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WHY DO SECONDARY SCHOOL CHEMISTRY TEACHERS ENGAGE IN LONG-TERM OUTREACH PARTNERSHIP WITH A UNIVERSITY?

S.R. Glover, T.G. Harrison, D.E. Shallcross

Abstract While the effects of outreach with secondary school pupils has been researched the reasons teachers engage or the impacts on the teachers engaging in long-term relationships with a university department have not. Detailed interviews with chemistry teachers associated with outreach at Bristol ChemLabS have revealed many reasons for prolonged partnership both for their students and themselves. Perceived impacts on students include; inspiration, enjoyment, reward, motivation, experience of a university chemistry department, raising aspirations, curriculum support, extension, enrichment, stretch and challenge and each are discussed. Impacts on the teachers from repeated visits over time including those on subsequent teaching are explored. The language of links and partnerships and the power dynamics of relationships are also considered.

Key words: chemistry outreach, secondary teacher engagement.

1. Introduction

The School of Chemistry at the University of Bristol is the home of Bristol ChemLabS [7] which has been engaged with outreach activities for more than a decade [16, 19–20, 23]. Outreach provision for secondary schools is varied and extremely popular, with 25000-30000 students engaged annually.

Outreach events take place either at the Bristol University School of Chemistry, and involve practical work and lectures, or teachers can host demonstration lectures at their schools. The events are sometimes organised at the request of particular teachers, or they may be arranged by the Bristol ChemLabS team or an external sponsor. A feature of Bristol ChemLabS' interaction with secondary schools is the network of secondary teachers, not their schools, called CHEMneT. As well as chemistry teachers, the network covers schools and other interested individuals, largely from South West England and South Wales, but also from the rest of the United Kingdom (UK) and beyond.

A feature of the kind of interaction that the CHEMneT network has developed is long-term relationships with particular teachers and their schools. Some of these relationships have followed teachers from school to school as they have progressed in their careers and have seen teachers using the outreach provision and resources in their teaching over the whole period of Bristol ChemLabS' existence. There are about 30 different activities on offer for secondary school pupils through Bristol ChemLabS outreach, suitable for a range of ages and many activities are adaptable.

A feature of the kind of interaction that the CHEMneT network has developed is long-term relationships with particular teachers. Since previous research has focused on the responses of pupils to the outreach work [16, 19,–20], teachers have been interviewed or surveyed in order to gain their perspective on pupils' response.

Teachers who have engaged long term with Bristol ChemLabS have not previously been profiled. As the recent reports on Widening Participation reiterate, the importance of relationship development with teachers and parents and the development of long-term partnerships have been highlighted as an important and effective means of reaching students regularly and over the course of their school careers [5, 9, 11].

The support and development of relationships with teachers and schools could be the key to effective outreach strategies that improve chemistry tuition at secondary schools and positively impact both attainment and progression to tertiary education, but neither the funding for outreach nor the research usually undertaken has effectively targeted this important area. This study begins to explore these relationships and answer questions about how and why these relationships develop through university-led outreach to secondary schools, as well as how these relationships impact and influence secondary teachers.

The research methodology employed for exploring secondary school teachers' reflections has been qualitatively led. Qualitative research lends itself to providing a rich description and a depth of understanding of circumstances and people's feelings and perceptions. The nature of the research questions and the paradigm within which these were to be examined, simply surveying teachers and asking them to fill in a questionnaire would not have provided the nuanced insight into the relationships and power dynamics under scrutiny. Semi-structured interviews both in person and over the phone, with the observations and field notes collected while these interviews were conducted, provided the richness and flexibility that these data collection methods provide.

2. Secondary teacher interview study

The secondary school teachers invited for interview in this study were chosen based on the length of their period of engagement with Bristol ChemLabS. Since it was necessary to understand how strong and lengthy relationships developed, schools that had been engaging with Bristol ChemLabS for the longest possible time were of interest. Twelve schools were identified from the Chemistry teacher network (CHeMneT) database as having sustained and ongoing engagement with Bristol ChemLabS since its inception as the Centre of Excellence for Teaching and Learning (CETL) in April 2005 [7]. These interviews were the first phase of data collection and formed part of the exploratory phase of research. The process of meeting with and talking to teachers and coding their interview responses shaped the research questions and the focus on relationship with the School Teacher Fellow (STF) indicated in the interviews. Twelve teachers were contacted via email and nine were eventually interviewed. The remaining 3 were not interviewed due to recent retirement, moving school and tragic circumstances respectively. These issues demonstrate some of the challenges inherent in maintaining a database of teachers as well as building relationships with both teachers and their schools.

3. Sample description

Table 1 provides information on the teachers who were interviewed and Table 2 the types of activity that they have been engaged in. For the nine teachers four were male and five were female. The schools at which they teach are described according to school type and intake, the community in which the school is situated and the distance from Bristol ChemLabS. The distance and time taken to travel between the school and Bristol ChemLabS was calculated using the directions function in Google Maps [10]. Four of the schools are independent schools, one is a school on the Channel Island of Jersey, one is a community maintained school and the rest are recent Academy Converters. The spread of English secondary schools with which Bristol ChemLabS now engages with is 20% local authority maintained, 47% academies and 33% independent schools.

Some of these schools have converted to academy status within the time frame of the research, but for the sake of consistency, schools are described according to their current status. These conversions have resulted in a slow shift in the distribution of school types among engaged schools. The number of schools classified as maintained state schools with whom Bristol ChemLabS engages, is very small compared with academy and independent schools. The schools that these teachers represent are thus representative of the schools Bristol ChemLabS engages.

By way of illustration, the 11220 secondary school children that engaged with Bristol ChemLabS in the academic year September 2011- August 2012 represented 165 different schools. (This number includes 2 home education associations). Of the schools, 22 were Local Authority maintained (13.3 %), 52 were academies (31.5 %) and 37 (22.4 %) were independent schools. The rest of the schools are Welsh, Scottish or Northern Irish, International schools (including Ireland, South Africa, Malta and the Channel Islands) or Further Education Colleges, which necessitates the inclusion of the

offshore school in the sample. The large number of academies include new academies and academy converters.

Table 1: *Secondary School Teachers Sample Description. Urban/Rural designations are as given on the Department for Education schools database [13] and are defined by the Rural and Urban Area classification system for England and Wales [22].*

Teacher	Gender	Highest Qualification	Bristol ChemLabS since:	School Type [3]	Mixed/Single sex [3]	Urban/Rural Designation [3, 22]	Distance from Bristol ChemLabS /Approximate Driving Time [10]
1	M	BSc Chem.	2006	Academy	Boys (mixed 6th form)	Urban > 10k - less sparse	34 miles/ 1 h
2	M	BEng	2008	Offshore	Girls (no 6th form)	Not applicable	188 miles/ 7 h (includes flight)
3	M	PhD Chem.	2007	Independent	Girls (Girls 6th form)	Urban > 10k - less sparse	43 miles/ 1h
4	F	BSc Chem.	2008	Independent	Girls (Girls 6th form)	Hamlet and Isolated Dwelling - less sparse	43 miles/ 1 h 40 min
5	F	MSc Chem. Ed.	2007	Academy	Girls (Girls 6th form)	Urban > 10k - less sparse	35 miles/ 1 h
6	F	BSc Biol.	2005	Academy	Mixed (mixed 6th form)	Urban > 10k - less sparse	39 miles/ 1 h
7	M	PhD Chem.	2007	Independent	Mixed (mixed 6th form)	Village - less sparse	46 miles/ 1 h 20 min
8	F	PhD Chem.	2007	Independent	Girls (Girls 6th form)	Hamlet and Isolated Dwelling - less sparse	46 miles/ 1 h 45 min
9	F	PhD Chem.	2010	Community	Mixed (mixed 6th form)	Urban > 10k - less sparse	71 miles/ 1 h 45 min

Some of the teachers in the sample have moved schools over the period of their association with Bristol ChemLabS, but for the sake of consistency the school they teach at is given as the one that was current at the time of the interview. Where the teacher has moved since the time of the interview, the new school is obviously irrelevant to their interview responses.

One school is on the island of Jersey, and thus does not fall under the designations applicable to English and Welsh schools. The distance and time here is given for driving for the sake of comparison, although when the school comes they travel by aircraft with a flight time of 1 h and about 2.5 h of total transit and connection time. With the timing of flights, in order to have a full day at Bristol ChemLabS the pupils and teachers need residential stay.

Table 2: *Teachers' Group Chemistry Outreach Involvement by Activity Type*

Venue	Involvement by Outreach Type	Teacher								
		1	2	3	4	5	6	7	8	9
Activities at Bristol ChemLabS	Practical Activities	x	x	x	x	x	x		x	x
	Spectroscopy Tours	x			x	x		x	x	
	Summer Schools	x	x	x	x			x		
	Demonstration Lecture	x	x	x	x	x	x	x	x	x
	Postgraduate lectures	x	x	x	x	x	x	x	x	x
	Evening Lectures and School's Conferences	x	x	x	x	x	x	x	x	x
	Research Activities/Special Events			x		x	x		x	
Practical Competitions	x		x	x	x	x	x	x	x	
Activities at the School	Lecture Demonstrations	x		x	x	x	x		x	x
	Practical Workshops	x			x	x	x			x
	Spectroscopy in a Suitcase				x	x	x			
	Special Event			x	x	x	x		x	

4. Ethical considerations and methodology

Appropriate ethical considerations were applied in the collection of these data including assurance of anonymity in their responses and given information at interview as to how their data would be used. In order to conduct the interviews with limited inconvenience to the teachers, teachers were emailed and asked whether they would consent to being interviewed, as well as asked whether they would prefer a face-to-face or telephonic interview.

All but two teachers were interviewed face-to-face. While the effects that the two interviewing modes can have on the data collected have been explored to some extent in the literature, telephone interviews tend to receive less attention than face-to-face interviews. While concerns such as the loss of non-verbal information, the lack of contextual information and the risk of loss or distortion of the verbal data are valid, it is not clear that the mode of interview makes a meaningful difference to the kind of data collected [12, 22]. In fact, some researchers express surprise at the richness and quality of data collected through telephonic interviews [1, 2] implying that they expect telephone interview data to be inferior. The questions were given to the teachers beforehand in order for them to prepare to have the necessary information to hand at the time of the interview. Interviews in person happened both at the teachers' schools and at Bristol ChemLabS if the teacher in question was attending a day of outreach with their pupils. The questions were sent to the teachers beforehand in order to give them a chance to look up any dates or details as the initial questions about teachers' history of engagement was going back 5 or more years. A copy of the questions was printed for the interviewee teachers and brought to the face-to-face interviews, although many of them had printed out their pre-sent questions and written notes of what they needed to remember.

Data collection took place through the recording and transcription of the interviews as well as research notes on recollections and observations collected at the time of the interview.

Questions and responses

4.1 Question 1: 'Could you tell me a little bit about your history with Bristol ChemLabS? How long have you been involved, how did you get involved, what kind of activities are you involved in etc.?'

This question provided the opportunity for teachers to talk about their history and experience of Bristol ChemLabS and allowed clarifying questions to be asked by the researcher. In many of the interviews, the teacher speaks freely of the activities they have attended, why they attended them, why they keep attending them and their developing relationship with the School Teacher Fellow (STF) [17, 18].

These teachers were all regular engagers at the time of the interview, meaning they had attended a number of activities every year since becoming involved. All but Teacher 7 had brought their students to Bristol ChemLabS to do synthesis and/or analytical work in the laboratories, and as demonstration

and postgraduate lectures usually form part of the day's programme all the teachers had experienced these activities. Only Teachers 2 and 6 had not brought their pupils to the School of Chemistry for the Spectroscopy Tours event (Teacher 2 due to offshore location, and Teacher 6 because she does not teach Post 16 chemistry –the intended audience). They had all brought their pupils to the Schools' conference or other evening lecture events for schools and all, apart from Teacher 2, of the offshore school, had involved their pupils in one or more of the practical competitions for secondary schools such as the Salters' Festival or the Royal Society of Chemistry's Top of the Bench Competition.

All the teachers with the exception of Teacher 2 had arranged events at their schools. Table 2 shows that these teachers have made the most of their association with Bristol ChemLabS and have largely taken advantage of the activities on offer at the School of Chemistry as well as arranged special activities for their schools and schools in their area. For some teachers (1, 4, 6 and 9) the special events they arrange are annual events whereas for others they have been one-offs or are less frequent.

4.2 Question 2 and 3: 'Why do you have Bristol ChemLabS come to your school to do the demonstrations/Why do you bring your pupils to the university?' and 'In your opinion, how is the experience valuable for the students 'Why do you have Bristol ChemLabS come to your school to do the demonstrations/Why do you bring your pupils to the university?'

Question 2 was asked in order to discover teachers' reasons for their involvement with Bristol ChemLabS generally. These two questions are very closely related to one another, as teachers tended to give similar answers so the responses are jointly reported.

Although Question 2 was sometimes answered with the reasons teachers had for beginning their engagement with Bristol ChemLabS, most teachers answered Question 2 by focusing on the value and benefits for their students – very similar to the responses for Question 3.

It is apparent that teachers' engagement with Bristol ChemLabS often began due to the receipt of information about the activities at the right time, (Teachers 3, 4, 7 and 8) or through being invited to events run by other schools and wanting Bristol ChemLabS to come to their schools to do something similar (Teachers 1 and 2). In other cases, the relationship with the STF, began in a different context such as Teacher 5 – taught by him during her course on chemistry as an additional specialism at the South West Science Learning Centre and Teacher 6 – met him when they were both teaching in the same district. Only one teacher, Teacher 9, sought out information about getting scientists to come to her school, and contacted Bristol ChemLabS through the information she found on the STEMNET (a science, technology, engineering and mathematics network) database. Advertising was thus a factor in about half of the cases. The other half became involved due to existing relationships with the STF; experiencing events arranged by other schools and making contact with the STF in person at these; or the one teacher who created the link herself.

Teachers engage for many reasons. Outreach provides; extension and enrichment (Teachers 2, 3, 4, 5, 6, 7, 8 and 9), reward (Teacher 6), motivation/something to look forward to (2, 3, 5, 6, 7), inspiration and excitement (Teachers 1-9), curriculum support (Teacher 2, 3, 4, 5, 6, 7, 8), aspiration-raising (Teachers 2, 3, 5, 6, 8, 9), funding being provided (Teacher 1), interaction with other schools (Teachers 3 and 8) and the flexibility of the STF and the quality of the outreach programme (Teacher 1, 5, 6) as initial reasons for being involved.

When teachers discuss the value of involvement in outreach for their students, their responses tend to focus on the Bristol ChemLabS-based activities rather than school-based ones. Many of the cited benefits rely on the activity taking place in the university labs. This is the case regardless of whether the teacher does more activities at school or more activities at Bristol ChemLabS. Benefits to students as cited by the teachers fall into a number of categories: Inspiration and Excitement Responses in this category were cited by every teacher.

5.2.1. Inspiration and enjoyment

As Teacher 5 says, her participation is 'about enthusing children about chemistry.' Teachers believe that inspiration and enjoyment of the activities is important, 'again, that's the thing about saying

science is fun and that's what it's about ...there's some educational bits hidden in there, but the main thing is...it's fun, and it's not just about beating them with the periodic table (Teacher 3),’ as is showing their pupils that chemistry can be a viable career and study option ‘our top chemist...he was inspired by coming down [to Bristol ChemLabS] in Year 9...that chain of events was set in place by him coming down here on a funded place in Year 9...that just proves how worth it the whole thing is (Teacher 1).’ Teachers 3 and 7 mention the role of postgraduate students in inspiring and exciting their pupils, ‘they get to meet some young people that are fresh in their field and exciting, that might inspire them (Teacher 3),’ ‘...and they really value talking to the current students in particular, so it's not just the chemistry (Teacher 7).’

5.2.2. Reward and motivation

Many teachers use the visits to Bristol ChemLabS as a reward or motivating experience to give pupils something to look forward to or to acknowledge good work (Teachers 2, 3, 5, 6, 7, 8, 9). Teacher 6 said that the experience was excellent to support students who needed an ‘extra boost,’ as the pupils really enjoy themselves and have fun, which was reiterated by most of the teachers (Teachers 2, 3, 4, 5, 6, 7, 8, 9). Teacher 1 mentioned a particular example of a student who had been inspired to study chemistry at university, saying, ‘it inspires a lot of them in the short term and...one or two of them...in the very long term...’

5.2.3. University chemistry experience

Every teacher gave this response. The specifics of these benefits to students range from experiencing the advanced facilities and hands-on work in the laboratories with equipment not available at schools, to having postgraduate demonstrators and lectures in the lecture theatres as a university student would. Teachers also mention opportunities to see ‘real-life’ chemistry, with the university equipment and resources and to speak to researchers about their work:

Teacher 1: ‘it's great to bring the kids down here (to Bristol ChemLabS) because they can see that chemistry can be done...with decent resources and decent instrumental analysis and all that after you've made something new.’

Teacher 2: ‘getting them [the students] to see it [Bristol ChemLabS] has given them an idea that it's very different to how we do chemistry at A-level.’ [A-level is one of the UK's pre-university national examinations for those at Post 18.]

Teacher 3: ‘they get to see the university, it's a second opinion - we're saying science is great...we run a very advanced synthetic practical course...so we can do quite a lot of the stuff that's being done here anyway...so we've got rotary evaporators, you know so we can do all that, but the main thing is having a third party, and they get to see a university. So it's kind of that “Wow!” they get to see a university...they get to see a few things we don't have, like liquid nitrogen, so they get to see... “Ooh! That's interesting.”’

Teacher 4: ‘Well, the spectroscopy is certainly valuable because it lets them see what's actually happening...and the...polymers is great because, they get more hands-on experience making polymers than they would at school...and also they just get the feel of [science at] a university’

Teacher 5: ‘last year we brought kids down to do their actual practical exam here...we did aspirin synthesis, which in a school laboratory it would take us probably 2 weeks... because of drying, we don't have drying cabinets...they only have hour and 40 min lessons, so by the time they've done it all...it would take 2 weeks of teaching time, or maybe a week, whereas you can come down and do it in a day, plus they've got all the kit here, so that's really good. So that's what we use it at A-level for...Plus also they've got IR and all of that stuff... and they get to use it...the Festival of Contemporary science it's about stretching my brightest kids. Giving them experience of university lectures.’

Teacher 6: ‘You take them to that lab, with the windows either side...there's stuff everywhere and they don't know what it is and it gives them a real picture of [university science]...it enthuses them. It makes them think...this is what university science must be like, it makes them feel grown up and special...you can see it on their faces...that this is actually really quite cool.’

Teacher 7: 'I think the Chemistry, I think seeing something that is, you know, closer to real-life chemistry... many of them are going to study chemistry or a related science ... so anything I think really that's just different to school environment and school chemistry ...the university is the closest environment to seeing different chemistry in operation. So...they really value talking to the current students in particular, so it's not just the chemistry. Again, I mean quite early on they may be thinking about chemistry, probably about Year 10 or 11 they're probably thinking about careers and such like, and they get a feel for what chemistry is like at the next level as such, and I mean even if they just get to see that there are real people, real people doing chemistry, it really helps, not just mad scientists.'

Teacher 8: 'some things can only be done in the labs which is why we take pupils to Bristol ...it's a chance to use the very best facilities and equipment to do practical work that we can't do at school'

Teacher 9: 'chemistry at school compared to chemistry at the university...well it's just so different.'

These experiences are exciting for pupils but they are also, as Teachers 1, 3, 4 and 5 mention, discriminating, helping pupils make an informed choice as to whether university chemistry or university science study is for them: 'We want to give opportunities to the kids to, you know, let them decide for themselves, are they interested in this, are they good at this? (Teacher 1),' 'I think they found the other lecture (postgraduate lecture on polymers) slightly hard going, but it depended who you talked to. If you talked to a bright group, they enjoyed it...if you talked to ones who found chemistry slightly more taxing, they didn't enjoy it as much because they didn't understand it as well. So, that's a very discriminating lecture I think. But I think it's fine, I think it should be left in there' (Teacher 4).

Teacher 3 similarly says, 'it's aimed at the ones who are keen...if you're keen about this [and] you want to think about doing it for university, go and have a look, make an informed choice. So we don't sort of say to a kid, hey, it's great, it's great, they get there and they hate it. You have been in the labs, you have seen it and spoken to these people, you're under no illusion of what it's about, so...it's an informed choice.'

Teacher 5: 'It's all about the challenge, can you handle A-level, is it something that you really want to do?'

5.2.4. University experience and aspiration raising

Teachers feel that the experience of being in a university is of great value to their students. They see that the value of being in the university environment is not limited to seeing the chemistry, but includes being on campus, and becoming familiar with what a 'good' university is like, and what being a university student might be like.

Teacher 7: 'you get double benefit, you get the benefit of... seeing all the labs and...seeing what the university is like.'

Teacher 5 states that, 'partly it's about enthusing them, partly it's about getting them interested in university... I work in a school where the majority of children are interested in university anyway, but it's about...aspirations, and saying, you can come here, it's familiar to you, making it easy for them to apply to a good university like the University of Bristol. That's really important.'

Teacher 6 describes her students' enjoyment of the 'whole experience,' 'they love hanging around in the foyer downstairs...it's simple things like the fact that they're not allowed junk food at school, it's an all healthy school. So they go there with their £3 in their pocket and just buy like 8 bags of crisps and hang around eating junk food with the proper students downstairs. It's a whole experience.' Similarly Teacher 4's students, 'just get the feel of a university. Because they're just beginning to think, "Well, do I want to go?"' which makes the experience valuable. Related to this is the perceived value of experiencing a university town, especially for those from a rural or offshore location, where cities and city universities are an unfamiliar environment.

Teacher 2 explains, 'the students got a lot out of it. For them, it wasn't just a case of just coming along and experiencing chemistry in the university, it was getting away from Jersey and also experiencing...a university town. A lot of them haven't had the opportunity to do it before.'

5.2.5. Curriculum support

Most of the teachers (Teachers 2, 3, 4, 5, 6, 7, 8, and 9) mention curriculum links and relevance as a value for their pupils attending. Spectroscopy Tours and Spectroscopy in a Suitcase are mentioned as activities particularly chosen for their curriculum relevance. For Teacher 4 the Spectroscopy Tours were the first activity she attended with her pupils, with her choosing to attend because of their curriculum relevance, ‘the reason we keep going to the spectroscopy is because it’s part of the course, and we teach A level and IB and it’s in both of those.’

Teacher 5: ‘It (Practical activities at Bristol ChemLabS) allows them to familiarise themselves with kit, that we would want them to know about, particularly if they’re going on to do A-level... in terms of the A-level use of it, last year we brought kids down to do their actual practical exam here ... (and) Spectroscopy in a Suitcase, which we also have used for a couple of years...that’s quite exciting that you can bring the machines into the school.’

Teacher 6: ‘...It (outreach) gives them a greater awareness of the world around them...I did something with [the STF] where I gained a £3000 grant from the Royal Society of Chemistry...you know the kids went and did a colour change workshop there for the day and that really supported the curriculum, actually and it was really useful...because it would have been...dry (otherwise).’

Teacher 7: ‘We’re teaching spectroscopy at the time of the spectroscopy visit anyway, so it...neatly integrates.’

Teacher 8 said how the activities were ‘all relevant and relevant to the curriculum, allowing my students to experience the analytical and spectroscopic techniques in the syllabus.’ However, Teachers 3 and 6 mentioned the difficulties in using Bristol ChemLabS outreach as curriculum support, with

Teacher 3 saying, ‘I’ve not used the Spectroscopy in a Suitcase much. That’s the one I probably have to work at, try and see what that’s like, but again, that’s hard to fit in when you’re teaching it... so I think trying to put the stuff in which is curriculum is very, very difficult,’

Teacher 6 mentioning the class size as a barrier to using Bristol ChemLabS outreach as a long-term curriculum support model, ‘there are curriculum links there – it doesn’t necessarily work-long-term as a curriculum support model...because obviously we might have 250 in a year group. So it doesn’t have that kind of long term sustainability and you’d kind of want to select a group. So it’s not supporting the curriculum for the whole year group.’

5.2.6. Extension, enrichment, stretch and challenge

Many teachers spoke about the opportunity for enrichment, extension, stretching and challenging their pupils, and the freedom to go ‘off-piste’ (Teacher 6), without needing to test them on what they have done.

Teacher 2 valued the opportunity for his pupils to really think about what was happening without need to get a right answer, ‘I think one of the good things was getting them to think as well, so rather than just giving them answers, they (the demonstrators and STF) were getting them to think about what the answers might be.’

Teacher 5 speaks about how, ‘at Year 10...it is about...having fun, I think like, sometimes for the younger kids it’s so great that they just get to do it. And don’t have to fill in a worksheet or fill in a lab report or whatever... and I think they were saying...in the lift on the way down, “Wow that man (the STF) knows loads, it was so interesting,” and they were like, “He’s so interesting.” So I said, “So what did you do?” They said, “Oh well we he was taking us on a little tour telling us about the different machines and everything.” And it’s like, well ok, but for them it’s really, really exciting.’

This account of the exchange between a teacher and her pupils shows how it’s often the little extra pieces of information, and conversation with the people involved and the chance to see different things that enhances and enriches the pupil’s experience. With Year 11, Teacher 5 speaks about the opportunity to challenge her pupils with A-level practicals, again, a chance to stretch them without the threat of testing or failure.

Teacher 6: ‘You know the perfume has no real basis in the curriculum, it’s just sometimes actually just nice to give them an opportunity to do something that’s completely, just for the love of science...and I just think just sometimes they, it’s nice to do something that they know they’re never going to be tested on because they’re tested so rigidly, it’s nice to go off-piste sometimes.’

Teacher 6 also mentions that it’s an ‘amazing opportunity for G&T [Gifted and Talented] kids, to stretch and challenge...to really give them an interest and give them a passion.’

Teacher 7: ‘Definitely, extension. And...motivation.’

Teacher 8: ‘A variety of enrichment activities is important, it makes chemistry come alive and it’s very good to challenge Gifted and Talented pupils.’

Teacher 9: ‘It’s for enrichment, particularly to stretch Gifted and Talented children and inspire them.’

Teacher 1, although never using the words ‘enrichment’ or ‘stretch’ and ‘challenge’, reveals in his desperation for funding for these experiences for his pupils, the value he sees in them experiencing chemistry outside of the classroom, and how important that is for expanding their horizons about chemistry and science.

Many of the teachers have also invited the STF and/or postgraduate students to speak at their extracurricular science clubs (Teachers 1, 3, 4, 5, 6, 8, 9), which would also count as an activity for extension and enrichment, rather than curriculum support.

5.2.7. Breaking stereotypes and meeting real scientists

Although not mentioned by all of the teachers, a small number of teachers specifically mention the breaking of stereotypes about scientists. Teacher 8 said that going to the laboratories at the University of Bristol and interacting with the academics, STF and postgraduate students ‘breaks stereotypes about scientists being boring and unable to communicate well,’ while Teacher 7 spoke about the value for his pupils in seeing, ‘that there are real people, real people doing chemistry...not just mad scientists.’ For Teacher 9, although she doesn’t specifically mention the breaking of stereotypes, she does share her reasons for getting Bristol ChemLabS to visit her school for the first time and while seeing the science in action was part of it, for her it was about having her students meet and engage with real scientists and seeing them as normal people in their school environment. Teacher 3 mentions the value of his pupils meeting and being inspired by young people, fresh in their field, and as a teacher at a girls’ school, the huge value for his girls in seeing ‘young female PhD students’ so that his pupils are able to ask, “‘Why did you choose science?’” because they’re thinking of doing it... one of the big things is where everyone’s male, that immediately turns off a young girl from doing science, whereas if they see a young female, grad student, postdoc, young lecturer,’ they hear from the young women themselves, rather than him as a male teacher, ‘see look you can do it, it’ll be hard, it’s a male dominated world, but you can get there, this is why I’m doing it,’ which aside from being of benefit for his pupils, is a plus for him as a teacher.

5.2.8. Meeting other school pupils

Although not mentioned by every teacher, this came up in Teachers 3 and 8’s responses as a good reason for their pupils and schools to be involved in various outreach activities.

Teacher 3 believes that, ‘mixing pupils together, you know, so some of the pupils might be brave and start talking to each other, that’s only going to be a good thing.’

Teacher 8 mentions the value of her students meeting students from other schools. Neither teacher really expands on why they believe this, but it is part of why they take their students to Bristol ChemLabS and also why they have arranged events at their schools for pupils and teachers from elsewhere to attend.

6. Question 4: ‘Can you describe your impressions of the department and people you have worked with (the STF (name given), Lab manager (name given), technical staff and postgraduates)? How does being here at the department make you feel?’

This question was asked to explore how teachers experience visiting the department and their views on the staff and postgraduates that run the outreach activities, as well as opening up discussion of some of the possible power dynamics at play for a teacher visiting the university with their students.

Overall, teachers’ impressions are highly positive (Teachers 1-9), ‘sense of space’, ‘clean’, ‘beautiful’, ‘impressive’, ‘brings back memories of research days,’ ‘professional,’ ‘well-funded,’ ‘reliable,’ ‘excellent,’ with many commenting on the professional set-up, ‘it’s so well organised...the organisation is really first class (Teacher 7),’ and the fact that everyone appears to know what they are doing, ‘I got the impression that it was something they had done regularly, they knew what they were doing (Teacher 2),’ ‘every time the kids...come here it’s been...a smooth operation (Teacher 3),’ ‘you’re immediately confident that all is going to be well and they know what they’re doing (Teacher 7).’

Despite the professional set-up and university location, a number of teachers mention that the Bristol ChemLabS people make them feel welcome.

Teacher 8 reports that ‘the people are very approachable, they are interested...they want to help’

Teacher 4 states, ‘I think it is accessible [for teachers]... it probably doesn’t make any difference, well, not much difference whether you’re experienced or not.’

Teachers seem to feel that there is flexibility and the opportunity for a tailor-made experience through discussion with the STF. A few teachers specifically mention that the STF asks for, and listens to, feedback, ‘[Name] is quite good at asking for feedback as well, actually...once or twice I have said well, this might be better if that was out and this was in, sort of thing, and he certainly looked at it (Teacher 4),’ so for them there sense that they are a valued part of the process.

The general responses to this question indicate that teachers’ impressions are of a great team, but the STF stands out – he is the main one they talk to and have a relationship with and they attribute this to the fact that he was a secondary school teacher for many years and understands their and their pupils’ needs, ‘obviously [name] (the STF) has always been amazing and because we’d had a relationship that goes back right to...the start of his kind of placement in this post, I think I’ve only ever really dealt with him. When I was dealing with this...grant...I used to deal quite a bit with [another academic] as well, but I didn’t have the kind of banter relationship that I’ve had...with [name of STF]. The technical staff, the postgrads, anyone who’s ever worked...with those kids...they’ve just been...really great. I couldn’t, you know, remember any of them particularly, but I just know that I’ve always been impressed with them (Teacher 6).

In contrast, they have no contact or relationship with other academics in the University of Bristol, School of Chemistry unless they are working on a particular project, such as Teacher 3, Teacher 6 and Teacher 8 have done through the Royal Society Partnership Grant scheme [15]. In fact Teacher 3 speaks about how academics are ‘conspicuously absent,’ from the outreach events and activities at Bristol ChemLabS, but he recognises that, ‘it [outreach] needs...to actually have someone like the STF [a permanent appointment] that’s actually there to engage schools.’ Many mention that because the STF is a teacher he knows what he is doing and they trust him and his team, ‘I know his background... having been a senior teacher before, he’s very useful to us because we’ve got a great deal of trust in him and his team, and we know he will deliver quality (Teacher 1),’ ‘obviously having been a teacher, he knows exactly how to phrase things and I think if you had someone in that post who hadn’t taught I don’t think it would be half as successful (Teacher 6),’ ‘(name of STF) background in schools, his understanding of how the school system works, makes my task easier (Teacher 8).’

Teachers are also impressed with how well everyone at Bristol ChemLabS relates to their pupils, ‘they [the staff and postgraduates] were constantly helping them out with bits of the experiment and getting [the pupils]...to think as well (Teacher 2).’ ‘I’m always impressed with the way the PhDs and postdocs communicate with the pupils...they make it very relevant and interesting, and that really, is

important to us (Teacher 8).’ ‘The technical staff, the postgrads...the PhD students working with those kids...they’ve never been anything but amazingly professional with them (Teacher 6),’ as they have understandable concerns that the experience will be relevant and suitable for their pupil’s age group and understanding.

Teacher 1 says, ‘Sometimes, you know, if you go off to unis with some kids you wonder exactly what you’re going to get...you know the kids don’t necessarily relate to who’s talking to them particularly well.’

Teacher 3 mentions bad experiences with other universities, ‘with my other collaborations...with other institutions, it’s embarrassing what they do compared to what Bristol’s doing...and I’ve made that clear with a few academics in other institutions.’

Similarly Teacher 7 articulates, ‘you know, young kids and chemistry, at university, you want to know that there are sensible people around... they [ChemLabS staff and postgraduates] are so inspiring as well and sort of bounce around a lot. Confident and inspiring!’

What is apparent is that people are important. While not many can mention anyone by name, other than the STF, teachers don’t just talk about the facilities when they are speaking about their impressions. They speak about how wonderful the people are. Teacher 5 encapsulates this as she talks about her apprehension when visiting the labs for the first time, ‘I was worried, but I wasn’t worried about kit, because the kit is pretty fine, but...you don’t want to feel a fool when you’re doing stuff...the physical bit of it is just impressive and professional. But the thing that makes you feel confident about doing what you’re doing, or asking, is the support staff. So, like [name of lab manager at the time] is fantastic, like, he’s a guy who’s really well qualified, knows absolute loads, who is really happy to take really stupid questions and not...make you feel like you’re a complete idiot. And in fact, so are all the others. [Name of Level 6 technician] I’ve worked with a little as well, a bit more now, I didn’t know him as well in the beginning, really good at, again, making you feel like you’re not an idiot. And in fact the demonstrators on the whole, are pretty...nice as well, so, in that sense I think...it’s the people that help...the other thing is, this, your team, your techie team and stuff is pretty stable and hopefully [the STF] is sticking around as well for a while, so that won’t change, but if it were to change...because people are so important, to make sure...that thing of continuous welcome and support [remains]. Because if you get the wrong experience, I’ll tell you ... [you] feel a bit of an idiot ... So I think people make a big difference.’

Teacher 3’s candid assessment of other famous institutions’ ‘embarrassing’ offerings, where he goes on to say, ‘I think they’re relying on arrogance of their name... I think that [Bristol] is the only one I’ve seen that’s actually trying to engage and do it properly,’ also seems to lend credence to the fact that along with offering a professional experience in facilities that are top class, people who are fully engaged, interested and committed are really important to teachers when choosing to engage with universities. The personal experience, welcome and relationships that are established are just as important to them as the reputation of the institution, if not more so.

7. Question 5: Does the school visit day affect your subsequent science teaching? How?

Very few teachers reported planning any pre- or post- visit activities, although Teacher 5 did say she had considered doing so, and she did do some topic-related pre-teaching, ‘I think you plan your teaching sequence prior to the event so that you maximise the topic. You refer back to it...in lessons, and some kids will remember it...and some kids are like, you know, “What?” So you can’t be sure that they’re going have remembered every bit of their lecture...if you’ve got Spectroscopy in a Suitcase coming in, you need to do some pre-teaching; ‘Pollutant’s Tale’- climate change, before ... [name of STF] comes in ... coming down to the labs is a bit different because they’re much more kind of one-off, apart from ... the A-level practical work where obviously we’re looking at ... organic synthesis.’ Teacher 3 said that he does not want to plan a scheme of work around the outreach visit because the visit is meant to be a fun experience.

Most teachers say they tend to refer back to what the pupils have seen and experienced in class as it is a useful reference point, (Teacher 2, 3, 4, 5, 6, 7, 8, 9), ‘Yup, definitely use it as a reference point.

Especially immediately after they've just been...for reinforcement (Teacher 4), or that pupils might be the ones to bring it up themselves, 'so it's generally brought up by the kids if they remember something, like ... the benzene rings ... and we'll have a brief chat about it (Teacher 1),' but this happens organically rather than as planned curriculum integration.

Teacher 2 mentioned that they had analysed the Infrared spectra the pupils printed at their visit when they got back to class, 'we look at the analysis, when we're looking at IR spectroscopy...because you know they got to keep their...spectroscopy of the caffeine...so we're able to...revisit it...it was useful. There wasn't a great deal that we could do that with [refer back to it in class], but that was certainly one area that we could.'

Similarly Teacher 3 said that they referred back to the spectroscopy tours when teaching the 6th form, 'Yip...all our 6th form got to see that one, if something's in there they might say, remember you saw that there?' In addition, teachers say they can't do much beyond simply referring back to the visit in due to the fact that not everyone in their classes will necessarily have attended (Teacher 1, 2, 3, 5, 6, 7, 9), as Teacher 7 describes, 'I'd like to say it was all part of the curriculum, but no, for us, what we do, is definitely isolated...well I guess we're teaching spectroscopy at the time of the spectroscopy visit anyway, so it kind of neatly integrates...[but] the rest of them tend to be [isolated], because it's not a whole year group going, only a select few.' Teacher 6 had arranged specially planned activities with the STF which were directly curriculum related, but these were made possible with special grant funding and were not the usual activities that are offered. Teacher 8 mentions that as a result of the outreach collaboration the school had bought the Bristol ChemLabS' Chemistry LabSkills software [6, 8] which she now uses in her teaching. However, she does not plan her teaching around the visit to Bristol ChemLabS.

These responses seem to indicate that the teachers' primary aim is not for their pupils to get increased knowledge or understanding of chemistry, but rather to inspire their pupils about studying science and going to university, broaden their horizons and expose them to the science happening outside their school classrooms. If teachers were most concerned about the direct usefulness to their pupils of the content, one could assume they would use the experience more intentionally in their teaching and preparation.

8. Question 6: You have been involved with Bristol ChemLabS over a period of time. What would you say has kept you coming back, aside from the benefit for the pupils?

This asks teachers about why they have kept attending events at Bristol ChemLabS over several years. The question is phrased, 'aside from the benefit for the pupils,' to force teachers to think about other reasons for attending, and to not 'hide' behind the reason of pupil benefit that has already been covered by other questions.

While Teacher 1 doesn't mention the access to funding as a benefit to himself in answer to this question, whenever he speaks about getting access to funding he speaks about it in the context of the STF getting it for them. The relationship between the STF and Teacher 1 is thus of paramount importance for him in being able to ask for funding for particular activities, 'it was made easy by Tim and his team for us to get hold of the funding, I mean, he'd look after that and so we would come down and someone would fund it for us...'and later he mentions, 'badgering' Tim to ask for more funding for things, something he would not be able to do without the benefit of the good relationship they have developed.

Teacher 2 describes arranging the residential trip to Bristol with the STF, and it emerges that their conversation, in developing the programme for their visit and making logistical arrangements, naturally allowed for a relationship to develop between them, 'Tim put together a programme for us which I think is followed by some of the other schools... since the conversations that we've had with Tim we had the opportunity to find out more about the ChemLabS work that's happening there.' The STF designing a programme their visit to get the best out of the time spent at BCL, was of huge value to the teacher, leaving the teacher with the perception of having developed a good relationship with the STF.

8.1 Career development and school publicity

Teachers recognise the impact that their personal relationship with the STF has had on them as teachers, but there is also the impact as perceived by school management on them as employees of their schools. School management values the teachers' personal relationships with the STF because as a result, they, as an institution, can claim to have an institutional relationship with the institution of the University of Bristol. This perception of whole-school impact by school management and the resultant career impact is discussed as a separate value outcome for teachers:

8.2 Student retention in chemistry until A-level and the increase in the status of chemistry as a subject

The increase in chemistry A-level numbers and the rise in the status of chemistry in the school is given by some teachers as a benefit of outreach involvement. Teachers appreciate having excited, inspired students as it makes their job easier.

Teacher 6 says, it is 'Hugely valuable for me. Because I get to ride on the back of that [excitement], as well, it's kind of everywhere you can chip into their education over the course of their two year GCSE course, or their 3 year Key Stage 3, it's valuable, because it gives you a frame of reference to talk about...it's hard to quantify – I just know that the kids love it, and at the end of the day as a teacher, that's really all I care about.'

A number of the teachers provided anecdotal evidence that their A-level numbers and the status of science in their schools has risen (Teachers 1, 4, 5, 7, 8), but, this information was generally given by teachers in answer to Question 6: You have been involved with Bristol ChemLabS over a period of time. What would you say has kept you coming back, aside from the benefit for the pupils? This category is mentioned here as it is clearly a value for the teacher and the school as well, although teachers tend not to speak about it directly in answer to Question 4. The responses pertaining to A-level numbers increases will be more fully dealt with in the section dealing with Question 6. Career development and school publicity Teacher 1 value's his outreach involvement due to the positive impact of outreach in maintaining A-level numbers and the chemistry department's status as a key department in his school. More about the A-level numbers is discussed in the section dealing with Question 6. However, he mentions the poster that he and the STF created of their outreach activities, that this has been displayed in the school, and that the school looks favourably on the department (and the teachers in it) as a result of their good A-level numbers which their outreach involvement has helped maintain.

Teacher 1 also speaks about how he thinks his involvement, 'may benefit [his] career at some point down the line,' showing that potential career benefits are part of what Teacher 1 thinks makes outreach involvement valuable.

Teacher 3 organises an annual conference at his school in conjunction with the STF and Bristol ChemLabS and he mentions career benefits in terms of the organisational aspect of outreach events at the school, 'you got it in terms of it helping your career... "I've organised outside speakers." So there's an element there for the career hungry teacher...' and goes on to explain how although his outreach involvement is viewed very favourably by the school which appreciates the publicity that it brings. 'Well the school recognises what's going on...it's not got me jobs...but it's got me...a welcome position. The school appreciates having that kind of input. I mean that's what we're about, it's educating from a variety of different sources...it's good publicity and you get the people there, but I think...it carries something of that it's a really cool thing, thanks for running it...so I wouldn't say career progression but it's sort of saying things in terms of, "are you doing a good job?" that answer would come as a yes, because... they're ticking outreach, public benefit, engagement, CPD, university links. So you're sort of hitting a whole thing where a lot of secondary schools, head teachers, are desperate for staff to forge these things, so we're ticking all of that extracurricular box in one ... !'

Teacher 5 specifies that her outreach involvement has increased the status and profile of chemistry within her school because it is exactly what senior management likes. While she does not mention career or promotion benefits, she does say that it shows her in a positive light with senior management and has enabled her to do more of the exciting things she wants to do with her pupils as a result of the

favourable view of her and her subject. She explains: ‘being involved in the outreach has been really good in terms of raising the profile [of chemistry] within the school, and what senior managers like is...something that’s very successful, and they like something that’s quite high profile. So when we had ... [the STF] come down for the International Year of Chemistry , you know, it was like, “wow, this is chemistry that’s really good,” and then...we did a poster of what we’d done, which he had printed and brought, which went up in the school...and so for the school and you know, for me it’s been fantastic...but for a member of staff, you know a senior leader...they want things that are, kind of “wow!, this is great, and our school is happening, we’re linking with universities, wow we’re amazing,” you know, it ticks a lot of boxes. So...I mean I sound quite cynical about it, but actually that’s all to the good because it allows me to then say, “shall we do this as well?” So that’s a good thing.’

Teacher 8 described how the events she has organised for the primary schools in her area and the science conference that she ran for local secondary schools at her school ‘produce publicity and praise’ both within the school for her as a teacher and for the school itself, such as in the local media, and she had some newspaper clippings positively reporting on the conference. She mentioned the ‘increased profile of the school’ that running outreach associated events creates and discussed, similarly to Teacher 3, the fact that her ‘school management looks on [her] relationship with Bristol favourably,’ as they are able to tick so many boxes with one event – recruitment, public engagement and positive publicity – the success of these events has led to greater freedom for her with the school management when applying to do extra, out-of-classroom activities with her pupils. Getting to know children outside the classroom and a chance to reward or boost children. Although this was commonly cited, two teachers particularly mentioned pastoral benefits to being able to bring children to Bristol ChemLabS.

For Teacher 2 pastoral benefits were the major value for him in taking his pupils on a residential trip. It is the first thing he mentions before citing any other benefits, saying, ‘well it’s given us the opportunity to know students better by bringing them over on the trip... it’s given us the opportunity to do that, to get to know students outside of the classroom.’ This value could be a function of the fact that the trip that this school makes is a residential one, as they are an offshore school, and the fact that they bring a small group of a maximum of 19, due to the size of the aircraft.

Teacher 6 also mentions the pastoral benefits of being able to take her pupils on trips, and as she is local, the residential aspect does not apply. She says that it’s a chance for, ‘identifying kids who need a boost or identifying kids who need a reward.’

Although not given as a reason to attend, or a value for teachers of their involvement by any other teachers interviewed, these pastoral aspects are worth mentioning, as they have nothing to do with the chemistry content of the programme, nor do they specifically relate to the fact that the programme takes place at a university. Yet, two teachers felt it was worth mentioning as a valuable part of their continued involvement in the Bristol ChemLabS outreach programme.

8.3 The language of ‘links’ and ‘partnerships’ and the power dynamics of relationships

The language used by teachers and schools to describe their relationship with Bristol ChemLabS is institutional. They describe their schools ‘linking’ with the University of Bristol, with Teacher 3 noting that school management view his outreach involvement as, ‘ticking outreach, public benefit, engagement, CPD, university links. So you’re sort of hitting a whole thing where a lot of secondary schools [and] head teachers are desperate for staff to forge these things.’

Similarly Teacher 5 also notes, ‘they [the school management] want things that are, kind of wow! This is great, and our school is happening, we’re linking with Universities, wow we’re amazing...you know it ticks a lot of boxes.’ Teacher 8 too, says, ‘The link with Bristol has become of prime importance to me and to the school.’ Engagement with universities is viewed in a positive light.

The teachers who have developed their relationship with the STF and maintained their involvement in outreach over the years, have strengthened their position to negotiate and achieve access to resources for their subject and their efforts have been looked on favourably by the school management. Many

teachers reveal how power dynamics have shifted in their favour as their engagement has opened up access to the university as a whole – they feel like ‘if there’s a university I can call on, Bristol is the one (Teacher 4).’

The perception of this link between institutions is very powerful and this, to a large extent, empowers teachers to negotiate for more, both within their schools and through the STF, with the university. HEIs, such as those in the Russell Group of universities, make partnering with schools, colleges and academies and forging links with secondary and primary education institutions an important part of their policy in Widening Participation [4].

The language of links and partnerships is used often, but many of the projects themselves involve one-off events for pupils [4], or ongoing support for a very small number of pupils but very few explicitly engage teachers or recognise the role that they play in maintaining the connection between the institution and the pupils they want to reach. The Russell Group Future Scholar Award Scheme [23] 24].’ Aside from this initiative, the Russell group’s own examples and descriptions of the links and partnerships their institutions have made with local schools and colleges involve only 2 universities explicitly engaging teachers; Sheffield University and the Reach Project [24, 14] at the University of Edinburgh, and only one where the school itself, due to being co-sponsored by the university is actually linked to the HEI in a broader sense, at the University of Bristol with The Merchant’s Academy [22].

A pattern emerges of language usage that implies institutional links, where actually personal and transient links occur. A university focusing on 5 Year 9 pupils a year at a particular school might make strong links with those particular children, and this may meet their Widening Participation (WP) goals for the project, but brand new links must then be forged in any subsequent year, with 5 new pupils and there is limited continuity year on year. However, any relationship that does exist is not ‘institutional’ in the sense that the relational aspect is between particular individuals at each institution, and not between the institutions as a whole. Even the WP projects linking pupils with the university, really only link pupils with particular students or the academics that they work with or are mentored by.

There is certainly a great deal of power in the perception that institutional links that have been made – both from the side of the schools, pupils and teachers and the HEIs themselves. However, for the majority of teachers, their link is with the STF and if he were to leave, the ‘institutional’ link would be broken.

Teachers who spoke about the continuity of the programme recognise this, and Teacher 1, 3, 4, 5, 6, 7, 8 and 9 all specifically mentioned the value of this continuity at some point in their interview. The individual and personal nature of the links is further illustrated by the effect on the frequency of engagement that Teacher 6’s promotion, leadership and career progression has had. She recognises the personal nature of her relationship with the STF.

Teacher 3 speaks of the need to hand the relationship over to a new person, showing that he realises that it is a personal relationship rather than an institutional link.

Teacher 1 took his relationship with the STF with him when he moved schools and the old school’s engagement frequency decreased. When a teacher retires or moves on from a school, a whole new relationship may need to be forged. The school itself actually has no relationship with the HEI, and the HEI has no relationship with the school. These personal relationships can be extremely powerful and used to the advantage of both the school and the HEI, opening up the closed gates between these institutions allowing access and helping to ‘bridge the gap’ between them. However, both should be aware of the tenuous nature of these connections.

While the language of links and partnerships is emotive in many ways this is an illusion which is unhelpful for organisations to hold on to. Cultivating of relationships is hugely important and Bristol ChemLabS looks for ways to broaden the number of individual teachers they engage with at a school, and encourages teachers to pass the relationship on when moving from one school to another.

The emphasis that individual teachers place on their personal relationship with the STF should also act as a warning to HEIs employing someone in this position; that in order for sustainable, successful long-lived engagement; funding and position longevity for STFs and outreachers/engagers/science communicators is of huge importance, and planning for their eventual retirement or career progression is vital to ensure that the relationships they have developed are protected and passed on. Schools and HEIs underestimate the strength and importance of the individual connections at their peril. Ignorance of the power dynamics at play in forming and maintaining these connections will undermine their sustainability.

9. Conclusion

The chemistry teachers interviewed have identified a myriad of reasons why outreach engagement with Bristol is of advantage to their own students. Long-term recurrent engagement of Bristol ChemLabS with secondary schools comes about through the creation of sustained relationships between the teachers and the STF. The newsletter is important in keeping teachers informed of what is happening, but the long-term regular engagers have spent a considerable time with the STF. It is not just the frequency of engagement that is important but the type. This sustained time with the STF leads to the development of a personal relationship with him. The relationship is teacher-to-former-teacher but the teacher also has a relationship with everything that the STF represents: access to the university and its resources, as well as status and favour at their own school. After a sustained period of engagement, maintaining the link or partnership between the teacher and STF, and the perceived resultant link between the school and HEI becomes its own motivation.

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Authors

S.R. Glover, formerly of the School of Chemistry, Cantock's Close, University of Bristol, BS81TS, UK, e-mail: s.r.glover@bris.ac.uk

T.G. Harrison, School of Chemistry, Cantock's Close, University of Bristol, BS81TS, UK, e-mail: t.g.harrison@bris.ac.uk

D.E. Shallcross, School of Chemistry, Cantock's Close, University of Bristol, BS81TS, UK, e-mail: d.e.shallcross@bris.ac.uk

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Appendix

Spectroscopy Tours

These are tours of the spectroscopic analytical equipment in the School of Chemistry for school pupils in Year 12 or 13, in groups of 8-10 with a postgraduate guide. Each instrument/spectroscopy type (including a selection from Nuclear Magnetic Resonance, Infrared, Mass Spectrometry, Scanning and Transmission Electron Microscopy, Gas Chromatography and possibly X-ray Crystallography) is presented to the students with a short talk by an academic or postgraduate/postdoctoral researcher with a demonstration and possibly hands-on experience. The students see the in action, while learning about how they work and the application of the technique in analytical chemistry.

Summer Schools

These are residential chemistry camps lasting between 2 and 5 days, where students have an intensive experience of university chemistry, spending each day in a combination of laboratory work, lectures and possibly spectroscopy tours.

The Trinity College Summer School involves time at the University of Bristol and also Trinity College, Dublin over a period of 5 days. Demonstration Lecture The demonstration lecture is 'A Pollutant's Tale', 'Gases in the Air', or 'A Chemical Delight', or a guest lecture which involves practical chemistry demonstrations. 'A Pollutant's Tale' is the more advanced older brother of 'Gases in the Air'. It involves many of the same practical demonstrations as 'Gases in the Air' but with a focus on Climate Change. 'A Chemical Delight' is a chemical kinetics demonstration lecture.

Postgraduate lectures

These are short lectures given by current postgraduate students (and sometimes postdoctoral students), on a topic related to their research. These lectures have no demonstration or practical component and usually take place along with one of the demonstration lectures in the afternoon after a morning spent in the laboratories.

Evening lectures/Schools' conferences

Schools' Conferences and lectures take place a few times a year, and involve talks by scientists from the University of Bristol (as well as other institutions) on their research, aimed particularly at secondary school students. They take place in the early evening or late afternoon. There may also be demonstration lectures by the STF along with visiting academics. They may be sponsored by learned societies or the University of Bristol alumni. Research Activities and Special Events These activity types refer to non-routine activities taking place at the university. This would be any practical activity or lecture event which is not run by Bristol ChemLabS as part of their usual offerings for schools, but is led by a research group or academic working with a school as part of a special project or grant, as has happened through Royal Society Partnership grants for example, which allowed for research partnerships between academics and schools.

Practical Competitions

These include Top of the Bench (Royal Society of Chemistry sponsored), the Royal Society of Chemistry Analytical Competition and Salters' Competitions sponsored by Salters.

Schools Lecture Demonstrations

These are the same demonstrations as would take place at BCL, but taking place at the school, often involving the whole school in an assembly-type context.

Practical Workshops

Practical Workshops taking place in a school for secondary school students are unusual, but occasionally fragrance/perfume chemistry workshops or the primary circus of practical experiments might be done in a secondary school with secondary school pupils. However, secondary schools often arrange these events for their primary feeder schools. This involves engagement with a secondary teacher as they organise the event, but in practice involves working with primary school children and their teachers on the day of the event. Included in this category is any specially arranged event taking

place at a secondary school and arranged by a secondary school teacher that involves hands-on practical work with either primary or secondary pupils.

Spectroscopy in a Suitcase

Spectroscopy in a Suitcase involves a mobile kit of Infrared and UV-vis spectroscopy instrumentation and activities delivered by postgraduate students for senior students at their own school. The visits are free due to sponsorship by the Royal Society of Chemistry.

Special Events

This category involves any special event arranged by the secondary teacher, taking place at the school and involving lectures/demonstrations rather than practical activities. Unlike the 'Lecture demonstration' category this would involve other invited schools and attendees not just a demonstration assembly for the school.