



Chemistry for All

**Reducing inequalities
in chemistry aspirations
and attitudes**

Supplementary material

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Supplementary material – Analysis
of interviews with students receiving
the programme from one provider

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1. Analysis of interviews with students receiving the programme from one provider

1.1 Introduction

This report presents a qualitative study of the two schools in one part of England where cohorts of students were interviewed. The intervention programme was planned so that events were consistent in terms of:

- Frequency – events took place each year in schools and in the university, from Years 8 through 11 for each of the two cohorts.
- student experience – the provider team and teachers ensured as far as possible that the cohorts of students being surveyed and interviewed in the Chemistry for All schools participated in the events.

The robustness of this programme suggested that the interview study could capture in detail the students' experiences and perceptions of Chemistry for All throughout their participation in the intervention. The continuing involvement of the interviewees suggested

that a detailed analysis and case study approach would enable particular insights to emerge. The context of the provider schools and the particular issues for these cohorts of students have been reported by the provider team (Mallaburn et al., 2018; Seton et al., 2018); details of their interventions have been documented thoroughly in provider annual reports and an overview in a chapter currently in press (Simon et al., in press). That chapter includes the provider team's programme aims, details and evaluation of the events and incorporates my observations and brief tabulation of Year 11 interview outcomes. This report sets out in more detail the scope and analysis of the interview study.

1.2 Interview data set and attributes

Cohort 1 were interviewed for 4 years, Years 8 to 11, Cohort 2 were interviewed for five years, Years 7 to 11. Table 1 shows the data set for the five years. In total, 55 interviews were completed in this timescale.

Table 1: Data set showing all students interviewed. Total number of interviews = 55. Students marked * were written up as case studies using the given pseudonyms.

Name	Gender	School	Y7 (2015)	Y8 (2015 and 2016)	Y9 (2016 and 2017)	Y10 (2017 and 2018)	Y11 (20189 and 2019)
A* Anna	F	W	x	x	x	x	x
B* Brian	M	W	x	x	x	x	x
C	F	W		x	x	x	x
D* Diane	F	W			x	x	x
E* Edward	M	W			x	x	x
F	F	W				x	x
G	F	W	x	x			
H	M	W		x			
I	M	W		x	x		
J	M	W			x		
K* Katie	F	C	x	x	x	x	x
L* Lucy	F	C	x	x	x	x	x
M* Martin	M	C	x	x	x	x	x
N* Nathan	M	C		x	x	x	x
O	F	C		x	x	x	x
P	M	C				x	x
Q	M	C		x	x		
Totals			6	12	13	12	12

Notes on the data set: The interview programme began with three students in Year 8 (cohort 1) and three in Year 7 (cohort 2) in each school. These students were followed through as far as possible to year 11. Some students at schools C and W left the school or withdrew from the project so alternative students were interviewed.

The interview schedule developed by the IOE research team was used. The Year 11 version is shown in Appendix 1. The same basic questions were used each year, though in Years 9 to 11 the focus was more on chemistry than science, and additional questions were added in Year 11 to capture students' perceptions of how Chemistry for All had influenced them. All 55 interviews

were transcribed and imported into an NVivo project to facilitate qualitative analysis. A series of attributes derived from the interview questions was assigned to each student, as shown in Table 2. The definitions of these attributes reflect the kinds of responses made to the interview questions.

Table 2: NVivo Attributes assigned to each of the 55 transcripts

Name of attribute (from the interview schedule)	Possible Values	Comments
Likes science/chemistry	Yes/No/Unsure N/A	This applied to science in the early years then more specifically to chemistry. Any positive answer was recorded as yes.
Chemistry difficulty	Easy/Difficult/both N/A	Again science in the early years. 'Both' was assigned when students said there were easy parts and difficult parts (most common)
Maths difficulty	Easy/Difficult/both N/A	Same as above for maths
Chemistry useful	Yes/No/Unsure N/A	A yes was assigned when students indicated science/chemistry was either important or useful
Family and chemistry	Yes/No N/A	A yes was recorded for any family member either working in a chemistry related career or studying chemistry
Chemistry out of school	Yes/No N/A	A yes was assigned if students were involved in any science/chemistry activity that was not school-related.
Aspires to do chemistry	Yes/No/Unsure N/A	A yes was assigned if students said they might opt for chemistry post 16
Might work with chemistry	Yes/No/Unsure N/A	A yes was assigned if students had an intention to work in a chemistry related career
Intervention impact Interest	Positive/negative/No change N/A	N/A was recorded if the students had not yet experienced any events
Intervention impact Knowledge/ability	Positive/negative/No change N/A	N/A was recorded if the students had not yet experienced any events
Intervention influence On aspiration	Positive/negative/No influence N/A	N/A was recorded if the students had not yet experienced any events, or been asked this question (only last interviews)
Intervention influence On career awareness	Positive/negative/No influence N/A	N/A was recorded if the students had not yet experienced any events, or been asked this question (only last interviews)

1.3. Coding the transcripts

As well as assigning values to the attributes for all 55 transcripts, a coding scheme was derived that would enable a qualitative account to be reported. The transcripts were read across the data set and it was decided that certain interview questions elicited insightful responses that would provide a useful thematic account and a set of comparative cases of students. Each transcript was coded by highlighting relevant text and assigning the appropriate code in NVivo. Whilst this coding took place, selected cases were constructed as text, using both the attributes that had been assigned (Table 2 above) and the codes (Table 3 below). These cases include two boys and two girls from

each school. The cases provide contrasting accounts of these eight individual journeys through secondary science. They are cross-referenced in the thematic account and are included at the end for the reader as individual student narratives. In Table 1 they have been starred. The pseudonym for each case begins with the project letter assigned to the student. For example, student A in table 1 is Anna.

The code names and descriptions in Table 3 below are derived from the interview responses across the data set – thus, this conceptual framework differs from the main body of Chemistry for All analysis, where similar terms may be defined differently.

Table 3: Codes applied to each transcript.

Interview questions	Code name	Code description
Do you think science/chemistry is important? Do you think chemistry will be a useful subject for you in the future?	Value of science or chemistry	Includes how students view the importance of science or chemistry widely, and/or how they perceive its usefulness to themselves as individuals.
What sort of things do you do in chemistry?	School science experience	Includes students' accounts of practical work, group work etc and how they viewed these experiences.
Do you find science/chemistry easy/difficult?	What is difficult	When students said they found science or science or chemistry difficult this code was used to highlight their reasons.
How do you get on in chemistry?	Self-concept in science or chemistry	Students were asked how they thought they were doing in science or chemistry, and also how they knew. Their evaluation of how they are doing is built on the experience they have of how they are assessed.
What do you do to succeed in chemistry?	Self-improvement strategy	This code is applied when they describe what they do to succeed.
Will you carry on doing science/chemistry when you have to choose? What do you see yourself doing in 10 years time?	Aspiration	This code was used to show their ideas regarding their future decision-making, both in terms of subject choice and future career.
Does anyone in your family take an interest in science of chemistry? Do you ever 'do' science or chemistry outside of school?	Family and science	For those students who did experience a family member involved in a chemistry-related career, studying for chemistry, or engage them in science conversation. Also, any out of school experiences that were reported.
Any questions in the schedule relating to the Chemistry for All events	Impact of intervention	This code that is used to highlight any views or accounts that students could recall from their intervention experiences that had impact on their interest, knowledge, aspiration or career awareness.

1.4. Thematic analysis

Value of science or chemistry

All the students interviewed with only one exception (student C) saw science as an important subject. Students' perceptions of science or chemistry either made reference to the value of science to the wider society or were in terms of the value of the subject to an individual's prospective career. For some students, an understanding of the natural world was of importance, science being able to answer such questions as 'why are the leaves on trees green?', or being able to understand environmental issues such as the use of plastic. Science was seen as important to society in the creation of medicines, students also highlighted the relevance of science learning to everyday knowledge, such as carbon monoxide poisoning, treating stings, hair dyeing and pH levels, and leading a healthy life-style knowing about balanced diets. Students focusing on the value of science to careers said it was important if an individual wanted to be a doctor or nurse, nutritionist, forensic scientist, or a sports scientist (careers frequently cited). In more general terms some students could see that having a science background would be beneficial in terms of getting a good job as part of a rounded set of qualifications.

With reference to the cases, Anna and Edward were focused on the career value of science, a view that was consistent throughout their secondary schooling. Brian had a very broad sense of the importance of science to our understanding of the world, which was also persistent throughout his schooling. Diane, Katie and Nathan had mixed views, as they expressed the relevance of science knowledge, but also value in terms of their intended career. Lucy also had mixed views, she was knowledgeable about environmental issues, as well being very aware of science in relation to career prospects. Martin was also eloquent in his explanation of why science was important to both the world and careers. The way these students focused on how and why science was important to them could be seen to have a bearing on how they engaged in science at school, and what kind of career aspiration they had. The intervention positively impacted on their value of science, but not on their career intentions as these stood in Year 11 (see below).

School science experience

Every student in the cohort liked practical work in science or chemistry – citing this as their most enjoyable experience of science. Clearly any intervention that aims to capture students' interest should include a practical aspect. Students were able to recall in some detail practical science lessons, both demonstration and individual work, for example, making salt crystals, constructing models of molecules, elephant toothpaste, testing acids and alkalis, alkali metals and water. Students also cited a range of school science experiences, including independent work, group work and revision lessons. Most found group work beneficial, because these provided opportunities for working as a team, sharing ideas, and also for enabling students to have confidence to express themselves. Structured

groupwork would seem to be a way of engaging students in science and chemistry, in addition to practical work, particularly for those students who struggled working independently, which some of these students reported. Revision lessons dominated the reported experiences in Year 11, in particular an online self-testing website called Educake was much mentioned.

Anna saw herself as a practical person, so appreciated doing practical work in science, Brian, Martin and Nathan also described in some detail their experience of practical work, which impacted on their interest in science. Edward and Katie recalled liking practical work and outlined specific topics that had meaning. Lucy's recollections were more physics orientated. All eight students saw benefits of groupwork and the sharing of ideas, as Brian said 'someone can explain something to you if you are a bit confused.... you can explain something to someone else if they're confused'. Diane was vaguer in her recollections of specific lessons, but clearly stated how group made her more confident as she was not 'a big speaker' in front of lots of people. For these students, groupwork gave them an opportunity for peer learning and raising confidence.

Difficulty

It has been well-documented that liking for science can fall away once it becomes difficult and students feel they are less likely to succeed. The students all started separate sciences in Year 9, either as triple or double science GCSEs, so they were able to distinguish difficulty in chemistry from Year 9. Many students mentioned formulae and equations as difficult topics, there was also an emphasis on topics being difficult when they are 'new' or have lots of unfamiliar terms to learn. For students who struggled more with maths, working with relative atomic masses and numerical aspects of chemistry were difficult.

Anna and Edward both saw themselves as having a poor memory, so in Year 9 when they encountered many new terms they found chemistry more difficult; however, they continued to enjoy it even though it was difficult. Brian and Lucy on the other hand found chemistry easy throughout, they could identify topics that were difficult when 'new' but could always 'get them' with perseverance, likewise Martin found he could overcome difficulties. Diane, Martin and Katie found chemistry difficult throughout years 9 to 11. To raise confidence and a sense of success in Year 9 emphasis is needed on the newness of chemistry and ways of making it more familiar.

Self-concept in science

How students perceived themselves in relation to science and chemistry was important as an indicator for future participation. Asking them to reflect on how they were getting on revealed how most students had mixed feelings, saying things like 'not brilliant but all right'. Most judged how they were getting on in relation to grades in their books, test results or whether they were meeting their targets, thus summative assessment measures. Many students used the terms OK, all right, quite well, and occasionally very well to describe how they were doing.

Anna, Katie and Diane saw themselves as doing OK in science then chemistry, Anna said she was 'not amazing' but all right, she, like most students, judged her performance on grades. Brian and Lucy were confident in science and chemistry throughout Years 7 to 11, Brian describing his performance as 'pretty well' across the years. He and Lucy were grade 9 students. Edward was pleased with his consistent grade 6s and saw himself as doing well in chemistry, Martin was grade 7 and also felt he was doing well. Nathan described himself as doing very well in Year 8, but by Year 10 was 'all right but not brilliant'. Though there was clearly a range in how students perceived they were 'getting on' in chemistry, it is possible that the means of judging performance could be expanded from simply test marks/grades. However, such assessments by students are a reflection of a performance culture.

Self-improvement strategy

I focused on answers to the question of what students do to succeed because these revealed differences in how higher achieving students engaged with self-motivated learning and revision. For some students it was simply a matter of 'getting your head down', 'behaving in classes', or 'paying attention' in addition to reading through their work over and over until it 'sticks in their head'. Some students took more responsibility for not 'being spoon-fed' by the teacher and writing down their own supplementary notes, others relied on teacher feedback in order to know what to focus on. For those students who recognised themselves as having a poor memory, flashcards and making posters were useful. Some students involved peers, parents or siblings in testing their knowledge. School C gave students access to an online testing system they called Educake, and all of those interviewed made use of this to set themselves questions on topics they were revising.

Anna and Edward who had self-confessed poor memories used the techniques of writing things down and flashcards. Brian's strategy included going over things and self-testing, then going back. In Year 10 he also developed a way of looking things up when they popped into his head and both he and Lucy used a wide range of resources including YouTube, GCSE video pods. In the early years Diane felt that she wanted to work things out for herself but became more reliant on teacher feedback and her Mum in later years. Katie had a whiteboard at home and pretended she was a teacher explaining things, she also focused on trying answer questions in exam style. Martin had attended study lessons to supplement his own revision. Nathan took revision very seriously in Year 11 – focusing on many past papers. In summary, a picture emerges of some students having serious and well-structured revision patterns early in their school years, others becoming more systematic as they had more structured revision strategies introduced to them in their GCSE years. It would seem that for success and confidence to emerge self-awareness of learning and improvement strategies should begin early in secondary school.

Aspiration

Most students did not know what subjects they would choose or what career they might follow when they were in Years 7 and 8. However, some had very fixed ideas that did not change over the years. So, there is a variability that suggests students could be influenced by their interest, experience of success and other factors. Some students suggested careers that they had heard about that seemed interesting, some were focused on what might be 'a good job', so utility value is important as well as interest. Many students seemed to consider a wider range of options that might be possible in Year 10, but then reverted to original intentions as they had to become focused on making choices in year 11. Having to make narrow choices at the end of Year 11 could inhibit further participation in chemistry.

Anna had 'no clue' about what she wanted to do in her future and her ideas changed - her case study provides details, but basically feelings of success in subjects influenced her choices until Year 11 when she was influenced by a sibling. Brian was never sure throughout what he wanted to follow as a career, but he was definite about wanting to do science and intended to do Chemistry A level. Lucy had many options open to her but decided that as she was good at physics and maths, she would follow a career in engineering. She had considered opting for A level chemistry to go with these subjects – but loved geography too much to give it up. Diane liked the idea of following in a career where she was helping other people, such as in a hospital. At the time of the interview she was still unclear whether she would carry on with chemistry after double science GCSE. Edward always wanted to be an electrician – in Year 11 this became an electrical engineer, good grades at GCSE were important to him. In Year 7 Katie expressed a wish to become a primary school teacher, this aspiration did not waiver throughout her secondary schooling. Like many students, though she liked science, there were other subjects that she liked more, or were more important for a chosen career path. Martin decided in Year 8 to become a musician and this did not change. Nathan had different ideas every year including sport and the police, but by year 11 he had decided that getting a job as an engineer at Land Rover would be a good option. He thought this path might include chemistry at FE college.

Family and science

Family role models and willingness to engage have been shown to be influential on students' decision-making. In this interview study, few students had family members working in science, but home conversations with family members did influence students over the years, as became apparent in interviews. Many students were influenced by older siblings who were doing science GCSEs or science beyond 16. Some had parents who though not working in science would be involved in conversations about careers and options, and in homework testing. Outside experiences in science were minimal and included family outings to museums or home chemistry kits, however these were mostly

reported in the younger age range, outside experience of science was minimal in the later years.

Anna and Edward's experience of family working or engaging in science was minimal. Brian had three older brothers who all went to different universities to study chemistry, one after the other. He felt there was an expectation for him to follow suit and he seemed happy with that. He talked a great deal about science experiences all around, particularly in later years. Nathan also had a close older sibling with whom he discussed school science. Diane's step mother was a pharmacist and was mentioned each year as an influence, she was involved in science at home with Diane. Katie and Martin had some early experiences of doing home experiments or visits but little engagement from family members other than help with school and options. Lucy had no family members working in science but engaged in conversation with her mother about options. She perceived how science came into many aspects of everyday life. To sum up, the only student of the eight to go on with chemistry A level was strongly influenced by family members.

Impact of intervention

Students of both cohorts began their Chemistry for All experience in Year 8. In this year recall of the school events which took the form of assemblies and drama was not very robust, and the university event had not taken place. However, in later years, many students recalled the Year 8 university event, which had clearly impacted on their interest regarding both the practical work and the university experience. The most memorable of the university events was the forensic science day in Year 9 where they tested for blood, and the school lesson on polymers, also in Year 9. The food science in Year 10 was also memorable. All students enjoyed the Chemistry for All experience, as exemplified in the eight cases, and most said that the events had made them more interested in chemistry. Most also said that they increased their knowledge of chemistry as a result of participating in the events. In Years 10 and 11 there was more awareness of possible careers in chemistry. In this cohort, Chemistry for All did not influence their Year 11 choices for post-16 study, in spite of the many beneficial effects on learning and appreciation of chemistry that were expressed. Any future participation as a result of Chemistry for All is unknown. There may be 'delayed effects' as choices and decision-making occurs later in their lives. For many, the experience increased their knowledge of university and what it might like to be a university student.

1.5. Case studies

1.5.1. Anna Years 7 to 11

Value

Anna's view of the value of science, then chemistry, was expressed mainly in terms of how it might have value to those following certain careers, in Year 7 she mentioned the needs for doctors and vets to learn about 'bodies and stuff', which she reiterated in Year 8, adding 'and all these different chemicals'. She also recognised the value

of getting good grades in science for jobs generally, and that science was one of the main subjects. Anna expressed a liking for science throughout her school years, though in Year 9 she was less certain. She aspired at this stage to 'do cooking' in her future but was not sure how science would help her with 'that kind of thing'. In Year 10 her value of science was in terms of personal value to her own career in the 'cooking industry' – but she thought science would not link to that.

School science experience

Each year Anna mentioned liking 'practicals' in science as the focus of her interest in science lessons, and in Years 10 and 11 in relation to chemistry. She liked the 'hands-on' of practicals, and saw herself as a practical person. In year 8 she could describe in detail a recent practical that she had undertaken involving acid-alkali titration using a burette. She also valued groupwork and mentioned this consistently over the years. She liked the sharing of ideas and learning together with her peers, and cited the kind of groupwork activities such as gathering information to create posters. In Year 8 she explained 'you get to listen to other people's ideas, not just yours then you get more information about the one subject', and Year 9 the experience of having 'more people to explain it to me'. She thought that as they were all in the same position, those that 'get it' can 'do it in the way they understand it'.

Difficulty

In Year 9 Anna started to experience difficulty in the subject, which she attributed to her poor memory and there being a lot of content to remember. She cited in particular her problem with learning the 'symbols of the periodic table', saying 'that's not my thing'. She did still enjoy practical science however. This problem persisted in Year 10, where she mentioned her difficulty remembering scientific words, such as the names of metals, and also equations. In Year 10 she appeared to find chemistry likeable (because of practicals) and manageable, because she was doing 'OK', and in Year 11 she still enjoyed chemistry even though some parts were difficult.

Self-concept

Anna's self-concept in science was that she was doing 'OK' – this perception was consistent over the years – she was very much influenced in her self-concept by whether or not she was reaching her 'targets', and how well she was doing in tests. In Years 10 and 11 she felt she was doing OK in chemistry – not 'amazing' but all right. Her main indicator of how well she was doing was exam results. With regard to maths, in Year 7 Anna expressed mixed views about difficulty – algebra she found easy but division was difficult. In year 8 she explained that she 'got algebra' because she found she just knew what to do, she was also good at graphs, which helped her in science. In Year 9 she began to find maths difficult, citing trigonometry, and in Year 10 even more difficult – it had become 'a lot more complicated and a lot more to remember about it'. By Year 11, Anna felt that she was doing 'OK' in maths (she was doing Foundation maths and had reached the top level in that – level 5).

Self-improvement

Anna's method of improving her science learning was to repeat something in her head and also to write it down 'over and over', this worked 'sometimes'. She asked her teacher to explain things if she did not understand, she also found flash cards helpful.

Aspiration

In the early years when we asked about favourite subjects, Anna began with music and PE which then progressed to food technology. Her aspirations also changed over time. In Year 7 she said 'I have no clue what I'm going to do in the future', but she mentioned that she had had ideas about being an artist or a musician, but that 'it just keeps jumping'. In Year 8 she wanted to 'do cooking', or 'working with children'. By year 9 she felt she was doing well in food technology so she started to lean towards thinking about a career in cooking, which persisted into Year 10. This comment reveals that her feeling of success would be material in making subsequent choices. There was a sense in this year that she was 'keeping her options open' whilst she found what she would succeed in, or what was needed to follow a particular career. In Year 11 she had more sense of not knowing what she wanted to do, but of keeping her options open. She had however applied for FE college to do biology, psychology and law. She had a brother studying law and had developed an interest in it.

Family

Anna's experience of science outside of school was very minimal, she mentioned having 'big conversations as we all sat round for dinner', which may have touched on science. She cited no family members working in science until Year 10, when she had found out she had an aunty working at something in science, she mentioned this again in Year 11. She had no experience of doing anything science related outside of school in all years.

Interventions

Anna had not started the Chemistry for All programme in Year 7. In Year 8 she had experienced some school events but had very little recollection of them. However, her recall of the university days and positive response to these was prominent in subsequent years. She was able to recall a lot of detail of the forensic science day at the university in some detail. She was positive regarding enjoyment and learning from the interventions in Years 9-11.

1.5.2. Brian Years 7 to 11

Value

Brian perceived science as an important subject. In Year 7 he said 'I suppose everything in life has something to do with science' and he expanded on this in subsequent years – seeing science as 'science makes up the world' in Year 8 and as affecting everyone in Year 9, so he had a very broad view of the value of science. He reiterated this view in Year 10, saying you 'can always find something which involves chemistry', and again in Year 11.

Brian expressed a liking for science throughout his school years. In Year 7 he described it as 'very exciting'

and in Year 8 he said that science was one of his 'favourites', he also liked English and maths. In particular he enjoyed 'finding out about new things.. see the world in a whole new way'. In Year 9 he had started doing triple science and stated that chemistry was now a subject he enjoyed and he particularly like practicals, he continued to find chemistry enjoyable and fun in Years 10 and 11.

School science experience

Brian liked practical work, mentioning this consistently over the years. In Year 7 he was able to describe in detail how he separated salt from rock salt and in Year 8 the reaction between magnesium and hydrochloric acid. In Year 9 he enjoyed the demonstration he had seen using alkali metals, which they had done when studying atomic structure and the periodic table. He was able to recall that group 1 metals 'lose the electron in their outer shell and form alkali solution in water'.. reactions 'getting more violent as they went down'. In Year 10 he was experiencing other strategies (as well as practical work), such as videos and 'data hunts', which he described as useful because it 'gets the raw content into your books, which is what you need when you come to revise'. In Year 11 chemistry lessons were more focussed on revision, with fewer practicals, though they had recently done a titration.

Brian valued groupwork, in Year 7 he said 'someone can explain something to you if you are a bit confused ... you can explain something to someone else if they're confused'. He also valued working individually, as mentioned in year 8, to be 'independent in your learning'.

Difficulty

Throughout the years Brian described science as easy, with some difficulties pointed out in Years 7, 8 and 10. His difficulty in Year 7 was in terms of 'new formulas and things like that', however he did not mind difficulty as he thought it was good to challenge himself. He added in Year 8 that his difficulty mainly lay in the newness of topics, which discussion with peers helped with – working as 'a team' they did well. As he started doing the separate sciences in Year 9 we focussed on talking about chemistry, which in this year he did not find difficult as it was like 'adding bits on', he knew a certain amount already and was learning more. In Year 10 Brian was more specific about areas of difficulty such as 'remembering really complicated formulas and stuff like that'. By Year 11 Brian described chemistry as 'easy' – he found that even the most difficult areas such as formulae he could go over and 'get them'.

Self-concept

Brian's self-concept in science was positive throughout. In Year 7 he thought he was getting on 'quite well', and then 'pretty well' in Year 8. He judged his performance on his assessed grades (usually As) and levels, and also, in Year 8 on the marks and grades in his book – which he could see were increasing through the year. In Year 9 he again thought he was doing Ok with all his sciences, he mentioned having exam style questions which would help him know if he was getting things right. In Year 10 Brian saw himself as 'doing all right, not too bad', and described having something called PLCs (personal learning criteria),

which included different parts of topics broken down that the students coloured in themselves once ‘you had got them’, in addition to test scores and feedback from teachers. So, self-evaluation was now part of the learning strategy for year 10. By Year 11 Brian was confident of doing well in his GCSE Chemistry – he had just had a grade 9 in an internal exam and needed a grade 6 minimum to do A level. Brian also liked maths and thought he was quite good at it throughout, finding it easy.

Self-improvement

Brian was able to describe in Year 7 his strategy for revising for tests, which involved going through everything in his book, waiting an hour then going back to see if he had remembered it, he also reporting asking the teacher in Year 8 if he needed help with something. His revision strategy was similar in Year 9 – he was always sure to revise if he had a test coming up. In Year 10 his method was elaborated by using flash cards and breaking down things into the key information. He had also developed a way of looking things up when they popped into his head and he realised he was not too sure of. In Year 11 he also used GCSE Bitesize and YouTube videos in addition to looking things up, asking the teacher and going over things himself.

Aspiration

Even though Brian was unsure of what he might eventually do as a career – right through Years 7 to 11, from the outset in Year 7 he was open to the possibility of working in science. In Year 8 he reported opting for triple science in Year 9, but thought it was a ‘bit early’ for him to be thinking about his future career. He had older brothers who were aspiring to go to university and he thought he would follow suit. By Year 9 he was sure he would do sciences in the sixth form, including ‘chemistry probably’. He was still very unsure of what career path he might follow. He did think that success was a factor in making a choice – he thought this was similar for others ‘some people know what they want to do and will do it, others, you know, do what they’re good at’. I think this was very perceptive and probably the case – unless there was a clear career view, students tend to do what they feel they will succeed in. His view was similar in Year 10, he still intended to do chemistry post-16 as he was ‘doing quite well’ and enjoyed the subject, though he was still uncertain of a career path. In Year 11 he had definitely decided to do chemistry A level and go to university but was undecided what course he would do.

Family

In Year 8 Brian reported one brother doing chemistry at university and learning a lot from him, and when he was in Year 10 he had another brother starting a chemistry degree at a different university. He did feel that his family wanted him to follow in something ‘science-y’. Brian did not recall doing any science outside of school in Year 7; however, in Year 8 he recalled doing an experiment when he was younger with bicarb and vinegar – he also saw visits to something like a factory that makes cheese as science related. He saw science as being all around and so was developing a broad view of where science came into many aspects of life.

Interventions

Brian started to experience interventions in Year 8, and was able to recall the school lessons that had been part of Chemistry for All – an activity called King Kong’s hand and creating bubbles with methane. He was about to go on his first university trip and was looking forward to it – he was able to say what this was going to be about ‘chemistry behind everyday products we use’. Brian’s recollection and appreciation of intervention events was very detailed in Year 9, he found them interesting and informative. He had just experienced the forensic science day and could recall the tests in some detail, also he could recall details of two lessons he had experienced by Chemistry for All at school (glow sticks and polymers). In Year 10 he was very positive about both university and school experiences of Chemistry for All. He liked using ‘hi tech’ equipment at the university and also felt that the experience had shown him what sort of things might be involved in higher education. The Year 11 university day was described as ‘one of the best’ because he felt confident to start his research straight away. He was positive about the impact of Chemistry for All on his interest and knowledge in the subject.

1.5.3. Diane Years 9 to 11

Value

Diane liked all her subjects and named science, PE and English as her favourites. She valued science because she felt that she was learning something new each lesson. She thought science was important because everyone was going to need it for their future. For herself, she thought it would be useful as she aspired to be a pharmacist, but it may not be useful for others, it depended on what they wanted to do. These views were consistent over the years.

School science experience

Diane recalled a topic that she had liked regarding the ozone layer and the use of aerosols. She also recalled practicals that had been fun, including making crystals and experiments on zinc – her recall was lacking in detail but enthusiastic. In Year 10 she was also a bit vague in her details but enjoyed the practical where her teacher had ‘set bubbles on fire’. She also liked learning with different approaches, describing information gathering and guessing games. She felt she learnt better from groupwork because ‘I can give my point of view because I’m not a big speaker in front of lots of people’. In Year 10 she was more definite that she liked both independent and group working, she liked working things out for ourselves’ as well as working as a team. Her main focus in Year 11 was practical work and learning equations.

Difficulty

Diane thought science was sometimes easy and sometimes difficult, she cited a biology example for difficulty – the newness of the content was hard for her ‘to get her head around’. In Year 10 Diane felt that chemistry was a bit ‘tricky’ but she enjoyed it. She found memorising it for exams difficult – ‘I get confused with protons and neutrons’, she had to keep going over it. In science you were ‘constantly learning something new’. She continued to find some things difficult and some things easy in Year 11.

Self-concept

In Year 9 Diane thought she was doing 'OK' in chemistry. She was being invited by the teacher to be part of the intervention – her perception was that the teacher had chosen her as she needed help to make progress, which she appreciated. She saw feedback from her teacher as the main indicator of her progress (unlike others – who focused primarily on grades), though she acknowledged grades as an indicator. In Year 10 she felt again that she was doing OK, it was not one of her stronger subjects, but not one of her weaker ones either, she again cited teacher feedback as her main indicator of progress, but also her 'target'. In Year 11 she was still doing 'OK'. With regard to maths, in Year 9 Diane felt that maths was one of her weaker subjects, but she was doing all right in her set. By Year 10 she had 'got her head down more' and was finding it quite easy. Her willingness to work things out for herself was clearly having a positive impact all round.

Self-improvement

Diane's main strategy for getting to grips with something difficult was to first try and work it out for herself, but then she would ask her teacher or her partner. In Year 10 she elaborated that she mostly relied on teacher feedback and constantly working on revision, using flash cards or posters. She also mentioned getting her step mum to ask her questions on a topic. In Year 11 she summarised her main strategies as 'revise, listen, make notes'.

Aspiration

In Year 9 Diane already expressed a wish to become a pharmacist. Her step mother was a pharmacist and she herself liked the idea of having a career where she was helping other people. At this stage she also thought that she would carry on doing biology and chemistry because they would be of benefit. She could see that it would benefit her job as a pharmacist. In Year 10 Diane had broadened her aspiration to 'something to do with a hospital', such as a nurse or 'someone who does medicine', like her aunty (a nurse) or step mum (pharmacist). She was doing double science and thought she might carry on with science after Year 11, but she was still making her mind up about what she wanted to do. In Year 11 she said she could see herself being a chemist or a psychologist.

Family

Diane's step mother was a pharmacist and clearly influential to Diane's aspiration. In Year 9 Diane reported that her step mum came home with stories about work that made the job sound really fun. She also had a young cousin who was interested in science and wanted to share her experiences with Diane. Diane herself wanted to show her family one of the Chemistry for All experiments she had done (glow sticks) and her step mum asked her questions about this and other science learning. In Year 10 both her step mum and aunty (a nurse) were 'constantly going on about how important science is and all that'. She cited her step mum continuing to take an interest in science in Year 11.

Intervention

As well as the inspiration of the glow sticks activity, Diane was inspired by her first trip to the provider (Year 8) where she recalled making things like Vaseline and measuring things out. She really enjoyed that because she could 'relate to myself in the future when I was doing that'. In Year 10 she reported having listened to the university students talking about what they did, and this sounded 'really good'. She also talked about the glow sticks and the murder investigation she had done the year before in Year 9. She enjoyed those experiences. In Year 11 she was positive about how the interventions had made her more interested in chemistry and also increased her knowledge. She was unsure as to whether the events had any influence on her aspiration post 16 but she was more aware of chemistry-related careers.

1.5.4. Edward Years 9 to 11

Value

Edward favoured PE and construction over other subjects, because they were practical subjects, but liked chemistry (Year 9). He liked seeing how things worked – the practical aspect of chemistry. He could see the value of chemistry as opening lots of doors for jobs, eg doctors or chemists. Though he did not aspire to these he thought chemistry might have value for his aspiration to be an electrician. His views in Year 10 were similar – chemistry was an important subject if you were going to follow a particular career. In Year 11 he was mostly focused on the importance of getting a good grade in his GCSE science as this would help him get to FE college.

School science experience

In Year 9 Edward reported that he was doing the topics of structure of the atom and exo- and endothermic reactions in chemistry. He liked the practical side and also the group work they did in practicals as this 'quicker and easier to get data ... and go through it'. In Year 10 he reiterated his enjoyment of practicals – he loved doing experiments. In Year 11 he saw his experience as focusing mainly on revision – for example he was working on electrolysis at that time.

Difficulty

In Year 9 Edward did not report any particular difficulty with chemistry, but in Year 10 he thought memorising the 'formulas' was difficult, describing himself as not having the best memory. In Year 11 Edward could not specify what he found most difficult. In all years, Edward reported finding maths difficult because he saw himself as a practical learner. In Year 11 had mentioned having a home tutor to help him with maths – as it was so important for him to get on his electrical installation NVQ course at FE college.

Self-concept

Edward knew he was not doing Triple science in Year 9, as he was in set 3, and you only do Triple in sets 1 and 2. However he felt confident in his chemistry, saying 'I'm all right at chemistry'. In Year 10 he felt that he had improved a lot since the year before and that he was doing well. He had jumped up to his target grade and thought he had

actually gone beyond it (grade 6). He acknowledged that his memory was not the best for remembering things. In Year 11 he thought he was still doing well in chemistry as he was consistently getting grade 6 for his work.

Self-improvement

For success, in Year 9 Edward reported using revision, though he always struggled to remember things. He used flash cards, went over questions and answers and would get someone to ask him questions. In Year 10 he said he paid attention in class, took notes, recognised he could not be 'spoon fed' by the teachers – he took responsibility for making the most of his classroom experience. In Year 11 he did add that he worked on feedback from teachers to improve, he also reported doing a lot of revision using his notes and websites.

Aspiration

In Year 9 Edward expressed his wish to become an electrician. He was not sure whether he would carry on with chemistry post-16, as he was uncertain as to whether he would need it for his chosen career. In Year 10, he was also keeping open the idea of doing something with sport but was still primarily fixed on becoming an electrical engineer. He was not sure whether he would do chemistry post-16 as engineering was his focus. In Year 11 he was more definite in that he was intending to do electrical installation. It seems that there is an original idea that opens up in Year 10 and reverts back in Year 11. Much may have had to do with having to make a college choice – so Edward had applied to FE college to do an NVQ electrical installation, for which he needed good grades in science (double), maths and English. This was his main focus.

Family

Edward had an uncle who worked in 'the chemistry area', he mentioned this in all the years, but did not know what the job was exactly. Outside of school, when he was younger he had chemistry sets that he found 'dead fascinating and interesting'. In Year 10 he reported doing science outside in relation to sport, as he looked at balanced diet for supporting his sporting activity.

Intervention

Edward was interviewed the day after a provider event (forensic science) which he recalled as having enjoyed, except for the poster session. He was interested in the testing they did in the lab and talked about the relevance of fingerprint testing and DNA evidence – 'dead fascinating'. He was able to recall details of the 'blood' testing and that the flame test for copper was green. He also recalled the school-based events – but in less detail. He did express the view that the intervention had showed him that there was more to chemistry than he had thought. In Year 10 Edward added that he enjoyed working with other people at the provider events, particularly as he was working with people he had not worked with before. He felt that the days helped him to develop social skills through talking to new people. He also felt he learnt a lot from the school-based event on bonding – this was useful as the subsequent chemistry lessons were based on that topic and he

already knew more than everyone else. He again talked about the interventions as opening up his view of what chemistry could be useful for. His interest in the events was sustained in Year 11 – when asked if these had increased his interest he said not, as he had always been interested. He valued the way in which doing Chemistry for All had put him ahead in his knowledge of chemistry. Overall, these events over the years had been interesting and valuable – however they had not impacted on his aspiration to be an electrician, as it was already fixed.

1.5.5. Katie Years 7 to 11

Value

Katie's favourite subjects in Year 7 were English and PE, and also food technology. English remained her favourite subject in subsequent years. She also liked science in Years 7 and 8, in particular practical work; her enjoyment fell away in Year 9. Her value of science was expressed mainly in terms of whether it would be needed for a future job, but she also recognised its value more widely in terms of 'cures for diseases and things', and also medical staff in hospital having the correct medicines. In later years she added other reasons for chemistry being useful for people, including knowing about carbon monoxide gas in heaters. She valued science personally as it would be useful to her as a primary teacher, this she mentioned each year.

School science experience

Katie could recall details of practical work as she enjoyed it so much. In Year 7 she described a DNA test that involved spitting into a cup and using 'loads of equipment'. They also do writing and pair work. In Year 8 she reported doing groupwork on projects, for example on the space shuttle. She liked groupwork as 'you can all do different tasks and then join together ... and discuss ideas'. Her points were similar in Years 9 and 10. Katie continued to like practical work into Year 11, though most activity involved revision at this stage.

Difficulty

Katie cited 'formulas and stuff' as the main topic she found difficult in science in Year 7, along with forces. She reiterated this difficulty in Year 8. In Year 9 she was clearly finding science more difficult to the point of boring. She cited 'long explanations' and it being a bit confusing. In chemistry she found the 'number side' of the work difficult and balancing equations. In Year 10 Katie continued to find 'formulas' and rules for things in chemistry difficult. She did feel however that with perseverance she would 'get it' in the end. By Year 11 Katie had identified organic chemistry as a difficult topic, she preferred protons, neutrons and electrons.

Self-concept

Katie's perception of how she was doing related to particular science topics, ones she found interesting (reproduction), and ones where she got a good mark that matched her target. She saw herself as a worrier and was always relieved when she met her target grade. In Year 8 she said she had picked separate sciences as she thought she was getting on OK. She also reported doing more peer assessment which helped her to know

how she was getting on. In Year 9 she saw herself as being better at biology and chemistry than physics. She described her progress as 'not bad but not amazing', being guided in this by her test results. She felt she was doing OK in Year 10, through persevering to get her head round it. She and many other students cited the use of Educake for using online revision questions. If she does an Educake question and gets it wrong she asks her teacher for help. By Year 11 Katie thought her progress was 'good' from her recent mock exam results, she also appreciated going over exam questions in class, because these helped her to know she was getting on well. Katie had a mixed view of maths – most topics were OK but she struggled with some. Her responses regarding maths were similar in subsequent years, some aspects she found difficult others not.

Self-improvement

In Year 7 Katie reported revising at home using printed worksheets. She used a whiteboard at home and 'pretended to teach it so then it sinks in'. She found peer marking helpful in Year 8, also asking for teacher feedback and using revision guides with practice tests. She planned for tests in Year 9 and always paid attention. She was still using her home whiteboard to 'teach it' – because the work stuck in her head that way. In Year 11 she used more revision tactics, such as Educake to help her answer exam questions and 'know the knowledge', she was keen to be able to answer questions in 'exam style'.

Aspiration

In Year 7 Katie expressed an intention of becoming a primary school teacher, so science was important to her as part of that role. This aspiration remained firm through to Year 11. Each Year she reiterated the importance of science in relation to her aspiration of becoming a teacher. By Year 9, when Katie was beginning to find her science subjects difficult (and sometimes boring) she said that she was not planning on carrying on science past Year 11. She recognised science was important as a primary teacher – but did not want to study science if it became more complicated. By Year 10 she had made up her mind to do biology, history and English post-16. In Year 11 this had changed to musical theatre, with English and history or sociology. She still saw herself as primarily specialising in English towards her goal of becoming a primary school teacher.

Family

Katie did not really talk to anyone at home about science, but she was aware that her father 'takes specimens to a lab' in a hospital. In Years 8 and 9, Katie said she talked to her grandad about science as he knew more about it than she did. Her mother helped her choose options. By Year 11 Katie reported not having a family member taking an interest in chemistry. With regard to science outside school, in Year 7 Katie remembered doing a cola with mentos experiment and it fizzing up. She had also been on a trip to the Museum of Science and Industry in Manchester which she found interesting. She actually mentioned this same trip three years running, so it clearly had an impact. In Year 11 she reported doing no chemistry out of school.

Intervention

As Cohort 2, Katie did not experience an intervention in Year 7, and in Year 8 all she was able to recall was 'something about a balloon'. In Year 9 she was much more forthcoming as the Chemistry for All experience was having more impact. The forensic science day at the university was described, including tests for blood. She also recalled school-based interventions, including the polymer lesson, as being interesting and helpful for learning. She enjoyed the more practical based days. In Year 9 she was not being influenced in her aspiration which was pretty much fixed as a primary teacher. Katie reported enjoying Chemistry for All events in Year 10, they had a positive impact on her interest and knowledge, and she had learnt about different careers. Her recall and response were very similar in Year 11.

1.5.6. Lucy Years 7 to 11

Value

From Year 7 Lucy had a broad view of why science is important, with a belief that everyone should know about science, to have a better understanding of life. She also thought science was useful if you were to follow a science-related career. Her view on the importance of science was reiterated in subsequent years, she cited many reasons including environmental issues in Year 8. In Years 9 and 10 Lucy continued to have this broader perspective but also was able to see how chemistry could be useful for different careers, for example forensic science. In Year 11 Lucy focused also on importance of chemistry for careers. She valued organic chemistry and topics that related to real-life situations.

School science experience

In line with most students Lucy liked practical science and could recall in detail experiments that she had enjoyed in Year 7, for example, the collapsing can. She also enjoyed doing groupwork as it was a means of sharing ideas and learning from each other. Most of her recollections were physics oriented. In Year 8 she talk about work they were doing on space, plus air resistance and forces. She saw these topics as useful for her aspiration to become an engineer. In Year 9 chemistry Lucy reported she was doing more theoretical work, for example on relative mass, and atomic theory. Lucy continued to value groupwork – 'it's good to interact with other people', but also liked working on her own. In Year 10 she liked practical work, also partner work and doing exam questions as these 'consolidate what you've done through the other activities'. In Year 11 she was most focused on revision.

Difficulty

Lucy's perception of difficulty in Year 7 was topic-dependent. If it was something she had met in primary school she felt more confident. Topics such as elements and the periodic table which she met for the first time were more difficult. In Year 8 Lucy cited terminology as the most difficult – for example knowing the difference between accuracy and precision. She could not think of anything particularly difficult in

Year 9. In Year 10 she continued to find it easy, and getting more challenging questions was interesting. In Year 11 as she was doing more exam questions Lucy sometimes found it apply her knowledge to questions that were 'harshly worded'.

Self-concept

Lucy's perception of her own progress in science in Year 7 was that she was 'doing very well'. Her evidence for this was from test results, but also that she was able to answer quite a lot of questions in class and she was aware of knowing things that others did not know. She cited that everyone referred to her as the cleverest in the class, her test results were always highest. This perception was consistent in Year, when she knew she would be doing triple science. In Year 9 she perceived herself as doing very well – she was exceeding her target grades, she saw herself as 'putting in the effort' needed to achieve. In Year 10 Lucy continued to think she was doing 'really well', she felt very confident of doing well in a recent test. In Year 11 Lucy reported having a grade 9 in her recent mocks, so she was doing 'very well' and teachers were giving her extra work. Throughout the years Lucy said that she found maths easy.

Self-improvement

To ensure good progress in science, in Year 7 Lucy reported 'paying attention', but primarily doing individual research if you want to know the answer, either on the computer or by asking a teacher. In Year 8 she also cited TV science as helping, in addition to revision. In Year 9 she had started using the school's online system Educake, as a way of testing herself on different topics. In Years 10 and 11 she continued to cite revision, listening in class and practicing questions as her main way of being successful. She also watched GCSE video pods.

Aspiration

In Year 7 Lucy did not have a clear view of what she wanted to be – her family hoped she might want to be a doctor because she was clever. She was open to the idea but this was not a fixed goal. In year 8 she had decided she wanted to be an engineer – based on her interest in travel, ability in languages and in physics and maths. She saw herself building bridges. With regard to future options, she could see physics and chemistry as important, particularly physics, but she was not certain which. In Year 9 Lucy was still uncertain about which science subjects she would choose post-16 but would do maths and geography. She definitely wanted to go to university. In Year 10 she had definitely decided to do geography but was also considering A level chemistry. She was unsure of a university course, but could see how chemistry 'fits into all sciences'. Her experience of chemistry had firmed up her aspiration to have a career in science in Year 11, however she had decided on her A level choices – as geography, physics, maths, further maths and possibly a language. She did not include chemistry as 'it was not her favourite science'. At this stage she had started to think about doing 'natural sciences' at university as she would like to travel.

Family

In Year 7 reported having no family member working in science, or having a particular interest in science, though she did go on family outings to the science museum. Lucy said more about her mother's influence in Year 8, she had travelled a great deal – for pleasure. In subsequent years Lucy reported having no family members working in or talking about science, other than providing advice about options and careers. Outside of school Lucy described science coming into her life, for example knowing how to make a fire in the Scouts. She also recognised the importance of science to swimming and squash, for example forces hitting the ball, and streamlining. In subsequent years she reported doing no science or chemistry outside of school.

Intervention

As cohort 2 Lucy started Chemistry for All interventions in Year 8. She recalled having assemblies and some details that made them valuable. In Year 9 she could describe in detail both university and school-based interventions, for example the forensic science day and its tests on blood and finger-printing, and the polymers day with glow sticks. She said that the interventions made her enjoy chemistry more and made her consider doing chemistry as an option. Likewise, in Year 10 she recalled in detail the interventions and cited them as enjoyable and valuable for chemistry learning, as they 'reinforced understanding or created new understanding'. Lucy thought that the interventions had the potential to positively influence her choice of doing chemistry. She also found them as useful sources of information about careers. In Year 11 Lucy again reported positively about her Chemistry for All experience, though in this year she acknowledged that they had not influenced her aspiration regarding post-16 subjects, though she knew more about chemistry-related careers from the talks about university courses.

1.5.7. Martin Years 7 to 11

Value

In Year 7 Martin cited science as his favourite subject and perceived science as a very important subject if you wanted to follow particular careers, such as a doctor understanding medicines in order to cure flu, or a singer knowing about sound energy. In Year 8 music had become one of Martin's favourite subjects, and was to remain so. He still liked science very much and now could relate science to music. He also described ways in which science informed the world, for example theories such as continental drift. In Year 9 Martin was doing triple science and he had 'taken a shine to chemistry'; he enjoyed learning about atoms, isotopes and ions. His other favourite subjects were still music and English. Martin also talked about the wider importance of science in Years 9 and 10, saying 'there is science behind everything'. In Year 11 he focused more on usefulness of science in career terms.

School science experience

Martin could describe practical work in detail in Year 7, and also other experiences such as group work, he enjoyed the chance to 'work together as a team'. In

Years 8 and 9 Martin described several science activities in detail, including practical work and projects. He also described group activities in detail, enjoying the team work. His accounts were less detailed in Year 10, and in Year 11 he reported doing mostly revision.

Difficulty

Martin reported getting 'the odd difficult thing' in Year 7, mostly when a topic was new and involved lots of new names. A difficult topic described in Year 8 was how light travels, because he had never been taught about how we see at primary school, so it was new to him. In Year 9 Martin was not finding chemistry difficult; when he came across a more difficult topic, such as using moles and relative mass, he worked through it until it was OK. Martin reported having had difficulty with exo- and endothermic reactions in Year 11, but got the gist of it eventually.

Self-concept

In Year 7 Martin perceived himself as getting on 'pretty well' in science, as he was getting good grades. Throughout the years Martin found maths sometimes difficult and sometimes easy, depending on the topic. Martin found he was to be doing triple science while he was in Year 8, and he was still getting on 'pretty well' in science. In Year 9 he was more tuned in to GCSE grades and still thought he was getting on pretty well. In Year 10 Martin described his progress in chemistry as 'quite well', and was pleased with his test marks. In his Year 11 mock he said he had got a grade 7 – like an old A – so he thought he was doing pretty well.

Self-improvement

To help with difficulties Martin asks peers and his teachers. He also described himself as persevering with things. In Year 8 he elaborated this strategy by going over tests to see where he went wrong and learning from his mistakes. In Year 9 he reported revising for exams; he also liked having practical activities that gave him a deeper understanding of what happens. Like other students Martin started to use Educake in Year 10 to set his own tests and found that useful. He also attended study sessions in Year 11.

Aspiration

Martin had many ideas of what he wanted to do when in Year 7, from being a doctor, or forensic scientist, following either arts or sciences. In Year 8 Martin's interest in music had grown and he was considering this as his main future subject, however he thought science would be helpful for it. By Year 9 Martin had the idea of becoming a musician, though he had not made a final decision. He liked sciences but was leaning more towards performing arts. In Year 10 he definitely wanted to be a musician, and thought physics was more important for this. He was not sure he would be choosing chemistry post-16. In Year 11 he reported having applied to do music, psychology, history and business in the sixth form.

Family

Martin had a stepmother who was a science teacher, he sometimes talked to her about science. In Year 8 I discovered she lived in Gloucestershire, so he did not

see her often. His mother and step father did not work in science and he subsequently reported having no conversations about science at home. Martin had visited the Salters festival of chemistry which he enjoyed and was able to describe in detail. He also reported having visited Quinta when in Year 8, where he did experiments, and working out the science of bread making in Year 9.

Intervention

Martin was in cohort 2 so had his first intervention experience in Year 8. He recalled a Chemistry for All assembly with a little detail. In Year 9 Martin recalled in some detail both the university and school events from Year 8 and early in Year 9, which he found enjoyable and informative. He missed the Year 9 event on forensic science as it clashed with a music event. Martin attended the Year 10 events at the university and in school, and was able to recall them in some detail. He was positive about the impact of Chemistry for All in both Years 10 and 11, in terms of enjoyment and learning chemistry. He had also learned a lot about careers in chemistry, but the intervention was not impacting on his own aspiration.

1.5.8. Nathan Years 8 to 11

Value

Nathan's favourite subject in Year 8 was performing arts but he liked science. He thought science was important for the world, and also to 'get jobs and stuff'. He liked practical work. In Year 9 Nathan liked PE and maths best, thinking he might do something related to sports when he was older. He still enjoyed science, particularly practical work (he was doing double science). He began to see science having an importance in everyday life – if you mix the wrong things you might poison yourself. By Year 10 Nathan still liked PE best but also liked science. Of the sciences chemistry was his favourite as he felt more confident. In Years 10 and 11 he thought science was most important for people who would have science-related jobs.

School science experience

In Year 8 Nathan described experimental work he was doing in science, also written work and investigation steps. He liked groupwork as they could share ideas but his reason was also 'usually you don't talk about science, you just talk'. He recalled practical work that he enjoyed in Year 9 that involved making copper sulphate crystals, which he also recalled as an experiment he liked in Year 10. The main focus of the work in Year 11 was doing revision papers.

Difficult

Nathan found science quite hard sometimes, being complicated, he found it difficult to be precise. In Year 9 he found the written work a challenge, particularly writing an account of the process of finding out something, such as investigative work. He also found language aspects difficult, such as sorting out words to fit into text or labelling things on the board. In Year 10 chemistry he found remembering formulas and equations difficult; indeed, he thought everything was a 'challenge'. In Year 11 however he thought chemistry was mixed, in that some things were easy and others difficult.

Self-concept

Nathan thought he was doing 'very well' in science in Year 8, as he was getting good grades. This continued in Year 9 – when he was told he could improve he worked to improve and this showed he was making progress by doing the 'next steps'. In Year 10 he thought he was 'doing all right but not brilliant', he had recently got quite high marks on a test. He did not report having any difficulty with progress in Year 11. He thought he was better at maths than science – describing it as both easy and difficult.

Self-improvement

To help himself make progress Nathan asked his friend and also the teacher. He thought it was important to listen in class and not get distracted. In Year 9 Nathan was more focused on revising to make progress; he would make a poster at home and keep going over things until they 'stuck in your head so you know it'. He started using Educake in Year 10, setting his own questions and marking the answers himself, and saw revision papers as important for revision in Year 11.

Aspiration

In Year 8 Nathan thought he would do something with PE or music, but he did not know what he would do leaving school, other than try to get a good job which might involve maths. In Year 9 however, he seemed more fixed on working with something to do with sport, which persisted into Year 10 but by then he was also considering going into the police. He talked about forensic science having interested him (at the intervention day). He thought he would carry on doing science post-16, probably chemistry. By Year 11 he had decided he wanted to be an engineer at Land Rover, so maths and science would be important, including chemistry.

Family

Each year Nathan talked about an older sister who was doing science, she was one year older than him, they had discussions about their school science. When he was in Year 9 and she was in Year 10, Mathew reported that she was disappointed that she was stuck in a lower set and so could not do the higher paper, even though she got a very high score. He continued to discuss science with his sister each year, she wanted to be a forensic scientist. This experience seemed to have a strong impression on Nathan. Outside of school he did not do science he 'played with his friends and stuff like that'.

Intervention

Nathan's recollection of Year 8 interventions was rather vague – but he remembered the professor coming in. In Year 9 he was more forthcoming, describing the university event in some detail. He enjoyed the interventions and thought they helped his learning. In Year 10 he recalled the forensic science day again and also the lesson on bonding that they had done in school with the intervention team. He thought Chemistry for All helped him to see what he might enjoy and be good at. Because he had always enjoyed chemistry he did not see that Chemistry for All had changed his view, he was positive about his awareness of careers through Chemistry for All.

1.6. Conclusions

In this report I have focused on providing the narrative stories or 'cases' of individual students that I was able to interview over many years. As stated in the introduction, the analysis was very much driven by the interview schedule and the responses elicited in these two schools – there are other elements of the Chemistry for All research that have different concepts and foci. This report is intended to complement the main body of work, by providing insights that only such an interview study can.

It was encouraging to find that almost all students had a high regard for the value of science, and justified their views with examples of how science has societal value, as well as a utilitarian value for individuals. I think this is important for these young people as citizens to recognise that science and evidence can aid society; even if they do not opt for science or chemistry-related careers. An intervention such the one these students experienced clearly reinforced this value, as their responses in Year 11 showed. Practical work was clearly an important feature of science and chemistry that made the subject interesting; the intervention provided novel practical experiences that were appreciated by students. Groupwork in class was highly valued for learning and gaining confidence. The point at which the 'newness' of chemistry made it appear difficult (and less attractive than other subjects) needs particular attention – presentation and focus of chemistry in the intervention that allowed for familiarity with important terms and concepts was seen as helpful.

Students had different ways of expressing how they 'get on' in chemistry, but most used their grades and test results and benchmarks. It would be interesting to see whether other kinds of feedback could help them think differently about their progress and about themselves as potential chemists. I found intentions regarding future choices and careers to be more fixed in younger students than I anticipated – though this was variable. So, though the intervention impacted very positively on interest, learning and value of chemistry, it did not appear to have impact on subject and career choice. The cases show that family influence or role models could play an important part in students' aspirations, more so than an intervention of this kind.

1.7. References

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2. Appendix 1: Chemistry for All interview schedule

1. What is your name?
 2. What do you think about science/chemistry?
 3. Do you think science/chemistry is important? (Prompt with respect to value of science, how it helps)
 4. Do you like science/chemistry at school? (Prompt for what they like/do not like about science at school)
 5. What sort of things do you do in chemistry? (prompt with classroom strategies)
 6. How do you get on in chemistry? (Prompt to see how they see themselves – successful or not – in science)
 7. Do you find chemistry easy/difficult? (Prompt for reasons)
 8. Do you find Maths easy/difficult (Prompt for reasons)
 9. Do you think Maths will be a useful subject for you in the future? (Prompt for reasons)
 10. Do you think chemistry will be a useful subject for you in the future? (Prompt for reasons)
 11. What do you do to succeed in chemistry?
 12. Do you feel you get on OK in school? (prompt for reasons yes/no)
 13. Does anyone in your family take an interest in science or chemistry?
 14. Does anyone in your family want you to be successful in science/chemistry?
 15. Do you ever 'do' science or chemistry find out about it outside of school? (Prompt for what they might do)
 16. Will you carry on doing science/chemistry when you have to choose? (Prompt for how long)
 17. What do you see yourself doing in 10 years' time?
 18. Would you be interested in working in science or chemistry?
 19. Do you imagine you could be a chemist?
 20. Have you had any chemistry events? What were they and what did you think about them?
- You have been taking part in extra activities (name what the activities are) over the past (year or years) organised by (name the university). With these activities in mind I am going to ask you a series of questions to ask you about the influence these activities have had on you.
- With these activities in mind:
21. Are you more likely to continue with chemistry/science at Level 5/post-16 and/or University level because of the activities you have been engaged with?
 22. Are you more or less interested in chemistry because of the activities you have been engaged in?
 23. Have they influenced your ability in Chemistry; has your ability increased or decreased as a direct result of these activities – or is there no change.
 24. Do you think your personal value of Chemistry (so for example whether you enjoy it) has increased or decreased as a direct result of these activities you have been involved in – or is there no change?
 25. Over the past few years do you think your knowledge about the careers and courses that are open to you with a post-16 Chemistry has increased as a direct result of these extra curricular activities you have been involved in?
 26. What sorts of teaching helps you to engage with chemistry the most?