Bøe, 2012). An attractive future career seemed crucial for their sense of sustainability of the choice, which matches my own experience although for me attractive was a

sense of potential enjoyment, whereas for others it might encompass financial reward, responsibility or power. One of Holmegaard's findings particularly strikes me as important for my own research, namely that students from more educated families articulated how they found it mandatory to continue into higher education, but career prospects were more important for students with less educated families. This is something I would like to examine when analysing my own research data.

Another well-known influence on student aspiration, not least within STEM fields of study, is gender. Studies indicate that boys and girls have different interests within the sciences (Osborne & Collins, 2001; Scantlebury & Baker, 2007). Boys demonstrate particular interest in technological advances and big picture theories such as quantum mechanics or relativity (Angell, Guttersrud, Henriksen, & Isnes, 2004) rather than the physics of the everyday world, whereas girls often prefer to learn about theories which more easily relate to this world (Bøe et al., 2011). Tytler, Osborne, Williams, Tytler, and Clark (2008) go further and suggest that girls appear to be generally less engaged by science than boys, particularly the physical sciences, perhaps due to having spent less time, on average, engaging with science and technology during childhood. The ROSE study corroborated these views, across many different countries, and contrasted boys, favouring explosions and technology, with girls' interest in the human body, animals and the paranormal (Schreiner, 2006). Interestingly, this is borne out by the gender balance in the three Advanced level sciences in England and Wales (Osborne et al., 2003) where the male:female ratio is 3.4:1 in physics and 1:1.6 in biology with chemistry, the central science, at approximate parity.

Two of the key decisions in the narratives presented here are choosing to study chemistry both in senior school but also as an undergraduate at university. I will attempt to consider if gender appears to have played a part within these narratives.

3.3.3 Choosing to teach

Although much has been published, over the years, about motivations to become teachers, there is also criticism that this research has been limited either by lack of transparency or without adequate consideration of validity and reliability (Watt & Richardson, 2007) due to the number of small non-representative studies being carried out. Different categorisations of intrinsic, extrinsic and altruistic motivations have been written about (Young, 1995) and Brookhart and Freeman (1992) suggest that these are the primary reasons teacher training candidates report why they decided to go into teaching.

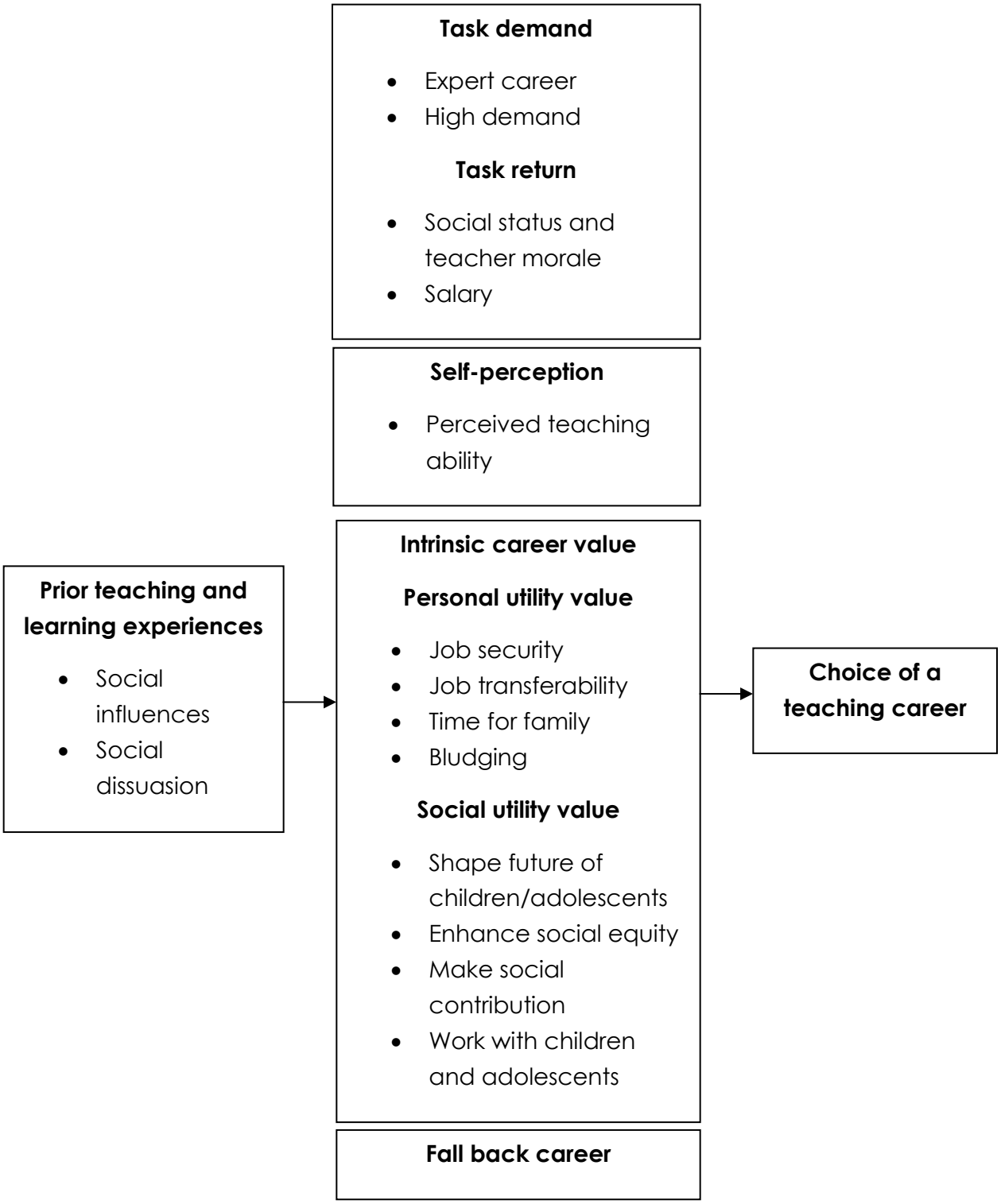
In an important study, Watt and Richardson (2007) attempt to address what they call two major gaps in the literature, namely a systematic application of motivational models to developing explanations within teacher motivation and using a large scale and representative study rather than small scale studies (Kyriacou & Coulthard, 2000; Kyriacou, Hultgren, & Stephens, 1999). The important theoretical framework for Watt and Richardson's work is that of expectancy-value theory for achievement motivation begun by Atkinson (1957) and developed by Crandall et al (Crandall, 1969; Crandall, Katkovsky, & Preston, 1962) and more recently by Eccles (Eccles, 1985, 2005; Wigfield & Eccles, 1992). This theory considers the expectancy of success and the value of the potential choice as being primary factors influencing academic decision making with secondary influences being social factors and prior perceptions of experiences already gained. I have discussed previously the work by Eccles (1983) and Eccles and Wigfield (1995) where values and ability beliefs are pre-eminent motivators.

Watt and Richardson (2007) have developed their Factors Influencing Teaching Choice (FIT-Choice) scale using the three self, value and task sets of variables used by Eccles and Wigfield and added items for antecedent socialisation and perceptions of previous experience (see Figure 1: Theoretical model guiding development of Factors Influencing Teaching choice (FIT-Choice)). Previous research influences the selection of each factor and a construct, 'bludging', was added by the authors. Bludging is an 'Australian colloquialism relating to people's adopting the laziest approach possible and choosing what they see as an easy

option' (Watt & Richardson, 2007, p. 172). The authors suggest that this factor may indicate a perception, amongst non-teachers, of relatively short hours and long holidays in the profession.

FIGURE 1: THEORETICAL MODEL GUIDING DEVELOPMENT OF FACTORS INFLUENCING TEACHING CHOICE (FIT-CHOICE) FACTORS

Adapted from Watt and Richardson (2007)



In their model, Watt and Richardson (2007) move from antecedent socialisation influences on the left, followed by more proximal influences leading to the eventual choice of teaching on the right. This FIT-Choice scale was intended to provide a psychometrically and theoretically strong framework to guide future research (Watt & Richardson, 2007, p. 196) and it has been cited in much published international research into teacher motivation (Flores & Niklasson, 2014; Fokkens-Bruinsma & Canrinus, 2012; Jugović, Marušić, Pavin Ivanec, & Vizek Vidović, 2012; König & Rothland, 2012; Lin et al., 2012; Richardson & Watt, 2006). Most of these studies have been carried out in a similar way to Watt and Richardson's original research with questionnaires being used with student teachers. This approach has led to valid and reliable discussions about motivation to follow a teacher training course, but caution should be exercised in attempting to extrapolate these results to serving teachers. As I have discussed previously, as our identities evolve as teachers and our perceptions of our prior motivations alter. The extent to which my data, gathered from teachers at different points in their teaching careers, will mirror these large quantitative studies of student teachers, will be of interest and contribute something worthwhile to this debate.

Narrowing down this discussion of the choice to teach, I would like to briefly consider teaching STEM subjects. There has been considerable concern internationally about the shortages of suitably qualified specialist teachers in mathematics and the sciences. Hillier, de Winter, and Twidle (2013) suggest that the reasons for this are probably complex but that there may well be subject differences and that there has not been much research into why physics graduates choose to become teachers. They attempt to address this, finding that many physics teachers did not wish to teach originally, but a positive experience of teaching has helped them recognise that they may enjoy to do so; they advocate more physics undergraduates and graduates could be enabled to recognise their potential in teaching, perhaps working with local schools. Both Hillier et al. (2013) and I agree that this potential approach is also relevant to other shortage subjects such as chemistry.

Issues relating to gender and the decision to teach a STEM subject such as chemistry are nuanced. On the one hand, as I discussed in 3.3.2, there are well reported differences between boys and girls in their engagement with science around the world and therefore the decision to continue to study the physical sciences. To go on to teach one of these physical sciences a student must have already undertaken undergraduate studies within the field, so we might expect to observe less of a gender influence in this decision. However, there are other established driving forces towards teaching for women (Klassen, Al-Dhafri, Hannok, & Betts, 2011; Priyadharshini & Robinson-Pant, 2003) such as its secure nature, contractually and financially, its compatibility with family responsibilities, as well as a perception within some cultures that teaching is particularly well suited to women, although sexuality may also define how a participant sees themselves rather than just gender. In this study, the narrative approach was deliberately open, allowing the participants to tell their story without being asked many foregrounding questions. Only one of the three female participants was a parent at the time of interview and its influence on her life came out as part of the life story she presented me with.

In the UK, there has been much written about attracting men into primary school teaching roles, contributing to government campaigns calling for male role models to help address an attainment gap, as well as address diversity issues in British schools (Epstein, 1998; Skelton, 2007; Younger, Warrington, & McLellan, 2005). Teaching, on the whole, is a highly feminised profession in Western societies and is likely to remain so (Drudy, 2008). While there is a gender gap in performance in public examinations in many countries, there seems to be little support in the literature for any contention that boys' performance would necessarily improve with male teachers. Rather, research to date (Drudy, 2008) suggests that the policy direction should be towards attracting high quality people into the profession irrespective of whether male or female. Traditionally, women are more likely than men to enter teaching (Guarino et al., 2006), but also have a higher attrition rate than men (Ingersoll, 2001) despite self-reporting a higher commitment to the profession (Ingersoll & Alsalam, 1997). This difference in attrition rates is also the case within the sciences, but the distribution of male and

female teachers of biology, chemistry and physics varies in line with the number of boys and girls who study these subjects to Advanced level and beyond. Most graduates considering teaching are female (Spear, Gould, & Lee, 2000) and yet only approximately 20% of UK physics students are female (Institute of Physics, 2010); this automatically reduces the pool of those most likely to enter physics teaching, but with a higher proportion of female students choosing A-level chemistry, as well as into higher education, we would not expect such a variation within chemistry.

3.4 Practice

Philosophers have long considered ideas about activity and practice, notably Aristotle, who compared *techne*, an activity leading to a durable outcome born of expert knowledge, with *praxis*, activity conducted in a public space within a community (Dunne, 1993). This *praxis* relates to the community under discussion and would be appreciated within that community and would require specific personal practical knowledge, which Aristotle called *phronesis*, which differs from *techne*. This is not just a skill but a reflection of how to use that skill for a specific purpose. If I try to relate these philosophical terms to my own place within a community of teachers in a school, *techne* might be talking to others about a type of chemical bonding which requires specific knowledge and *praxis* might be teaching this concept to groups of students, which requires both *techne* and *phronesis*, discussing this theory in a very particular way to a specific audience. The main difference is that *techne* is outcome driven, using skills and knowledge to ensure they have the concepts of bonding; *praxis*/*phronesis* is understanding that scientists might have different theories of bonding over time and exposing these to student reflection.

We all operate in different communities and express different skills in different ways dependent on the community we are in. A professional footballer would have the same skills on a given day, but would express them differently if he were coaching twelve year olds compared to playing a competitive match, with different outcomes in mind.

Bourdieu wrote widely about socialisation and he used three concepts: habitus, field and capital. The habitus of an individual is related to the cultural and family roots from which a person develops and 'operates below the level of calculation and consciousness' (Bourdieu, 2010, p. 167) and is manifested in interests, practices and works which constitute a particular lifestyle. Children would be expected to develop these 'tastes' via what they see, hear, smell and touch at home and within family life. As this child grows up, their ability to perform appropriately within a given environment will largely influence their place within this environment.

'It is in the two capacities which define the habitus, the capacity to produce classifiable practices and works, and the capacity to differentiate and appreciate these practices and products (taste), that the represented social world i.e. the space of lifestyles, is constituted' (Bourdieu, 2010, p. 166). Here Bourdieu suggests that family roots and background are pre-eminent in determining future success, however he does concede that other factors will also influence end results. Harrington (2005) explains that the habitus operates in a wider setting, called the field, the structure of social relations in which an individual is located; this is a dynamic concept which changes over time. Hart (2013) uses the example of higher education institutions to conceptualise the idea of fields. There are many courses, institutions and places and it is quite possible that individual prospective students select according to their own tastes and preferences, as well as against the educational backgrounds of their family and social capital.

Bourdieu argued that there are various types of capital that help influence an individual's social position, not only economic capital, but also other forms such as social, cultural and symbolic capital. As Riddell (2010) suggests, middle class parents are more likely to have had a university background themselves, they are more likely to have contacts who could offer advice, work experience or jobs and it is this social capital that can help such a child to not only make certain higher education decisions but potentially succeed. Bourdieu (1986) says that this 'domestic transmission' of cultural capital is the socially most determinant educational investment. Cultural capital can involve interests and knowledge (embodied cultural capital), cultural goods like books, instruments, machines, etc. (objectified cultural capital) and institutionalised cultural capital such as qualifications. It is therefore the conversion of capital into capability that may lead to desired outcomes such as not only being able to carry out a certain job but also get on well with your co-workers.

Cultural Capital Theory (CCT) suggests that social classes preserve a strong cultural identity leading to each class having its own distinctive habitus and that traditionally pedagogic practice and assessments relate to the culture of the

upper class, perhaps conveying some advantage for those students with that identity (Barone, 2013). However, it is suggested that the boundaries between these identities are weaker since Bourdieu first coined the term cultural capital in 1960/70s France (Guillory, 2013; Prieur & Savage, 2013) and students can learn different conventions from others at school, as well as via the media on- and offline. We are all products of an extremely complex, and unique, set of circumstances and social class alone cannot tell the whole story. Aside from this, parental and internal cognitive skills, aspiration and economic resources must also play a part, as well as with whom we mix at school, at play and work. In a world where many teenagers and adults play online games, blog, tweet or communicate with others from anywhere in the world, this mixing produces a far more complex system than just the school we attend or the street we live on.

Giddens (1984) describes humans as knowledgeable agents, ones who know a great deal about the conditions and consequences of what they do in their day-to-day lives. The idea that agency is not the intention people have in doing things but their capability of doing these things in the first place, seems to draw a link between Giddens's work and that of Bourdieu. All individuals express meanings in their activity and detect meanings in the actions of others, even if unintended (Harris, 2003). These meanings can include what is called practical consciousness, which are those mutual understandings that are assumed in everyday interaction (Harrington, 2005). In my initial study the industrial chemist interviewee talked about the 'lab girls' from whom he learnt how to carry out various laboratory tasks and implied that they were merely processing chemicals, following a practical rubric, rather than engaging with what was occurring in these processes, which could be a casual sexist view or an assumed understanding within that environment for those people carrying out relatively simple chemical analysis.

Assumed understandings are crucial in any community of learners; it tends not to be normal practice to ask another person why they engage in an activity that is conventional within that community (Cassell, 1993) although these activities and shared assumptions may be difficult to understand as an outsider.

Giddens also talks about structures, systems and structuration: structure being the rules and resources which provide the formulae and the means for action which allow us all (the actors) to understand what we can do and what is unacceptable; systems are the relationships between the actors which are organised and dynamic; structuration is the conditions and the media by which structures are transformed into systems. The easiest way to view structuration is to consider how we might interact with our doctor in the supermarket, rather than the surgery, even though the doctor-patient dynamic is not directly in play, a particular dynamic is likely to be retained despite being out of context. This practical consciousness is the assumed mutual understandings we may have with any other person we are familiar with and underpins social practice to ensure that it takes a meaningful and relatively predictable form (Harrington, 2005). This is important in my research as there will be assumed mutual understandings between fellow chemistry teachers which should be clarified as my readers may or may not share these. For example, we often use the word laboratory instead of classroom, a word which may conjure a different image and reaction to non-chemistry teachers than it does to us.

The idea of practice has been written about frequently in the literature. Gherardi (2009a) writes about this extensively and says that the term is 'often assumed to be synonymous with 'routine', or taken to be a generic equivalent of 'what people really do', without addressing the link between practice and knowledge. She discusses how we can inquire about practices from the outside, looking at patterns and organisation, or the inside looking at things from the view of the practitioner and the activity being performed. According to Bourdieu, it is through habitus that practice (agency) is linked with capital and field, but this relationship is complex and will generate a wide range of potential actions which will depend on past actions and other peoples' contributions (Reay, 2013).

In the 1970s it was argued (Pickering, 1990, 1992) that scientific knowledge is intrinsically social and must be understood as such and studied as a set of historically situated social practices. Gherardi (2009b), in her reading of the literature, suggests that scientific knowledge was thus removed from the pedestal

erected for it, echoing the view of it as the cathedral, by positivism, and science could be seen as a culture as much as every other form of knowledge. The theory of social practice emphasises the relational interdependency of agent and the world around them, meaning, cognition, leaning and knowing (Lave & Wenger, 2005). The process of activity produces, reproduces and changes meaning and therefore participation in a social activity, as a member of a community, will influence an individual's habitus and that of others as relationships, within a community, change and develop. This suggests to me that if someone begins to participate in a community then their habitus and capabilities will change and their social class and background may diminish in importance; however, the latter may well influence whether or not a person is able to begin to participate in particular communities. Without a particular educational background and certain aspirations, it is unlikely a young person will participate in a community of medical doctors, even if they possess certain cognitive abilities.

More recently Corradi, Gherardi, and Verzelloni (2010) say that practices are not directly accessible, observable or definable; rather they are hidden, tacit and often inexpressible. This is in contrast to the view taken by Hitchings (2012) whose research with city businessmen and elderly people suggests that people can talk about their practices and indeed can critically reflect upon them by focusing interviews on the seemingly obvious and mundane. Corradi et al. (2010) attempt to define and understand practice along two different lines: practice as an empirical object and practice as a way of seeing.

In the first category practice is viewed as 'what we do' when engaging in a task. This can be developed through practice-based learning or work-based learning, allowing people to bridge the gap between theory and practice. In the second category practice is seen as a wider entity involving knowledge, the senses and reflexive thinking as well as other people and objects such as a machine. Corradi et al. (2010, p. 77) view practice in three dimensions:

1. The set of interconnected activities that, if socially recognised as a way of ordering, stabilise collective action and the common orientation;

2. The sense-making process that supports the accountability of a shared way of doing things and which allows the continuous negotiation of the meanings of a practice by its practitioners;
3. The social effects generated by a practice about other social practices. This is the dimension of the reproduction of practice that answers the question as to what doing the practice does.

There is no one correct definition of practice and therefore one must use the term clearly, stating how you mean it. The above dimensions allow one to see actions, how we account for those actions with others and the effects of those actions can all contribute to the whole 'practice'. In a community of butchers cutting, trimming and slicing beef would all constitute actions that are common and interconnected. Any butcher would know that there are specific cuts that are conventionally produced from a particular piece of meat, which produces a commonly understood outcome, not only by other butchers but by chefs and customers in a restaurant who might eat the meat and therefore influence other social practices, say at a market or a restaurant.

Science itself has an interesting history as to how it is viewed with an opposition between 'science as knowledge' and 'science as practice', a distinction important when considering educational choices or career options. Most scientists work in teams and are dependent on each other for the intellectual and technical resources with which they work. Furthermore, legitimacy is conferred on a publishing scientist by a community of practitioners, which determines what counts as acceptable scientific practice and exercises strict control over what and what is not admitted into the body of accepted knowledge (Wong & Hodson, 2010, p. 1443). School chemistry often claims to position itself as an introduction to chemistry (van Berkel, Pilot, & Bukte, 2009), with the student seen as a future chemist. But science can be seen as a process for interrogating nature, not simply as a compendium of facts, so the role of science education must be seen with regard to this interrogation, as well as 'science in practice'.

Is it possible to separate what we know, what we observe, how we interact with our environment and what we 'do'? These aspects seem to contribute to

'practice' and are all but impossible to separate but should be considered if I wish to probe what contribution chemistry might have to decisions we may make at school and beyond.

3.5 Chemistry and chemists

"One of the characteristics of chemists is that most have no interest in the philosophy of science…The disinterest appears to work in both directions. Modern philosophers very seldom give even a passing mention to modern chemical issues (Michael Polanyi and Rom Harré are among the few exceptions I know of). Recently, a few philosophers have attempted to discuss 'scientific practice'; but generally, they have not included chemical practice. It is as if philosophers have believed that the way physics is 'done' was the way that all science is, or should be, done. (Physicists, no doubt, are the source of this opinion.)" (Good, 1999, pp. 65-66)

Erduran promotes the relevance of philosophy of chemistry for chemical education and suggests that 'scholarship in the area is ripe for further studies. The fundamental questions such as ''What is chemical knowledge and how does it develop? What criteria, standards and heuristics shape its development?'' are directly relevant for ensuring that teaching and learning environments are effectively structured and resourced for sound and deep understanding of chemistry.' (Erduran, 2013, p. 1561). Chemists are surely important, as chemistry is on the one hand unpopular (Risch, 2010) but on the other hand in an exceptional position, being relevant to jobs and everyday life and important for innovation capacity and problem solving.

According to the dictionary (*The Concise Oxford Dictionary*, 1990, p. 192), chemistry is 'the study of the elements and the compounds they form and the reactions they undergo'. Originally this would have been in cooking, heating and observing the changes caused by heat leading eventually to human attempts at pottery and metallurgy; the extraction of metals from their ores and the working of these metals. Fabbrizzi (2008) talks about the history of chemistry and its derivation from European alchemy, which in turn derives from Arabic, Greek and Egyptian alchemy, and says that alchemists were essentially practitioners, mainly concerned with producing new substances. However, theories for the rationalisation and explanation of their experiments did not happen until the 18th century with the invention of the precision balance, which led to Lavoisier and Dalton to establish the law of the conservation of mass and atomic theory. Compounds were then described by formulae combining the old alchemical

symbols together. This led to the establishment of the modern chemical notation and chemistry as a distinct subject, where making new substances was important but so was the establishment of models which seek to make sense of these new substances and their formation.

This long process suggests a development from utility – making substances for specific purposes – to understanding it, to make new and better substances and finally to considering causality where the links to utility are less explicit. Modern chemistry encompasses all three of these developmental stages, from the margarine being made by the industrial chemist interviewee and his knowing about different oils used to make it, through to theories such as pharmacokinetics and pharmacodynamics used by the hospital pharmacist and by academics and teachers. Talanquer (2011) discusses the techno scientific nature of chemistry and how its nature is manifested in the way chemists think about, explore and transform the natural world. He suggests chemists have largely been concerned with making new compounds and analysing and transforming matter rather than with 'uncovering the deep secrets of Nature' (Talanquer, 2011, p. 3). He goes on to compare and contrast chemistry and physics graduates working in the US in 2010 where 88% of physicists are employed in research and education whereas only 39% of chemistry graduates are; he says the picture in the UK (in 2002) is very similar and suggests that chemistry can be conceived as a 'hybrid of academic and industrial endeavours' (Talanquer, 2011, p. 4), which places the subject in the midst of Layton's (1993) three categories of cathedral, quarry and company store that I discussed earlier, whereas physics seems to figure more highly within the cathedral descriptor.

A further question to consider is 'are all my interviewees, and indeed myself, chemists?' The relevant dictionary definition of a chemist (*The Concise Oxford Dictionary*, 1990) is 'a person practising or trained in chemistry', which seems to suggest education alone will qualify all of us as chemists. However, what we all mean by a chemist and our view of what they do may well vary enormously; the industrial chemist in my pilot study, labelled as such by me, continued to describe himself as an analyst rather than an out-and-out chemist. I see myself as an

educationalist more than a chemist, but the extent to which I can separate these may be moot; my chemical education preceded my work as an educationalist so must have had some influence on its development.

Thalos (2013) compares and contrasts chemistry to physics in terms of the reductive impulse of the physicist to the chemist's wish to consider behaviour in context i.e. considering molecular properties, such as shape, in situ rather than an isolated entity. She suggests that chemistry students should recognise 'that their lens really does differ from the lens of physicists – and biologists too, obviously' (Thalos, 2013, p. 1719). If chemistry students do indeed have a way of looking at nature, as distinct from biologists and physicists, then how might that affect how we see ourselves and what chemistry can do for us? As I discussed previously, research into the recruitment of teachers of STEM subjects has not particularly considered the differences between, say, typical physics and chemistry students (Hillier et al., 2013) and if chemists do see themselves in a different way to others then perhaps we should examine chemistry teachers separately to teachers of other STEM subjects.

3.6 The defended self

In the early stages of my doctoral studies, I was focused on the idea of what a chemist is and how studying chemistry might influence a person's ability to carry out a specific task or role. I became aware of the UPMAP [13] project into participation in mathematics and physics in UK schools and realised that making choices about potential qualifications to be studied or career paths to follow linked into my thinking about identity and practice and would provide a useful backdrop to my consideration of participation in chemistry, as an academic discipline, relative to mathematics or physics, something far less considered within the literature. In this approach a lens is applied that views the participant as having an identity that is relatively fixed which is a property of that individual that they seek to protect against external forces. This intra-psychological approach was useful as a contrasting lens by which to view the research data against a more inter-psychological lens.

Nimier (1993) used Freudian defence mechanisms, developed and reformulated by the psychologist Melanie Klein, to develop a framework of defence mechanisms where anxiety about, in this case, using mathematics could be displaced onto mathematics or that other anxieties can be defended against using mathematics as an instrument of this defence. He used questionnaires, to categorise defences against mathematics or using mathematics, with high school students.

He presented six defence mechanisms: three phobic defences where the defences displace anxieties and therefore contain these anxieties by keeping away from them; and three manic defences which use mathematics from within to defend against anxiety elsewhere. I would suggest that one could apply these six defences equally to both chemistry and teaching and therefore consider my own defences, and those of my interviewees, in light of them. By examining these defences, and hence potentially hidden anxieties, I will be able to explore the decision-making process behind the literal justifications that we may all give.

[13] UPMAP = Understanding Participation in post-16 Mathematics And Physics

One can view each of Nimier's six defences with its corresponding opposite (Rodd, 2010) and using this approach here, but for chemistry, the six defences are:

1. Phobic avoidance (phobic)
    a. Cannot do chemistry
    b. Not going to take on chemistry
    c. Chemistry is remote
    d. Chemistry is difficult
2. Repression (phobic)
    a. Chemistry is not relevant to me
    b. Chemistry is not interesting
    c. Chemistry is not worth investing effort into
3. Projection (phobic)
    a. Chemistry is dangerous
    b. Projecting myself onto chemistry is dangerous
4. Reparation (manic)
    a. Chemistry is creative
    b. Chemistry is useful
    c. Chemistry will allow me to make things for myself
5. Introjection (manic)
    a. Chemistry helps me
    b. Chemistry is good for me
    c. Chemistry can give me skills e.g. trains my mind
6. Narcissism (manic)
    a. Chemistry gives me joy e.g. when I solve a problem
    b. Chemistry is comforting

As described by Black, Mendick, Rodd, Solomon, and Brown (2009) with their own experiences with mathematics, Nimier's work has resonance for me and my relationship with chemistry. The subject has, and had been, a secure place for me, which can help me and give me joy but also, at times, has engendered fears and insecurities and so should be avoided. In my narrative to be discussed in

detail later, chemistry was both successful and satisfying for me at school but became a source of insecurity at university contributing to me not going into post-graduate science studies, despite a wish to do so.

Black et al. (2009) found Nimier's typology both useful and problematic in their research with mathematics biographies. On the one hand, it fitted well with parts of their gathered narratives where defences were clearly expressed, but some social dimensions were missing, such as the strictures of assessments like GCSE or A-level or having to make choices, something extremely important in my research. The idea of defended self will be a useful lens through which to view my collected narratives as it will allow an analysis that goes beyond just the words that are said but seeks to uncover unconscious feelings which influence behaviour. However, it would best act with other lenses as it may miss other factors at play in an individual's decision making process.

This idea of ourselves as defended subjects has developed from the work of Melanie Klein, who took the view that 'sufficient ego exists at birth to experience anxiety, use defence mechanisms and form primitive object-relations in phantasy and reality' (Segal, 2012, p. 24). Klein, in contrast to Freud's model of psycho-sexual development (Waddell, 2002), views the self as characterised by 'positions' or 'states of mind' which invoke particular defences, anxieties, and types of relationship with others. Klein considers phantasy as central to all psychic processes:

> Phantasy emanates from within and imagines what is without, it offers an unconscious commentary on instinctual life and links feelings to objects and creates a new amalgam: the world of imagination. Through its ability to phantasize the baby tests out, primitively 'thinks' about, its experiences of inside and out (Mitchell, 1986)

These phantasies are the means by which we compute the outside world and they 'continue throughout development and accompany all activities; they never stop playing a great part in all mental life' (Klein, 1959, p. 251). Klein developed theories as to two particular states of mind which are separate in the way they shape our understanding of the world and ourselves: the paranoid-schizoid position (Klein, 1946) and the depressive position (Klein, 1935, 1940). This

paranoid-schizoid position, evident very early in life describes a disintegrated mental state. It refers to a constellation of anxieties, defences and internal and external object relations that Klein considers to be characteristic of the earliest months of an infant's life that continues to varying degrees throughout life. The chief characteristic of the paranoid-schizoid position is the splitting of both self and object into good and bad, with at first little or no integration between them. Waddell (2002) describes this as encompassing both the nature of the dominant anxiety and the nature of defence against these fears. Babies are exclusively concerned with their own well-being and an object, such as their mother, can be identified with good and bad feelings. These extreme feelings illustrate the idea of 'splitting', key to the paranoid-schizoid position 'in which both people and events are experienced in very extreme terms, either as unrealistically wonderful (good) or as unrealistically terrible (bad)' (Waddell, 2002, p. 254).

After around three to six months, a child is thought to move to the depressive position, gaining in physical and emotional maturity, beginning to integrate its fragmented perceptions of its parents and having a more integrated sense of self. Bringing together conflicted feelings of love and hate, realising the hated person and the loved person are one and the same leads to a sense of guilt and, in time, a wish to repair. The splitting referred to previously can no longer be maintained, as the good object cannot be distinguished from the bad. This wish for reparation is repeatedly revisited and refined throughout early childhood, and intermittently throughout life.

These two states are not considered to be fixed and therefore, as adults, we can move between them depending upon the situation we find ourselves in. As Waddell (2002, p. 9) puts it, 'states flicker and change with nuances of external forces and relationships – forever shifting between egotistic and altruistic tendencies'. It is these shifts that Black et al. (2009) have sought to make sense of with relationships with/in mathematics, using a Kleinian analytic lens, and I will do with/in chemistry.

Black et al. (2009) discuss the narratives of three young people and show how such a psychoanalytic approach enabled them to see how discourses

surrounding the processes of assessment and selection affected the mathematical identity of their participants and allow phantasies to develop, some supportive and some anxiety-making which need defending against. These identities are complicated by the community in which they are formed, potentially constraining choice. A good school student may find themselves in a top ability set and see themselves as a 'failure' relative to the elite of the class, something I have observed and tried to combat as a science teacher many times, particularly with 'triple science' GCSE students. Brown, Brown, and Bibby (2008) talk about this very phenomenon, with sixteen year olds, within UK mathematics education. Hodgen and Marks (2009) go further and consider the different tensions between different aspects of a person's identity, dependent on the communities they operate in. The good student I referred to earlier may see themselves as a better scientist than mathematician due to the classmates they compare themselves with, as opposed to a more objective measure, like grades.

In the study by Black et al. (2009) all three participants would be considered to be successful mathematicians, all having graduated with a degree in mathematics. However, all three experience feelings of failure which influence decisions they make subsequently. Mirrored with my own narrative of abandoning any thoughts of post-graduate chemistry study, one of their participants, Nikki, describes (despite holding a first-class degree from a prestigious university) going into teaching rather than further mathematics and then undertaking a maths education PhD. She talks about her changing identity from a child 'nurtured with mathematics' to an undergraduate where mathematics became dangerous, but as a teacher coming to terms with the depressive position signified by accepting mathematics as both good and bad.

One of the other participants, Zoë, aligns herself even more firmly with my own narrative and as a maths teacher says, 'No I did not get a maths doctorate. Probably why I had to compensate and do a maths ed[ucation] one' (Black et al., 2009, p. 28). The authors suggest that Zoë's use of the word compensate suggests an attempt to equalise the world of mathematics and that of mathematics teaching, moving from the paranoid-schizoid to the depressive

position, something like my own relationship with chemistry. Through understanding my own narrative and relationships with both chemistry and teaching, I will be able to examine similarities and differences with the narratives of the participants but also explore joint meaning making more effectively.

4 Methodology

4.1 Introduction

Throughout my research, the key influence on me has been my job as a chemistry teacher, both in terms of inspiring an interest in the decision to study the subject and then teach it. I spend most the week at school, surrounded by teachers and therefore I have access to a group of chemistry teachers, who all share a context. When I finalised my research questions, it became clear that I had many issues to grapple with to try and find some answers to those questions.

I wanted to try to get to grips with two sequential life decisions that people had made, one to study chemistry beyond school and then to become a chemistry teacher. To pursue these questions different kinds of naturalistic studies might have been possible such as a case study or comparative study between people who had studied chemistry. A longitudinal study did not seem to be a possibility due to the time constraints in terms of my full time job and a snapshot approach (Cohen, Manion, & Morrison, 2011), where I considered particular situations or events at a single point of time, seemed to be a sensible starting point.

In my initial research phase, I felt it was less important to worry too much about categorising my approach, but more appropriate to try gain insights which would inform the longer-term study I would undertake by gathering some data. I had various options regarding collecting data from my initial RSC magazine article respondents, although with a relatively small number of them and an initial wish to see what emerged from them rather than testing a hypothesis, qualitative methods were my starting point. Once I started to collect data, points of interest naturally developed, so I realised that this process is inevitably a balance between emergence and testing irrespective of your initial intentions. Examining life decisions could be carried out in various ways, but they could not be investigated by participant observation or by field work. I could, however, use questionnaires and/or interviews which both offer the advantages that they can

be organised by email and carried out in person or on the phone, and can be a source of rich data, as well as flexible to carry out (Cohen et al., 2011).

Over a period of time, after my initial interview study, I decided to carry out semi-structured interviews with colleagues at school and attempt thematic narrative analysis, with the aim of uncovering more of the big picture in the participants' lives in order to identify the major players in their stories and how these players may have influenced their decision making. I will seek to examine and justify it throughout this chapter, focusing on interviewing, narratives, ethical issues and reliability and validity.

4.2 Interviewing

4.2.1 Exploratory interviews

Interviews can enable participants to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view and can be a powerful implement for researchers (Cohen et al., 2011). Maccoby and Maccoby (1954, p. 449) offer a well-known (Mishler, 1986) definition: 'an interview will refer to a face-to-face verbal interchange, in which one person, the interviewer, attempts to elicit information or expressions of opinion or belief from another person or persons'. This working definition sets out immediately the power dynamic where one person has something to gain from eliciting, perhaps hidden information from another.

Initially I had volunteer contributors who had contacted me via an article I had written about chemical equilibrium. I thought I would interview a small number of these volunteers, in an exploratory way, to see if I could uncover anything about their jobs and background in chemistry. Oppenheim (1992) suggests that exploratory interviews are designed to be essentially heuristic and seek to develop hypotheses rather than collect facts and numbers, which was what I sought to do here, as a novice researcher and interviewer.

For these exploratory interviews, I sought to ask open questions which allowed the participants to go in the direction that they wished rather than me directing them too much. This approach encouraged lengthy responses and reduced the possibility that they would feedback what they perceived my desired outcome to be, as I had not mentioned any such outcome to them. The participants in my exploratory study had all volunteered their time as well as expressed an interest in my research, so I was confident they would try to be helpful, but as I did not question them particularly directly, they could talk about aspects of their job and education that sprang to their mind.

Conversational-style interviews allow for extensive mining of interviewees' perspectives, views, understandings, and interpretations (Varelas, House, & Wenzel, 2005). These authors caution a researcher to remember that interviews

are subject to the same limitations as any communication and depend on the interviewees' articulation of their thinking and interpretation of questions asked of them. Given that I was unsure of what I might uncover as potential themes for further consideration, these interviews offered the opportunity for me to consider how to engage with my interview participants and what I might be able to learn from them. Johnson (2002) says that it is a sign of skilled interviewers to allow interviewees to deviate from a set schedule and to follow up on interesting leads, which was my intention, although I fully acknowledge that I was a novice interviewer at the time, so did not necessarily succeed in wholly meeting my intention.

I tried to engage with individuals about their own lives, rather than seeking to force them into prejudged categories. They had originally emailed me in response to potentially strongly held views about chemical equilibria but what I wanted to explore with them was far more general. Thus, it was in my interests to allow them to talk about their work and background as naturally as possible, rather than force any agenda upon them.

Arksey and Knight (1999) suggest an interviewer should ensure that the interviewee understands a question, checking if necessary, and if a response is inadequate, but the interviewer feels that the respondent may have more to say, thank the respondent and add 'and could you please tell me....?', which seems similar to the view expressed by Silverman (2011) that in order to produce rich data, the keynote is active listening where the interviewer allows the interviewee freedom to talk and ascribe meanings by presenting yourself appropriately, gaining and maintaining trust and establishing rapport. My ability to do this increased as I carried out more interviews. I noted my own feelings as to the rapport I experienced immediately after each interview and reviewed the contents to allow me to build on what I felt was effective the next time, for example I realised I did not give my first trial interviewee (chemistry professor) enough time to articulate his answers and tended to move straight on to a new question, rather than try to draw out further information from anything fruitful he may have said.

In a discussion about interviewing, Holstein and Gubrium (1997, p. 114) suggest researchers take a more active role, as interviewees are not a resource to be mined but rather 'constructors of knowledge in collaboration with interviewers'. The participants are all practitioners of chemistry teaching, something they share with me, who are communicating features of their experiences and these interviews are a concerted project for producing meaning, where each participant brings together ideas which they already hold with new ideas presented in talk (Mortimer & Scott, 2003). Although I tried to avoid leading participants into specific responses, I was not afraid of interacting with them about an issue or of involving myself emotionally. For example, if an interviewee discussed an achievement of which they were proud, I did not feel impeded from commenting on this as I might in a normal conversation rather than a formal structured interview; this fits in with my natural personality and inclination and made me more relaxed and able to articulate myself more effectively and establish a comfortable rapport with the participants. This allowed the participants to widen our discussion at times and gave me the opportunity to try to see a bigger picture, directly or indirectly alluded to, an advantage of this approach relative to more restrictive ones such as questionnaires or more structured interviews but with the consequent concern that they would merely try to please me.

Research cannot provide a mirror of the social world but it may provide access to the meanings people attribute to their experiences, (Miller & Glassner, 1997) even my own. My initial interviews provided me with a means to explore the points of view of the research subjects but I recognised that any analysis of these deviates from the interviewees' subjective view as experienced directly by them. The telling of any story will vary according to the recipient of it and the relationship they have; I was not able to remove this factor, but attempted to create an atmosphere in which the interviewee felt respected and appreciated. In the exploratory study, we were all members of the RSC and held qualifications in chemistry, so I felt a sense of mutual understanding and respect throughout and hoped that this was reciprocated by me. Again, I regard this shared understanding and background as an advantage to my research methods as,

firstly, it allowed me to decode certain comments which required a chemistry background, such as the discussion I had with a retired industrial chemist about the titration skills he learnt as a young man in the laboratory. Secondly it increased the likelihood of such comments being made in the first place as we share a community of practice (Lave & Wenger, 1991).

Hitchings (2012) discusses the role of interviews when researching people's everyday lives. He says that much of what we do is so habitual that we may not even think to mention particular things, or may prioritise particular incidents that are, in fact, not the norm. For example, a teacher such as myself might tell a story about the time a child fainted in class, when this has happened very rarely; I might not think to mention norms such as what I wear or how I walk around the classroom, despite these having more influence on my students and my experience of my job, than how I dealt with a specific, unusual, incident. Hitchings concludes that we should not discount interviews on routine practice because they superficially seem inappropriate. Surely you can find out about the habitual and the routine if you ask the right questions but also, as discussed above, create an inclusive atmosphere in which the interviewee feels that their anecdote/story is not too mundane or of no interest.

My initial set of four interviews produced a lot of rich data and, despite my status as a novice researcher, analysis of this data gave me direction for the subsequent research interest and methods. I spoke to people who had an interest in talking about chemical education but I felt that they were convinced I was equally interested in talking to them about their lives. Kvale and Brinkmann (2009) remark that an inter-view is an interchange of views on a topic of mutual interest, which we had established here. My first interviews could be described as 'informal conversational' according to the typology described by Patton (1980) with no/little predetermination of question topics or wording; this offered me the advantage of flexibility and matching the questions asked to the interviewee themselves and what they had said. Because of my initial interviews, I realised that the circumstances by which they had reached the careers that they were

currently in was of greater interest than the theory they had learnt, such as chemical equilibrium, to get there.

Moving forward into my next tranche of interviews, I had focused my research interest onto why some people become chemistry teachers, but I decided to keep much of what this style of interviewing offered me. Patton (1980) warns that this style of interview will produce less systematic and comprehensive data than other methods making data organisation and analysis more challenging; however, this seemed to me a price worth paying to make the experience as natural as possible for both interviewee and me.

To make data collection as comprehensive as possible Patton's 'interview guide approach' was used to ensure potential contributory factors, such as parental or sibling influence, were at least raised even if that was not an area that the interviews focused on. In this approach the interviewer predetermines topics and issues to be covered beforehand but decides sequences and working questions during the interviews themselves. This allows an interviewer to retain flexibility to go with the flow of the interview and, importantly for me, keep it convivial and conversational. This also allowed what my interviewees might consider uninteresting to me to be accepted as an interesting topic (Patton, 2003). Whilst this approach will not result in interviews that are comparable in the way one might wish to achieve with chemical analysis data, this is not a major concern for me as I am seeking to delve into the key influences on individuals' career trajectories and a directly comparable interview technique would be unlikely to uncover this as effectively because these influences, and their subtleties, will be different.

To maintain this conversational approach and to help me provoke a lengthier narrative response rather than brief factual ones, I aimed to ask very open questions ('could you tell me the story of how you came to be a chemistry teacher?') and always to ask for follow up where the situation merited ('could you tell me more about that?'). I intended to be careful with my probes for more information. As Aldridge and Levine (2001) suggest, we are looking for a fuller response, but must make this as unthreatening as possible. Rather than asking

interviewees, 'Is there anything you would like to add?' which perhaps implies a termination of interest, asking them to tell me more about a specific incident/event implies a genuine interest to be explored and potentially opens the narrative rather than closing it.

This approach explicitly used the word story with the participants and is quite non-specific in terms of how they should answer. For the researcher, it had a certain risk/reward associated with it: on the one hand it offered the interviewee carte blanche to tell their story, or the story they are prepared to tell as they saw it on that day, without undue indication of what was of greatest interest; on the other hand it could also be an overwhelmingly big question and provoke a brief and possibly trivial response – it really is a possibility that the interviewee had not thought of their journey to teaching as a whole story but more as a sequence of separate logical decisions. I was looking to uncover the influences upon different chemistry teachers' journey towards the profession and asking for a story at the beginning of my interviews was the best way to try to achieve this. If the participants had not thought about it in this way before then their response is equally valid to those who had a well-worn story to tell, but the story would need to be articulated through conversation rather than a monologue. Some of the participants such as Aaron and Richard had established narratives ready to share which they articulated immediately, but others like Claire and Sara seemed to be generating it as we spoke. This flexible approach ultimately allowed me to gather meaningful data from a variety of different participants whilst maintaining a friendly and co-operative atmosphere.

4.2.2 Logistics and data collection

To pursue the research aims of investigating the decision to study chemistry after leaving school and the subsequent decision to become chemistry teachers, but to do so in such a way which would enable an investigation of the wider life influences on these decisions, my own story became important both in terms of me as one of the subjects of the research and in terms of trying to understand co-construction between me, the researcher, and the participants within our shared community of chemistry teachers.

I therefore wrote about my own story on three separate occasions (see appendix 1), as the research progressed and I will consider the privileged yet problematic nature of autobiography/autoethnography later in section 4.3.4. My initial cohort of participants was found from my workplace, then chemistry teachers at the school I teach at. This offered the advantages that I already knew them, had easy access to them and that they would be receptive to the idea of giving up some time to talk to me about their journey towards teaching, due to already established positive relationships between us. Interviews were organised with five colleagues, who offered to talk to me about their lives. I cannot say the extent to which this demonstrated a genuine interest or merely a willingness to help me. Regardless of motivating factors, all five of them did, however, talk to me informally about their interviews and my research after their interview with me, so this suggests at least a polite interest in what I was doing.

Two other chemistry teachers from a local school different from mine were interviewed. Their working context would be different to the other participants, and they did not have a prior working relationship with me. This enabled some comparison in case different themes emerged from those teachers, as well as meeting some ethical concerns I had, and will discuss in section 4.4. Having a participant group which covered only one setting, that of my school, a mixed comprehensive London school, reduced the variables that would have needed to be considered, but this reduction in complexity is outweighed by the comparison of contexts and dealt with the potential criticism that the teacher trajectories I have considered were only valid within that one context.

The presentation of a narrative is influenced by the presenter's present situation even unknowingly. For instance, if one of the participants was having a particularly positive or negative experience of teaching, within the institution, when I interviewed them this could skew the story they chose to tell me. Therefore, I carried out one interview with each of the participants, which offered a snap-shot of their thoughts, on that particular day, regarding their own decision making process, influenced by the time of day, mood and a multitude of other factors, not least my own mood and attitude towards the interview.

Even one interview produced a lot of data and to view this data through more than one lens, taking these 'snapshots' and attempting to tease out what these narratives could tell me was better than introducing additional complicating variables by interviewing the participants on multiple occasions. It is a recurring feature of narrative research to talk about co-constructed realities (Bochner & Ellis, 1995), as existed between myself and the participants during our conversations. This reality would be different on any subsequent occasion and add another layer of complication onto my analysis, something already complex. The obvious exception to this was my own story, which did not take the form of an interview and I chose to consider it on three separate occasions, as I was interested to see how my accounts, written without having reviewed the previous ones recently, would differ. In addition to this, the participants, if interviewed subsequently, would have had time to review and renegotiate the narrative that they presented me with during the first interview and a second interview would inevitably be affected by this reflection (Goodson, Biesta, Tedder, & Adair, 2010) thereby complicating an already complex system.

The logistics of my interviews, perhaps inevitably for eight teachers with busy full-time jobs, developed as time became available and opportunities presented themselves. I informally approached each of the five colleague participants over a period of 12 months and explained to them a little about my research and asked them if they were willing to be interviewed, which all of them indicated that they were (see 4.4 Ethical issues). We chose times that were suitable for each of us and the consequent locations were dictated to by these times (see 4.2.4

The participants). Two interviews took place in my laboratory after school and one in a neutral office after school as my laboratory was not available. I interviewed the Head teacher, Jonathan, in his office during the school day as this fitted his schedule best. My other colleague interview took place during a school vacation and I carried it out in my home with Claire, who I know well and had visited my home on numerous occasions previously.

For my two subsequent interviews with teachers at a different school, I contacted one of them through my supervisor who knew her and we arranged for me to visit after school one day. She said that three of their chemistry teachers would be willing to speak to me but, on the day I visited, one of them had to leave school early. Nevertheless, I was able to carry out separate interviews with two of them in a neutral laboratory in their school.

In gathering personal experience narratives, as I will discuss shortly, narrative researchers would almost always seek to obtain written, aural and/or visual recordings of their participants' stories (Squire, 2008a). I obtained permission from all the participants to audio record all the interviews. The consequent audio files were downloaded onto my home computer and backed up on a separate, cloud memory facility, both password protected.

When discussing narrative interviewing, Kim (2015) describes the process as being made up from two phases, the narration phase and the conversation phase, a useful way to consider the process undertaken in this research. In the narration phase, the interviewee can talk freely with very little contribution from the interviewer, apart from the starting invitation to talk, in my case about the story of why they became a chemistry teacher and small indications of interest and attention such as nods and smiles. In the narration phase my role was to encourage the story telling and be an active listener, something thought to be a requirement in psychanalysis (Spence, 1982). Once the narration phase has ended, the conservation phase is entered, where the interviewer takes a more active spoken part, perhaps asking for clarification or more detail about facets of the story that has been told. It is quite possible for these phases to interchange depending on the story or stories being told. This second phase was dangerous,

however, as it was here that I had to be cautious of asking leading questions or zeroing in on particular areas of interest to me that may only have had secondary importance in the narrative, as told. I was seeking to pursue detail in an open way and not to put words in the participants' mouths.

4.2.3 Interviews

The seven interviews were carried out over the course of two academic years (2014-16) and were informal conversational in style, an approach I both felt comfortable with and would elicit salient and relevant responses and follow up questions (Patton, 1980). Prior to each participant's interview they knew that I was researching chemistry teaching and chemistry teachers but did not know what I was going to ask them about specifically. The interviews were deliberately not structured to a great extent because I wished to try to elicit the participants' narratives, as far as was possible, the way they wished to tell them.

Each interview was begun with a statement, "I'm interested in talking to people about the story of how they became to be a teacher", which in most cases led the participant to ask where I wanted them to begin whereupon I said that they could begin wherever they wished. It was important for me to explicitly ask for a story but also not to ask a direct question which might have limited the participant to a brief factual answer or a list. This was what Stylianou (2008) would call the 'interview control question' or statement in this case. This research did not seek to adhere to the control of variables used in the physical sciences, far from it, but the starting point was the same in each case, apart from my own autobiographical written accounts.

The interviews then evolved into a conversation about points that that been raised initially by the participant. I had no other statements or questions prepared to ask the interviewees, merely a mental list of areas that I thought that they might mention that I could compare and contrast with each other, as well as the literature which emerged from my own story such as family, school experiences, university experiences, friendships and relationships with chemistry.

I asked for more details about some of these things if they had been mentioned but largely allowed my interviewees to talk freely. For example, when Claire mentioned in passing that she had changed her mind from a Masters degree to a Bachelors whilst at university I asked her, "You said that you applied to do a Masters at university and then dropped down. Why did you apply for the Masters originally and what's the story behind that?". Her response to this was, "That's a

good question!" which suggested I was asking her to articulate something that she was unused to considering.

Sometimes, I introduced aspects of my own story into the mix, often in comparing and contrasting areas of my narrative with theirs, which allowed conversation to flow more naturally than a more directed style of interview, moving from a narrative phase to conversational. When Sachin talked about his university friends' reaction to him considering teaching and his enthusiasm about the idea, I said that my university friends had reacted similarly which led us to talk about how we had found teaching after our initial, possible naïve, enthusiasm:

> Friends, I think found it quite exciting to be honest, they found it quite interesting that I was going into that and, yeah, because it was different and maybe because I was enthusiastic about it I could, when I would speak about it, I was interested rather than the friends who were doing things, more kind of business type things. (Sachin)
>
> *My friends were exactly the same (Alex)*
>
> My friends were, it was all they ever wanted to talk about (Sachin)
>
> *We all relate to schools don't we, we have that experience (Alex)*
>
> We've all been through it and we can all relate to it and we all have an opinion on it and we all think we understand it and so yeah, I had exactly the same reaction. (Sachin)

On the whole I tended to draw the parallels between the interviewee and myself, such as the wish to do chemistry over maths despite being good at maths, with both Aaron and Claire or in terms of being strategic with Richard.

The Interview texts, varying in length from 20 to 40 minutes, are co-constructed and aspects of my own narrative and positioning are inevitably entwined with the participants'; nevertheless as Polkinghorne (2007, p. 482) says an open listener can ensure the participant's own voice is heard by carefully 'attending to the unexpected and unusual participant responses', something that I attempted to throughout. When I spotted something unexpected or new, such as Claire's sudden mentioning of her chemistry teacher towards the end of our interview, I acknowledged this and attempted to get the participant to give more detail or

consider what it was that they were saying, often with a "Could you tell me more about…" style question. The length of the interviews varied in length mainly due to my giving the participant the space to tell the story they wished to tell, as well as having natural conversation about points they had raised. Some, like Jonathan, told this story succinctly whilst others like Richard had much more to say about his decision-making processes.

The stories gathered here are representations of participants' meaning as shared with me. I will discuss narrative research in more detail in section 4.3 and reliability and validity of this approach in 4.5.

4.2.4 The participants

I carried out interviews with five chemistry teacher colleagues from my place of work, one of whom is also the Head Teacher of the institution in question. In addition, I carried out two interviews with chemistry teachers from another London comprehensive school who I did not know personally beforehand and had never worked alongside.

Six of these teachers will be referred to under assumed names, which maintain their gender, apart from Jonathan, the Head Teacher of my school who has agreed to be named as he is already easily identifiable via my name. Information about each participant in my study follows in Table 1: Participant information.

TABLE 1: PARTICIPANT INFORMATION

Name	Gender	Years teaching (time of interview)	Location of interview
Aaron	M	2	In my laboratory at work
Alex (me)	M	19	n/a
Claire	F	3	In my home
Jonathan	M	30	In his office at work
Richard	M	1	In a neutral office at work
Sachin	M	16	In a neutral laboratory at his work
Sara	F	10	In a neutral laboratory at her work
Sonia	F	25	In my laboratory at work

This is a small sample of teachers from which to try to investigate career trajectories and hence what we can learn from these in terms of teacher recruitment. However, the stories that this sample provide, when compared with the wider literature, do add to our understanding of how individuals come to become teachers. The intention is not to generalise from these narratives but to compare key influences that have emerged with those from larger published

studies into teacher choice and recruitment using methods that have not been generally common within this research area.

4.2.5 Interviewing defended subjects

One of the lenses through which I planned to analyse my narrative data was from a defended subject point of view, written about, in the context of research about anxiety and the fear of crime, by Hollway and Jefferson (2000). They suggest that all research subjects are meaning-making defended subjects who may interpret questions differently from the interviewer, as they make meaning differently and may, possibly unconsciously, disguise the meaning of some of their actions or feelings.

As the narrative approach discussed previously is seeking stories, therefore the agenda is open to change dependent on how the narrator and listener experience these stories being told. To elicit these stories with defended subjects. Hollway and Jefferson (2000) advocate asking open-ended questions and, where possible they suggest following up interviewee comments with questions that use their own phrasing rather than blunt 'why' questions. For example, if one of the participants mentioned a particularly inspiring teacher from their school days, rather than asking them why they were inspiring, I should look to ask them if they can tell me more about this teacher. As they say, this approach reveals choices made by the story-teller which are revealing in themselves and often more than the teller suspects.

One aspect of my work with interviewing defended subjects is that, as a fellow chemistry teacher, I am also an anxious, defended subject and therefore both our 'mental boundaries are porous where unconscious material is concerned' (Hollway & Jefferson, 2000, p. 45). With two of the participants, whom I did not know in advance, the impressions we made on each other are influenced strongly by what we said and did, as mediated by internal phantasies and our histories of relationships with others as well as our responses to expressed defences in light of our own. For the five other participants, this would still be true but complicated by an already generated relationship. Whilst trying to elicit their story from my defended subjects, I had to be aware of my own defences, which I viewed against writing my own story, and their potential influence on them.

4.2.6 Power relationships and insider stories

Adriansen and Madsen (2009), in their work on insider interviews within a community of geographers, suggest that it is not uncommon to interview one's colleagues within educational studies. I remarked earlier how educationalists commonly review their own practice in published studies and, therefore, it is not particularly surprising that they carry out studies into the practice of others in their field. Adriansen and Madsen (2009, p. 147) use the stance given by Narayan (1993) that we all belong to a number of communities simultaneously and therefore, 'to us, an insider is someone who is considered an insider by other members of a community and/or who participates on a par with the other members of that community.' By this definition, I was acting as an insider in all my interviews and I needed to consider how this affects both how my interviews were carried out and how I analysed them.

My privileged position as an insider allowed me to plan my interviews and gave me access to suitable participants, as well as giving me an ability to empathise with them and the pressures and demands on their time. However, two issues arise, those of power and of presupposed shared understandings.

Kvale has written extensively about how to go about interviewing (1996, 2008) but he criticises his own previous work, and that of others, for a lack of consideration of power asymmetry and conflict in qualitative interviewing (Kvale, 2006). He posits that research interviews are not as open or dominance-free as we might like to think and are a 'specific hierarchical and instrumental form of conversation, where the interviewer sets the scene in accord with his or her research interests.' (Kvale, 2006, p. 485). The asymmetric power relations within these interviews are balanced to some extent through my being an insider prepared to be open about his own story, but ultimately the interviews were carried out by me and some asymmetry remained.

As I have been discussing, I knew five of my seven interviewees personally, some very well as colleagues for up to twenty years, and others for less than a year. This was a double-edged sword in that I had a positive relationship, at least from my perspective, with them all already and therefore had developed a natural

rapport when talking conversationally with them, which allowed them to talk to me without having to overcome the barrier of awkwardness with an unknown interviewer. Nevertheless, inevitably, a power dynamic already existed between me and each one of my interviewees before and during my interviews. I was the Head of Chemistry, and therefore line manager, to three of my interviewees and co-mentor of the student teacher and therefore in a formal position of influence, authority and power over four of my seven interviewees.

This relationship and consequent power dynamic could have led to a subconscious wish, on behalf of the participants, to please me and give me the story they perceive that I was looking for, to present themselves as dedicated and happy teachers and to display an affinity for chemistry, things they may see in me – these concerns applied to all seven of the participants and no less so to the two interviewees that I did not know personally beforehand. Perhaps I represented academic chemistry in some way, being Head of Chemistry at a local school, and aligning themselves with this would, in some way, be how they would want to be seen by me, or to present themselves in an idealised form (Olsen, 2006).

These power relationships do not diminish the value of qualitative interviews and here I agree with Kvale (2006) that all interviews have a particular power dynamic which should be considered conceptually, methodologically and ethically. He advocates that researchers consider the specific power dynamics at play, which I have attempted to do as part of my analysis in chapter 5, for example when Claire aligns with a view of Chemistry that I am known to hold, although even by doing this I am expressing power!

My relationship with the fifth interviewee is a complex one, as he was my Head of Department for four years before I took over that role and he became promoted, first to Deputy Head and then Head teacher of the school I work at. Over the past five years his teaching load has steadily reduced to one class, then to stopping classroom teaching altogether, so his consequent chemistry teacher identity must have been influenced in some way. However, as a representative of that identity, within our school, it was interesting to see where discernible influences of

this were apparent when he told his story. He was senior to me within the hierarchy as well as a more experienced teacher, but I represented the identity of a current chemistry teacher, something perhaps he did not see himself as anymore.

These power relationships will have had an influence on the interviews, but they did not necessarily prejudice what was said about the participants' lives and decision to teach. Cohen et al. (2011) cite the observation made by Hitchcock and Hughes (1989) that, where interviewer and interviewee are known to each other and they are peers, the power differential is less important, but that participants may attempt to give the answers that they perceive the interviewer wishes to hear. In this research, I have guarded against this somewhat by using two different lenses with through which to consider my data, a face-value thematic interpretation as well as a defended participant interpretation. The latter of these approaches looks beneath what the participants talk about in terms of how they defend themselves or decisions they have made, something hard to fake if they are merely attempting to keep the researcher happy. For example, when Richard talks about his love of science, this defence of studying chemistry at university is not invalidated but belies a previously asserted defence of abandoning a promising mathematical future to increase the chance of studying at Cambridge, and may have been what he expected me to want to hear.

These relationships, whilst important to acknowledge, do not invalidate conclusions I have made about teacher trajectories. The shared community of chemistry teachers, and consequent shared knowledge, of all the participants allows the researcher a privileged position for shared meaning-making. Adriansen and Madsen (2009) caution researchers that conducting insider interviews with colleagues or friends demands an attentive interviewer who is conscious about pursuing 'you know' type answers; a shared understanding of something like teacher workload may help connect with one of the participants but can weaken the data produced and I may end up with data material that is of little or no use because it is full of insider remarks which do not make sense to an outside audience.

Adriansen and Madsen (2009, p. 152) recommend that the interviewer:

- pursues 'you know' answers. This term implies a shared understanding which would be expected from fellow chemistry teachers, so my aim was to try to elicit more detail from the participants if they used such terms;
- is aware of their own and others' role and shifting roles during the research process. I paid close attention to this positionality, especially when sharing aspects of my own career or my own defences, as it had implications both for the interview situation and for the interpretation of the gathered material;
- acknowledges that some people may be too close to one to establish an interviewer/interviewee relationship. This was the case with the participants from my school and whilst these were interviews, they were also comfortable conversations between colleagues where mutual respect existed before the interview commenced. My experience of these was from my own perspective but all five of these colleagues came back to me subsequently to talk about my research and to offer further time to speak if I desired, which suggests that these conversations were relatively comfortable for them too;
- steps back from the insider role to gain perspective, while being prepared that questioning taken-for-granted knowledge may change one's role from insider to outsider in relation to the research community under research. This was difficult to manage during my interviews as I am an insider within this community. However, even when asking the participants further about their stories, the nature of my interest was not such that I was challenging our community, more pushing the participants for more detail or clarifications.

Interviewing is a subtle art, but I tried to make it as pleasant an experience as I could for the participants as well as myself, whilst keeping conversation flowing about the participants' journey towards chemistry teaching. I could not remove any power asymmetry or take back times when my enthusiasm led to my asking slightly leading questions, or where, on reflection, I disregarded some of the

advice given by Adriansen and Madsen (2009) above. Nevertheless, I have acknowledged where such instances occurred within my interview transcripts, such as when I talk to Claire about her A-level chemistry teacher she mentions towards the end of her interview, having not talked about her own teachers at all previously.

4.2.7 Processing the data

In order to preserve and analyse my interviews I audio recorded them and attempted to carry out an unfocused transcription. Cohen et al. (2011) suggest that transcription is crucial but also has a potential for massive data loss, distortion and the reduction of complexity, as this process inevitably involves interpretation by the transcriber, even if they intend to transcribe verbatim. The fact that I audio recorded my interviews is already a selective method and will have filtered out various contextual factors, neglecting the visual and non-verbal aspects of the interview. These issues were compounded as transcription represents translation from one set of rule systems (oral) to another (written) and therefore there can be no 'correct' transcription. But that transcription problems are essentially insoluble does not mean you cannot produce something meaningful; the researcher must remember that the transcript is not the reality but a partial representation of speech (Mishler, 1986).

The interviews were transcribed as close to verbatim as possible and contractions like 'gonna' were reproduced rather than rephrased into correct written English. Brief field notes were also produced as the interviews proceeded to try to capture the mood, or at least some of my own feelings at the time. This approach best suited the exploratory nature of my interviews and, whilst acknowledging the complexity mentioned above, it would best give me something to analyse that was a fair representation of the interviews. Transcription itself occurred soon after each of the interviews took place having listened to each audio-recording at least twice through between times. When using the transcripts to generate themes I also listened to these recordings through as a starting point; as Psathas and Anderson (1990) point out, the transcript is not the data, the audio-recording is the data and one should therefore not disregard the latter (Lapadat, 2000).

After much material of interest emerged from my exploratory initial interview transcripts, I used a similar approach with my seven subsequent interview recordings. By listening to the audio-recordings I could interpret hesitations, inflections, volume or verbal stresses, where important to the narrative, even though these were not transcribed. This approach to transcription is common

within the experience-centred narrative research field I am pursuing, as opposed to event centred research (see 4.3.2 Approaches to narrative research) as my focus is on *what is* said rather than *how* it is said (Squire, 2008a), although both play a part in interpretation. My research is about uncovering the underlying stories in the participants' journeys towards teaching rather than counting how many times they mentioned a person or incident and therefore the third set of data is my own interpretation of these stories at the time, which influenced what I said during the interviews as well as my brief notes made at the time. For example, as I mentioned above, Richard gave me the clear impression he went into chemistry for practical and utility reasons despite him professing a love for it at one point and I noted this down at the time.

It was not possible to consider what my interviewees said, at the time or when reading a transcript, without it being through an interpretive lens based on my own experiences and the way in which I think about chemistry and teaching myself. An active interview might appear to be 'contaminated' (Holstein & Gubrium, 1997) by such influences but all interviews rely on the interaction between participants and therefore all participants are implicated in making meaning. As I have commented previously, my belonging to a common community of chemistry teachers with all the participants accords me the privileged position of shared knowledge and experiences to compare and contrast with the participants'. This allowed me to participate in conversations about teaching styles with Richard and Sachin or about the difficulties in studying some topics like quantum mechanics with Claire. Without a shared understanding of such issues it would be more difficult to interpret some of the life decisions made by the participants, particularly those that form part of the career trajectories under discussion in the research questions; the challenge becomes acknowledging and explaining these interpretations to an audience who may not have this shared understanding.

Once I had transcribed an interview and listened to the audio-recording, I considered the data and established any interesting points that an interviewee had made and how they related to the experiences and life of that participant.

To begin with this involved trying to identify key players or circumstances in each story, but as the transcripts were read sequentially, I could see similarities and differences between the participants, as well as to my own story, which enabled me to choose areas to consider further. I will discuss this in more detail in sections 4.3.5 and 5.2.

4.3 Narrative research

4.3.1 Introduction

Narrative research is an ever more popular way of conducting qualitative research in the social sciences and can produce rich data which may prompt the reader to 'think beyond the surface' (Riessman, 2008). Much of the literature into STEM teacher recruitment is conducted with student teachers on a large scale (Heinz, 2015). My research interests are within the same field but on a more individual and holistic level, as I consider the broader and subtle influences that affect career choices of current chemistry teachers. Eliciting stories from the participants in this study and going on to co-construct narratives has generated a sense of deeper understanding of why these individuals studied chemistry and went on to teach. By using two analytic lenses to view the gathered data, and via participant validation of my summary of my interpretation of their interview, this individual understanding demonstrates validity (see section 4.5) and, although there was no intention to generalise from eight narrative threads, the nuances that pervade them have allowed me to contribute to the wider teacher recruitment debate.

Stories can enable the researcher to investigate causality and this approach 'not only conveys information but brings information to life' (Cohen et al., 2011, p. 553). I decided to pursue interviews that sought to draw out the stories of the participants' lives in relation to them becoming chemistry teachers, as the thought provoking data produced from the initial set of interviews convinced me that this was an excellent way to explore the nuances behind the obvious decisions to choose specific A-levels or degree course.

Squire, Andrews, and Tamboukou (2008) point out that narrative research 'offers no automatic starting or finishing points' and indeed the word 'narrative' itself is much disputed; however, it also can reveal truths about human experience (Riessman, 2002) and allow these truths to clarify themselves as part of conversation between a researcher and interviewee. Potential synergy between both parties appealed to me, in terms of data collection, as well as opening an

opportunity for investigation of the wider picture of academic choices and the path towards teaching, something we had all undertaken.

Narrative Inquiry is considered a relational methodology in that the researcher is always a part of the study and involved in the process of living, talking, retelling and reliving (Clandinin & Connelly, 2000) and therefore suggests that consideration of my own story was important as a point of comparison and relation to the rest of my data. In this chapter I wish to discuss my approach to narrative research within the approaches available, as well as consider my autobiography and the analysis of the data.

4.3.2 Approaches to narrative research

Josselson points out (Wertz et al., 2011) that narrative research is an interpretive enterprise which consists of both researcher and participants within a conceptual framework. Any meaning making is therefore constructed through social discourse and cannot be divorced from this process. Narrative research offers no rules to choose potential materials or modes of investigation, but nevertheless, narrative researchers use narratively framed research tools to try to see different and often complex layers of meaning, to attempt to understand more about change on an individual or social level.

In this research I am interested in the participants' lives and therefore stories about their lives, as to a large extent the stories about our lives and ourselves 'are who we are' (Goodson et al., 2010, p. 1). Goodson has written extensively about narrative research and says that we do not just learn from a narrative account, but we are learning in and through these narratives, so these processes will have occurred, and be occurring, when we present our stories. He distinguishes life stories, 'the story we tell about our life' (Goodson, 1992, p. 6) and 'lives interpreted and made textual' (Goodson & Sikes, 2001, p. 16) from a life history which is 'a collaborative venture, reviewing a wider range of evidence. The life story teller and another (or others) collaborate in developing this wider account by interviews and discussions and by scrutiny of texts and contexts. The life history is the life story located within its historical context' (Goodson, 1992, p. 6). I am interested in the career trajectories of a small group of chemistry teachers, but wish to avoid narrow discussion of only, say, their practice in class as their wider life is of greater importance here, a point stressed by Zhao and Goodson (2013) in advocating that studies into the work of teachers must be conducted within the context of their lives, something I have done here.

To develop the life stories I have gathered into life histories, a much greater focus would be required onto the broader contexts within which these stories are situated, such as educational settings, as well as social and political contexts. My research focus was on major life decisions leading to becoming chemistry teachers and attempting to consider these decisions was already a complex

matter situating them within their narrative, as presented by them, without adding more layers of complexity. Asking the participants about these background contexts would have enabled me to draw upon these as well as compare and contrast each participant in terms of each context. However, what this approach gains through comparison, it loses in hearing the story that is being told, as well as the story that is not being told. To examine my research questions, I wanted to elicit the story that the participants wished to tell without imposing particular background features upon them thereby changing the story itself.

The narratives gathered here are situated in a space where the participants spoke to me directly and told me the story that they wished to tell. By viewing the data through two lenses I can find instances where these stories match well the defences presented, strengthening my analysis. However, where this story does not appear to match the defences given, for example with Richard's professed love of science matching what he might wish to present to me but not his defences of science versus mathematics and attending an elite university, this allowed me to consider a subtler analysis of his motivations than would have been possible from either a face-value analysis only or from an interview where he had been asked many standard questions.

Narrative has become a popular modality within social science research (Squire, 2008a) for a variety of reasons. Firstly, it allows for interaction between theory and practice throughout a variety of disciplines, such as sociology, anthropology, psychology, medicine and history. It is a process that is 'open, in movement, in the intermezzo of academic research fields, philosophical traditions, scientific methods' (Andrews et al., 2011, p. 7). Secondly, it can combine traditional social science, describing and interpreting human experience with more recent postmodern views about representation, such as those derived from psychoanalysis, that I am seeking to use with the unconscious expression of the 'defended subject' (see sections 3.6 & 4.3.5), an intra-psychological analysis. Thirdly, it allows potential analysis to be carried out on multiple levels – structures of language used, the content of texts such as my inter-psychological analysis of

my gathered stories at 'face value', as well as the context of storytelling such as examining co-construction between me and the participants.

Squire (2008a, p. 9) describes three contemporary perspectives on narrative research, as first categorised by Mishler (1986):

1. Focus on narrative syntax – concentrating on the syntax/structure of life events or event narratives (Labov & Waletsky, 1967) where there is an assumption of fairly direct relationships between experience, cognition and representation and it turns our attention to language itself, not just what language 'means'. By considering a starting point, the orientation and complicating action a story can be considered credible or not and compared to other stories;
2. Focus on narrative semantics – where a link between narrative and experience is assumed and examined. Here we are not just interested in the events but also talk that is not about the events, where a sense of who the teller is can be developed, as well as the relationship between the teller and the listener, as co-constructors of the story;
3. Focus on narrative pragmatics – where links are made between narrative and cultural genres, the so called 'small stories' (Bamberg, 2006). From this perspective 'context' may be understood as that of interpersonal language, interpersonal relations, or the broader field of social and cultural relations, in my case between me and the participants.

Squire et al. (2008) draw the distinction between research focused on the first two of these categories, events that happened to the narrator and experience centred work focusing on more general or imagined phenomena, the latter of which appealed to what I was attempting to investigate, where I would take a hermeneutic approach to analysing stories, with the final aim to interpret and try to understand them.

Narratives of events tend to follow the approach advocated by Labov and Waletzky in the 1960/70s. As Patterson (2008) explains, their approach treats a narrative as a story text and not in terms of social interaction and produces a

structural analysis of specific oral personal experience narratives through the specific text of the interview transcript. The Labovian method for analysing transcripts involves separating the text into clauses and then categorising these into elements of Labov's model: abstract (what is it about?), orientation (who, when, where?), complicating action (then what happened?), result (what finally happened?), evaluation (so what?) and coda (ends the narrative).

This method has its uses to a qualitative researcher as it is detailed and rigorous and can help one identify important narratives within the data gathered (Patterson, 2008), as well as to compare these narratives and examine the perspective of the narrator. However, this methodology can be seen to be inflexible and might work better when analysing a monologue rather than the kind of interview that I have undertaken. In my interviews the relationship and power-balance between me and my interviewees is of importance in our co-construction of the narrative and such an approach, centred only on the interviewee, was not the way I wished to proceed.

Squire (2008b) suggests that when we consider personal narratives as event-centred we tend to neglect any talk not about events, even if it is significant in terms of expressing something about who the narrator is; also by representing the story, in speech or text, we distance the story from the happenings that are being described and any meanings implied would never be the same if the story is told again, even to the same person. Therefore, in the type of research I am engaged in, I was wary of viewing any kind of analysis as the whole picture however neatly some methods might package up a story.

In order to take an experience-centred approach we assume (Squire, 2008b) that narratives:

- are sequential and meaningful;
- are definitively human;
- 're-present' experience, reconstructing it, as well as expressing it;
- display transformation or change.

This approach takes a more holistic view of a person's narrative, including asides about previous events, future events or perhaps events that did not happen. Possible applications include those that focus on one event, a more general experience such as that described in Wertz et al. (2011) about a traumatic event and its consequences, life histories or in interviewing several people about the same phenomena such as the work by Mishler (1986) about men's stories in the light of interviews with their wives. As I focused my study on why people study chemistry or become chemistry teachers, this approach stood out to me as delving into different people's stories, including my own, and comparing them is not the usual way in which such decisions have been investigated previously, where the methodology has been more quantitative through questionnaires and some specific follow up interviews, such as Kyriacou and Coulthard (2000), Richardson and Watt (2006) and Watt and Richardson (2007). Not only, therefore, did this narrative approach fit well logistically with my work and access to colleagues, but it also enabled me to investigate a recognised problem, that of teacher recruitment, in a different way.

4.3.3 My approach to narrative research

My own research interests are more experience centred as representations vary over time, even from the same narrator. I have spent twenty years teaching chemistry so even if I tried to give an opinion on my motivations to undertake a PGCE in 1995, I am unlikely to present this negatively as this would undermine my entire working life. It would have been interesting for me to have kept a journal or be interviewed over that period of time and such longitudinal narrative research has been carried out by Holmegaard et al. (2012b) into students' choice of STEM subjects for Higher Education in Denmark and this might have been a very useful way of approaching my current interests into why people choose to become chemistry teachers.

Nevertheless, such an approach was not suited to my timescale and full-time job, so I decided to view each of the participants via a snapshot. People make sense of their lives according to the narratives available to them; their stories are being constantly restructured and revaluated in the light of new events because stories do not exist in a vacuum but are shaped by lifelong personal and community narratives (Webster & Mertova, 2007, p. 2). Apart from my own narrative, which I have no option but to view over time, I regarded my gathered stories as data from a specific time and fully accept that had I gathered this data on a different occasion, the stories told may be different. This does not invalidate my approach but cautions me not to makes claims about how the participants may feel now, after time has elapsed since I spoke with them.

Josselson (Wertz et al., 2011) makes an important point that is echoed throughout the literature on narrative research which is that we are not seeking to generalise our findings but, instead, explore subtle nuances and possible interrelationships. I have done this by considering life decisions such as the decision to teach or to study chemistry via employing different lenses to interrogate my data thematically as 'face value' and then through a 'defended subject' lens. Therefore, my sample needed to be taken from serving chemistry teachers, preferably a small but varied sample, from which these subtle nuances could be explored and compared both to each other and the wider literature and

subsequently consider similarities and differences and what we could learn from these.

4.3.4 Autobiography/autoethnography

Eakin (1998, p. 27) has argued that 'autobiographies offer a precious record of the process of identity formation, of the ways in which individuals employ cultural models of identity and life story'. In my research, I am co-constructing narratives with the participants and it is my own shifting identity that is the basis against which I can do so. My own story is pivotal to this research, as it the starting point against which I consider the gathered stories as well as the backdrop to the interviews and how the participants presented themselves to me.

Bruner (2004, p. 693) writes that autobiography is 'a privileged but troubled narrative because it is both subjective and objective, reflective and reflexive, and in which the narrator is also the central figure'. This is not to say that such a narrative should be disregarded, but issues in analysing it should be acknowledged. When I look at my autobiographical narrative accounts I have attempted to explain what they are telling me, as a researcher, not as the central figure myself, which was be challenging. Riessman (1993) cautions the researcher to consider what is not said, as well as what is said, which is easy for me to do about my own story but dangerous also, as all my interpretation is influenced by everything in my life, as Sacks (1998, p. 110) observes, 'each of us constructs and lives a 'narrative' and… this narrative is us, our identities'.

From autobiographical writing, I have analysed my own personal experiences embedded within a larger social and cultural context and reflected upon this in a critical way, as an autoethnography (Kim, 2015). It is this critical analysis which is important, rather than just the telling of my story, which could be anyone's story. Ellis, Adams, and Bochner (2011) suggest that this autoethnographic approach is distinguished from that of merely reflective story telling by:

- Comparing and contrasting personal experiences against the existing research;
- Analysing personal experience considering theories and literature;
- Considering ways others may experience similar experiences;
- Illustrating facets of cultural experience embedded in personal experience.

All four of these distinguishing features of an autoethnographic approach are part of what I have attempted to do in my analysis, both of my own autobiographical writing, but also that of my interview transcripts using my story as comparison. Teachers are used to reflecting on their own practice in the classroom and, indeed, much educational research is centred around such self-reflection (Tenni, Smith, & Boucher, 2003)

Ultimately any observer cannot be truly independent of the observed and thus autoethnographic approaches are legitimate (Roth, 2005) although study of personal experiences requires a willingness to deal with one's own prejudices and prejudgements. This was one of my biggest challenges, dealing with my own decision making processes and the wider experiences that might have influenced them. To deal with them, I had to be honest enough to write about them in the first place and not to try to present myself in a good light but to present it as it is.

Attempting to understand my own narrative threads, both in taking chemistry forward within and beyond school and then choosing to undertake a PGCE qualification, was crucial in helping me try to understand the other participants' stories. It enabled me to recognise certain subtle influences in their narratives that mirrored my own, such as Claire's changing relationship with chemistry, but also spot differences, such as differing parental influence in the cases of Sara and Aaron. Without presenting my own story or at least one version of it, to my readers, these other threads, co-constructed with me, are not complete and much more challenging to interpret.

4.3.5 Narrative analysis

I have thought about my own story, and some of my big life decisions, and have viewed this in relation to research published as part of the UPMAP project in terms of my defended self. As I discussed in chapter 3, in the UPMAP project Rodd (2010) built on the work of Nimier (1993) and his work in mathematics education, and suggested that a given anxiety can be displaced onto mathematics or contained in some other way and defences can be seen to be mounted against this anxiety, mathematics serving as an instrument of this defence.

One could apply the six Nimier defences equally to chemistry and I have considered some of my own decisions in the light of these ideas. As Holmegaard et al. (2014) suggest, identities are always in transition and this seems to apply equally to our defences. How I position myself against, say, the decision to do a chemistry degree or to become a teacher is necessarily a consequence of where I am today and how I view my life now, rather than explaining how I saw myself when I was 17 or 22. Psychologists talk about autobiographical memory which 'helps to locate and ground the self within an ongoing life story featuring extended lifetime periods or chapters, knowledge about typical or characteristic life events, and specific and sometimes vivid details of particularly well-remembered scenes' (McAdams, 2001, p. p117). These memories are influenced by current goals and anticipation of how events will pan out in the future, as well as acting as self-justification for decisions made. Perhaps the person we need to defend against to the largest degree is our self!

I viewed the gathered data through two lenses, that of a thematic analysis, attempting to identify key players and themes, as well as a contrasting defended subject analysis. This thematic approach offers us a situated view of the participants evolving identities in contexts described in hindsight from a time in the future. The defended self offers a contrasting defence of identity against these contexts to maintain their view of 'self'. Comparing and contrasting the results of these two distinct approaches has allowed me to more confidently uncover key influences on the career trajectories of future chemistry teachers, both when the analytic lenses aligned and when they oppose each other.

Josselson (Wertz et al., 2011), says that narrative research is an interpretive enterprise which consists of both researcher and participants. Any meaning making is therefore constructed through social discourse and cannot be divorced from this process. She suggests analysis of such discourses can be either holistic, where the story is considered as a whole and pieces of this are considered against the others, or categorical where abstracts are coded and compared to other narratives. She suggests the following general approach:

1. Overall reading of interview transcripts to gain a general sense of the story;
2. Multiple readings to identify different 'voices' of the self;
3. Iterative readings continue until some constancy is reached (good gestalt);
4. Conversation with the larger theoretical literature.

Narrative research is not the method through which findings are generalised but, instead, how subtle nuances and possible interrelationships are explored. I have done this in considering people's life decisions, such as the decision to teach or to study chemistry, via employing different lenses to interrogate my data and in common with Rodd et al. (2010), I viewed my data thematically and then through a 'defended subject' lens and compared what emerged from examination in these two ways.

I have discussed previously some aspects of event narratives and personal narratives. Squire (2008b) suggests that when personal narratives are considered as event-centred the focus tends to be on the events described and other dialogue is ignored, even if it is significant in terms of expressing something about who the narrator is. What must be borne in mind, in this kind of research, is that we are looking at the bigger picture, a picture that is constantly changing and would look different viewed on a different day or by a different researcher. I have viewed one big picture but it will never be the whole picture, however neatly I try to present it.

An experience-centred approach takes a more holistic view of a person's narrative, including asides about previous events, future events or perhaps events

that did not happen. Squire (2008b) says that the most appropriate way to analyse interview data in this way is to begin to describe interviews thematically, within individual interviews, and to use these to develop and test theories that may go some way to explain the stories, then moving to and fro between the interviews themselves and the theories generated. This approach has distinct advantages in terms of rationalising the 'big picture' although there would always be multiple perfectly valid interpretations. For example, my own narrative points to a certain relationship with chemistry that changed during my undergraduate studies and this, allied with a lack of natural risk taking, may well have led to my decision to study for a PGCE. It could well be the case that other undergraduates may have followed a similar pathway but also that many others would not have done so. I am not seeking to generate a typical story of the pathway to chemistry teaching but more to try to examine different stories for areas of similarity or difference, so that these can be explained within the larger perspective of that teacher's life. A veneer of similarity, such as parental influence on academic choices, may belie a different outcome due to that influence, so examining these against the wider narrative offers something that much other research in this area does not.

Olsen (2006) discusses different sociolinguistic methods that could be employed when attempting to uncover meaning in teacher interview transcripts. He used language to try to uncover his participants' knowledge, meaning-perspectives and the interpretations of their own teacher identities. Two sociolinguistic methods can be used when looking at interview data: the code model and the inferential model. In the code model the speaker transfers information (using words) and the other person decodes this information using the same understanding of this information. This is direct communication and analysing what is said at literal face value. Nevertheless, as Olsen contends, it is virtually impossible to use the code model without using aspects of the inferential model. This model assumes that both participants in the conversation rely on shared understandings, as I would expect in my study with chemistry teachers and myself, as well as shared subjectivities; I had to decode what was said but do so knowing that the way in which it was expressed may have been heavily influenced by this

shared understanding. For example, Jonathan when talking to me about leaving academic chemistry behind and going into teaching, says, 'increasingly as I went through the chemistry degree, I'm so sorry but I'll appal and horrify you, but I knew that research was absolutely not for me'. Here he was alluding to his opinion of me as a dedicated chemist, something he had alluded to many times, particularly when I became Head of Chemistry, and he began to teach less and less himself; someone who might be horrified by his decision not to go into chemical research, despite me having made the same decision, even if not for the same reason.

Riessman (2008) suggests a good narrative analysis will prompt a reader to think about what is below the surface of a text and move towards a broader commentary. There is no set of rules for thematic analysis and she cautions novice researchers from being too taken with its apparent intuitive and straightforward nature but to realise that, in fact, it can be an extremely methodical and painstaking method. She presents exemplar narrative research and shows that they can be represented very differently (through lengthy interviews, brief interviews, written documentation, etc.) but that they share a considerable focus on 'macro contexts' where authors make connections between the worlds depicted and the larger social world. Bold (2012) also advocates such an approach suggesting a researcher is often seeking and identifying themes within the narratives and exploring experiences which usually involve the relationship between people and the contexts they find themselves in.

My two analytic lenses both involve examining connections between the life depicted and the larger social world. Where they differ, and offer interesting contrasts, is in the way that these influences are depicted, as a major part of evolving identity described thematically or as something to be defended against a more static self.

Of particular interest to me was the thematic analysis method presented by the qualitative psychologists Braun and Clarke (2006). They assert that flexibility is at the heart of thematic analysis and that it is a method for 'identifying, analysing, and reporting patterns (themes) within data'. In contrast with other methods such

as interpretative phenomenological analysis (IPA) or grounded theory, thematic analysis is not associated with its own pre-existent theoretical framework, but it can be used within different ones.

According to Braun and Clarke (2006, p. 82) a theme 'captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set'. Counting how many times a particular instance occur need not drive the choice of key themes and the researcher must be careful in their judgement here and keep in mind the relevance of a theme to the overarching research interests. There are two ways of identifying themes through thematic analysis: an inductive approach where the themes are formed from the data itself and they may differ considerably from the questions asked during the data collection; or deductive approach where the researcher's theoretical interest has driven the production of themes. In my research, themes emerged inductively which began to form hypotheses which were used to interrogate further interview data.

Holmegaard et al. (2012b) use a thematic narrative analytic approach in their study about students who held a STEM subject as one of their favourite subjects at school but did not choose to study STEM at the tertiary level. They apply aspects of narrative psychology to try to understand how identities are produced, in particular the social practices in which these identities are embedded and explicitly use the process of thematic analysis advocated by Braun and Clarke (2006) which consists of six steps:

1. Getting familiar with the data – transcription and reading and re-reading the interviews whilst noting ideas down;
2. Generating themes – constructing analytic questions (themes) which may or may not depart from the original research aim;
3. Searching the data – systematising the data across the entire data set and sourcing relevant quotes within each theme;
4. Understanding the themes with the theoretical framework – trying to understand the patterns within the themes in terms of the theoretical framework being adopted;

5. Reviewing themes – re-reading transcripts to check the themes and patterns in the context of the entire data set;
6. Producing the text – defining the analysis heading towards a thick description of the data.

This is the approach I have taken with my data in a 'face value' way: what were the participants telling me about their lives, their changing identities and how these identities were presented to me, as interlocutor? Hycner (1985), in his work on phenomenological research, cautions his readers to various issues relevant to the analysis of interview data, which I have addressed in the following sections of this chapter:

1. *Randomness*. My sample is not random, something of potential issue to experimentally-oriented researchers, and, in fact, I have sought a particular type of person for my study. This is a necessary condition of the kind of research I have attempted to carry out; only chemistry graduates/teachers can take part in such a discussion with me and fully articulate the experience of career choices I am discussing with them. By choosing to interview graduates who eventually chose to teach, I am not considering chemistry graduates who did not become teachers. Therefore, I will be unable to compare the differences between these two groups, which would be an interesting thing to do, but beyond the scope of my study;
2. *Small sample size*. My sample includes interviews with seven teachers in addition to my own autobiography. This is a small sample but the data produced is rich and is being viewed through different lenses and my focus is on the complexity of their evolving identities rather than the quantity of different types of changes;
3. *Generalisability*. In the strictest sense my results will never be generalisable. However, I am using my gathered narratives to investigate individuals' unique experiences which will illuminate their wider world which, in turn, raises points about the recruitment of chemistry teachers which act as a different perspective to already published studies;
4. *Accuracy of descriptions*:

a. *Retrospection*. All my interview data concerns a retrospective verbalising of mainly non-verbal experiences. Time will have elapsed, sometimes by a few decades, between the experience being described and the description itself. One can see this as a disadvantage because the recollection of the experience has become dulled or distorted over time, but it could also be an advantage because it has been reflected upon and rationalised with a wider life-perspective. My own autobiography can therefore be seen as a primary document produced by me as the main subject involved but also as a secondary document (McCulloch, 2011) through my attempts to analyse what has taken place throughout my life leading to the point of writing it;

b. *Confabulation and psychological defensiveness*. As I share a context with all the participants, confabulation is a real concern to me. Will my interviewees 'fill in the blanks' of their collected memories, unconsciously, in a way that they perceive will please me or help me? This is an inevitable danger in interviewing people the majority of whom know me and share a chemistry teacher identity with me. Hycner (1985) describes psychological defensiveness as a potential issue to be aware of here, but in my use of the Kleinian 'defended self' described previously, I hope to turn this to my advantage to tease out the nature of these influences, for example the role of family members in career choices;

5. *Subjective influence of researcher*. I cannot claim to be a wholly objective judge of my narrative data and, in fact, if I was then it would detract from what I am trying to describe and investigate, namely why people, including myself, make certain career decisions. I am actively attempting to compare the participants' stories to my own and their defences to my own, to help broaden understanding of how people make these decisions;
6. *Validity*. As has already been discussed in 4.5, I have checked my initial conclusions with the participants themselves, as well as with my supervisor and a group of education students and academics;

7. *Replicability*. My interviews produced joint meaning in the same joint space which generated the data presented here and although they are unique to this space, they offer the opportunity to explore the complex factors at work when people make life decisions in a manner that can pick up on nuances and contextual factors at play;
8. *Absence of control groups*. By their very nature, such studies cannot have a control group. I have considered the participants to be unique individuals and finding common themes or defences between them, or differences, is what I have done. The approach taken in the natural sciences is not applicable here;
9. *Absence of hypothesis*. I have been open with my analysis of my interview data; yes, I have a research interest but I have not wished to restrict this analysis against a narrow hypothesis;
10. *Absence of prediction*. I am not seeking to predict major decisions made by individuals, as part of their complex life, but rather explore these decisions retrospectively and compare them with others.

When constructing the 'face-value' themes I went to and fro from my audio-recordings and transcripts to my gathered themes, then gathered suitable excerpts from the participants which were illustrative and detailed enough to provide context for the reader. I was very conscious of the ease with which very brief excerpts could distort what the participant was saying. When constructing my defended subject analysis, I used a similar strategy but this was much more challenging to carry out, as defences are subtle and may be found underneath the literal meaning of the words expressed. Here I was looking to identify particular manic and phobic defences, or their counters, and then compare the participants in terms of which defences they used, then compare these defences to the story they had told, which I had already considered in my first analytical pass. This comparison allowed me to attempt to judge the extent to which what they said matched what their defences suggested and therefore draw out nuanced meaning that was not always so obvious at face value.

4.4 Ethical issues

Choosing to interview one's colleagues offered obvious advantages to me where time available for my research is at a premium being a part-time researcher. Knowing the interviewees, some very well, influenced the nature and conduct of the interviews, as I have discussed earlier. Nevertheless, ethical issues are always crucial to any research that involves other people and their lives.

Although it was unlikely that my interviews with these teachers would touch on controversial issues or topics that could prove embarrassing to them, they would still be personal and potentially recount positive and negative life experiences and third parties such as family members, school friends and teachers. Therefore, I decided early on to anonymise my interviewees' names throughout my thesis. A participant is considered anonymous when the researcher or another person cannot identify the participant or subject from the information provided (Cohen et al., 2011). A subject agreeing to a face-to-face interview can in no way expect total anonymity; at most, the interviewer can promise confidentiality. The principal means of ensuring confidentiality is by not using the names of the participants or other means of identification.

My major ethical concerns about this study related to that fact that the majority of my study took place at my place of work, which means the school will be identifiable, via the internet, from my name despite affiliating myself to the UCL, Institute of Education rather than indicating the school's name on publications. Raffe, Bundell, and Bibby (1989) have shown that maintaining anonymity is sometimes difficult when, for example, combining data may identify an individual or institution, so I wanted to therefore ensure that individual members of staff were not identifiable to any of my readers, even if they were familiar with my school and its staff. Using anonymised names allowed me to achieve this, except in the case of any interviewees expressing a narrative thread that unknowingly exposes their real identity to someone who knew my school well. I did not want to lose any important threads from my stories but wanted to maintain confidentiality. Therefore, I decided to seek to interview a small sample of teachers from a different school. This made analysis slightly more complex as it introduced extra

variables – shared context versus non-shared context as well as knowing me personally versus not. However, it would be very difficult for a reader to identify one of my interviewees unless they knew one of them very well.

Therefore, the members of staff from both schools are non-identifiable from each other with one exception. My biggest dilemma involved one member of the Chemistry department who was also the Head teacher of the school I work at. That he had this role is a very large part of his narrative, as well as having a profound influence on the power dynamic between us, and I felt it was important to tell this part of the story. However, the school where I work would be identifiable to a reader who knows me or researches me and this, therefore, identifies this particular interviewee beyond doubt. I therefore decided to seek his permission to use his real name in my transcripts and my thesis, for me to be able to try to consider his story to the fullest extent that I was able. He granted me consent to do this.

Informed consent has been defined as 'the procedures in which individuals choose whether to participate in an investigation after being informed of the facts that would be likely to influence their decisions' (Diener & Crandall, 1978, p. 57). When I first broached the idea of being interviewed, particularly with the Head teacher, I made it clear that there is a possibility that a reader of my thesis/other publications could identify the school and hence speculate about staff identities. I used names in my writing to make it more personable, but they are pseudonyms which preserve gender identification. I addressed any potential concerns that interviewees may have had regarding being identifiable and hence possible discomfort or embarrassment by acknowledging this potential identifiability and that they might not be prepared to be interviewed. After the interview, I provided a summary of the main points we discussed for the interviewee to verify. Informed consent is a cornerstone of ethical behaviour, as it respects the rights of individuals to exert control and make their own decisions (Howe & Moses, 1999) and I made the above clear in the letter and consent form provided for all potential interviewees (see appendix 2).

Although the Head teacher is in an important position as a representative and figurehead of my school, I did not foresee a likelihood where his responses in my interview would compromise this position. The focus was on him personally and his decision to teach, rather than how our school runs or its abiding philosophy. Nevertheless, I spoke to him about this and sought his permission on the above basis.

I had the advantage that, from my perspective, I already had a good working relationship with the staff who work at my school, so I could speak to them about any concerns they may have at any point during the research. Although I am the line manager of three of the participants, I do not feel this research prejudiced this in any way, although this power dynamic is important to the research itself. I was trying to find out about their story and compare it to others rather than sit in judgement of decisions they have made, although I acknowledge that they may not have seen it this way.

In some respects, the interviewees that I did not know previously were not as complex to consider, as they did not have to moderate their comments to me in terms of me working alongside them and their knowledge of me. However, my position as an outsider may have influenced my ability to put their minds at rest or to trust me with the ethical design of my study. Therefore, it was particularly important for me, from both an ethical point of view but also in a bid not to skew my data, to explain to these interviewees how my study was organised and how I was negating any risk of their identification, as well as preserving their right of reply and censure.

I have kept all computer files from this research on my home computer which is password-protected. I kept a backup on an encrypted password-protected USB drive. The only people who have any access to these computer files are me and my supervisor. I shared relevant printed excerpts with my interviewees when I carried out some analysis and I also shared anonymised sections of chosen transcripts with other academic staff who assisted me in validating my analysis. At no point was anyone able to keep any of this printed material outside of the participants themselves, myself and my supervisor.

I sought ethical clearance based on the above for my own school, under British Educational Research Association (BERA) guidelines, and gained this in December 2014. I sought, and gained, additional clearance to carry out interviews in another school in November 2015.

The modus operandi for narrative interviews is that they are conversational but allow the interviewee free rein to talk about their life history. Therefore, my input was largely asking the interviewee to elaborate on an interesting point or to relate their story to my own, to keep conversation flowing. There was no intention to put an interviewee on the spot or to ask 'awkward' questions, as a supportive atmosphere must be developed for the interviewee to feel comfortable about telling part of their own 'story'.

I transcribed the interview data and analysed it thematically as well as from a defended-self perspective. Rather than present the participants with unwieldy transcripts, I gave each of them a précis of my thoughts regarding their interview and the key influences upon life decisions they had made (see appendix 3); this allowed me to partially validate my thought process and, more importantly, gave my interviewees a chance to disagree or to comment on an emphasis I had taken. They were also able to express any issues they may have had with what I was planning to say in my thesis. I planned to abide by anything they wished to be changed or deleted from my analysis of their interview, although none of them chose to request this of me.

4.5 Reliability and validity

This research has considered the key influences on the career trajectories of chemistry teachers and what we can learn about recruiting into STEM teaching roles from teacher narratives. In order to do this, I have first told and examined my own story which has allowed both me, the researcher, and you, the reader, to view my interpretation of others' stories in terms of my own. Maxwell (1992) argues that qualitative researchers attempt to replace the positivist notions of validity with the notion of authenticity. We, as researchers, are part of the world that we are researching, and we cannot be completely objective about that – all perspectives are equally valid. Validity therefore is the meaning that subjects give to data and inferences drawn from it. I will present this meaning as I see it and invite the participants to voice an opinion as to these meanings applied to their own stories.

The participants were interviewed once each in a semi-structured and conversational way and then I used different lenses to undertake a thematic as well as a defended self-analysis of my data. These two lenses were used to try and complement, as well as challenge each other's interpretation of the data collected. Narrative research produces claims about the meanings different events hold for their subjects (Polkinghorne, 2007) and therefore makes claims about how these people understand particular events, others and themselves. Perelman (1982), when providing guidance to narrative researchers in making persuasive arguments, suggests that the researcher leads the reader through a progression of evidence and explanations of why particular explanations are being offered, almost in mapping out their thought process, something that I have done throughout chapter 6.

Triangulation may be defined as the use of two or more methods of data collection in the study of some aspect of human behaviour (Cohen et al., 2011, p. 195). There are a variety of types of triangulation and Denzin (1970) produced a typology, four of which are often used in educational studies:

1. Time triangulation: comparing longitudinal and cross-sectional designed studies;

2. Space triangulation: comparing, say, different schools within an area or country;
3. Investigator triangulation: different observers independently consider the same phenomenon e.g. in the classroom;
4. Methodological triangulation: where the same method is used on different occasions or different methods are used on the same object of study.

In planning my study, I wished to widen my participant base to include teachers who did not teach at the same school as me. This allowed me to consider if similar themes emerged from their narratives as from my own and my colleagues', which enabled me to negate the idea that any themes generated were specific to my school or only generated due to a pre-existing relationship between researcher and participant.

This also allowed me to use space triangulation, albeit within a small study. My use of different interpretive lenses is an example of methodological triangulation, where the same data set was examined in two distinct ways which augment each other

To reduce invalidity, I have sought to:

- Seek some respondent validation by giving a summary of my thoughts post-analysis to each of the participants and give them the opportunity to comment and/or dispute any of my interpretations;
- Avoid subjective interpretation;
- Reduce the halo effect, where knowledge of the person skews interpretation. This has been difficult to legislate for, as my knowledge of my colleagues adds another layer to my co-construction of their narrative. Nevertheless, in my analysis I have concentrated on the words they said during their interview and the nuanced picture they presented, rather than adding to this from prior or subsequent knowledge of them;
- Avoid poor coding. My analysis was not coded in the traditional sense, rather successive readings of the transcripts and hearings of the audio-recordings were used to generate themes or instances where a defended

participant could be detected. Illustrative quotes were included where I was making a particular point, so my reader is at liberty to consider these at face value and consider their validity in terms of believability, which Polkinghorne (2007) says is how this should be considered;

- Avoid making inferences and generalisations beyond the capability of the data to support them. I was not seeking to generalise from my narrative interviews, but rather consider different influences that have affected the participants and hence discuss what we can learn about teacher recruitment from their stories and, in comparison with the wider literature, suggest areas that may prove fruitful to investigate further.

All five of the above pitfalls were possibilities in my research analysis, particularly when coding my data against Kleinian defences which can be quite subtle to spot and interpret. I was also concerned that knowing some of the participants might skew my analysis of what they said, so I wrote a very brief summary of my thoughts regarding each of the participants' stories and emailed it to them and invited them to comment if they wished (see appendix 3 for two of these summaries). The participants each thanked me for getting back to them and some of them offered me the opportunity to contact them again if I had any further questions, but none of them offered any alternatives to my summaries or disputed them in any way.

Separate to seeking respondent validation, I also shared two of the interview transcripts (Claire and Sonia's) with a mixed group of education students and academics and gave them an opportunity to comment on the data and then some of the interpretations that had emerged from them. This peer validation referred to by Loh (2013) in his discussion of trustworthiness of interpretation of narrative data, bolstered my belief that these narrative interviews were a rich source of data and that interpreting them in the way I intended could add to the literature in the area. Many of their suggestions or issues were taken up as the research proceeded, such as using teachers from a second school and to consider questions of power as well as what I mean by the word 'chemist.

Loh (2013, p. 9) asks two key questions 'if a narrative study is about the participant's particularized meaning-making interpretations, then how can it be of any relevance or use to the consumers of this study? If the study is not of use, then what is the raison d'etre of the study?'. He suggests that an author of such research needs to address two issues, that of verisimilitude, and that of utility. Verisimilitude, where an account 'rings true' to someone in a similar position can be seen when a story resonates with the reader, something I experienced many times during the research process whilst speaking to other chemistry teachers and attested to by my supervisor, an ex-chemistry teacher, when discussing my transcripts.

Utility is considered by Riessman (2008) to be the acid test of a piece of narrative research. Is it useful to the communities which it is aimed at, in this case the educational research and teaching communities? Eisner (1998, pp. 58-59) gives a list of three criteria by which to test a study's usefulness, its "instrumental utility":

1. Comprehension: can help us understand a situation that would otherwise be enigmatic or confusing;
2. Anticipation: provides descriptions and interpretations that go beyond the information given about them;
3. Guide / map: highlights, explains, provides directions the reader can consider; deepens and broadens our experience and helps us understand what we are looking at.

The narrative approach used here has aided comprehension of the world of teacher recruitment through examining the nuances of individual teachers' narratives and comparing these to a wider, largely quantitative, literature. It does not seek to refute this literature but to augment it and suggest that influences on individuals are more complex than might have been thought from the large body of work produced using the FIT-choice scale discussed in 3.3.2. The interpretation presented here does go beyond what the participants said as I have sought to explore the bigger picture particularly using the defended self lens where subconscious defences are used by the participants. The comparisons I have drawn, between the narratives gathered here and the wider literature have

allowed me to suggest potential interventions for undergraduate students which could influence the teacher recruitment debate in this country.

5 Analysis and discussion

5.1 Introduction

I decided to structure this chapter in a slightly unconventional way, combining analysis and discussion. I chose to do this because I am trying to weave together narrative threads from eight people, including myself, and I wanted to give a sense of my interpretations of their subtle nuances within my analysis of my interview data itself. This allows the reader to formulate his or her own interpretations alongside my own rather than artificially divorcing these two simultaneous processes.

Throughout my studies I have considered my own story at different junctures, as well as interviewed seven other chemistry teachers. I have uncovered key influences in the lives of these eight teachers and compared and contrasted them with each other, exploiting the potential richness that narrative interviews can reveal about their decision to become, and continue to be, educators. I reveal how decision making can echo other influences in our lives and aid renegotiation of our identities within these influences. As I introduced in section 4.3, I used thematic analysis to tease out larger themes and examined these within the context of the wider narratives the participants have presented to me. I also viewed the same narratives using the idea of the 'defended self' (Nimier, 1993; Waddell, 2002). I compared what these different lenses reveal and themes revealed by the participants through their defences, which uncovers different motivations they may have had in making life decisions. In this chapter, I will examine my own story, as it provides the context and backdrop for the rest of my analysis.

5.2 My story

Structuring my analysis in this way is unusual, but as I have mentioned previously, my own story is crucial both in terms of my own meaning making and analysis of other participants' narratives. The joint space that my interviews took place in was influenced by my own story, as well as those of the interviewees. It is important for me and my readers to try to understand my own influences and defences before considering my interpretation of others'.

Attempting analysis of one's own story is a peculiar business, and not entirely straightforward. I have been teaching for twenty years and have often been asked by students why I became a teacher or why I did not use my qualifications for a variety of differing outcomes. Therefore, I have been presenting my own chemistry teaching narrative to others for many years and renegotiating it in my own mind. I would suggest that it is within human nature to present big life decisions positively when viewed retrospectively. I am still a chemistry teacher, so my current identity is somewhat threatened, and even belittled by, the presentation of a negative narrative. This is not to say that my story is not genuine, but will reflect me as I am currently and not me when I made these big life decisions. My thirteen, sixteen, eighteen and twenty-one-year-old selves might not agree with my interpretation of their decisions with the benefit of hindsight. As Berryman (1999) puts it, autobiography is a series of paradoxes: fact and fiction, private and communal, lessons and lies.

This is also true for the narratives I collected from my interviewees, all at different points of their teaching careers, but also presented me with a hindsight view of their decision processes at key stages of their lives. Considering how successful chemistry teachers view these decision-making processes still revealed key influences on these decisions and therefore how these may affect recruitment of teachers in the future.

I wrote my own story three times during this research project, the third of which is presented verbatim in appendix 1. It may seem strange to attempt to analyse your own narrative, but in some ways, it is no different than trying to analyse the transcript of an interview you have carried out. I aimed to try and divorce myself

from the autobiographical mode and looked critically at what I actually wrote focusing on themes around career choices and trajectories. Tenni et al. (2003) acknowledge that this autobiographic approach is well established in disciplines such as education where self-reflection is so important. They suggest engaging in cycles of data gathering and analysis, mirrored in my writing and reading my stories multiple times. As looking into data produced by yourself about yourself depends upon 'understanding one's defences and sources of resistance to difficult, unexpected and sometimes extremely confronting information or our reactions to such material' (Tenni et al., 2003, p. 6), I applied the same rigour in examining my own defences that I used in examining my other participants' as my analysis proceeded.

I considered influencing factors from my story in light of my reading regarding how these influences may have acted. I mention my parents and their background immediately in all my accounts. There is a pervasive theme of support and aspiration throughout my writing; I comment on discussing my learning with them throughout my schooling and their interest in these conversations and encouragement to continue learning. This resonates with Riddle's (2010) writing about middle class British parents being more likely to have the educational background themselves and, as Bourdieu (1986) describes it 'social capital', whereupon contact can be used and work experience could be organised and advice sought on matters to do with university entrance, school studies or the world of work. In their work on career decision making, Hodkinson and Sparkes (1997, p. 33) suggest that young people are rational when making career decisions, basing this on advice from friends, neighbours or relatives and therefore their decision making is context-related and 'cannot be separated from family background, culture and life history of the pupil'.

I suggest my father's background as a physics graduate was important as without him, and before the internet, my resources outside of school for indulging my interest in science would have been limited. Perhaps, coming from this particular background was even more important for someone of my age as there are more opportunities nowadays for students to pursue their academic interests without

direct support from home. Many of my students devour information about wider science via the internet and their parents acknowledge at open evenings that their child's knowledge has far surpassed their own. My dad's influence is multi-faceted: promoting the idea that I can be successful/do science/be a graduate, but on the other hand pushing me away from physics, something I comment upon in each account, although I always relate this to the subject itself, as well as my father. Would I have studied chemistry had he been a chemistry graduate? I appear to situate chemistry as the most interesting and positive of the sciences across my writing, although that is almost inevitable from my current standpoint. This defence of me as a chemist is something I will examine, alongside that of my other participants, later in the chapter.

Towards the end of each account I comment on why I decided to do teacher training, and not a PhD in chemistry, suggesting how my aspirational identity had encompassed university but had been influenced by it against taking academic study of chemistry forward. My accounts are superficially similar to each other but also prioritise different facets of the story. Common is the idea of not being good enough for post-graduate study within chemistry, both in terms of unfavourable comparison with my peers and experiences doing my undergraduate research project. In my latest account, I present a 'seminal' moment when I discussed the possibility of remaining at Oxford for post-graduate research which was not particularly encouraged by my then supervisor. I remember this meeting well, but did not mention it at all when I first wrote about my story. Looking back on writing these stories I find it hard to understand why I did not place this anecdote into all my versions, but I can only suggest that putting this down on paper acknowledges the feeling of deflation and failure I felt at the time, something important but hurtful to reveal to others. Nevertheless, good autobiographical data should include the self-doubts, the mistakes, the embarrassments, the inconsistencies, the projections and that which may be distasteful (Cherry & Bowden, 1999; Tenni et al., 2003), so it might not be pleasant for me to write about but it is important for me to do so.

The phenomenon of the scientific elite ensuring the 'right' next generation of scientists carry on their legacy is written about in the literature. Aydeniz and Hodge (2011) write about this very thing and suggest science educators (Balinsky, 2006) draw attention to the culture of teaching in the sciences and argue that science professors intentionally make their learning tasks difficult in order to select the best students and to feed them into the 'elite' culture of science, which has earned them the privilege. Scantlebury (2002) maintains that this culture and ways of engagement with the teaching provided forces students to adopt marginalised positions and develop identities which hinder their engagement with science.

On one level, I feel that my position at the time was marginalised. The impression given to us was that the work we were being set weekly was relatively straightforward and that your struggles were an indicator of your own lack of ability rather than a reflection of the work being challenging. This teaching approach, well established at an institution like Oxford University, promoted a feeling in me of not meeting some unknown standard which influenced how I saw my academic future. What I now realise is a continuum of opportunity seemed, at the time, to be a binary one of 'good enough' or 'not good enough' and that it was clear to me at that I was in the latter category. This determined potential plans for my future, despite nobody having articulated any of this to me directly. This view of my studies in a Kleinian paranoid-schizoid (see section 3.6) way perhaps goes a long way to explaining my investigating other options, away from academic chemistry, and it is only in retrospect that I have moved to a more depressive psychological position seeing chemistry both as good and bad.

My angle in the first account was that I had reached my limit academically but wanted to remain within a sphere where I had been successful in the past, namely school level chemistry. In my latter account, I explicitly linked the decision to do my teacher training to not wanting to 'waste all these years focusing on chemistry to then go and sell chickens or add up numbers in an accountant's office'. I presented the options, as I saw them, as science in industry or teaching with a rejection of science in industry quickly following. I find it interesting, in

hindsight, to note my perception of the acceptable career routes open to me when, in fact, I could have headed in many different directions; also, the way in which I am seeking to justify decisions made a long time ago in light of choosing to teach being a positive in my current identity. My initial angle is a 'positive' one of looking towards an area where I had experienced success, my latter one more 'negative' in terms of not wasting all this perceived effort I had put into getting my degree. I made no reference to the benefits that studying chemistry might have given me, in the wider sense, something I did acknowledge in my initial account. The irony here is that the rhetoric of chemistry teachers, myself included, and by the universities, is that studying chemistry has many potential benefits separate to the interest one might have in it inherently.

When discussing my option choices at school, I generate a narrative that ultimately rejects biology and physics in all my stories. This says a lot about how I perceive them and how strong my prejudices are. Science can be seen as being artificially segregated into separate disciplines which have so much overlap it may be almost meaningless to do so. Nevertheless, I am a product of a system which does separate them, as well as a teacher in a system which continues to do so. My comments may be a little on the facetious side but they do imply either a pride in chemistry, a feeling that it is a superior discipline perhaps engaged in a battle for supremacy with biology and physics, or a genuine feeling of interest in it in comparison with the others. I suspect we are all unduly influenced by events when we are young and my dismissal of biology, sadly slightly retained even now, is partly caused by seeing a teacher dissect a cow lung in front of me in secondary school which made me feel sick. In the cold light of day, dismissing a whole academic discipline based on a demonstration at school seems churlish, but is probably part and parcel of many of the life decisions we all make. In primary school, I remember being made to finish a spotted dick pudding with 'lumpy' custard and I have refused to eat this dessert ever since and even its mere mention makes me feel queasy. I associated biology with body parts which I did not want to see or smell and this is one of the main reasons why I have never studied it, despite having realised as an experienced chemistry teacher how fascinating biochemistry would be to study.

As for physics, I did study this for three years at school and largely enjoyed it, but I preferred the practical work in chemistry and the interconnection between these practicals and the theory we had learnt grabbed me, despite physics also having a very similar approach linking theory and practical work together. Interestingly, studies into practical work suggest that during practical work in UK schools, the teachers' 'presentation of the task, and the discussion of students' actions and data, was on the substantive science content rather than on aspects of experimental design or the collection, analysis, and interpretation of evidence' (Abrahams & Millar, 2008, p. 1965), which for the authors is an issue with developing pupil engagement with the scientific method, but for me was allowing me to verify theory in a stimulating way. Both subjects involved learning some theory in class followed by subsequent practical activities, but chemistry practical work would usually involve observing something obvious and stimulating (to me at least), such as a colour change or observable change, whereas physics practicals seemed to involve lots of measurements and subsequent graph plotting to establish the link to the prior theory. I remember thinking as I mixed two chemicals, this should turn blue or form a precipitate and when it did, it gave me intellectual satisfaction that chemistry 'works'. Physics practicals seemed to defer this satisfaction to the point of it not being particularly satisfying, as well as the fact that they did not seem to work half the time! There are a multitude of reasons why a young person may be motivated to continue to study a subject, one of which is an existing personal interest (Abrahams, 2009), something I had for the sciences, but practical work helped to push into the chemistry area over that of physics.

I also comment about my father's background in physics and I am serious in expressing how this would have made studying physics at university less desirable. Whether this is in the sense of wishing to follow a distinct path, to avoid unnecessary competition and comparison with him or to be able to move ahead in one particular area I am not sure I can say, but I am sure this was an influence on me. He both opened the world of science and aspiration within science, but arguably (unintentionally) narrowed my choices as well.

Another facet of my writing that my autobiographical narratives all share is mention of one of my secondary school chemistry teachers. All my accounts echo that he met my needs well, as a student. I was a relatively quiet and shy student who felt more confident in an organised, calm and strict classroom. Moore (2004) reviews the dominant discourses in teaching and teacher education in his book, 'The Good Teacher' and talks about teachers as charismatic subjects, competent crafts persons and reflective practitioners. He comments that students talk about their good teachers in terms of personality and not in terms of what they learnt and I exhibit this. The extent to which chemistry suited me is entwined with learning the subject within an environment that suited me. I would say that my teachers were important in my narrative, but it may not be a case of the usual cliché where a teacher 'inspires' their student with the subject; perhaps they instead facilitated my discovery of the subject. Chemistry itself must be playing its part, however, I also was taught other subjects by strict teachers who I liked and respected, but did not identify in the same way with their subjects.

On reading these accounts again, one thing jumps out at me – I state in all of them that I knew I would study chemistry at university when I was thirteen. This demonstrates the certainty I had that I would experience higher education, despite me also being consistent in the view that I did not realise I was particularly academic until I started sitting for external qualifications, at around fifteen years of age. This says a lot about the family and school culture I was brought up in, neither of which felt pushy or ambitious, at the time or in retrospect, but there must have been a very consistent assumption underlying in terms of where school qualifications can and should lead. That I identified so strongly with chemistry, as a subject, almost from the outset of studying it as a distinct discipline is interesting and hard to ascribe just to a single effect. I suspect the reality lies between a genuine interest, a natural aptitude and possibly most importantly, of success academically; I was interested, yes, but I always did well in assessments in the subject – my place within the year was higher in chemistry than in any other subject. Does academic success in a subject, above others, inspire an interest

which, although genuine, was not in fact as natural as it might look many years down the line, when viewed as a chemistry graduate?

My own story seems to revolve around a genuine engagement with the chemistry I learnt at school augmented by the satisfaction I gained through success in it, coupled with a drive to attain a high level of education, an aspiration coming from my family as well as the schools I attended. The assumption in my own mind that I would attend university must have developed through seeing this as a norm, within my extended family and friends' families. I was under the impression that attending university would give me access to a variety of careers in the future, so I did not particularly worry about this until I was coming towards the end of my undergraduate studies. Chemistry acted as the conduit through which I would reach this graduate status and may have played little further part in proceedings, but my interest in the subject was strong enough to make me resistant to moving away from it. The congruence of my interest in chemistry, my relative success academically and the comparison with even more successful contemporaries, as measured by our relative positions in the undergraduate academic pecking order, blocked the obvious progression towards chemistry research and pushed me towards teaching.

My own trajectory towards being a chemistry teacher has been influenced by the subject itself, the level of education in my family and the consequent, perhaps unsaid, expectations upon me, as well as the influences of my peers at university, although I express this in terms of not being good enough at my subject. My own teachers, although weaved into my story, appear as secondary players in the journey towards chemistry and of little influence towards becoming a teacher myself. It was of great interest to me whether the other participants in my study would talk about similar influences and, if so, whether the same influence, for example parents, influenced them in the same way.

5.3 Teacher identities

At the end of my data collection I had recorded eight stories (including my own) of current chemistry teachers reflecting on their journey to where they found themselves at that point in their careers. My relatively short interviews however only gave glimpses into seven of these far more complex lives, so my challenge was to view these glimpses and compare and contrast them to each other, as well as my own story, to attempt to understand different influences at play for prospective teachers.

From my reading of the transcripts and my own story write-ups, I decided to focus my analysis on four themes: parents, teachers, chemistry and teaching experience, all four of which have been reported as influences previously to a greater or lesser extent (Heinz, 2015). These overarching influencing themes emerged from my data after a process of reading my transcripts and identifying anything which came up in more than one interview and then looking for whether this was mentioned in most the narratives. I attempted to cycle in and out of my interview transcripts, selecting possible themes and then examining these against the rest of my data set. Once themes had been identified I considered the wider context that participants set this theme against to enable to me to attempt to unpick aspects of the participants' decision making processes.

I will discuss each of these themes in turn and, where appropriate, illustrate this discussion with quotes from my interviewees:

- the interviewee's name (gender maintained pseudonym) will be included in round brackets (xxx) after each quote attributed to them;
- italicised quotes will be mine, followed by my name (Alex);
- additional guidance to help make sense of a given quote will be in square brackets [xxx].

5.3.1 Parents

Parents and parental influence pervade all eight of my stories. On the one hand, this would not be a surprise to any reader as almost all children grow up with a parent or parental figure in their life whose values and behaviour shape much of the lifestyle and outlook of the child. However, it is very obvious that my interviewees reported very different influences from their parents as they looked back on some of their life decisions. Sawitri, Creed, and Zimmer-Gembeck (2015), in their research in Indonesia, examined two important contextual variables that have been found to affect individual career progress. The first of these was parental career expectations, which have been shown to influence educational and occupational aspirations and commitment to occupations chosen (Fouad et al., 2008). The second variable was parental support, which includes encouragement, instrumental assistance, modelling desired behaviours, and emotional backing (Garcia, Restubog, Toledano, Tolentino, & Rafferty, 2012). My own data shows both influences of parents on their children.

For some, parental influence is obvious and direct, particularly when the parent concerned was in a professional career themselves. Aaron and Richard particularly exemplify this influence.

> So, I did at sixth form, my grandfather's a doctor, my father's a doctor, young Aaron too shall be a doctor and I started my A levels in Biology, Chemistry, Maths and Physics. I'm not sure at the time if I was particularly interested in any of them or if I was particularly interested in being a doctor, but it is the path that life had dictated for me. (Aaron)

To use a word like 'dictated' suggests the direct nature of the parental influence at play in Aaron's teenage life. He went on to discuss how he did not want to study medicine, but also did not want to displease his parents so went on, not only to study these subjects at A-level but to gain places at two medical schools, one of the most competitive routes any UK school student can take.

> I didn't want to go through it [medical school], but despite that, I didn't want to tell my parents I didn't want to go through it, so applied for four of

> five different medical schools and got a place to study medicine at King's and at Queen Mary. (Aaron)

Richard's parents are both accountants and their views, particularly his father's, on suitable career paths for their son were explicitly expressed.

> I took a year out between school and university working for a firm of accountants. Both my parents are accountants and so they were very happy with that, it's a profession, they saw that as being a very professional move that would maybe end up in a situation that they themselves could sort of empathise with and encourage. So when I decided to go into banking they were like, that's a bit spivvy[14] for want of a better word! They were concerned that I was going to lose some kind of moral fibre in me for not following a proper profession. (Richard)

Rather than necessarily expect a specific career path, like Aaron's parents seem to have done, Richard's seem to have values associated with particular job roles. He planned to go into banking after university, largely for the rewards that such a career can offer but his parents seemed concerned that he might end up showing less moral consideration, going down this route, than in others. The two teenage boys depicted seem to have been very clear as to their parents' views on career paths post school, but handled this in different ways, Aaron seeming to acquiesce to parental aspirations, Richard in confronting them head on with the decision he had made. Nevertheless, Aaron does confront the issues at hand in the end whilst on a year abroad.

> I think about, it didn't take me very long, about a month in, I decided to 'fess up' [confess] to the parents and tell them I didn't want to do medicine. My mother claims that she always knew, my father was a smidgeon disappointed I believe… they were very accepting which is often the case with the things that you are most terrified to tell your parents, they are very accepting of and they were accepting but with, my mum

[14] A man, typically a flashy dresser, who makes a living by disreputable dealings.

> said she always knew I wasn't going to do medicine, she just always thought it wasn't going to be the path that I went down. (Aaron)

Aaron uses the word 'terrified' to describe his emotion on confronting his parents with his decision not to study medicine, despite holding a place to do so. This exemplifies the importance he put to his perception of his parents' aspirations for him and the worry over feeling he was going against this. The other stories do not relate such explicit drives to particular careers but do reveal distinct influences to follow in broader footsteps.

Sonia, Sachin and Sara all mention parental background or occupation early on in recounting their stories. Unlike Aaron and Richard, all three seem to have been influenced into the direction of the sciences, rather than into a particular career path. Sonia's father, an academic, espoused the value of education and the sciences.

> He was quite the rebel in his family and so everything he ever taught us was about having disdain for money I guess. But it was a healthy distaste; and so we never really thought about a career in terms of great wealth; it was always about educating ourselves in a very academic way I guess… So, I thought, oh ok, one of my sisters had done biochemistry and one of them had done I think microbiology and my brother did physics; my sister who's a bit older than me did art, she was the one that got away; my dad, for some reason, let her do that art. Yeah, I don't think it was really an imposition but I think that he thought that about science. He was so into metaphysics and finding out about the absolute and so on and so on, he thought it was an important training for us, in many ways; we had that method and that specific way of thinking, that methodical desire to find out about life. (Sonia)

Sachin echoes this leaning towards the sciences in his family:

> As a kid in school and stuff and I think probably having a dad who was a technician in a school and having a mum who was also a technician in a school, so having that connection was always surrounded by science and

> surrounded by school and education talk and growing up with that; it was always a thing that I was around, so I chose science A levels, they weren't actually the subjects I did best in, I did better in my history and my geography and my French and all that but I felt that I had more of an interest in the sciences… Most of the people in the rest of the family were all some kind of science type backgrounds – dad's brother was an engineer, my mum, two of her brothers were professors, the other brothers were all sort of engineers, her sister was a doctor, so it was always kind of in the family background so I did the sciences at A level and really enjoyed them. (Sachin)

Sara also talked about her family where she and all her siblings studied chemistry or chemical engineering. Without saying so explicitly she implied that the sciences were seen within the family as having utility to lead one to a fulfilling career with a good deal of material benefits.

> My older brother who… most my family are investment bankers with chemistry degrees. We all did chemistry degrees; he was working in a bank, basically, my sister was working in publishing as a translator, and she did chemistry with management, and that sort of stuff and they'd be like come and watch what we do. I went along and saw what they do and thought this is so boring, I can't do this either. I thought what am I gonna do with my life? I'm now getting to that age where I must have a career of sorts. (Sara)

Six of my eight stories involve children of professional parents who, in more direct or subtler ways, promoted the idea of education and professional careers to their offspring, which agrees with research by Holmegaard (2015) in Denmark. One story is different, although in no way demonstrates less of a parental influence. Jonathan tells of his parents:

> My late father would have been disappointed that I became a teacher. He always thought I should have become an engineer, but I think that was partly because he thought I would start my own business and he wanted

> me to make money. That was where he was coming from. He was a tailor and he never went to university; he was bright enough to but the war came and there were family circumstances for him, so the fact that I went to university was a source of great pride for both of them. My mum was a shorthand typist and book keeper, so there was no science background from my parents. (Jonathan)

Despite Jonathan's parents not having had the educational opportunities afforded him, the aspiration towards engineering and starting/running a business is clear to see. Aaron describes in a very articulate way how immigrant families view education and the opportunities it can afford:

> Within most immigrant communities you have sociologists talk about a set number of generations: the first generation tends to come with nothing and work their ends off trying to achieve something so the next generation can go to school and the next generation ends up getting more professional and then the generation after that tends to be the higher professions, so doctors, lawyers and accountants and which is why so many kids at this school and so many people of my generation and my age will have parents who are doctors and lawyers and accountants… it's considered a respected profession and then so you have that generation where you've got doctors, lawyers and accountants and then the next generation they do humanities and whatever they want to because they don't have the same ethic of I need be this professional, I need to impress x, y and z. When my mum got engaged to my dad, they still say that my mum called up her grandmother and she was saying on the phone, I got engaged to this boy, and then asked how old is, what does do? Oh, he's a doctor, then silence, ooh, a doctor and that was all she needed to hear, as that's what it was like for that generation. It's not what it's like for our generation. That doesn't mean that the aspirations don't carry over so that's the context within which me and my social circle grew up in. (Aaron)

According to Salikutluk (2016) there are four main theoretical approaches in the literature to explain the aspiration gap apparent in immigrant communities

compared with the rest of the majority population. Firstly there is a perceived immigrant optimism approach, where the very fact that immigrants have left their country of origin suggests a drive towards socioeconomic improvement (Kao & Tienda, 2005) with the next generation being expected to be successful, with degree level education often being seen as the best way to achieve this (Heath, Rothon, & Kilpi, 2008). Secondly the idea of blocked opportunities takes the view that many immigrants assume that there are barriers for their children to overcome and that this spurs them into having high educational aspirations for the next generation, where becoming graduates will overcome these barriers in the more meritocratic world of graduate employment (Jonsson & Rudolphi, 2011). Thirdly a lack of knowledge about the education system in the destination country can bias perceptions and expectations of the next generation can be excessively optimistic or pessimistic. Lastly, parents who were educated in the original country are not considered good role models by their children/grandchildren so other family members, such as older siblings, can act as substituted role educational models giving younger siblings a lot to live up to.

All my interviewees were born and grew up in the UK, but some of them have explicitly stated that they were from an immigrant community, although second or third generation in the UK. The values and expectations that Aaron mentions within his own family resonate, in some respects, with the stories being told elsewhere by Richard, Jonathan, Sara, Sachin and Sonia albeit in different and subtler ways. The professional careers that they all describe themselves and their siblings working towards, when they were at school and university, seems telling to me, even though for some like Aaron and Richard this is in the light of having professional parents and others like Jonathan whose parents who were not but aspiring for him to become. For Claire and myself, our narratives suggest a supportive background where education is valued highly but we experienced less overt or actual pressure to go into particular fields of study or professions is expressed. Claire says of her parents:

> They've always been pretty easy going in terms of what I want to do; they've never forced me into anything. They're very much what makes you

> happy and what you enjoy and so they were pleased when I wanted to do chemistry and I think they wanted me to do something that was worthwhile and they think that it was worthwhile doing that. But when I told them I didn't want to do medicine anymore, and become a teacher, and drop down from a Masters and do a PGCE they were really supportive and they said, actually I think that is the right thing; I think you'd be well suited to that. They said whatever you want to do, we'll support you and so I don't think they've had a huge influence on me, but they've been very supportive. (Claire)

Despite the support from her parents that Claire is consistent in acknowledging in her interview, she also comments on how she perceives her academic place within her family:

> I thought they'd all say to do your Masters and then decide, thought my parents would be like that, especially my grandparents, my grandad, all of their reactions weren't – they were like yeah I think you're doing the right thing, that's more what we thought you'd be suited to. We never put you into the going into research category; no one had ever said anything to me but they realised that me in a lab for the rest of my life wasn't the thing… Yeah, I think I doubt myself a lot but I think there are a lot of jokes in my family, because my brother is so intelligent, that I am stupid; even this Christmas, it's always Claire we pick you last for a team – you don't know anything. In terms of general knowledge that probably is true but I think on the whole, all of the time, I'm the one that doesn't know anything; I'm used to that. I doubt myself and then sometimes I shock myself, I can do this! (Claire)

Claire views it as a positive that her family have supported the big decisions she has made, be it her subject choices at school, a wish to abandon an early wish to study medicine, to drop down from a Masters degree at university or to go into teaching. Nevertheless, also explicit in what she says is the feeling of being second best in her family to her younger brother and, perhaps, seemingly not being of the calibre to do certain things at university or as a career, similar feelings

evoked in me by my bright friends at university. We are not necessarily used to articulating how we arrived at these decisions but how we see ourselves, within our own contexts, profoundly affects our thought processes. It seems to be an inherent advantage of a narrative approach to begin to spot some of these subtle (or less subtle) influences.

It appears that the parents of all eight of us have had a large role in shaping our career identities from an obvious and direct way in the cases of Aaron and Richard where opinions of the relative merits of different options were articulated directly to their children, to the less direct of examples being set through their own lifestyles/choices or the indirect fashioning of one's place in an academic 'pecking order'. It would come as a surprise that one's parents or the adults you grow up with would not be key influences on your identity and values regarding education and career possibilities. This does not mean that we wish to follow in our parents' footsteps, I certainly have never felt the slightest urge to join the Armed Forces, despite both of my parents serving in the RAF[15]. Nevertheless, whether we seek to accede to their stated, or unstated, wishes for our futures or to rebel against these, they surely have a profound influence on us and our identity and therefore decisions we may make in our formative years and beyond.

I have summarised the perceptions I have picked up from my transcripts of primary parental, or wider family, drives alluded to by the participants in Table 2: Parental/family responses.

[15] Royal Air Force (UK)

TABLE 2: PARENTAL/FAMILY RESPONSES

Participant	Parents	Parental occupation	Position in family	Siblings
Aaron	Towards medicine	Dad = doctor Mum = charity CEO	2nd child of three	Not mentioned
Alex	Towards higher education	Dad = aeronautical engineer	1st child of two	Not mentioned
Claire	Towards higher education	Dad = finance	1st child of two	Younger brother studied maths at Oxford – compared to Claire
Jonathan	Towards business/engineering	Dad = tailor Mum = book keeper	Only child	n/a
Richard	Towards a profession	Dad = accountant Mum = accountant (Grandparents = teachers)	2nd child of three	One brother = doctor
Sachin	Towards a profession	Dad = lab technician Mum = lab technician	Not known	All siblings studied science
Sara	Towards a profession		One child of five	All siblings studied chemistry
Sonia	Towards a profession	Dad = academic	3rd child of five	All but one siblings studied science

There is a distinct difference between the implicit expectation of obtaining a good education, in the cases of myself and Claire, and the more explicit drive towards a professional career in the cases of my other participants, as if education may be a potential means to an end for them, but for us it is an essential ingredient for success. Despite the unquestioned and unwavering support for us, this parental drive towards higher education has led both Claire and me to question our own ability to achieve at this level, Claire questioning herself relative to her brother's achievements and me relative to my contemporaries at university. We both attended university, so this expectation had been met, but it was how far we would go with higher education – or what level we would reach, that became the issue. Our accounts do not say that our parental support for higher education led to this questioning, rather it led to our going to university and then questioning how far we could go. The point here is more to do with expectations from our parents about professional aspiration being less clear than for the others and then comparisons with peers being used to help make decisions on post graduate directions. This utility of degree for a professional career is differently expressed as a parental aspiration; for me and Claire it is more an aspiration to move towards higher education, for the others higher education leading to a professional career is expressed as a need to be professionals via the route of a degree.

This parental aspiration demonstrates a certain cultural capital apparent in both Claire and my families and the norms established within both. The cultural capital of a university education is present in all the participants in this study; our having become graduates is not of interest as this is obvious given our career choices, but all of us are in families where all our siblings, if any, have also achieved a university degree, which strengthens this idea of cultural capital within these families. However, for Claire and me, the attainment of this degree appears to be the significant driver, but for the other participants it seems to be what is done with this degree that drives family aspirations.

All the participants except Jonathan, an only child, and Aaron mention their siblings and Richard openly mentions competition between him and one of his

brothers, but only Claire implies that her perceived lack of academic ability, relative to her brother, has contributed to decisions she has made, such as dropping out of her Masters programme. This sense of an implicit family hierarchy is particularly strong in Claire's case and speaks volumes about parental influence, but in a very different way to my other participants.

In my other participants' families, some of whom are second or third generation immigrants to the UK, the pressure to enter a profession may seem to be demanding but in fact does not seem to have placed the burden of expectation as heavily on them as a more hidden but powerful expectation to attain a high level of education has done for me and Claire. Nevertheless, in my own case this family expectation to aspire towards university education appears to be just that, but for Claire the same expectation, allied with an acknowledged place within the family hierarchy has in some way capped her expectations for this aspiration.

5.3.2 Teachers

In the eight narratives, teachers appear for very different reasons and seem to play a smaller part than I might have suspected as measured against other important players in the stories expressed. As Timmerman (2009, p. 230) says in his study into teacher educators' lives, 'secondary schooling – as well as primary schooling – provides plenty of opportunities for young people to become familiar with the teaching profession'. Teachers are observed daily in their work by their students more than is the case for any other occupation, as well as engaging with them. Observing and engaging with a teacher are both aspects of what (Lortie, 1975/2002) called the 'apprenticeship-of-observation'. This apprenticeship gives young people an insight into the world of teaching and may set them on the way towards becoming a teacher themselves, or so I might have thought.

Nugent et al. (2015), in their work on learning and career development within STEM disciplines discuss the influence of peers, family and educators on these. They assert that teacher influence can be very strong through instructional practices as well as encouragement (Wang & Eccles, 2012) or the support students perceive that they receive from teachers for potential academic or career choices they are considering making.

A particular teacher seems to have had an impact on six of my eight subjects, but this person is not necessarily a chemistry, or science, teacher. Claire and I mention our chemistry teachers as important, and Claire waxed lyrical about hers although it gets relatively near the end of the interview before she mentions him, something she is surprised about when I remark on it, although my question to her is somewhat leading:

> I got on really well with my chemistry teacher at [Sixth Form] college and he's the one who influenced me, my passion for chemistry, if you'd asked me at school, I wouldn't have said chemistry was my favourite subject, I would have said I like all sciences. (Claire)
>
> *That's interesting, that's something we haven't heard before. In your story of becoming a chemistry teacher you've not mentioned him till just now,*

then you just said he's the main influence in you being interested in chemistry. And you're a chemistry teacher now... Can you tell me about him because it sounds like he might have been more of an influence here than you thought? (Alex)

Yeah he was a big influence, so I ended up doing chemistry, it's really bad. I basically chose chemistry, at the time, I'm not interested in forces as that's all I thought physics was, and I needed another A level and I had already chosen biology, which I liked, I knew I liked it from GCSE so thought I'd do chemistry. From my very first chemistry lesson I was like, ooh, actually I really like this. He was really inspirational. He loved chemistry and he was really strict but also really funny. He was a really good teacher. I remember the first lesson and he was right, if you're not prepared to work then I'm not prepared to work either. The door's there. Leave, I'm not bothered. We were all like 'whoa who's this person?'. He also said if we'd done double science we were going to struggle and he could spot us a mile off. I barely even knew what the periodic table was. He showed us the periodic table, he had a large one at the side, right in tomorrow's lesson you need to know the first 20 elements and we had this really hard homework we had to do and I got a D on that first piece of homework and it had a huge D written on the bottom *laughs* Oh no, I'm going to fail right from the beginning!

But from then, the way that he taught, his way of teaching worked for me well coz actually that made me go right, ok, I'm not a D grade student and I am going to prove this to you, so I kind of, it went the opposite. I went the opposite, I worked really hard; I'm competitive and getting a D, that's not acceptable! Yeah and he, I used to go to him a lot for help. We had workshop sessions; just his passion for the subject was in every lesson and that made me really passionate about it and from really early on I said chemistry was my favourite subject. (Claire)

This teacher appears to have inspired Claire with a particular teaching style and passion for the subject that seems to have changed her mind about chemistry, from a reluctant fourth AS-level subject to her favourite one. Naturally the big

question is whether a teaching style that 'fits' a student bolsters their interest in the subject or whether it facilitates the student to discover their natural love for the subject, something that may remain undiscovered without that intervention. Do we as teachers generate interest in our subject which leads to harder work and greater success and consequent 'interest' in the subject or do we unlock a door that allows natural aptitude to flourish?

Claire also reveals something about her personality here, demonstrating a certain determination to rise to challenges set, such as getting a D grade in her first assessment, which she reveals throughout her interview. She is not always confident about her ability to succeed but, when challenged, has much inner drive and possibly stubbornness to prove others (and herself) wrong:

> …they said they were going to do a PhD; I thought maybe I'm not as good as them, but then I kinda of made a decision in myself I'm going to prove myself for me and them and prove to them that I was just as good as they were. (Claire, talking about two of her university friends)
>
> I doubt myself and then sometimes I shock myself, I can do this! I approach from the opposite angle - I kinda think I don't know anything so sometimes when I can do something it's more of an actually yeah I can do this. I don't know. (Claire)

I also remark about one of my chemistry teachers with fondness, but I largely credit him for the strict, systematic and logical way in which he organised our lessons, an approach particularly suited to a student like me. I do believe that chemistry was my natural inclination with or without a good teacher, but being taught a subject you enjoy in an environment in which you feel very comfortable must surely be an advantage and allowed me to make progress in something I enjoyed.

Jonathan has many fond memories of teachers at school across the curriculum, often outside of the science department, and he tells of one particularly good chemistry teacher and one dull physics teacher:

> I can think of particular teachers now who were very memorable, less so the science teachers interestingly enough, although there was one particular chemistry teacher who was just brilliant, inspirational, whose strongest piece of advice was, whatever you do, don't become a teacher… He helped me to enjoy chemistry and he taught me I think O level, he certainly taught me first year A level and that was the point I realised I didn't want to do chemical engineering and wanted to do chemistry so I think that was quite a seminal moment. (Jonathan)
>
> *What was the physics that put you off in the end therefore, not to do chemical engineering but to do chemistry? (Alex)*
>
> As you know chemistry is vastly superior to physics! I think it was partly because the physics teacher we had, who was a deeply experienced person, knew his stuff really really well, but I'm afraid he was really really boring. And I remember one of the most exciting things I learned in his physics lessons; he had a display on his wall of the Greek alphabet, so I learned the Greek alphabet. (Jonathan)

Although Jonathan, in talking to his successor as the Head of Chemistry in the school he is now Head teacher of, would inevitably show bias in favour of chemistry, it is instructive how he cites a boring teaching style as a nail in the physics coffin as far as he is concerned. Even for a passionate chemist such as me there are aspects of the subject/curriculum which I find relatively dull, which I would imagine would be true for all students, but the offence cited is the boring teaching style not the subject matter. Jonathan is implying a deep respect for his teachers, as one might expect for someone who has wanted to teach from a very young age, including the knowledgeable physics teacher, but he actively links enjoyment of the two subjects to his teachers' styles.

Sara also talks positively about her science teachers although within the confines of an already established hierarchy of inter-subject ranking:

> I really liked chemistry obviously, that was my favourite subject. Biology I didn't like so much, it was one of my harder subjects as I couldn't

> remember a lot of the content but the teachers, I remember the teachers, and that was quite inspiring, the teachers that came in to teach. Chemistry was just the subject that I loved and in fact it was; one of my teachers was an NQT[16] and she was very inspiring and I didn't realise she was an NQT until afterwards when she let us know, years later. (Sara)

Richard also talks about his old chemistry and physics teachers with fondness, although he accepts that in some regards they were poor teachers and disliked by many of his contemporaries. Immediately he points to them both holding Cambridge degrees, something that has cache in his life, as he discusses in detail subsequently his drive to attend Cambridge from a young age. He credits these teachers with letting their students do experiments in the laboratory and then try to use logic to explain what had happened, an approach which he enjoyed:

> So by the first year at senior school, aged 13, half the lessons were practicals and it was pure discovery, like not here's a worksheet, do the practical, this is what we're going to do today; how do you think we'd do that? Ok, have a go. There would be chaos galore, but chaos seemed to be encouraged somehow. And as I got better at science the chaos receded and the understanding improved so by the time I got to Sixth Form, I was very comfortable with that kind of area and whilst I wouldn't call myself an experimental scientist having that pure exploratory exposure to science, having something explained experimentally then theoretically was fantastic for me. It's where I could try and use my logic, my understanding, going from what I'd seen and link to theory. And that became a stronger magnet to me than the logic of maths alone. (Richard)

Despite being pushed in the direction of mathematics at a young age, the physical sciences seem to also appeal to him – he also makes similarly disparaging comments about biology to ones made by me – and the approach taken by these physics and chemistry teachers allowed him to make progress and find enjoyment in chemistry and this allowed the sciences to overtake

[16] NQT = Newly Qualified Teacher (in first year teaching after qualifying)

mathematics as his subject of choice. I am cautious of following this logic entirely as Richard also talks about a strategic determination to study natural sciences at Cambridge, having decided that getting into maths at Cambridge would be too competitive. It seems to fit his identity well to present this view of the physical sciences surpassing mathematics in his affections, but it certainly fits into his ambitions at the time.

Sonia waxes lyrical about two of her history teachers and, as exhibited by Richard, immediately comments on both teachers having attended Oxford or Cambridge, demonstrating the value she attaches to educational background. The Oxbridge she seems to value is an educational aspiration which can offer a social capital far more than a degree in a subject. Of all my cohort, Sonia seems to have the least attachment to chemistry as a subject and this perhaps is echoed in her relative reluctance to teach it compared to everyone else. However, although this educational background was a cause for Sonia to respect these teachers, she also obliquely criticises some of the values that came with this education when she was at school:

> I loved history and I liked the arts subjects. When I was at school, because it was a comprehensive school we were only allowed that year to take eight subjects, so I had to drop French. I had this fabulous history teacher, he was a Cambridge graduate and he was a very great teacher but I think, in those days they were quite misinformed about what you needed to have to go to university; they assumed because they had had their very upper class education, that everybody had to have the Latin and the French and the languages to do history and I guess I thought that perhaps because I hadn't done French and I hadn't done Latin it wouldn't be the right path for me to take. (Sonia)

This excerpt demonstrates one of the influences on an important educational decision in Sonia's life, someone who subsequently studied chemistry, holds a PhD in chemistry and has taught it in schools for twenty-five years. Her passion was history but the view of these teachers, held in high esteem, that History A-level study was not for those who had not studied Latin and French. And so, she did

not study history, despite having the interest and I am sure the aptitude to do so. I cannot fail but to see the parallel between this and my own dismissal of PhD studies into chemistry due to an apparent rejection by a respected authority figure, in my case my undergraduate project supervisor at university; whilst this parallel is obvious to me, this could be because the event in my life I am comparing it to is so seminal, whereas this exchange between Sonia and her history teachers may be one of many that are contributory. Sonia went on to study the sciences at A-level and I did not even consider science PhD studies. If nothing else, these snippets do illustrate the influence of a brief conversation with an authority figure. Aaron has a very different tale to tell about his school and teachers:

> When I was in school the culture of the school I was in was such that the smart kids did science and applied for medicine and everybody else did English or History and all knew they were going to do business studies or finance or something along those lines. So, studies for them weren't ever particularly important but because you wanted to get into medicine, studies were important… I finished, by the time I finished the lower sixth, I had dropped out of Physics because, probably because I didn't get on with the teacher so well and then moved into year 13 probably knowing I didn't want to do medicine. (Aaron)
>
> I had a B in Biology and, as a teacher, I am reluctant to do this but I still happily will blame the teacher on this occasion. (Aaron)

It appears that he is partly laying the blame for his acquiescence to his parents' wishes for him to study medicine at his school's door and the earlier noted underlying aspirations common amongst its largely second/third generation immigrant pupils. He makes no positive comments about any of his teachers and suggests that dropping physics was largely because of him not seeing eye to eye with his teacher and only getting a B in A-level biology was due to his teacher. This does not tell me that Aaron had nothing positive to say about any of his teachers, but that they did not figure in the narrative he was presenting to me. His later decision to study chemistry at university, rather than the medicine for

which he was originally accepted, is largely defended by it being his best A-level grade rather than him professing a passion for it at the time, a case of utility where I have demonstrated I can succeed here, so why not take it forward and succeed there too? This would therefore appear to be a case of a teacher having a negative impact on a student and had Aaron got on better with his physics teacher, or been able to attain a better grade in biology, who can say what he would have gone on to do.

Teachers represent a given subject to a student which can link them explicitly in some way with that subject in our minds and our memories. How this link manifests itself will vary, mixing feeling about learning about the subject, the teaching style of the staff member, the way in which they go about explaining concepts and the outcomes experienced in their subject. In their UK study into the range of factors that influence uptake of chemistry and physics, Bennett, Lubben, and Hampden-Thompson (2013) report that not many of their sampled students reported that external agents such as teachers hugely influenced their subject choices. Nevertheless, the authors do go on to say that in practice, many students use a combination of strategies, which are not mutually exclusive. Broman and Simon (2015) believe that these choices are related to interest and different choice strategies are influenced by enjoyment. They suggest therefore that the choice-interest connection is complex, as also acknowledged by Bennett et al. (2013). Bøe et al. (2011) found that the key factor for increasing students' interest and participation in STEM subjects is teacher quality, particularly good subject knowledge and a dialogic approach to teaching (Simon & Osborne, 2010).

Is there a tendency to cite an overarching 'interest' in a subject as a major determinant in the decision to take that subject further and the influence of teachers in general, or a particular individual, may be lost, despite much literature which finds a link between the two? Despite this, when I reflect on my analysis of my teacher interviews and the participants' thoughts about their own teachers, what strikes me is that where a link is made it is between our teachers and studying chemistry rather than becoming teachers ourselves.

I credit my chemistry teacher with helping me go into a particular direction academically but not with a decision to go and do a PGCE and follow in his footsteps, despite him being the main role model for that career in my life. Perhaps this is in line with the chronology of A level choices or university applications being made whilst at school and directly under the influence of teachers, whereas career decisions are made later having left school and so teachers are not such obvious key influences. Nevertheless, we do not consider our own teachers as one of these influences on our decisions to teach ourselves, which surprises me a little.

My findings here appear to be slightly at odds with much of the published work on the influences on teachers' career choices. In her meta-analysis Heinz (2015) cites multiple international studies that suggest prior teaching and learning experiences have been said to be important in making these decisions – some student teachers appeared to 'map' their own personal qualities against teachers they had respected at school (Richardson & Watt, 2006; Thornton et al., 2002; Watt & Richardson, 2007; Younger et al., 2004). Lortie (1975/2002) suggests that the influence of schools and teachers is unsurprising given the millions of people who pass through these institutions and surely some of these young people will wish to remain in this environment.

Much of this research, with the exception of that by Younger et al. (2004), has been quantitative in nature with data mainly gathered through questionnaires. Decision making is a complex thing and such quantitative studies are extremely helpful in generating important themes as collected by Heinz (2015). The participants in this research have discussed the influence of their teachers in a broader sense than is possible to glean in large quantitative studies. Are these influences so subtle that they do not particularly occur to my cohort or are one's own teachers less important a determinant of becoming one yourself than might be thought from the wider literature?

In my study, I asked the participants to tell me the story of how they came to become a chemistry teacher and they raised what they wanted to tell me this story. I cannot say that teachers were not important to the participants but that

they did not seem so important when telling me this story. In much of the quantitative literature cited by Heinz (2015) experiences with their own teachers were specifically asked about, usually as part of a Likert scale questionnaire (Lortie, 1975/2002; Thornton et al., 2002; Watt et al., 2012; Wong, Tang, & Cheng, 2014). The FIT scale (Watt & Richardson, 2007) (see section 3.3.2), used recently across many international studies, uses an initial research instrument which contains three items (B) asking specifically about prior experiences with participants' own teachers, as well as others (C) which invite comparison to their own teachers.

B17	I have had inspirational teachers
B30	I have had good teachers as role-models
B39	I have had positive learning experiences
C10	Do you think teaching requires high levels of expert knowledge?
C14	Do you think teachers need high levels of technical knowledge?
C2	Do you think teachers have a heavy workload?
C7	Do you think teaching is emotionally demanding?
C11	Do you think teaching is hard work?

Had I asked about teachers so explicitly I might have gathered different responses. It is interesting in of itself that the participants did not feel that their own teachers were key in the telling of their story of becoming teachers, beyond their choices to study chemistry, perhaps because this was implicit, perhaps because they were portraying these decisions through how they felt rather than why they felt this way.

I have summarised the responses given by the participants towards their own experiences of teachers in their lives in Table 3: Teacher responses.

TABLE 3: TEACHER RESPONSES

Participant	Positive Chemistry	Positive Science	Positive other	Negative Chemistry	Negative Science	Negative Other
Aaron					Physics teacher put him off; Biology teacher not good	
Alex	Chemistry teacher's style suited him					
Claire	Chemistry teacher inspired an 'I can do it' response					
Jonathan	Inspiring Chemistry teacher		Good teachers in other subjects e.g. History		Physics teacher 'boring'	
Richard		Oxbridge Science teachers allowed for an exploratory approach to the subject				
Sachin						
Sara	Good Chemistry teachers	Inspiring Biology teacher				
Sonia			Inspiring Oxbridge History teachers			

My research suggests that teachers can influence subsequent choices their students may make, but that these effects vary and can operate in both directions. Some teachers seem to have inspired their students into a lifelong interest in their subject or learning generally whilst others have provided an environment for their students to flourish, through challenge (Claire), a specific learning approach (Richard) or through providing a safe disciplined environment to learn in (Alex). This is countered by teachers putting students off a specific subject area via personality clashes (Aaron) or presenting the subject in a dull manner (Jonathan).

Others have acted more as role models or aspirational models, providing symbolic capital, such as Sonia's history teachers or Richard's science teachers being Oxbridge graduates, which is something they seem to respect and be aiming for themselves; Richard ultimately attends Cambridge University and studies Natural Science and Sonia undergoes post-graduate study at Oxford. There is much written about admissions to and occupational destinations after Oxbridge including criticism of the profile of student entry to both universities (Sutton Trust, 2009, 2011). Donnelly (2014), in his examination of the hidden messages sent out by UK schools about Oxbridge, asserts that there are parallels between schools and families and the messages they give out in terms of potential entry into higher education, from an explicit drive to apply to one of these universities to subtler expectations. In a more recent Sutton Trust report (de Vries, 2014) the salary of UK graduates was compared three and a half years after graduation and differences noted are significant:

> It may not surprise anyone that an Oxbridge graduate on average commands a higher salary than someone from a newer university, but a £7,500 (42%) difference which only falls to just under £5,000 allowing for social background and prior attainment is a bigger difference than many might have expected. At £3,300, the salary advantage of Oxbridge graduates over even graduates from other elite universities is also significant (de Vries, 2014, p. 4).

Sachin is my only participant that does not mention his school teachers in his narrative. This is not to say that his teachers played no role in his development or

life choices, but he did not present them to me in this regard. Aaron is the only participant who presents his teachers in wholly negative light although, again, not mentioning positive influences does not mean that there were none. He presents the subsequent decision to switch from an offer to study medicine to chemistry at university in terms of the grades he held rather than any particular school interest or inspiration. In fact, mentioning an inspiring chemistry teacher at this juncture would be counter to the narrative he is telling.

None of the participants have cited teacher 'X' as the reason they studied chemistry or became a teacher themselves, but their influence is felt within the narratives presented to me. I might have expected us all to mention how they made us interested in chemistry through particular activities or lessons, but it seems to be more a case of teachers inspiring something in us to develop our own chemical knowledge and understanding ourselves through their personality and teaching style. Broman and Simon (2015) agree that teacher approach and lesson structure is of utmost importance in influencing students' opinion of school chemistry, which echoes work undertaken by Darby (2005) highlighting lesson structures. My research does not support the notion that a particular teacher, including a chemistry teacher, is the catalyst for undertaking studies in chemistry in higher education, but it does suggest that some of a person's teachers subtly influence how they see themselves and routes open to them through and post-compulsory schooling.

5.3.3 Chemistry: interest versus utility

At its heart, my journey to becoming, and remaining, a teacher involves my interest and relative success in studying chemistry. When it reached the point of making career decisions as an undergraduate I was determined to continue with science, which I firmly believe led me to teaching rather than having a previous drive to teach. I always had pride in being a capable chemistry student, something of a badge of honour as it is often seen as a 'difficult' subject and I did not wish to continue down a path where this knowledge was not of some direct use. Furlong (1992) coined the term 'career trajectory' which can be seen as patterns of career progression and are largely dependent on the background of the person in question (Hodkinson & Sparkes, 1997). Career trajectories can be viewed via turning points (Strauss & Rose, 1962, p. 71) where 'an individual has to take stock, to re-evaluate, revise, re-see, and re-judge'. One of the major turning points in my career trajectory was my developing interest in chemistry at secondary school.

Despite criticisms of the work of Bourdieu (1977) into social and cultural representation, such as rejecting his concept of cultural capital (Kingston, 2001) or finding habitus too vague a concept to be useful (Van de Werfhorst, 2010), his ideas of capital, habitus, practice and field are of interest here, but they should be taken together, as suggested by Edgerton and Roberts (2014). The practice of chemistry, and subsequently the teaching of it, is a consequence of the participants' habitus and cultural capital interacting within the context of their fields, be they within their families, their peer group or wider ones such as the educational field. Lareau argues (Lareau, 2011; Lareau & Cox, 2011) that class is important here, where middle-class parents are more likely intervene in their children's 'educational trajectories' and engineer certain activities that promote life-skills, such as Aaron's youth groups and consequent leadership of them. All of the participants in this study, except Jonathan, come from families where professional occupations are the norm, so in this sense we have similar backgrounds, where education is important; on the surface, we all studied the same subject at university but the justifications and defences we used vary considerably.

All the participants comment on an interest in chemistry, which is hardly surprising given their current job titles and consequent identities. The subtleties are somewhat different however and often chemistry is compared with a different area of academic interest to explain choices made. Both Claire and Richard compare their interest in the sciences, and particularly chemistry, with that of mathematics. They both admit that they were good at maths at school but seek to justify their choices to go into the sciences. Claire takes the side of interest:

> Yeah, coz actually I got a better mark in maths so in terms of my best grades I got an A in chemistry and maths but my A was better in maths; but if you take what I was better at I guess, I should have done maths but I really liked chemistry and I said to my parents I want to study something I enjoy if I'm going to spend three years doing it. I'd rather sit for days on end reading chemistry text books and understanding something than maths. I like maths but I'm not that interested in it… I felt maths is just .... without being in the context of something you know, you kinda work out how many people whatever, but chemistry gave me maths, maths was in chemistry which is why I went into physical chemistry because I liked calculations and I liked working that way and that's the way my brain works more than organic and so that's what I preferred so I got the maths in chemistry so chemistry offered me the best of both worlds I guess. (Claire)

She takes the view, retrospectively, that chemistry was more interesting to read about and could also offer her plenty of mathematical opportunities whereas maths itself was more theoretical and less easily applicable to real life. Richard however makes telling statements about how studying the sciences could have utility for him, especially in terms of his ambitions for attending a prestigious university:

> At school, it was a lot easier for me to score well in chemistry exams than it was in maths exams, doing the same amount of work. I did very well at maths but that's because I put a lot of work into it and enjoyed doing it. In chemistry I seemed to put less work in but scored better than other very good scientists, who definitely knew they knew they wanted to study these

> things at Oxford or Cambridge or wherever, so I thought well hold on a sec, I can do that if I put a bit more work it should be fairly straightforward. (Richard)

This is not to say that Richard does not express an interest in chemistry, but he clearly saw it as a conduit to attaining a place at Cambridge, whereas maths would be far less of a sure thing. This ambition shows how utility can be prioritised over simple interest and is something that Richard feels comfortable presenting to a fellow chemistry teacher, which others may or may not. This raises the extremely important sense of co-construction between me and the participants; Richard is happy presenting this angle to me, something which fits in with previous things he had said about his family and school career. Did my own expressed interest in chemistry influence other participants to present a positive relationship with it, the potential confabulation warned about by Hycner (1985)? But that Richard could say this to me offers some sense that I was successful in providing an environment where he felt comfortable acknowledging something that might be at odds with my own means of choosing to study chemistry at university.

Despite chemistry being the subject that could take him most easily to his desired outcome at the next stage of his educational life, Richard changes tone and cites an interest in science as being the inspiration to teach, after his career in the city:

> When I was at school, science seemed so fantastic. If I was going to teach, it would be the only subject I would teach because they seemed to have so much more fun. I mean, maths is so incredibly dull. I mean if you're teaching incredibly bright kids, you can do really complex problems that really requires you to think laterally about how you use your skills, but teaching maths to run of the mill students, I think would be incredibly boring and formulaic. Whereas science, there are so many different angles – you can link it to life. More importantly than that, the thing that developed within me since I left university, about the teaching, was, the career I had was a very numerical career, it was very unorthodox in the sense there is no manual that tells you how to be a trader in financial markets, tells you how to do it. You literally turn up, are given a desk, you watch, you observe,

> you learn, you try things out and the people who succeed have one thing in common, it's not that they're good at maths, they all have a lot of intellectual curiosity. (Richard)

Whilst all my interviewees all mention some aptitude for the sciences, they do not all regard the sciences as their most successful subject. Some, like Sachin, cite his interest in the subject as the primary factor in continuing to study it from A level to university although he lets slip a far more utilitarian reason for taking it after GCSE:

> I got a B in my science and based just on grades I should have gone with the humanities and the languages, but I went with the science one because it had always been something, I had thought maybe I wanna be a doctor, maybe I wanna be an engineer, or wanna do this… I had kind of thought about medicine and then on closer inspection, looking at the work involved and I don't really feel confident that I would have got the grades to get into that so I sort of dropped out of those sort of programmes and things and then started thinking, what could I do? And thinking about my individual subjects I thought, I really like chemistry, it's the one that I enjoy the most. I'm doing the best at it, I'm not struggling at it, it seems to come quite naturally for me. (Sachin)

He suggests a subtle tension here between choosing subjects based on success achieved previously, something I have suggested is a strong influence within my narratives here and the influence of the obvious utility of the sciences within the context of an extremely biased scientific background within his family. He fits nicely into the expectancy-value theories of motivation and self-concept of academic success put forward by Eccles (2009), where motivation is optimal when a given school setup fits well with a student's own goals and that an individual believes they can succeed at a given task. Furthermore, according to more recent research by Wang and Eccles (2013) when students consider classroom material as being related to personal interests or goals, they feel more confident about mastering that material. Sara demonstrates a similar narrative in her decision-making process:

> Well, I was doing my A levels in the sciences, biology, chemistry and maths and I wanted to be a cat doctor, but there's no such thing! Apparently, I had to do all animals if I wanted to do veterinary science, so I was like dammit no cat doctor, so what am I going to do? I thought I would go and do my chemistry degree because I wasn't really interested in medicine, my grades weren't good enough. (Sara)

There appear to be definite end goals in mind for both of them which get renegotiated as time passes, lower grades than required for Sara and a similar realisation for Sachin. Within this renegotiation, the stock of chemistry appears to increase and then the defence of continuing with it is in terms of enjoyment, like my own, but at a later stage of the process. Scholars have argued that life in the 21st century will require one's orientation and skills to repeatedly explore and reconstruct identity in order to cope with continuous change and uncertainty (Flum & Kaplan, 2006). Our education is in pole position to influence these orientations and skills and must be considered as entwined with our identities, particularly during our school days. School contexts and school-work constitute central domains in students' life experiences and sense of who they are and who they want to become (Kaplan & Flum, 2012). Aaron's reason for deciding to study chemistry at university was one of practicality, or even necessity, after he decided to reject the offers he held for medicine. He suggests he has less attraction to the subject itself than other participants but also realised that it provided his best grade in his A levels, so would be a good bet for future success. He talks about how his relationship with chemistry developed as an undergraduate:

> I really enjoyed my first year of chemistry, I really enjoyed the introduction to chemistry, I loved quantum mechanics, I loved the introduction to quantum mechanics, the proviso; basically because whilst I was away [on his two years out studying abroad], I had really got really interested in metaphysics and philosophy and I was actually, at the time, teaching metaphysics and philosophy; those were the things I had got into, things I was enjoying, things I had never studied before and so I really enjoyed that. I took a course on the history of science as well which I really enjoyed.

> Unfortunately, in the second-year things went a bit downhill because basically the details, the general picture is always fascinating and exciting, the Schrödinger equation is fascinating and exciting, solving it is not, it was humdrum and dull and I found myself getting bogged down in details that I cared not at all about. (Aaron)

He talks about his academic interests having become a teacher and these seem to be a logical progression from his undergraduate studies:

> As committed a chemist as other chemistry teachers I have met, probably not… I am happy where I at the moment, I am enjoying teaching science I am enjoying teaching chemistry but for me the things I enjoy the most about it is when I get to do stuff that they won't come across anywhere else so I always try and do the history of science with my class. (Aaron)

Although Aaron does not see himself as a chemist in the narrow way perhaps I do, he expresses an interest for wider science and particularly its philosophy and history, something he has a passion for. If I consider Aaron and how he sees chemistry in terms of a love of the subject versus what it can do for him, he seems to simultaneously express both ends of the continuum: wider science is a clearly expressed passion, as is working with teenagers, something he has done since he was sixteen himself and yet he has chosen chemistry for undergraduate study in quite a calculating way, as his highest scoring A level grade, and goes on to discuss its place at the end of his degree:

> Even though I had originally applied for and had a place for the Masters programme, I realised pretty quickly on that life in chemistry was not for me. I did my degree there and I applied myself and did just well enough to get a first. I think I finished, after three years, I finished with 71.5%, which was absolutely perfect, in fact 1.4% too much! So I was more than happy with that but I knew that the chemistry wasn't going to be for me. (Aaron)

His decision to study chemistry had paid off, he secured a first class degree classification, but his passion was never for the finer chemical detail, but the bigger picture. For Jonathan and Sonia their presented narratives are far less in

terms of enjoyment but more in terms of where these studies would or could lead. Sonia is explicit about this:

> If I had had enough conviction myself to have done the history and if I had had the languages and Latin I probably still would have decided to do history but because I hadn't I though oh well, again, I quite liked chemistry so I did it. I did like biology but I just thought in terms of getting a job, I thought afterwards that maybe the chemistry was more analytical and maybe be more useful in getting a job really… It sounds easy but as I'd seen my sisters struggling to get employment after because it was the fallow years, the 80s when they graduated, it was so hard to get jobs in anything; it was the miners' strikes and all of that kind of environment in England. I thought maybe being a chemist would be useful than having a biology degree, I don't know why, I just thought it would. (Sonia)

This leads me back to an important theme I picked up on when discussing parental influence on decisions we have made. For some of the participants such as Sonia and Jonathan, these decisions are within a trajectory that is expected to lead to a professional career, whereas for others like Claire and me, it is the educational outcome that is valued the most. Is it any surprise therefore that Sonia is more willing to acknowledge the jobs that she might be able to access with studying chemistry, despite it not being her passion, whereas Claire highlights her interest in the subject she would take forward to higher education? These relationships with the subject match the trajectories that the participants have described themselves as being on.

Richard finishes his interview with me, as he was about to embark on a career in teaching, with a very clear statement about how he views the utility of learning chemistry and how he sees students' views of the subject:

> I don't think people realise the skill sets science gives you. If I think back to work [as a trader in the city of London], we had a lot of Economics graduates, who (a) think they know everything about how economies work, which they don't and (b) they think they have good numerical skills

> and they typically don't. If you want someone who can crunch data, interpret data, look at graphs, you know, explain to people using very simplistic language to explain something, get a physicist, get a chemist, get an engineer who will do a lot of a better job than anyone else. Kids don't realise that, you can see them [think], "what am I doing chemistry for? I don't wanna be a chemist". You might not want to be a chemist but you know, you want to have a good job don't you? (Richard)

Here Richard seems to be justifying why teaching chemistry is a good thing for him to do, over other subjects, and he nails his thoughts about the utility of studying the physical sciences to the mast in no uncertain terms. How my sample view chemistry as the driving force towards teaching or vehicle that will get them to a destination is of great interest. I present a summary of how I see the participants' presentation of where chemistry fits into their story in Table 4: Interest versus utility.

TABLE 4: INTEREST VERSUS UTILITY

Participant	Chemistry interest	Other interests	Chemistry utility
Aaron		Wider science interest; philosophy	Best grade so worth taking forward
Alex	Enjoy subject – do not want to stop studying it		Am good at it; can lead to a variety of graduate employment options
Claire	Enjoy subject	Medicine (rejected in terms of emotional reality of being a doctor) and mathematics (rejected as dull compared to sciences)	
Jonathan	Enjoy subject; good teacher	History & astronomy Wants to be a teacher	Am good at it & enjoy it – can lead to teaching
Richard		Mathematics (rejected considering competition to study maths at Cambridge)	Best option to get into Cambridge; good for financial city job
Sachin	Enjoy subject	Medicine (rejected after grades not good enough)	Scientific family – best route for future career
Sara	Enjoy subject	Veterinary science (rejected after considering the practicalities)	Scientific family – best route for future career
Sonia		History (rejected after advice from teachers)	Science has value in terms of future employability and fitting in with family values

Of all the participants, Richard has been the most explicit about how studying one thing would open doors for the next phase of life and whilst interested in chemistry, it was fitting into his general plan. Although his narrative is different, this shares much in common with Jonathan and his drive to teach, and perhaps also Aaron; chemistry fitted the pathway already developing for all three of them rather than being the driving force for that pathway exhibited by myself and Claire. This balance between intrinsic motivations, where we do activities for some kind of inherent satisfaction, rather than for some separable consequence, versus extrinsic motivations which push us to carry something out in order to attain a separable outcome (Ryan & Deci, 2000) appears to be different in these two groups. Claire and I perhaps became teachers to continue to gain satisfaction from chemistry without further post-graduate study, whereas teaching itself was the motivation for Richard and Jonathan and chemistry was useful in getting them there.

What can be learned from the difference between a person wanting to be a teacher but who happened to have studied chemistry, such as Jonathan or Richard, or the chemistry student who then decides to teach, such as myself or Claire? And how these may compare with the person who genuinely wants to be a chemistry teacher from the outset? I envision people as being on a continuum between chemistry or teaching being their primary driving force.

Jonathan and Richard are my only participants who mention a desire to teach whilst still at school themselves and, although both defend the decision to study chemistry, the end goal of teaching, after a financial career for Richard and direct from undergraduate studies for Jonathan, was clear for both irrespective of chemistry. Claire and I are to be found in the opposite side of a ternary plot; we both talked about enjoying studying chemistry and wishing to take it further, but then making the decision at university to drop down from a Masters level course to a Batchelor's (Claire) or not to investigate Doctoral studies (Alex) despite this identification with our subject. Teaching appears to be the pragmatic choice in light of both the enjoyment of the subject and the abrupt end of our own academic studies into it, but it was never our ambition.

Aaron and Sonia profess no drive to study chemistry or to become teachers. Both had wide academic interests at school and beyond and seemed influenced by family and school to go down the science route (Aaron with the parental push towards medicine and Sonia with her father's push towards the physical sciences), which was being recommended as the direction of choice for wider career choice later in life. Sara and Sachin both seem happy to have studied chemistry and did not have a desire to teach when they were young but both develop this whilst at university and had the opportunity to spend time working with children in local schools.

5.3.4 Prior teaching experience

Thinking about my own career and after speaking to colleagues and students alike over the years, it does not surprise me that parents and teachers might be cited as key influences in the journey towards being an educator. The context of chemistry itself was also hard to ignore, but what I would not have predicted from my own reflections is that prior teaching experience or work with young people would have come out so strongly in my data. Then again, surely positive experience of what the job might entail is exactly what one might expect to influence someone towards it. Although I never had particular experience teaching, apart from helping my sister with homework occasionally, I did sometimes help my mum with athletics coaching when I was an older teenager and I felt I had some affinity with young people throughout school. I also enjoyed being a patrol leader in scouts working with younger boys. None of these childhood experiences made it into my own story but, in thinking about subtler influences on my life, in the light of my interviews, I am certain that these experiences gave me some confidence to give teaching a go, even if not the major driver in that decision.

However subtle these contributions may have been for me, direct experience working with young people whilst a student played a major role for three of my interviewees and a more oblique one for two of the others. Sachin is emphatic that a chance opportunity, whilst an undergraduate in London, changed the direction his life would go in:

> During my degree there was a scheme, at my university… instead of playing sports you could volunteer to go into a local secondary school and they were all in inner London, in Lambeth and other places. You could volunteer to go in there and for one afternoon a week you would work with science classes or maths classes in those schools. You'd be like an extra pair of hands or a tutor… absolutely loved it, absolutely loved it, it was highlight of my week. I really used to look forward to going in there and working with the kids, they were like year 7 or year 8 classes. I think I was in the year 9 maths class too. Really enjoyed it, really enjoyed

> interacting with the kids and explaining things to them and seeing them get things and understand things and helping the teacher out with practicals and stuff. I really really loved it there, and then got into third year of the degree and kind of had that as an idea at the back of my head, maybe this could be something that I do, but I was fairly open ended, so I didn't do anything in the milk round, I didn't apply for anything… and I wasn't really getting anywhere with that and then the idea of teaching was still kind of always there, it was like yes, maybe I will do a PGCE, apply for one next year and if I like it, great, and if I don't like it, I've got the qualification, it's a bonus. (Sachin)

When I asked him about this experience and his consequent PGCE and career as a chemistry teacher, he was unsure he would have gone down this road had he not had this experience; it opened his eyes to something that had not been particularly on his radar previously. Sara also chanced upon a teaching experience whilst studying for her Masters degree. She seems to have taken a very analytical approach to her career and had organised work experience with each of her siblings and rejected these as possibilities for her. She talks about her siblings:

> We all did chemistry degrees; he was working in a bank, basically, my sister was working in publishing as a translator and she did chemistry with management and that sort of stuff and they'd be like come and watch what we do. I went along and saw what they do and thought this is so boring, I can't do this either. I thought what am I gonna do with my life? I'm now getting to that age where I must have a career of sorts and it propelled to thinking right, who am I going to contact, I know, my old biology teacher, who happened to be a Head teacher and I got in touch via email. That was one of the nice things, when you get along with your teacher so well, they inspire you and they like to stay in touch to see what you're up to. I dropped an email and didn't expect him to reply so quickly. He was like why don't you come along and spend a week with me in my school. I took some leave of absence and went along and I absolutely

loved the atmosphere and that was it really. It sold it to me, I walked into school and it was crazy. The kids were crazy, it was one of those really weird surreal moments when you think this is amazing, crazy kids but they have got inspiring teachers, I don't even know who they are. They just stood up there and got the class silent and in control and I said that's what I want to do with the rest of my whatever… (Sara)

Wow, you had a seminal moment! (Alex)

Yes, I really did, I thought let me just check it out and see what it's like. I didn't think I would enjoy the kids and the environment but it was such a buzz and I was there for five whole days just being part of that science department. I was just observing and asking them questions and through questions, I think you're inspiring me to rethink what I'm doing. You're asking me why I do things so now I've got to think about why I do it because I didn't want to get into the whole doing things day in day out, so it was quite a nice thing actually that they can get through to me even though I was only there briefly. So I was in in the morning and left in the afternoon and it was really good, so after those five days, now I know what I want to do, so after I just applied for my PGCE. (Sara)

It is possible that Sara did have an interest in teaching at the back of her mind, as she decided to contact an old teacher for advice but she described this week in a school so emphatically in the sense that it showed her the appeal of teaching versus the office jobs of her siblings.

Claire also spent time doing work experience in local schools whilst she was doing her GCSEs, but her driving force appears to be working with kids rather than being an educator – being a paediatrician was her plan at that time:

Teaching didn't cross my mind when I was at school, definitely didn't, but I was so preoccupied with the fact that I wanted to do medicine, I liked science, I'm going to do medicine, I wanted to be a paediatrician, I liked working with kids, even from being quite small myself, everyone who knew me knew I wanted to work with kids. But in what capacity kind of changed

> as I grew up, but teaching never occurred to me until I was at uni, I don't think, maybe at the end of my A levels, start of uni. (Claire)

She went on to be part of a primary school project at university, like that undertaken by Sachin, which seems to have crystallised a desire to consider teaching as a career:

> I worked at primary school when I was at High school and my other week was in a nursery. I just wanted to do things where I could work with kids. I enjoyed working in the nursery but not as much as the primary school as I felt I could interact with the kids more and influence them a lot more in terms of helping them learn. So, I guess that planted the seed and then when I went to uni I was part of the primary school project, so we used to go into primary schools every week and do work with the kids there, so sometimes I did science stuff with them, sometimes I would just act as the TA[17] and did loads of work there. And then that's when I think, doing that at uni as well alongside my degree, that's when I realised that was the context I was happy in. I also knew primary school wasn't for me at that point as well; the kids aren't old enough *laughs* you can't talk to them enough. There wasn't enough science; I wanted to teach them proper science and the only way I was going to do that was in the High school. Initially I just wanted to work in a sixth form college; because I went to a sixth form college, I really liked A levels but now I've worked in a school with year 7s, I like the range. (Claire)

It is interesting that both Sachin and Claire experienced a similar school placement programme whilst undergraduates, Sachin in a local secondary school and Claire in a local primary school. Both experiences appear to have galvanised them into considering teaching as a career pathway post-graduation. For Claire, the drive was always working with young people, but primary school science seems to have proven frustrating for a chemistry undergraduate and she realises secondary school teaching might fulfil her science enthusiasm more easily.

[17] Teaching Assistant

Sachin however seems almost surprised by his enjoyment of his school placement and the satisfaction he gained from students understanding a new concept or an experiment. For Sara, it seems that the atmosphere and observing inspiring teaching role models has had as much impact on her than something either from the subject perspective or from the pupils.

Of all the participants Aaron had by far the most experience working with young people prior to becoming a teacher.

> When I was sixteen I was a youth leader at a local [youth group], so [did that] every weekend for a couple of hours. When I was seventeen I carried on with that but this was the first time I could be a leader on camps so when I finished year 12 I was a leader on camp, when I finished year 13 I was a leader on a camp, when I finished my first year [at university] I was a leader on a camp, when I finished my second year I was leader of a camp again. The next winter I was a deputy head of a camp and then that summer I was a leader on a foreign tour for the kids who were sixteen, then after that I was overall head of a camp twice, so basically aged 21 I was in loco parentis for sixty kids and twenty-six 16/17/18 [year old] junior leaders. (Aaron)

> I vaguely starting ruminating about teaching, I had done a lot of youth work, I had been doing some teaching [in my community] because we had been [short of leaders], so did a lot of teaching there. I had done some teaching at… plus youth work as well, so it was something I knew that I enjoyed and basically thought well why not give it a punt? … I am enjoying teaching science; I am enjoying teaching chemistry. (Aaron)

Aaron does relate his experience in youth work to becoming a teacher. He had already rejected the academic science world, despite his first-class chemistry degree, as his passion was not in this direction. His rejection of an academic science career was for a very different reason to mine, despite leading us both in the same direction, towards teaching; my passion was for the chemistry and the teaching had the utility of keeping the chemistry within a career path that I might

be able to succeed in, whereas Aaron's passion was for wider learning and his prior experience led him to teach as the logical consequence.

> I like enthusing people about science, I think I'm pretty good at doing the teaching thing so it's definitely where I see myself for the next while at least and we'll just have to see. (Aaron)

Even this throw away comment about waiting and seeing, demonstrates Aaron's view of teaching being something that fits well with his current stage of life, but not necessarily for keeps. Again, it is a case of being good at something so I may as well go in that direction rather than particularly wanting to study chemistry or be a teacher. Sonia entered the teaching profession in the most haphazard fashion out of the participants and does not give me the feeling that she particularly wanted to teach. She describes a teaching experience whilst she was writing up her PhD:

> I did do a bit of teaching whilst I was doing the write up of my thesis, at an international school. I did science teaching and it was a range of kids actually from about ten to GCSE level, but because it was an independent school you didn't really need the qualification anyway. I did that for… (Sonia)
>
> *Was that a positive experience? (Alex)*
>
> Yeah, I quite liked it and it was near a place called… and it was a small school, we used to do some of our Biology lessons in the park and fieldwork; I liked it. (Sonia)

This teaching experience was an enjoyable one for Sonia and may have influenced her later on when she finally decided to apply for teacher training:

> Originally I wanted to work with primary school children coz I always had that affinity with little children rather than older ones but because I applied too late, in a way, in that year. (Sonia)

Nevertheless, Sonia's wish to teach in primary school was scuppered by her considering applying too late and therefore taking a place on a secondary

science PGCE course instead. This suggests to me that teaching fulfilled a need for a career and one that Sonia was eminently qualified for, holding a PhD in chemistry, but neither a particular love of the subject nor a drive to teach was pushing for this career pathway. If I had wanted to be a primary school teacher, I would not have contemplated teaching in secondary school and I wonder if Sonia in fact followed the path of least resistance.

I have considered all the participants' prior teaching experience or work with younger children in Table 5: Prior teaching experience.

TABLE 5: PRIOR TEACHING EXPERIENCE

Participant	Prior youth work experience
Aaron	Lots of experience with various youth groups and leading summer camps
Alex	None mentioned
Claire	Primary school teaching assistant at school and university; buddying
Jonathan	Buddying at school
Richard	None mentioned
Sachin	Secondary school placement whilst at university
Sara	Secondary school work experience whilst at university
Sonia	Taught at an independent school whilst writing up PhD thesis

Here experience working with young people seems to have achieved one of two things, or a combination of both: some people have been turned towards teaching as a positive career option by an experience in a school (Sachin, Sara and Claire) whereas others have had previous experience demonstrating that they have a particular aptitude or interest in working with children (Aaron and to a lesser extent Sonia). For the former group teaching appears to be a likely or even inevitable consequence of this experience but for the latter group these

experiences seem to have made teaching a viable option to consider rather than an inevitability.

Watt and Richardson (2007, p. 198) call for broader national strategies for the attraction of people into teaching, particularly those that promote social utility values and introduce intrinsic values and individuals' individual perceptions regarding their teaching-related abilities rather than what the authors assert is an overreliance on 'the opportunity to make a social contribution and the opportunity to work with children'. Although the FIT-choice scale (Watt & Richardson, 2007), which has been used in a multitude of international studies, has its limitations due to questionnaire responses being made on a seven point Likert scale and therefore reflecting a judgement of one's own motivations rather than a fuller justified account, I agree with its authors' conclusions regarding widening teacher recruitment strategies. In my study, prior teaching experience, as opposed to the experience of being taught, was important, or extremely important, to five of the eight participants. I detected very little sense of altruism in my discussions about career motivation, but rather a sense that it took time in the classroom, or working with children more generally, to promote the idea of teaching and its potential value to the participant him- or herself.

As I mentioned in the background chapter, studies suggest that exploring and addressing differences between student teachers' intrinsic and altruistic career motivations and their actual experiences during their initial teacher training programmes as well as once employed may help to improve teacher retention (Heinz, 2011, 2015; Lin et al., 2012; Manuel & Hughes, 2006) as, for some teachers, the reality does not match up with their expectations. Two of the ten student teachers on my own PGCE course who had been placed at the same school as me (in 1995/6) dropped out of the course within the first term citing that the reality of life in a secondary school was not what they had expected. I could not say that previously spending time in the classroom, or working with teenagers in a different capacity, would have prevented this outcome for them, but at the very least it might have lowered unrealistic expectations so that the discrepancy referred to by Heinz (2015) would be narrowed.

5.4 The defended self

Having considered the themes developed using a thematic analytic lens, I will now consider my second lens, a defended-self analysis. As I discussed in chapter 3, Nimier (1993), in his work in mathematics education, suggested that a given anxiety can be displaced onto mathematics or contained in some other way and defences can be seen to be mounted against this anxiety, mathematics serving as an instrument of this defence. He presented six defence mechanisms: three phobic defences where the defences displace anxieties and therefore contain these anxieties by keeping away from them; and three manic defences which use mathematics from within to defend against anxiety elsewhere.

I have suggested that one could apply these six defences equally to chemistry and that I should consider my own defences, and those of my interviewees, in the light of them. One can view each defence with its corresponding opposite (Rodd, 2010) and I will use this approach, against chemistry, here.

The six defences as adapted from those for mathematics to apply to chemistry are:

1. Phobic avoidance (phobic)
    - Cannot do chemistry
    - Don't blame chemistry
    - Not going to take on chemistry
    - Chemistry is remote
    - Chemistry is difficult
2. Repression (phobic)
    - Chemistry is not relevant to me
    - Chemistry is not interesting
    - Chemistry is not worth investing effort into
3. Projection (phobic)
    - Chemistry is dangerous
    - Projecting myself onto chemistry is dangerous
4. Reparation (manic)
    - Chemistry is creative

- Chemistry is useful
- Chemistry will allow me to make things for myself

5. Introjection (manic)
    - Chemistry helps me
    - Chemistry is good for me
    - Chemistry can give me skills e.g. trains my mind
6. Narcissism (manic)
    - Chemistry gives me joy e.g. when I solve a problem
    - Chemistry is comforting

I have considered all my gathered data and attempted to roughly quantify the extent to which the participants have used each of the six defences, or their opposites, in Table 6: Defences against chemistry:

TABLE 6: DEFENCES AGAINST CHEMISTRY

Participant	Defence											
	Phobic Defending self against chemistry			Not-phobic			Manic Using chemistry to defend self			Not-manic		
	Avoid: remote/difficult	Meaningless: not relevant/interesting	Dangerous: bad to project myself onto it	Approach: good at it/ easy	Enjoy: relevant/interesting	Beneficial: safe	Creative: useful	Good for me: helps me/gives skills	Comfort: gives me joy/comforting	Useless: not creative	Bad for me: doesn't help me	Anxiety making: gives no comfort
Aaron	Little	None	None	Little	Some	Little	None	Some	None	None	None	None
Alex	Little	None	None	Some	A lot	Some	None	A lot	Some	None	Little	Some
Claire	Little	None	None	Little	A lot	Little	None	A lot	Some	None	Little	Little
Jonathan	None	None	None	Little	Some	A lot	None	Little	None	None	None	None
Richard	None	None	None	Little	Little	A lot	None	A lot	None	None	None	None
Sachin	Little	None	None	Some	A lot	Some	None	Some	None	None	None	None
Sara	Little	None	None	Little	A lot	Little	None	Little	None	None	None	None
Sonia	None	None	None	Some	Little	A lot	None	Little	None	None	None	None

The process of quantifying the defences used by each of the participants was not straightforward and involved multiple reading of my interview transcripts, where I tried to locate where defences were being used and then to roughly quantify them in a similar way to how Rodd (2010) analyses her interviews with two undergraduate students, Ali and Robin. I used four designations:

1. None: no discernible use of this defence;
2. Little: at least one use of this defence;
3. Some: multiple (two or three) uses of this defence;
4. A lot: consistent use of this defence.

My strategy here was not just to count instances of a defence but to consider how the use of a defence fitted into the whole narrative that I was being told. All of us use defences in everyday life and I certainly would expect chemistry teachers to defend both chemistry and teaching to a fellow teacher. Therefore, I was sceptical of defences given that seemed, to me, to be at odds with the rest of a narrative as presented. An example of this is Richard's relative lack of enjoyment of chemistry compared with others such as myself, Claire or Sachin. He does talk about an interest in science:

> By the time I got to Sixth Form, I was very comfortable with that kind of area and whilst I wouldn't call myself an experimental scientist having that pure exploratory exposure to science, having something explained experimentally then theoretically was fantastic for me. (Richard)
>
> When I was at school, science seemed so fantastic. (Richard)

However, I felt that any such comments about an enjoyment or interest in science were within a context of a rejection of mathematics due to ambitions both to study at Cambridge but also to access a financially successful career and therefore the posited interest in science was, in fact, a manic defence of himself and decisions made for future utility rather than the genuine expressions of interest expressed by, say, Claire:

> I knew I really liked science and I was really interested in science and why things worked as I always wanted to know why things happened. And so,

> I chose biology, chemistry maths and psychology as my four AS levels. Then as soon as I started at college, I found that I really really enjoyed chemistry; I found it really interesting and I found that it was starting to answer some of the questions I'd had since GCSE. (Claire)

Claire talks about areas of chemistry she enjoyed, both at school and at university, and why she enjoyed it over maths, which she was also good at. She also uses chemistry to defend herself as it promotes useful skills for the future, eventually as a teacher, but the sense of chemistry as utility only which I associate with Richard is not there in Claire's narrative.

Various aspects of this analysis stand out to me when I consider these eight stories and Table 6: Defences against chemistry. Firstly, there is a sense of enjoyment of chemistry as well as a feeling that it is good for them, or can offer them something positive, expressed by all the participants; this is perhaps not surprising for eight chemistry teachers – of course they would defend themselves in this way, especially to me – but what is interesting is that two of them, Richard and Sonia, hardly use this defence compared with everybody else. Richard, however sees chemistry as very good for him, strong evidence to me of chemistry having utility for him above any feeling of interest in the subject.

Similarly, Sonia does not particularly express much enjoyment from studying the subject but sees it as beneficial – she talks about the economic situation at the time and the science route helping her elder siblings find work, as well as the implying that teaching would fit well with her having children subsequently, something acknowledged in the literature as a common extrinsic reason for some people to enter teaching (Heinz, 2015; Priyadharshini & Robinson-Pant, 2003; Richardson & Watt, 2005). Both Richard and Sonia show no evidence of the necessity to defend themselves against chemistry, in complete contrast to Aaron, Alex, Claire, Sachin and Sara who all, for different reasons, feel the need to avoid chemistry during or after university. I contend that this phobic avoidance of chemistry has contributed to the move into teaching for some or all this group, certainly myself and Claire. Interestingly, this group, apart from Aaron, also express the largest enjoyment of chemistry. Identification with a field of study,

expressed by enjoyment, whether that is through genuine excitement at learning or an experience of success, would be a positive thing, but also exposes that person to a bigger fall if their relationship with the subject sours, which both Claire and I attest to in our narratives; we are the only subjects of my study who openly express non-manic traits of anxiety caused by chemistry and a sense that it is bad for us. Will someone who expresses no particular original enjoyment from a subject ever express such anxiety?

Jonathan is an interesting case to consider here; he expresses no phobic defences of himself against chemistry nor non-manic traits. If we take this interpretation of his data literally, we conclude that he has not been forced into a depressive state in his view of chemistry, unlike myself and Claire – chemistry was, and still is, positive for him, something not particularly surprising given his anomalously expressed (within my small sample) desire to become a teacher from a young age, something he achieved via studying chemistry.

5.4.1 My defences

If I try to interpret my own story I can see two key themes, one of general closeness to chemistry in terms of its benefits to me and its relevance (not-phobic defences) and of a crisis at university where my comfort and self-worth derived from chemistry (manic defences) lead to not-manic ones of anxiety and that I am not good enough anymore, leading ultimately to avoidance of studying post-graduate level science.

As I progressed through my degree I was confronted by more and more challenging and ultimately off-putting chemical theory, leading to anxiety and seeing chemistry as bad for me. This begs the question of whether the study of an academic subject, be it mathematics, history or chemistry, will eventually lead to this 'flipping' of orientation when we measure ourselves against it and therefore defend ourselves differently. Or is it more of a question of how we see the relevance of the subject within our wider life? As a schoolboy and a teacher, I was and am positive about chemistry and see its relevance and positive influence in my life; in between these two phases of my life, at university, I began to see it differently when I was confronted with challenges I felt I could not meet.

Rodd et al. (2010) discuss the story of history student Robin and compare it to that of mathematics student Ali. Of the two of them, Robin is the one who indicates a closeness to mathematics that Ali never shows but Robin is the one who does not opt for it at university; he reached his 'flipping' point at school, perhaps due to just missing out on an A* grade at GCSE or for feeling less able than his friends in a very bright Further Mathematics A-level class; whereas Ali merely reasons that mathematics offers him advantages post-graduation. The parallel between how Robin seems himself at school and how I saw myself at university leading to a rejection of academic study or chemistry is striking, whereas Ali aligns well with Richard or Sonia who both explicitly cite chemistry as a sound option for the career path they would like for themselves.

I have examined my choices regarding subjects studied at school and then university by looking at the defences expressed in my written autobiographical testimony via four turning points in my trajectory. I must accept that this was a

privileged yet troubled narrative and was acquired differently to the UPMAP interviews with undergraduate students by Rodd et al. (2010), as well as looking at myself as a chemistry graduate as opposed to mathematics and physics undergraduates in their project.

I found much in the study by Smith and Cooke (2011) into experiences of recent UK arts and science undergraduates that I recognised from my own experiences, so the following personal passages are interspersed with quotes from that study or my own interviews carried out prior to my main study (in italics):

1. Standard grades

In Scotland students choose their standard grades when they are around 13 years of age and sit the final examinations when they are 15. In the late 1980s mathematics and English were compulsory, as well as a language; I chose German as this was the language I had studied in the first two years of secondary school and, in addition to this, I chose chemistry, physics, Latin and modern studies (a Scottish humanity which sits between modern history and politics). My rationale for these choices, as I remember them, was that I enjoyed chemistry more than any other subject, although I had only studied chemistry topics, as part of general science, up to that point, so I must wonder if this memory is more a case of me imposing the logic of subsequent events upon this initial decision.

My father influenced my decision to study physics; he is a physics graduate and suggested to me that a future in the sciences would require me to study more than one. I was naturally good at maths and had taken a dislike to biology (or what I perceived to be biology), so this seemed to be a sensible decision. On the flip side, I remember my mother influencing my other decisions; she was aghast at my flippant dismissal of history as a subject (as 'boring') but convinced me modern studies might be more up my street. She was even more influential in my decision to study Latin, a subject I went on to dislike fairly intensely, mainly due to lack of ability and effort on my part. She suggested that many scientific terms had etymology rooted in Latin and that this might help me in my scientific endeavours. Looking back, I suspect her intention was to try and keep my education as broad

as she could whilst I was so young. However, even then, I would have taken only sciences and maths given half a chance. This interest and drive to learn more is echoed in the literature and from my own research:

> I think even way back…I was always interested in science, maybe without even knowing it particularly. Even as a child I used to make potions in the bathroom sink and things like that… and it felt like a natural progression to be honest, (female, chemist)

> *I always used to be the kid, I always used to have a little chemistry set, I'd be the kid that didn't want to follow the instructions and want to do my own thing and find out what happened. So, I really can't remember a time when I wasn't doing that kind of stuff and even when I was really little, making soup in the garden - getting a bucket of water and sticking leaves in it and watching it go brown and green and stuff and so I think from the outset, not chemistry necessarily, but the science route was the only way I was going, (my interview with undergraduate chemist, 2012).*

2. Higher grades

Highers are sat at sixteen years of age and chosen at fifteen. Again, maths and English were compulsory and, in addition to those, I elected to study chemistry, physics and modern studies. I am far clearer about these decisions than I am about the standard grades. I chose the subjects I had most enjoyed at standard grade which, probably unsurprisingly, were the ones I had achieved the best grades in (standard grades are graded 1 to 7, with 1 being the highest grade; I got a grade 1 for maths and my three Highers 'choices', a 2 for English and German, as well as a 3 for Latin). This was an extremely easy decision to make at the time. Teachers have been said to have an influence on such decisions, although in my case I liked all my teachers, including the Latin one, but my aptitude/interest seems to have been the overwhelming determinant of this decision. Again, I must question the extent to which interest being given as a defence of studying a particular subject is in fact camouflage for aptitude/success fuelling this perceived interest; the two factors are inextricably

linked but citing interest is a more modest way of defending such curriculum decisions as opposed to listing academic achievements, which is easier to commit to paper or to tell a fellow professional.

3. University subject choice

I do not remember being in any doubt about my studying chemistry at university throughout my senior school years. I enjoyed chemistry lessons the most, I got my best marks in the subject, I wanted to talk to my dad about what we had learnt that day (especially when I realised my knowledge had eclipsed his), I felt it as a personal affront if I had not got on top of a particular chemical concept that day (and often went straight up to my room after school to deal with this) and loved the way in which chemical models seemed to explain behaviour I could test during practical work. I enjoyed physics most of the time, but maths was always second in my favour to chemistry, I suspect because I loved the satisfaction derived from getting a set of problems right, rather than an intrinsic interest in the mathematics I had covered. In common with the participant Claire, I felt I was good at maths, but I had no intention of pursuing maths at university; it did not hold the same interest or variety for me something I suspect we hold in common with many physical science graduates such as those interviewed by Smith and Cooke (2011):

> It was like the … subject I felt I was best at and so I kept pursuing it till A-level until I sort of had no choice but to do it at uni, other than do maths, but I didn't really want to do maths, (female, physicist)

4. Post university

In third year, of a four-year course, I had no idea what I was going to do with my life. At no point did I regret reading for a chemistry degree, but I found it intellectually challenging, at times to the point of feeling clueless. I recognise the sentiment of the following quote, particularly in my third year:

> In my second year of my degree, I found it extremely hard to stay motivated and remember why I like science so much …I had to sort of grind through it and get it done, (female, chemist)

For many of us on my course, finals exams were all consuming, as means to an end in terms of future prospects, as well as a maelstrom in which we found ourselves being supportive of our friends as well as engaged in fierce competition with them. Like the quote below suggests, at this point of my studies, my enjoyment of chemistry was at its lowest ebb before or since.

> I am sitting here now trying to recall what modules I did last semester and it is shameful to say that but I don't think there's enough onus on the students to actually learn for the sheer joy of learning … You learn to pass your exams, to pass your degree, to get out and get a good job … (female, chemist)

Smith and Cooke (2011, p. 321) discuss the similarity between arts and science students in terms of the 'difficulties of adjusting to the teaching and learning experiences of university, as well as of the need to become independent learners and the extent to which this particular experience differed from that of school. In this way, many of our respondents found the transition from school to university to be challenging, regardless of subject, and many reflected upon a better-quality teaching experience at school.' Where they suggest the two groups differed was in the science students' reports of heavy workload and the extent to which they work 'even harder than the medics'. I did feel that I worked harder than many of my friends at university, especially those doing humanities subjects

Despite my comments above at being at my lowest ebb in terms of interest in chemistry in third year, we did a research project in fourth year where I regained much of my previous passion, but also reached a view that I was not good enough for PhD studies in chemistry. Much of this was coloured by some outstandingly talented friends who were taking up PhD/DPhil places post-graduation and I did not see myself in their exclusive company. Concurrently I felt alienated by the idea of the corporate world, with its 'milk round' events in exclusive hotels and long application forms complete with what I regarded as pretentious and pointless questions. I decided to stick to where my interests had always lain and apply for a PGCE at my undergraduate university, something that filled me with trepidation as I was not at the time at all confident I would have

the personality and confidence for teaching, but felt like if I could get past that, it might suit me very well. Interestingly my mother was the loudest voice of caution in terms of this decision, as she suggested I was playing it safe and remaining within the world where I had been comfortable, that of education. I can reflect on this, twenty years later, and conclude she was probably quite right!

If I consider my own story as presented above, it seems clear that I have positioned chemistry as 'good' throughout school as I got to grip with its ideas and attained a certain level of success but moved towards it being 'bad' at university when I began to struggle and achieve at a level lower than many of my friends. This resonates with the interview presented by Rodd with Robin who began to struggle in his further mathematics class, as he didn't feel he had their 'kind of ability'; she suggests he had a mathematics-specific anxiety, which could be parallel to a chemistry-specific anxiety which I still have and exhibited when deciding not to even consider chemistry PhDs when I was an undergraduate. I suspect I felt 'good enough' for a chemistry degree but not for post-graduate studies in the subject.

As Rodd (2010) points out, this use of Nimier typography does not include key relationships in the mix, but rather considers things on an individual basis, although I have tried to examine some of these key relationships as part of my thematic analysis. In my own narrative above, I mentioned my parents as key influences, although I cannot be sure whether their influences were directly in terms of the things they said to me or were far subtler, in terms of their own backgrounds and hidden messages that were never explicit to me as a teenager. Having asked my mother subsequently, she agrees that neither of them pushed either of their children towards university explicitly, but she said that she knew early on that this would be the direction that we would take. She says she is not sure how they would have handled it if we had announced we were going to leave school and get a job instead unexpectedly; as she said, it's easy to say you are open minded about such things when you have not actually had to deal with that situation.

5.4.2 Defences of others

Defences of studying chemistry

To add some depth to my previous general discussion about the defences used by the participants, I would like to illustrate different defended themes with quotes from the participants or my own story. I hope to add here something below the surface of a description of the participants' voices and delve deeper into the particular discourses discussed by Hollway and Jefferson (2000) in their work with gender, anxiety and the fear of crime, where participants feel the need to defend themselves against feelings of anxiety.

If I consider the enjoyment of chemistry being expressed, both my story and that of Claire stand out:

> In parallel to science entering my consciousness in early secondary school, chemistry did so in third year onward when I studied it as a distinct subject. I think I loved it from the first day I had a name to pin to it. (Alex)

> I really enjoyed chemistry... So that's why I did chemistry at uni – really enjoyed it. (Claire)

Both of us suggest an inherent joy in learning chemistry in our narratives that are not quite so clearly identified with my other participants. Most of the participants express their interest in the subject in terms of other things, even Claire:

> When I did my A levels chemistry was my favourite subject so I knew I wanted to do a degree, and I wanted to do something I enjoyed so I wanted to do chemistry as I thought that would give me good base for whatever I wanted to do in the future. If I had a chemistry degree, nobody was going to turn around and say that's not a good degree, we don't want to hire you. (Claire)

Having chosen to study chemistry largely because it was his highest grade at A-level, Aaron talks about loving a particular facet of his university course, but this is placed with the context of other facets being less appealing:

> I wasn't living on a different planet in terms of my mathematical ability and so I thought chemistry is the option. It's what I've got, it's what I should do. (Aaron)

> I do like chemistry, I love science, I very much like the philosophy of science I love the theoretical underpinning that stand behind it more than I love getting weighed down in the details of this and the details of that. (Aaron)

Aaron expresses how chemistry fits into his wider academic interests of the history of science, religion and philosophy; he enjoys finding out about the big picture but the wider chemistry is not a driver for him. Both Aaron and I have a love for learning chemistry, but mine is narrower and something held dear as can be seen by my use of chemistry to defend myself – leading to eventual anxiety and seeing chemistry as a negative influence – unlike anything Aaron expresses. In fact, Aaron defends the decision to leave academic science through it becoming dull as opposed to it becoming too demanding. Claire aligns herself with me, in that she chooses chemistry for interest rather than expectation of success, unlike Aaron:

> Actually, I got a better mark in maths so in terms of my best grades I got an A in chemistry and maths but I would say my A was better in maths, but if you take my, what I was better at I guess, I should have done maths but I really liked chemistry and I said to my parents I want to study something I enjoy if I'm going to spend three years doing it. I'd rather sit for days on end reading chemistry text books and understanding something than maths. I like maths but I'm not that interested in it. (Claire)

Both Sara and Sachin express their interest in chemistry rationally rather than emotionally, Sara against the backdrop of her siblings having studied chemistry and Sachin in relating chemistry to his other subjects:

> We all [Sara and her siblings] ended up doing chemistry degrees, so I went to [university] to do my chemistry degree and I really enjoyed the chemistry. The love my chemistry was still there and then after my degree, my

> supervisor who I was working with, said why don't you come with me and we'll do your Masters/PhD programme. (Sara)
>
> They weren't actually the subjects I did best in, I did better in my history and my geography and my French and all that but I felt that I had more of an interest in the sciences. (Sachin, describing choosing A-levels after GCSE results)
>
> And thinking about my individual subjects I thought, I really like chemistry, it's the one that I enjoy the most. I'm doing the best at it, I'm not struggling at it, it seems to come quite naturally for me. (Sachin, describing his A-level subjects)

Sara's use of the word 'so' is interesting as it implies an inevitability about her decision to study chemistry at university, following in her siblings' footsteps. She immediately defends this decision with a comment about her enjoyment and love of the subject. This is not to question her interest in the subject but there is no suggestion here of a love for the subject leading to qualification decisions, whereas for Claire and I this enjoyment is a driving force for decision making independent of other factors.

Sachin, however, appears to contradict himself within one interview, although within the context of what he is talking about the time, this may not be so. When he talks about his GCSE subjects he says that science was not the area he achieved most highly in, but that he made the decision to study the sciences due to an interest. Again, I do not suggest that this interest is not genuine, but Sachin, like Sara, had already positioned himself as being part of a family of science graduates and that much value was being placed on studying them. I do wonder the extent to which this interest is a defence of the decisions he made at the time. During his A-levels Sachin now perceives chemistry as his best subject, as well as the most interesting, so he is secure in his decision-making process moving into higher education.

Sonia, like Sachin and Jonathan, was an academic all-rounder at school and, in fact, expresses no huge affection for the sciences, but defends her decision to

study them in two ways, in terms of not having the classical educational background to continue with history and the utility of chemistry for future career prospects.

> I think that if I had had enough conviction myself to have done the history and if I had had the languages and Latin I probably still would have decided to do history but because I hadn't I though oh well, again, I quite liked chemistry so I did it. (Sonia)

> I thought maybe being a chemist would be useful than having a biology degree. For example, I don't know why, I just thought it would. And I preferred chemistry. Although I did like biology I think that perhaps I thought that it was a more serious subject. (Sonia)

Richard defends his decision-making process differently by defending his interest in science/chemistry against both mathematics and aspirations to study at Cambridge University:

> I'd been good at maths my entire life, I only got interested in science when I was about 13/14 and I went to secondary school. Before then I had been an average student at best in the subject. I realised the difference that was made was by my teachers and how they made the subject interesting, how the subject became more interesting, but it was how they made it interesting and they really made me want to know more and more about it which is something that I'd only really experienced in maths before. (Richard)

> My parents got it into their heads that I was some sort of maths genius; which didn't seem illogical given that both my mother's parents were very good at maths. And so, from about the age of three upwards it was in my head, you're good at maths, you're good at maths, you're good at maths, you're good at maths. I was the best at maths in my school, and this came naturally, because I was told this and did well and did more work at it so was even better. I was never told that about any other subject. The link between science and maths was never made, I didn't get told anything

about science. Then I went to senior school, the first thing that was told to me was if you're so good at maths you should be brilliant at physics and chemistry. (Richard)

There were two reasons I haven't mentioned [for studying science]. The first was that I really wanted to go to Cambridge; I knew I wasn't good enough to do maths there. Or I was scared if I wasn't good enough there, I would be left with little option, so I went for the subject that I had a better chance in, chemistry and physics, and natural sciences at Cambridge. At school, it was a lot easier for me to score well in chemistry exams than it was in maths exams, doing the same amount of work. I did very well at maths but that's because I put a lot of work into it and enjoyed doing it. In chemistry, I seemed to put less work in but scored better than other very good scientists, who definitely knew they knew they wanted to study these things at Oxford or Cambridge or wherever, so I thought well hold on a sec, I can do that if I put a bit more work it should be fairly straightforward. (Richard)

Richard seems to express a love of mathematics which then cannot fulfil aspirations he has for himself as he gets older; it becomes harder, more time consuming and his perceived competition for a place at Cambridge begins to intimidate him. This move to present the physical sciences more positively is simultaneous to the presentation of mathematics as something to be avoided, through a non-manic defence of himself. Even his praise of his science teachers at secondary school is within the context of him being a good mathematician and hence them commenting on an inevitable ability in the physical sciences.

Jonathan mentions an interest in all his studies and that choosing the sciences was largely a consequence of the way things were done at his school:

I think it may be that I was very passive about it all, disinterested I suppose, but I enjoyed everything pretty much and wasn't particularly fussed about which direction to go into. (Jonathan)

> My A level choice was dictated by the fact that the school decided that if you could do science you did, so I did, and then the choice was that whether you did biology or maths with your physics and chemistry. That was the way that it operated in the school I went to, so I ended up with qualifications in maths, physics and chemistry. (Jonathan)

In fact, Jonathan uses the words passive and disinterested to describe his decision-making process, as well as saying that his choices were dictated to him. None of my other seven participants use words like this to describe how they made qualification decisions, they defend their decisions with either an interest in learning about the subject or with what it could do for them in the future. Richard and Jonathan both identified with different academic subjects in early secondary school, but both go on to study chemistry at university and then to become chemistry teachers.

We can see that both Richard and Jonathan had a similar trajectory where chemistry is concerned, both identifying more and more with it as time passed, Jonathan due to the policy at his secondary school leading to him taking the sciences for A-level and Richard being told that his mathematical ability would lead him to be able to succeed at the physical sciences in parallel to him realising that progressing to his university of choice to study mathematics was by no means certain. Despite their similarity in terms of chemistry trajectory, they differ when it comes to teaching, although being the only two of the participants who express a desire to teach whilst at school themselves. Jonathan professed a wish to teach from as early as primary school, which seemed to sustain itself until he became a teacher, whereas for Richard it evolved from a potential wish to teach 'by the time I'm forty' at secondary school to him considering routes into teaching from a successful city job.

Defences of teaching

As the participants talked about their decision to teach, they all expressed some rejection of other options such as chemistry research, working in industry or the city. Some of us, like myself and Claire, do so in terms of chemistry causing anxiety whereas others do so in terms of a rejection of a particular lifestyle.

> Being an average/mediocre chemist and surrounded by very talented students was on one hand a great experience and on the other, rather hard to deal with. Any confidence I had gained from doing well at school and gaining a place at the institution [Oxford University] was tempered by the reality of the ability of many of my friends and the gap I perceived between them and myself. In fact, I performed perfectly acceptably at Oxford but I came to the conclusion that I wasn't of PhD material. (Alex)

> I think in terms of carrying on, I don't think I was good enough to carry on maybe. I could have done a Masters, but wasn't good enough for a PhD. I think I'd hit my limit at a Bachelor's. (Claire)

Both Claire and I seem to have positioned ourselves relative to others in terms of chemistry itself. Perhaps at school we were both relatively high flying but within our university cohort comparisons were less flattering. None of my other participants express any anxiety caused by chemistry, but do give other reasons for not taking it further. Claire gives a separate defence and joins Jonathan, Sachin and Sara defending leaving academia here by rejecting the world of laboratories and chemical research:

> I was supposed to be doing a Masters but then I realised that working in a lab wasn't for me; I found it interesting but I didn't want to do it 24/7. (Claire)

> Increasingly as I went through the chemistry degree, I'm so sorry but I'll appal and horrify you, but I knew that research was absolutely not for me. And it was too late to go into pharmacy, which probably wouldn't have interested me either. I had always had the intention, I wanted to try teaching and gave it a try and if that hadn't have worked out then I would have thought again, but it did. (Jonathan)

> I enjoyed my research project, I did for the last six months, but in the cold light of day, thinking about going into a lab every day and not necessarily having a great deal of interaction, coz seeing a lot of the PhD people around me, in the lab, they would come in and they would set the experiments up and then they would leave the experiment or they'd be there watching it and it seemed a very solitary existence and every so often they'd meet their supervisor and stuff but I thought, no I couldn't really, I don't think I could really do this for however long it is to get to that point and the other thing seemed the stress they were under, incredible stress and pressure and I thought no, maybe it's not quite for me, as much as I loved the chemistry and I loved doing the experiments and all the rest of it. I think it was a bit too much. (Sachin)

> I was thinking after four years of doing a chemistry degree I'm not going to give it up. I loved the subject, I really enjoyed it but then [post-graduate university] just takes it all out of you, it sucks the life out of you, the academic side and research side; I still loved the chemistry but didn't enjoy the research as much as I thought I would enjoy it. (Sara)

I have previously applied the six Nimier defences to chemistry and I will do the same with teaching. One can view each defence with its corresponding opposite (Rodd, 2010) and I will use this approach, against teaching, here.

The six defences as adapted from those for mathematics to apply to teaching are:

1. Phobic avoidance (phobic)
    - Cannot teach
    - Not going to take teaching on
    - Teaching is difficult
2. Repression (phobic)
    - Teaching is not relevant to me
    - Teaching is not interesting
    - Teaching is not worth investing effort into

3. Projection (phobic)
    - Teaching is dangerous
    - Projecting myself onto teaching is dangerous
4. Reparation (manic)
    - Teaching is creative
    - Teaching is useful
    - Teaching will allow me to make things for myself
5. Introjection (manic)
    - Teaching helps me
    - Teaching is good for me
    - Teaching can give me skills
6. Narcissism (manic)
    - Teaching gives me joy
    - Teaching is comforting

I have considered all my gathered data and attempted to roughly quantify the extent to which the participants have used each of the six defences, or their opposites, in Table 7: Defences against teaching.

TABLE 7: DEFENCES AGAINST TEACHING

Participant	Defence											
	Phobic Defending self against teaching			Not-phobic			Manic Using teaching to defend self			Not-manic		
	Avoid: remote/difficult	Meaningless: not relevant/interesting	Dangerous: bad to project myself onto it	Approach: good at it/ easy	Enjoy: relevant/interesting	Beneficial: safe	Creative: useful	Good for me: helps me/gives skills	Comfort: gives me joy/comforting	Useless: not creative	Bad for me: doesn't help me	Anxiety making: gives no comfort
Aaron	None	None	None	Some	None	None	None	None	Little	None	None	None
Alex	None	None	None	None	None	Some	None	A lot	Some	None	None	None
Claire	None	None	None	None	None	Some	None	Some	Some	None	None	None
Jonathan	None	None	None	None	A lot	Some	None	None	Some	None	None	None
Richard	None	None	None	Some	Some	None	None	Some	Little	None	None	None
Sachin	None	None	None	None	A lot	None	Some	None	A lot	None	None	None
Sara	None	None	None	None	A lot	None	Some	None	A lot	None	None	None
Sonia	None	None	None	None	None	Some	None	None	None	None	None	Little

As previously I used four designations:

1. None: no discernible use of this defence;
2. Little: at least one use of this defence;
3. Some: multiple (two or three) uses of this defence;
4. A lot: consistent use of this defence.

Again, I tried to categorise the participants' defences within the context of what their whole narrative told me, so I questioned standalone statements which perhaps contradicted their narrative or did not align fully. When I looked at the participants' narratives it was apparent that most of us use teaching to defend ourselves in some way but we do so differently. Richard, Claire and I say we enjoy teaching and it gives us happiness but we concentrate on what it does for us,

whereas Sachin and Sara absolutely defend themselves narcissistically in terms of the joy their work gives them:

> …but the practice in the classroom, I was absolutely ecstatic about it. Really enjoyed it just getting involved and being able to pass on that knowledge and that love of the subject. (Sachin)

> I just went in there and taught and absolutely loved it. I didn't have lots of restrictions and that was it really, and that was why I carried on being a teacher and after ten years I'm still there. (Sara)

Both Sara and Sachin express this narcissistic joy in teaching to defend the decision to become and remain teachers. Interestingly, unlike Richard and Jonathan or Claire and me, this desire is because of an experience of teaching as opposed to an aspiration earlier in life or a rejection of post-graduate science. I would like to compare myself and Claire to Richard and Jonathan here as we have particularly different relationships with chemistry and teaching which illustrate clearly why some people could be attracted to teach in the future.

I have collected my analysis of these four participants' defences against chemistry (C) and teaching (T) in Table 8: Chemistry versus teaching.

TABLE 8: CHEMISTRY VERSUS TEACHING

Participant	Defence											
	Phobic			Not-phobic			Manic			Not-manic		
	Avoid: remote/difficult	Meaningless: not relevant/interesting	Dangerous: bad to project myself onto it	Approach: good at it/ easy	Enjoy: relevant/interesting	Beneficial: safe	Creative: useful	Good for me: helps me/gives skills	Comfort: gives me joy/comforting	Useless: not creative	Bad for me: doesn't help me	Anxiety making: gives no comfort
Alex (C)	Little	None	None	Some	A lot	Some	None	A lot	Some	None	Little	Some
Alex (T)	None	None	None	None	None	Some	None	A lot	Some	None	None	None
Claire (C)	Little	None	None	Little	A lot	Little	None	A lot	Some	None	Little	Little
Claire (T)	None	None	None	None	None	Some	None	Some	Some	None	None	None
Richard (C)	None	None	None	Little	Little	A lot	None	A lot	None	None	None	None
Richard (T)	None	None	None	Some	Some	None	None	Some	Little	None	None	None
Jonathan (C)	None	None	None	Little	Some	A lot	None	Little	None	None	None	None
Jonathan (T)	None	None	None	None	A lot	Some	None	None	Some	None	None	None

In terms of chemistry the division between Claire and myself, opposed to Richard and Jonathan, is obvious with us defending ourselves in terms of enjoyment and the subject being interesting to us in its own right, whereas Richard and Jonathan defend it in terms of its benefit to them. That is not to say that they do not enjoy it and that we do not see it as beneficial, but our defences align differently. As I have mentioned previously, crucially, Claire and I also express that chemistry has caused us anxiety and was bad for us in some sense, whereas Richard and Jonathan have no such issues.

When it comes to teaching itself, all four of us show some narcissistic manic defences of teaching giving us joy in some way, but we defend the decision to teach differently; whereas Claire and I talk about the benefit teaching has given us, Richard and Jonathan talk about the enjoyment they get from teaching. I do enjoy teaching, and have done so for twenty years, but my narrative suggests that I use teaching to defend myself against chemistry – when chemistry became

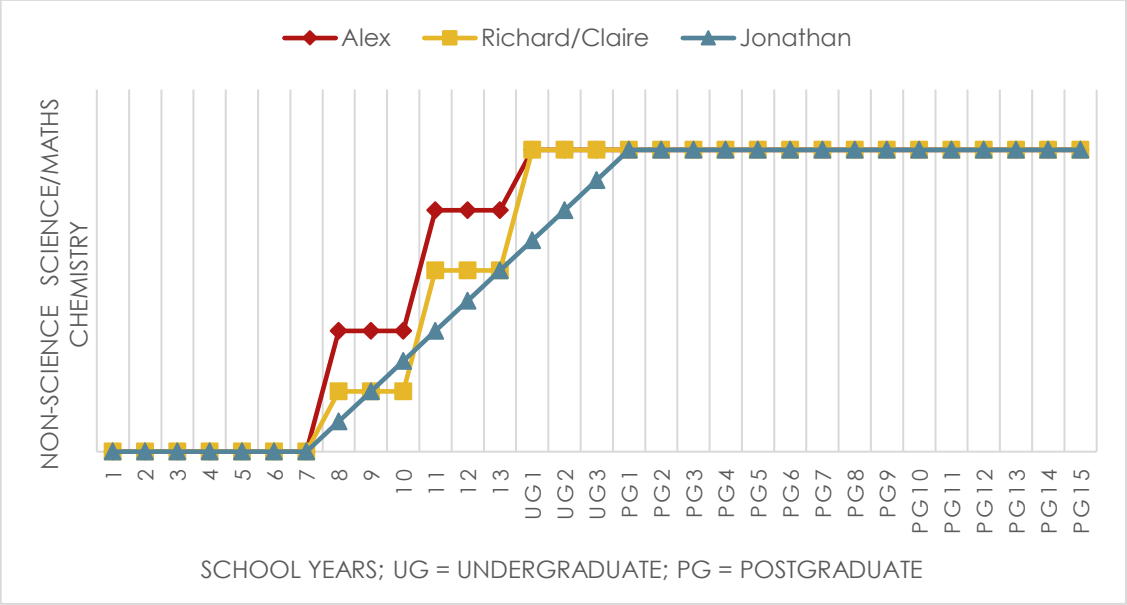
a negative influence, teaching took up its place. With no such crisis to deal with, Richard and Jonathan can assert their enjoyment of teaching without having to use teaching to defend themselves, although Richard does do somewhat.

5.5 Trajectories

Using what I have gleaned from the participants' narratives I have constructed trajectories for the participants, both against chemistry and against teaching. This will enable me to consider key loci or tipping points, as I have referred to them previously, in our timelines which have taken us all to becoming a chemistry teacher. These loci will help identify moments where there may be opportunity to promote the study of chemistry or the possibility of teaching it to others.

In Figure 2: Trajectory against chemistry, I have taken the timeline for only four of the participants (myself, Richard, Claire and Jonathan) and have attempted to show how our trajectories towards studying chemistry developed over time. The four of us have distinct trajectories against chemistry and offer an interesting contrast to each other. The other four participants have trajectories towards chemistry like that of Richard and Claire, but their relationship with the subject appears less important to their eventual teaching trajectory, so for greater clarity I have not included them here. I have considered this timeline on a yearly basis from school year 1 (5 years old) until fifteen years after graduating.

FIGURE 2: TRAJECTORY AGAINST CHEMISTRY



This chart shows three different trajectories, but also some loci in common, namely the arrival in secondary school (7), the beginning of GCSE studies (10) and the

end of formal schooling (13). These turning points are not surprising for any UK educated child as they mark the times at which circumstances change or formal curriculum decisions need to be made. Nevertheless, they do indicate where we came to become chemistry students. I consider Jonathan's journey to be almost linear as he became part of a science stream at school due to his ability to cope well with the subject, which he said led to his various curriculum choices:

> When I became a teenager, I sort of thought I wanted to go into teacher but I didn't know what it was going to be like so decided that I wouldn't do a B.Ed. qualification, I'd get a degree then do teacher's training and my A level choice was dictated by the fact that the school decided that if you could do science you did, so I did, and then the choice was that whether you did biology or maths with your physics and chemistry. That was the way that it operated in the school I went to. (Jonathan)

This linear trajectory towards science (chemistry) at university is completely unlike any of my other teachers' trajectories, but Jonathan was the only participant who was fixated upon becoming a teacher at a very young age. In some ways, the subject chosen was irrelevant; he had decided to teach at a secondary school and therefore a subject would need to be studied at undergraduate level, in his eventual case, chemistry.

I consider Richard and Claire to have followed a very similar trajectory towards studying chemistry at university. Both were strong mathematicians and only moved towards the physical sciences during their GCSE studies and then towards chemistry itself during their A-levels. Although their reasons for choosing chemistry at university were slightly different, their trajectories were very similar, with chemistry most able to fit in with their aspirations at the time.

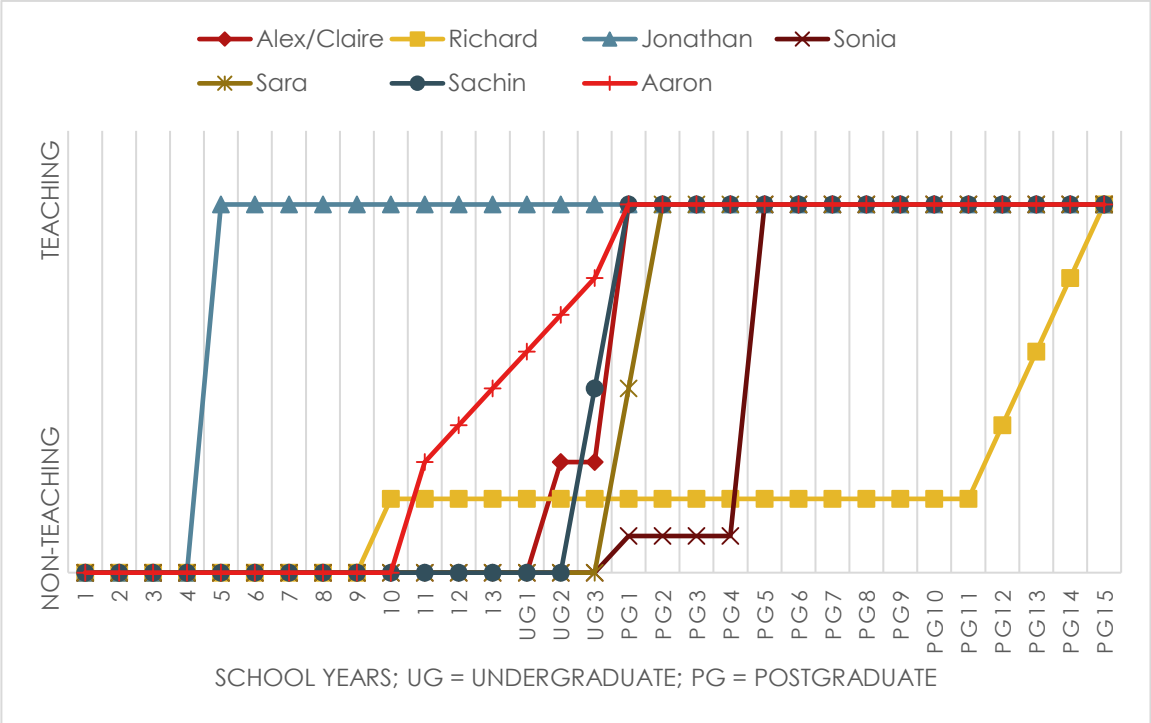
My own trajectory is parallel to that of Richard and Claire, but shifted towards chemistry at a younger age. As I have discussed earlier in section 5.5.1 through my four turning points, I too enjoyed maths at school, although was far more attracted towards science and chemistry at a younger age. Thus, external

curriculum choices formed the major turning points for me, although my path was defined earlier:

> Looking back, it was probably beginning to study chemistry as a distinct identifiable subject at thirteen that I associate most with setting me on the path to chemistry at university and eventually spending a career teaching it. (Alex)

Similarly, in Figure 3: Trajectory against teaching, I have attempted to represent the timeline of the participants towards becoming a teacher and have used the same time designations as in Figure 2.

FIGURE 3: TRAJECTORY AGAINST TEACHING



What strikes me here is the differing times in our lives at which we made the move towards teaching. Jonathan stated that he wished to be a teacher from a young age, at primary school, and this desire did not diminish until he finally realised his goal after university. This trajectory is very different to that of the rest of the participants. As Brooks (2016) points out in her book about geography teacher identity, some people just want to teach, for example Steven, one of her interviewees. These people are on a steady trajectory towards teaching from a

young age and for potential secondary school teachers like Jonathan, the subject they will teach is almost incidental to this trajectory, which is not to say that the subject is not important but that the trajectories towards it and towards teaching are separate entities.

Sonia showed little desire to teach right the way through school and university but began to earn some money teaching whilst studying for her PhD which led her to undertake a teacher training qualification subsequently, despite it never having been a particular desire of hers. Of all the participants Sonia gave the least impression of wishing to teach, rather it fitting the bill at a time in her life where she needed to work post-PhD. Without stating it outright, she gave the largest indication of an extrinsic motivation to teach; she needed a break from academic life after her PhD, so first took an administrative role away from family pressure in London, then saw a teaching career as a logical next step and, despite preferring to teach at primary level, she trained as a secondary school chemistry teacher due to a place being available (and having missed the deadline for primary training application). This also was compatible with the idea of having children in the future. Therefore, I have not considered her to be on a trajectory towards teaching at all until the utility value of teaching became clear to her.

Claire and I had a similar trajectory towards teaching with no stated desire to teach until we reached midway through our undergraduate studies when we both rejected postgraduate science studies in favour of teacher training. This was a major turning point in both of our lives where we both changed our academic aspirations, in my case from doing a science PhD and in Claire's from staying on to do her Masters degree. This turning point in the latter part of our undergraduate studies must occur with many students, particularly science students, where the proportion who go on to further academic study or research is high compared with other disciplines e.g. in 2012 34% of chemistry graduates were studying further six months after graduation, of whom 64% were studying for doctorates

compared to 19% of economics graduates being in further study, of whom 3% were studying for doctorates (Redman et al., 2013).

Both Claire and I would say that we became teachers to remain close to our subject, something in common with two of Brooks' (2016) subjects, Steven and Paul, whose subject knowledge influence their teacher identity strongly and permeate their practice. This major turning point may be an opportunity missed for other students who reject further study, in the same way Claire and I did, but do not consider teaching as an alternative.

Richard expressed a wish to teach whilst at secondary school, but with the clear intention to do other things first, which he did do during a career in the city of London. Nevertheless, years later, he stuck to his original plan and undertook teacher training. Although Richard, in some ways, was as driven to teach as Jonathan, he still has a major turning point whilst a successful banker:

> I'd been doing it 10 years at that point; I started to think about it, I wasn't quite at the stage, age or financially, to make the move away but I could see where it was going. So, I began to put plans into place of what I was going to do and over the next four years it materialised and I got myself in a position where I could say to the firm, I've had enough, I want to leave and we talked about it and when they found out I wanted to be a teacher they were very supportive and helped me out financially as well which was quite nice and I gave it [my notice] in. (Richard)

This turning point, after ten years working in the city, depended on Richard being able to organise his own affairs, financially and administratively, so that he felt he could resign his well-paid job and train to teach. Had he not been able to do so, I am fairly certain he would not have made this change. Therefore, this turning point is less easy to directly compare to others as it is so dependent on a multitude of factors and individual circumstances.

Sara and Sachin both showed little desire to teach as they went through their school and university studies. However, they both had a major turning point, Sachin in his final year as an undergraduate when he took part in a scheme that

placed students in local schools and Sara when she organised work experience in a school in the first year of her postgraduate studies. These turning points took two successful chemistry students directly into relatively long and successful careers as chemistry teachers. Without the opportunities that were available to them at this juncture of their education, it is not certain that either of them would have followed this path.

Relative to trajectories versus chemistry, the participants' trajectories versus teaching are complex and show different turning points, at school, during undergraduate studies or subsequently. I would like to conclude my analysis by drawing these turning points together with a sense of the key players in my participants' stories and their defences of decisions they have made.

5.6 Conclusions

The themes that I have generated from my interview data largely match those identified from the international literature into teacher recruitment currently published. However, as I have commented on previously, my data indicates a greater emphasis on the influence of parents compared with that of our own teachers as well as a very strong influence of prior teaching experiences compared to learning experience at school. Heinz (2015) reports that many studies show that prior experience of teachers and learning influence people positively towards becoming teachers themselves but that there is far less published about the influence of actual prior teaching experience. In fact, in her meta-analysis Heinz only finds two such studies (Heinz, 2013; Younger et al., 2004) which reflect this influence, interestingly published in Ireland and the UK respectively.

There is a culture of Teaching English as a Foreign Language (TEFL) in both of these countries, although equivalent schemes exist in other English majority speaking countries, such as Teaching English to Speakers of Other Languages (TESOL) in North America (Braine, 2014) and schemes such as these may contribute towards training as a teacher. However, the teaching experiences mentioned by the participants are all within their own home town or local to their chosen university, rather than part of national or international schemes, which suggests there is a need to consider this influence more thoroughly, as there seems to be little published in this area of the teacher recruitment literature.

Gender is a well-known influence on STEM students' aspirations and I was interested to see whether any such influences could be discerned from the research data presented here in this study of eight chemistry teachers, three of whom are female. As I discussed in section 3.3.2 choosing to teach chemistry is only a possibility once one has already chosen to study it to degree level. Gender did not explicitly arise as a discussion point or as a justification in any of the narrative accounts presented in this thesis. Where parental influence was noted, such as Aaron's parents' drive for him to go into medicine, it would have been very interesting to compare that to his siblings as potential gender bias could

have been found there. However, this was far removed from the remit of the research and none of the participants chose to place their gender as part of the story they presented me. Claire perhaps had the opportunity to do so when mentioning her younger brother and her feelings of inadequacy relative to him, but she cites his academic ability and the undergraduate university he attended rather than their difference in gender as the root cause of these feelings.

My thematic analysis considers all the participants' relationship with chemistry itself and compares interest in the subject versus utility through studying it. The two participants who express the greatest enjoyment of the subject, Claire and myself, also are the only ones to use non-manic defences against it when the going got hard. Perhaps we both go into teaching, rather than science research, as a way of maintaining this enjoyment whilst defending ourselves against the difficulties we encountered when studying it. Viewing the other participants through a defended-self lens supports my thinking when considering the stories thematically, as teaching itself is presented as more positive than research or other occupations for Sara, Sachin and Aaron rather than chemistry itself having become negative. I would suggest that the more chemistry is used to defend the self, the larger the influence of the subject in a person's identity which suggests a larger phobic defended response if the going subsequently gets hard. Teaching is in perhaps a unique position to cater for both these positions and therefore, there may be potential teachers amongst the national undergraduate student body who experience a similar tension.

My thematic analysis has allowed me to examine some of the stated key players in the participants' decision to study chemistry and subsequently to teach and to examine the ways in which these players influence us differently. However, by viewing our defences against chemistry and teaching I have also been able to unpick influences that were less obvious or not directly stated. This has led me to consider the trajectories that the participants have undertaken towards becoming teachers and, whilst in agreement with my other analysis which seeks to understand why we made the decisions we did, this approach has identified

some particular turning points which could and should be considered, if we wish to influence future chemistry teacher recruitment.

In terms of studying chemistry itself these turning points occur at school, for some early on when chemistry becomes a distinct academic entity and for others later, as they experience success in the sciences or it aligns with other ambitions, such as the acceptance onto particular courses or into specific universities. In the UK, these key turning points are in entering secondary school (11 years old), beginning GCSE study (15 years old) and choosing A-levels (17 years old). As I have mentioned earlier, the key moments for people to decide to become teachers are more complex. Some teachers have been on a path towards this since primary school, with no particular turning point other than attending school themselves and noting something there that they would like to experience for themselves. Others reach this decision at university, when the need to commit to one of their options post-graduation is very high; teaching seems to particularly attract some students at this point, some who were considering teaching anyway but others who may have wished to study their subject further. The last group of turning points towards teaching occur after graduation, sometimes many years later. These could be caused by a change of circumstances, such as having children, or by dissatisfaction in a career choice or even a residual wish to get back into their undergraduate subject.

Using the defences expressed at these turning points for the participants' different trajectories considered from their narratives, some significant commonalities and differences can be noted which influence the decisions that are subsequently made. In terms of choosing subjects I have found resonance between my narratives and STEM subject uptake research findings, but the participants imply influences and key turning points towards becoming teachers that do not have as much research backing. I would like to consider the implications of these findings in my final chapter.

6 Implications

In this final chapter I will consider the implications of my research in relation to the journey from chemistry to teaching and the teacher recruitment debate. Finally, I will look at limitations and propose areas for further study.

6.1 From chemistry to teaching

In this research, I have contemplated major life decisions within the context of the bigger picture of a person's individual narrative, including my own. By considering these stories, I have exposed some of the reasons that the participants have had for educational and career decisions they have made.

At the heart of my research is evidence that people choose to study chemistry, both at school and beyond, for a variety of reasons but that two factors dominate: an interest in and joy from learning about the subject and a sense that studying it has utility. Chemistry, as an academic discipline, has cache (Mujtaba & Reiss, 2014; Sheldrake, 2016) as a respected and challenging subject to study, as a gatekeeper to many 'successful' careers and one that will be seen in a good light irrespective of what you choose to do with it. There is an intimation from the participants in this study that studying chemistry can lead to certain respected careers such as medicine and banking

I have frequently used this perceived utility to justify studying chemistry to my own students and I believe that students who succeed in the subject tend to have developed certain useful characteristics, such as problem solving, independent learning and analysis, which may aid them in particular job roles. Of course, if some students with natural proclivities for these characteristics are indeed the students who elect to study chemistry, then we are in fact part of an inevitable production cycle. An ability to use algorithms successfully to solve moles calculations and apply these to different problems of amount, may help a chemistry student develop quantitative skills that may prove useful to train to become an accountant, a relatively popular career route for some chemistry graduates. Interestingly, within the accountancy education literature, we find generic skills like problem solving, communication and time management to be key requirements for the industry (Webb & Chaffer, 2016). Nevertheless, there is also a need for application of numeracy and analytical skills, which are both also associated with chemistry graduates.

Less explicit or indeed obvious, although expressed, is a subtle feeling of a hierarchy of careers that one could enter legitimately through studying the

subject. For school age students medicine, dentistry and veterinary science are acknowledged to be amongst the most competitive and highly regarded of degree courses available to them (Parry et al., 2006). Chemistry is the only compulsory subject for admission onto these courses at all UK universities and is the traditional 'deal-maker' (or 'deal-breaker') for such students and there is evidence that success in A-level Chemistry is a predictor of success at medical school (James & Chilvers, 2001; McManus et al., 2005). This creates an idea that these careers sit above other viable options in such a hierarchy. For Aaron, with a medical family and an ability to succeed in mathematics and the sciences, the pressure towards studying medicine propelled him to gain two medical university offers despite him not wishing to be a doctor.

Running in parallel with this respect for and ambition to gain admittance to a medical profession is an aim to make money. To make this money you probably need to get a well-paid job and, realistically, you may need to work in some kind of city job be it management consultancy, accountancy or the law. For young people making A-level choices or university applications, chemistry can provide a tried and tested route towards these blue-chip city jobs. Whilst acknowledging the fact that I teach in a London school where the city is perhaps a larger lure than in other parts of the country, I suspect this view is prevalent amongst many young people. Again, it could be that the subject offers intrinsic support to certain desirable characteristics or that potential financiers gravitate naturally towards it, but undeniably a certain proportion of chemistry students do tend to go in this direction: in 2013 of 2500 UK chemistry graduates, 38% were working full time in the UK within six months after graduation, of whom approximately 25% worked in business, PR, law, HR and finance (Redman et al., 2013).

Going directly into teaching has also proven to be a popular option for recent chemistry graduates, with 39% of 2013 chemistry graduates engaged in further study of whom approximately 11% were on PGCE courses (Redman et al., 2013). This would appear to show that government strategies to encourage graduates to go into teaching have succeeded. It would also appear to place teaching as a central part of the graduate landscape for chemistry students, which it

undoubtedly is. However, I believe that this place in the landscape masks its place in the hierarchy in the UK.

George Bernard Shaw's infamous adage, 'those who can, do; those who can't, teach' may be unjustifiable from current statistics as many graduates with good degree classifications become teachers through PGCEs, graduate training placement (GTP) or Teach First (TF), but a new adage of 'those that learn by teaching can then do something better' might be applicable to schemes such as TF (Macbeath, 2012). A government spokesperson might well suggest that Teach First has brought a lot of young and talented people into the profession, many of whom have remained in the classroom after their Teach First secondment has expired, as approximately 50% stay on in teaching (Muijs, Chapman, & Armstrong, 2013). Some of these may be motivated to gain leadership experience during their two years in school because of the positive impact on their CV and others because teaching is a positive career choice for them. I have multiple ex-students who have benefitted from following this path into teaching. However, schemes such as this presuppose that degree class is a good predictor of teaching ability. In 2014 the Sutton Trust published a report: What Makes Great Teaching? (Coe, Aloisi, Higgins, & Major, 2014) which outlines six components of great teaching, the first of which is pedagogical content knowledge, but goes on to say that, once a minimum knowledge is reached, it is how that knowledge is used that is important. Monk (1994) suggests that the positive relationship between teacher's subject knowledge and student performance drops off after this minimum point is met. The overwhelming majority of chemistry graduates have reached this minimum level of content knowledge and only reaching out to higher achieving graduates is a flawed national strategy; perhaps we would be better off looking for chemistry graduates that have the potential to use their knowledge effectively.

A subtle message that is therefore given in the UK is that teaching is important and skilled but sits below other graduate destinations in the hierarchy. All my interviewees express defence mechanisms against the non-teaching options, be it against chemistry itself being too demanding academically (Claire/me) or

other careers being dull, too repetitive (Sachin/Sara/Richard) or not offering benefits such as school holidays and that these negatives led to teaching as a suitable career path. These negatives or indeed this hierarchy are not part of the landscape in some other countries, where teaching retains its status as something to be aspired towards. In France for example, teachers are civil servants and have a relatively high status, perhaps partly due to the competitive way in which students qualify to become teachers (Moreau, 2015). In Finland teaching is consistently the most admired profession, above doctors, architects and lawyers and where only the most successful at school are able to become teachers, so entry is very competitive and normally some prior experience is required (Sahlberg, 2012); a similar situation exists in Singapore (Goodwin, 2012). Perhaps it should not therefore come as a surprise that UK teachers express this view of teaching, when the status and relative position of teaching here is as it is.

Despite the widely-held perception that chemistry can and will lead to success in the world of careers, all the participants are chemistry teachers. For some of them, the positive way in which they project an interest in or joy from learning chemistry is tempered by the sense that deciding to teach, or the realities of teaching itself, was slightly negative, even if there is also a sense that they were largely happy teaching. These negativities varied between the participants but were expressed clearly enough, even if they were not all fully aware of them. Aaron talked about teaching being 'definitely where I see myself for the next while at least and we'll just have to see. Do I imagine myself for the rest of my life? I don't know'. Sara mentioned the struggles she was having keeping up with the workload during that academic year and made very telling comment about her sixth formers asking her why she was a teacher, 'I say I really enjoy it and they're like well what if you don't enjoy it. I suppose I shouldn't be teaching anymore. And that's that point, I'm waiting for that point but I don't know when it's going to happen. There's not a set time frame you see'. Even for those teachers who view joining the profession as a positive decision, there is some sense that the negative aspects, such as workload, will eventually lead to them leaving the profession.

If some chemistry teachers have a feeling that teaching the subject is second best to other career paths, then this raises the dual questions of why they view it in this way and how this can be challenged in the future. If the adults inspiring the next generation with their love of chemistry view careers in this way, then perhaps we should not be surprised by the idea of teaching not occurring to many students. In the UK, we appear justly proud of our scientific and chemical heritage as championed by institutions such as the Royal Institution, Royal Society or Royal Society of Chemistry as well as our world leading universities. That chemistry itself offers students great utility and choice post school or post undergraduate studies is something to value. However, the cost is the subtle message that studying chemistry can lead to a certain respected career which might be unobtainable if you studied something less academically worthy; thus, a student who chooses not to follow through to these careers has let themselves down. Both Claire and I changed our academic aspirations as undergraduates, Claire first from doing medicine and then by dropping out of a Masters programme and I from applying for a science PhD. We both give a sense of feeling we were not good enough for these aspirations and therefore teaching emerges as second best, although the decision to teach does not appear to be related to its status relative to alternative career options. Richard made the career change from a city banking job to teaching and whilst he defended that decision by saying that his city job was 'atrophying his brain', he also said becoming a teacher was contingent on his finances, suggesting that teaching is a lovely idea but only after being successful elsewhere.

Teaching itself is often portrayed positively and no more so by my sample of teachers who, in their different ways, seem to enjoy their jobs and feel they made a good decision by going into teaching. And yet, negative feelings are expressed be they academic frailties by some of us, including myself, or subtler ideas of worthiness – I will do something more financially viable first before teaching – and these are underpinning subtle comments and asides that teachers make every day in classrooms and laboratories to the next generation, although these are often blindly financial rather than downplaying teacher status. The major thrust of this research was into career trajectories of UK chemistry teachers and what we

can learn from this about teacher recruitment, which I will focus on in the next section, however the data presented here does add to the debate about teacher status in this country.

6.2 Teacher recruitment

As I have discussed at the beginning of my thesis, there are teacher recruitment and retention issues in many countries around the world, including the UK. In conclusion to her international meta-analysis of student teachers' motivations to teach, Heinz (2015, p. 275) says that, 'there is clearly much room for advancing the field of teacher career motivation research, and future projects should aim to engage in much more nuanced analyses of trends within as well as similarities/differences between countries and cultural contexts'. Most of the studies examined in this meta-analysis were quantitative or mixed method in approach, not subject specific nor addressing the question of how we can attract potential teachers, not just the people who are training for entry into the profession. Klassen et al. (2011), critiquing much international research in this area, also advocate a more qualitative approach to examine differences, such as those across cultures, that are often masked when mixed methods or qualitative approaches are used.

In this thesis, I have considered the key influences in eight participants' career trajectories towards becoming chemistry teachers using such an approach, specific to chemistry, a STEM subject, examining subtle nuances via a narrative methodology to apply what I have learnt to the important issue of recruiting science teachers in this country.

Firstly, some people have always wanted to teach; two of my eight participants express a wish to teach at a relatively young age, Jonathan whilst at primary school and Richard at secondary school. Despite both being on a trajectory to teach, their routes are completely different. Jonathan would have become a teacher no matter what and had chemistry not been the conduit to him realising this wish, a different subject would have replaced it. Jonathan himself said his interests at school were well spread but his natural ability in the sciences automatically led to him going down that path. Richard had a very specific pathway in mind, which prioritised attending a high-status university to increase the likelihood of a well-paid financial career which, if the (financial) circumstances were right, could lead to teaching eventually. Richard, unlike

Jonathan, was not predestined to become a teacher because he explicitly says this move was contingent on having made enough money to feel he could change career before the age of forty. People for whom teaching has been a life aim, intervention is not necessary but suitable and flexible routes must exist so that the move into the profession is viable, whatever their age. Good teacher training and early career mentoring is essential for the profession to live up to such an early life goal, as international literature points to this problematic gap between career motivations and actual experiences in the classroom (Heinz, 2011; Lin et al., 2012; Manuel & Hughes, 2006).

Richard was the only career switcher within this group of participants and his assertion of intrinsic reasons for wanting to teach, in evidence from his teen years, but only acted upon in his late thirties after becoming financially stable and secure aligns well with other studies into teacher career switchers (Priyadharshini & Robinson-Pant, 2003; Richardson & Watt, 2005). For the purposes of this research into career trajectories, switching to teaching after a career elsewhere is not in a separate category, but rather on a different timeline with different turning points to others, which I will discuss shortly.

For the other participants teaching only became an option to be considered after certain life turning points. Claire and I became chemistry teachers after our original academic aspirations were challenged at university but our association with the subject remained strong. For me, teaching seemed to offer the only obvious way I could reconcile my self-image as a chemist with a career choice I regarded as viable. Although Claire and I made the leap towards teaching unaided, how many other students experience similar crises of academic identity, particularly those at elite universities, but do not make this leap? National strategies, or more localised university ones, could and should focus on the academic/subject side of secondary school teaching, as a viable alternative to post-graduate studies, but without the emphasis on it being a stepping stone to something else that Teach First and equivalent schemes promulgate. This could prove to be a useful teacher recruitment strategy, aimed at second/third year undergraduate students.

Whilst Sonia clearly had a major turning point a year or so after her PhD was completed, I am not convinced that such an intervention would have made her more or less likely to teach. She realised that teaching could have personal utility value (Richardson & Watt, 2006) at this point in her life and these values are independent of other factors. There will always be people who choose to teach for sound personal reasons and, in common with those for whom teaching was a life-long goal, no additional intervention is necessary, apart from offering different routes into the profession.

Of particular interest to me were Sachin and Sara, both good chemistry graduates, who were considering post-graduate science study without the crisis in confidence displayed by Claire and me. They both seemed unconvinced by the reality of PhD study but were equally unsure of other career routes. They both stumbled into opportunities to spend time within the classroom, Sachin via a university scheme placing undergraduates in local schools, Sara via an ex-teacher organising some work experience for her in their new school, having already tried work experience with all her siblings in their respective workplaces. Experience in a real classroom proved pivotal for both who subsequently considered, applied for and undertook teacher training. Schemes such as the Student Associate Scheme (SAS) have long existed in the UK as well as student ambassadors being placed into schools by organisations like the Royal Society of Chemistry (RSC) and smaller schemes, such as that experienced by Sachin, also exist within individual universities. Nevertheless, many potentially excellent teachers, such as Sachin and Sara, must be lost to the profession every year.

Therefore, an important implication of this research is to advocate an increase in schemes that would encourage undergraduates into schools, not necessarily teaching but experiencing the classroom from the educator's perspective, something called for by Hillier et al. (2013) in the case of physics. Sara explained the benefit of such an experience succinctly:

"I absolutely loved the atmosphere and that was it really. It sold it to me" (Sara)

I am advocating this time in the classroom from the perspective of eight people who were happily teaching at the time I interviewed them but I acknowledge that many others would have a less positive experience within the classroom, whilst an undergraduate, and never wish to return. This is not a bad thing, in fact quite the opposite; what must be an aspiration is to open the world of the classroom to undergraduates because otherwise the only way to judge a potential career teaching is one's own experience of being a school student and personal opinions of teaching and teachers, influenced by friends and family, as well as promulgated in the media. The surprise expressed by both Sachin and Sara and, in the case of Sara, her almost immediate decision to teach, indicates the power of a real experience in the classroom. Perhaps if students were able to judge their interest in teaching more effectively we might see an improvement in teacher recruitment numbers in the UK and, even if not, we could improve upon the current attrition rate, where four in ten teachers leave the profession in England in their first year (Brooks, 2016), in the longer term.

The most important influences on the participants in this study's decision to study chemistry and then become teachers were their parents, teachers, interest in the subject and prior teaching experiences all of which appear in the international teacher recruitment literature (Heinz, 2015) as acknowledged influences towards teaching, although much of this literature has involved large numbers of student teachers who tend to be younger, and more recently at school themselves, and may have been asked to reflect on their own schooling as part of their training course. Extrinsic motivations such as salary and job security are more important in countries with different socio-economic contexts compared with European, North American and Australian studies, where altruistic and intrinsic motivations appear to be more prevalent. Significantly, in this study, our own teachers appear to have influenced the participants less than might be imagined from the published literature in terms of becoming teachers and, in fact, teachers seemed to influence the subject choice far more heavily than career choice later in life.

It is well established in the literature that a love for the subject to be taught and enjoyment of it can be a prime motivator to become a teacher (Clarke, 2009;

Kyriacou & Kobori, 1998; Younger et al., 2004). In my study the participants' own teachers, although not necessarily their science/chemistry teachers, have promoted a love of, or confidence in, learning which has been important to them in selecting subjects to study both at school and beyond. Whilst there was no equivalent sense of our own teachers influencing our decisions to enter teacher training, this sense of subject interest being important suggests that this is there but perhaps unsaid and even unseen by us all.

By considering individual trajectories towards teaching, I have been interested at not only the key turning points in the participants' lives but also the timing of these turning points. I am advocating for second/third year undergraduates to spend time in the school classroom so that they can challenge their own preconceptions of teaching and, perhaps, consider it in new light. In addition, I am calling for teaching to be an academic choice, distinct from post graduate study, but not one that is a springboard to something more lucrative. This time in the middle/latter years of undergraduate study is pivotal for the attraction of the next generation of young teachers.

However, career switchers are also valuable contributors to schools and many of them seem to have similar trajectories to Richard, where they had wanted to teach but other factors were at play to begin with, often financial (Crow, Levine, & Nager, 1990; Richardson & Watt, 2005). Therefore, it is important not to focus all our efforts on undergraduates but remember that career switchers may have had long-term desires to teach which, for a variety of reasons, they might not have been able to fulfil. Routes into the professions must exist, and continue to be funded, that facilitate this transition.

6.3 Limitations and further study

This is a small study which considers eight teachers at two London mixed comprehensive schools. Su, Hawkins, Huang, and Zhao (2001) compare and contrast candidates for teacher training in China to those in the United States and find that extrinsic motivations are generally stronger in China and the decision to teach is often a consequence of scores being too low to secure a place on more prestigious higher education courses. My study is localised both in terms of the UK, as well as London, although its broad conclusions are applicable to other countries like Australia, Canada and the US where similar debates persist. Nevertheless, it is less applicable to other countries, where the status of teachers, history of the profession, as well as socio-economic conditions deviate significantly from the UK.

One of the major criticisms of much of the research into the teacher recruitment debate is methodological. The strengths of this study, relative to this wider literature, are that its approach is holistic, it attempts to examine the bigger picture via the narrative interviews carried out. Generalising to the population at large, or even to that of chemistry teachers, from this extremely small sample was never the intention of this study, but instead it sought to investigate influences on its participants' career trajectories and examine what we can learn from these, whilst interrogating larger quantitative studies and considering nuances that exist.

The relationship between researcher and participant was important in this study, particularly the subtle balances of power between me, the line manager of three of the participants, mentor to one of the others but junior to the head teacher of the school in another case. To mitigate against this, I also interviewed two other teachers who I had not met prior to our interview. The power relationships at play here are complex and distinct. This is inevitable in such research, as I was seeking to construct meaningful, but individual narratives then view them collectively and see if themes developed.

I attempted to mitigate against the small size of the data set by taking different theoretical stand points in analysing the gathered narratives in two distinct and contrasting ways. The narrative approach sought to view the narratives as stories,

influenced by and situated within a wider context and co-constructed with me, a fellow chemistry teacher. Using the defended self approach, I analysed the gathered data and identified intra-psychological manic and phobic defences used by the participants. Comparing and contrasting what I could identify using these two analytic lenses allowed me to present a more nuanced view of the small data set I gathered than would have been possible had I limited myself to one approach and could serve as a useful strategy in similar small scale studies. As Wertz et al. (2011) demonstrate, there are different ways in which one can approach qualitative analysis with their own strengths and weaknesses. By using more than one of these I managed to extract more from the data then had I limited myself to in either of my approaches.

To follow on from the research presented here there are two areas of interest that should be investigated further and which could add considerably to the teacher recruitment and attrition debate worldwide:

- Our teachers influence subject choices. To what extent do they influence us in becoming teachers, as this research suggests this relationship is more complex than current literature suggests?
- Can more systematic prior teaching experience, as opposed to the experience of being taught, increase participation in initial teacher education and/or improve attrition rates for those who do enter the profession?

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Appendices

Appendix 1: My story

I have considered my own story on various occasions throughout my research. My decision to study chemistry at university, and then to go on to teach, is the major driving force behind my eventual decision to examine these decisions in others. The big picture and the stories behind these large life decisions interest me, so are the influences that may affect them. My own story must be the starting point here, for my own benefit as a narrative researcher to potentially reveal my own thought processes which will have, knowingly or unknowingly, have influenced the way in which I view other narratives. It is also for the benefit of my reader, who may spot these influences or biases, even if I am unable to, and at the very least situates my research within the context of my life.

Finally, and perhaps most importantly, it may help illuminate the way in which I carried out my interviews with my colleagues. As I have already discussed, I know most of them personally and have a working relationship with five of them, precisely the issues of power, emotionality and interpersonal process referred to by Holstein and Gubrium (1995). My own story will have influenced every word I uttered in my interviews as well as inferences I may have drawn subsequently,

I present my most recent written version of my story, as well as some observations as to similarities and differences between this and its previous iterations. I have not altered this from the original, apart from correcting minor spelling or grammatical errors. Where I have used casual or context specific language I have inserted explanatory footnotes, rather than impose another change and produce a different piece of writing.

12/7/15 Attempt 3

As I think back through my life, I realise that life decisions are complex and hard to pin down. Even when one feels confident in a decision at the time, hindsight

can act as a lens upon other factors that might not have seemed important at the time. In my own story, as I reflect upon it this Sunday morning, of particular importance seem to be my family, and their educational example, my relationship with chemistry as a subject, my contemporaries at university and the teaching I received at school and university.

My father studied physics at university and ended up being an aeronautical engineer, via flying helicopters in the RAF[18]. My mother studied general arts at university and taught English and general studies to adults, in the RAF, before having children. Without particularly realising it at the time, I was part of an academic[19] family, particularly on my mum's side. My parents were not the slightest bit pushy in terms of education, but an interest in academic things surrounded me and my sister throughout our lives; they would read a quality newspaper every day and watch the news and talk about what was happening in the world. They would also be interested in what I had been learning and engage with me about it, with my mum covering the more humanities side of things with my dad talking to me about maths and science. In characteristic fashion, I think I did believe, at one time, that he knew everything! This bubble burst when I was around fifteen years of age when I categorically found out I knew things he did not. Chemistry gave me this edge, as it had already developed into my academic passion by this stage and I had overtaken what he could remember from A Level Chemistry when he was a schoolboy.

As a child, I was quite needy of adult attention, perhaps in common with many firstborn children and hung around my mum a lot. She always says that my sister was far more independent as a small child, happily playing on her own for hours on end. The game changer for me was learning to read, as I have had a lifelong passion for reading fiction; from the age where I could read unaided I was happy to sit still with a book. In fact, as a moody teenager, I would far prefer to read a book, preferably a very large one, than speak to my family at all, which could get awkward on family holidays in a small caravan when it was raining outside.

[18] UK Royal Air Force
[19] By academic I mean university graduates.

Many childhood and teenager memories revolve around sporting activities, a passion shared particularly with my mum and sister, being a sports fan, shared with my dad, and reading books which I had no intention of sharing with anyone!

Primary education passed by uneventfully, apart from moving from the south of England to the northeast of Scotland, with a change of education system and my first taste of being bullied (for my accent). I had no concept of being academic throughout these years at school, in fact I felt distinctly average. My only memories from primary school were sporting (sports day being the most important day of my year), feeling frustrated by things I found hard (I remember getting stuck on ratios at primary school; as a chemistry teacher, I now realise many 18 year olds seem unable to understand them either) and occasions that were embarrassing like giving a talk or being told off. I was very well behaved and, in fact, I can only remember being told off directly, as opposed to the whole class being, once in thirteen years in primary six[20] when I was speaking to my friend Paul. On reflection, I got put up a year on our move to Scotland due to my March birthday, so was the youngest in the year for the rest of my school years, so perhaps they felt I was reasonably academic but if so it certainly didn't transmit to me until I started cashing[21] in exam results in secondary school.

I had no conception of science as a subject until early secondary school when we started to study it formally, although the distinction between biology, chemistry and physics did not become clear until third year[22] when I began to study chemistry and physics for my O grades[23]. This does raise the question of how I made the choices for my O grades. From what I can recollect I had already developed an aversion to biology from what little we had studied as I had no intention of ever studying it. I suspect the influences on me here were my natural squeamishness and dislike of blood and anything to do with dissecting anything that was alive as well as my dad's passive support of chemistry and physics. I do

[20] Sixth year of primary school, which in Scotland would normally include 9/10/11 year olds
[21] In Scotland, this cashing in would refer to external examinations taken aged 15, 16 and 17
[22] Third year (S3 = secondary year three) would be for students aged 13-15
[23] O grades were qualifications taken aged 15-16 and were the first external examinations sat by Scottish school students at the time

not remember any conversations about this but he retains a passion for maths and the physical sciences and talked to me a lot about what I had been learning and usually could add something or ask me meaningful questions about these subjects. As always, I suppose it is a combination of a multitude of factors that influence a decision. At the time, I had no doubt about the decision to take physics and chemistry. The only contentious decision was that to take Latin, which can be laid firmly at my mum's door. She convinced me that knowing some Latin words would aid me in my scientific endeavours with so many Latin roots being used across all three sciences. I'm not convinced this did help me in any way and I was a very poor Latin student, but does clarify my memory that I was already hell bent on the sciences at this point. I knew it and so did both of my parents. I would be interested to ask them about this sometime!

In parallel to science entering my consciousness in early secondary school, chemistry did so in third year onward when I studied it as a distinct subject. I think I loved it from the first day I had a name to pin to it. I had a very strict teacher who was not everyone's cup of tea, but was right for me. I was quite quiet and shy at school and I liked a controlled and safe environment in which to learn. Not only this but I liked his teaching style and was interested in everything he had to say. Chemistry won out, for me, as I could carry out practical work, which I enjoyed but that the theory we learnt aligned perfectly with the practicals we did; sometimes the experiments tested out the theory we had just studied or opened questions which subsequent theory could explain. Put simply, I found it amazing that I could mix things and something would happen, a colour change or precipitation or effervescence, and even more amazing if I felt I had a reason for why it happened.

I suspect I knew I would study chemistry at university when I was thirteen. I do not remember working towards anything else at school since I began to study it as subject in its own right. Interestingly I assumed I would go to university but do not remember my parents telling me I would or pressuring me. I think the background of my parents and the subtle influence of how they spoke to us and how they were implied that higher education was important and both myself and my sister

worked towards it without any aggravation or challenge. As I got older I began to realise I was reasonably academic, or at least, naturally good at some subjects (sciences and maths) and not incapable in the others. I put the most effort into my preferred subjects as I was aiming for top grades there. My mum always pushed me to work harder in other subjects but I argued that this was the direction I was going in so they were more important. I worked hard and consistently at school but my work was skewed in terms of what I enjoyed; I was blessed with being a fast worker naturally so this helped me enormously as well as being able to organise my time and still play a lot of sport in the evenings. I knew I was doing well in my preferred subjects but never felt anything above that; there were two or three boys in my year who were better than me and I never once came top of a year-wide ranking in a subject at school.

As I got to the eldest year group at school I had to choose universities. I was dead set on chemistry and so choosing universities was the only job to do. In retrospect, I realise how lucky I was as so many of my students struggle immensely to make that decision. In Scotland students already have their higher results at 16 before they apply for university, so I approached UCCA[24] knowing I had better grades than that required to go to the top ranking Scottish universities so was guaranteed an unconditional offer. My mum was brought up in Oxford and both of her parents, as well as two of her four siblings, attended Oxford University. Had it not been for that family tie, I don't think I would have even considered applying there. It wasn't so much whether I was good enough or not as not even occurring to me. However, I remember my grandfather visiting and asking me if I was thinking of applying to Oxford or Cambridge. This was the world he came from but not particularly the world I came from in a northeast Scotland comprehensive school. I remember thinking no way, then well it can't hurt to find out about it. He dearly wished for one of his grandchildren to attend Oxford and particularly Oriel College, where he was still part of the Senior Common Room, and one of his sons had attended too. I only applied to three universities in the end: Edinburgh,

[24] Universities Central Council on Admissions – a clearing house for university applications in the United Kingdom from its formation in 1961 until its merger with PCAS (Polytechnics Central Admissions Service) to form UCAS in 1993

Glasgow and Oxford, as I knew I was certain to get unconditional offers for the Scottish ones with my grades that were in the bag. Oxford was a punt I guess and an attempt to see what happened. The interesting part of the story is when this 'punt' became serious. Although it hadn't been on my radar to apply, once I had applied my natural competitiveness kicked in and I wanted to get accepted. Sadly, for me, my first attempt at Oxford interviews took place when I was only sixteen, as I had been moved into a higher year group, and I had been unwell; it did not go well and I still quail when I think of some of the answers I gave on that day. Being rejected was one of the harder moments of my life, conjoined with the spirit that you feel you must pretend you're not bothered (I was giving it a punt, remember). Even harder was deciding to pull out of UCCA and reapply. I was already applying for deferred entry because of my age, so I did not have to hurriedly arrange a gap year, but I did have to face a second attempt at Oxford interviews with the associated trauma of being potentially rejected twice. I had left school by this time and was a year older, and knew a bit more chemistry, and this time found the interviews much easier to negotiate. In the days before the internet, having faced the interviews the year before provided vital information which helped me subsequently.

So, I studied chemistry at Oriel from 1991 until 1995 and this time was very happy, although tough. Being an average/mediocre chemist and surrounded by very talented students was on one hand a great experience and on the other, rather hard to deal with. Any confidence I had gained from doing well at school and gaining a place at this institution was tempered by the reality of the ability of many of my friends and the gap I perceived between them and myself. In fact, I performed perfectly acceptably at Oxford but I came to the conclusion that I wasn't of PhD material. It was extremely arrogant of me, and short-sighted, to assume that not being as naturally academic as a few Oxford friends meant I wasn't capable of further chemistry study but comparison with others is so powerful. In fourth year, we did projects in the research labs and a seminal moment occurred when I had a meeting with my supervisor and he implied to me that I wasn't of the quality to stay at Oxford for a DPhil; this apparent rejection allied with my own comparison to my contemporaries ended any potential

avenue for further study dead in the water and I didn't even look into applying for a PhD despite it being what I thought I would have liked to do. I enjoyed chemistry still and found experimental work interesting and, if anything, my natural organisation led me to be a better experimentalist than theoretician, perfect for many kinds of chemistry PhD projects.

Despite not investigating the further study route, I had a view that I didn't want to have wasted all these years focusing on chemistry and go and sell chickens or add up numbers in an accountant's office. To my mind there were only two other options, science in industry or teaching. When I found out how appalling the forms were for companies like Shell and BP, as well as being slightly put off by my dad's hatred of corporate culture – he worked for BP by this time or 'Bloody Pathetic' as he tended to refer to them as – I decided that that life wasn't for me. As I look at that now, I realise that I was making a very big decision based on very little knowledge and sweeping generalisation as to the operation of the corporate world, something I am still suspicious about to this day but have never worked in. Therefore, applying for teaching was the preferred/only option I saw for myself that kept me in science but didn't involve large corporations. It seems like a weak decision in some ways, as I was sticking to what I knew and being naturally risk-averse it fits my character very well. I do remember exclaiming that I had no idea if I would be a good teacher or not but I'd give it a go and see if I was cut out for it. And if not, I'd seek out something different; the rest is almost twenty years of history!

Appendix 2: Consent Letter

Alex Dawes
ADDRESS

Telephone: TELEPHONE NUMBER
Email: EMAIL ADDRESS
DATE

Dear NAME,

I would like to invite you to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. I would be very grateful if you could take a little time to read the following information about the research carefully.

Information about the research

As part of my PhD studies at the Institute of Education, London, I am looking to speak to Chemistry teachers about their current roles and their background. I hope to interview approximately five teachers in this phase of my research. Taking part is entirely voluntary. If you do decide to take part, you are asked to sign the attached consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason.

I hope to interview my sample and record these conversations on a digital audio-recorder, as well as take field notes. I would not expect these interviews to last beyond an hour. The electronic files will be stored on my home computer and will be password protected and only seen by myself and my supervisors. In addition, anonymised sections will be seen by other education academics for verification of analysis. They will be destroyed at the end of the research. All information collected about individuals will be kept strictly confidential and will be anonymised if used in any published research. I will send each interviewee a summary of their interview for feedback on the content and any potential inaccuracies. Furthermore, as it might be possible to identify the school, and hence interviewees, from my name, all sections of writing for publication will be made available for review, so you can be confident that you are comfortable with what is potentially revealed about you and the school.

If you are happy to be interviewed by me in the manner outlined above, please could you sign the consent form attached and return to me. Thank you very much in advance and I look forward to involving you in my study.

Yours sincerely,

Alex Dawes

CONSENT FORM

Full title of Project: Chemistry teaching: a narrative approach

Name and contact address of Researcher:
Alex Dawes, ADDRESS

Please tick box

1. I confirm that I have read and understand the information sheet for the above study. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason. ☐

3. I agree to take part in the above study. ☐

Please tick box

	Yes	No
4. I agree to the interview being audio recorded.	☐	☐
5. I agree to the use of anonymised quotes in publications, once I have reviewed the content.	☐	☐

Name of Participant	Date	Signature
Alex Dawes		

Name of Researcher	Date	Signature

Appendix 3: Sample participant summaries

Richard

The first influence you mention was the enjoyment of maths from a young age and the realisation during secondary school that you enjoyed and could be successful at science. You talk about the background of your parents and grandparents and suggest that you had a drive to teach from a relatively young age, but that it would not be until later in life. You describe a change in direction towards the sciences at school and how entry to Cambridge may have influenced this decision, then the decision to leave your city job to pursue teaching. You talked about your science teachers in terms of how their style suited you, even if they might not have been seen as 'good teachers'.

Sara

The first influence you mention was your original plan to become a cat vet, but that this soon became a path towards chemistry, influenced mainly by an interest in the subject and by siblings also having studied it. You compare and contrast your siblings' occupations with the experience you had during work experience with an ex-teacher and made the big decision to quit your PhD studies for a PGCE. You talk about how you have enjoyed the job and how the stresses and strains are quite different to those experienced by your siblings. You also talk about some of your ex-teachers in very positive terms.