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Factors Influencing Teachers in Engaging with University Outreach: Is it Just Cost?

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Abstract

A chemistry outreach day event was offered, free-of-charge, to schools in the south west of England who do not normally engage with Bristol ChemLabS outreach events delivered at the University of Bristol. The participating teachers were interviewed to find out their expectations of the day in terms of helping their students or in helping the teachers, whether the "free" aspect, or not, triggered the application to the event and whether finance or other barriers normally prevented engagement in such events. The value versus cost of such outreach an event is discussed. While finance was the biggest issue for the majority of the interviewed teachers they recognised the value of the inspiration rather than subject knowledge acquisition for their students. The advantages for the teachers were seen as better motivated students and the likelihood of more students taking their subject at higher levels. Having attended such an event and observing the quality and impact on their students, teachers were more inclined to engage in the future whether there was a financial charge or not.

Keywords: chemistry outreach, financial barriers to engagement, value versus cost

1. Introduction

Bristol ChemLabS (Harrison et al., 2016; Shallcross et al., 2013), at the University of Bristol's School of Chemistry has a major outreach project (Harrison & Shallcross, 2010; Harrison et al., 2010a; Harrison et al., 2010b; Shallcross et al., 2013) that engages directly with 25000-30000 school students, teachers and members of the wider community per year through a portfolio of activities. Among these activities are the "Open Laboratories Programme" days where school students engage in a number of laboratory workshops during the morning and enjoy an afternoon of talks and lecture demonstrations. The events are organised and supervised by the department's School Teacher Fellow (STF) (Shallcross et al., 2014; Shallcross & Harrison, 2007a; Shallcross & Harrison, 2007b). Schools book these events up to 12 months ahead and visit annually despite the charges made by the university towards the costs incurred. Why some schools, who engage in other Bristol ChemLabS activities do not make use of this well-established programme was of interest.

A free-of-charge event was created and schools were invited to take part. This is referred to as "the Perturbation Study". The teachers accompanying the students were asked to take part in interviews with the researcher during their visit. The findings should be of interest to other university outreach activities.

The issue of funding is repeatedly mentioned by many secondary teachers as a barrier to engagement, particularly outreach activities that require transporting students to the University of Bristol. It has been noted that the cost of the activity itself, transport and the cover/supply teacher(s) being prohibitive for many schools. The Perturbation Study was envisaged as an opportunity to "perturb" the status quo by removing part of this barrier and funding the event cost. The school would still need to cover transport and the cost of supply teachers.

2. The Open Laboratories Day Outreach Event

The perturbation study event took place in May 2014 and was advertised to teachers as a Sponsored Caffeine Extraction Practical Day at Bristol ChemLabS (Tuah et al., 2009). The idea of the study was to limit the number of participants per school to 15 which is a convenient number that can be transported in a school minibus, rather than in hired coaches and make the activity itself free-of-charge. We could then look at which schools applied for the activity; whether they were previous engagers or new schools, what kind of engagement they had previously participated in, and how far away the applicants' schools were situated from the University of Bristol.

It was hoped that this would elucidate which schools are most affected by funding constraints and through interviewing the accompanying teachers on the day of the event, some insight into their reasons for applying and participating in the sponsored visit could be gained.

The perturbation study was conducted at the Bristol ChemLabS's Undergraduate Teaching Laboratories during an outreach event which involved the extraction of caffeine from tea during the morning. During the afternoon students and accompanying teachers received a talk from a postgraduate student on their research followed by the lecture demonstration "A Pollutant's Tale" (Tuah et al., 2010). This is the normal format of secondary school visits to Bristol ChemLabS. Only school teachers registered with CHeMneT, Bristol ChemLabS network of nearly 1000 teachers (mainly chemistry teachers and mainly in the south of the UK) were invited to apply for their students to take part in the event through the CHeMneT newsletter in December 2013. The places were offered to the applying schools chosen through a draw.

2.1 Sample Description

Eleven schools applied to be considered for a place. What is immediately apparent is that no Independent schools applied, all but 2 of the schools are less than 50 miles away, and only one school is more than a 2 hour drive away. The spread of applicant schools is thus different to the spread of school-types that normally engage with Bristol ChemLabS (Glover, 2016; Harrison et al., 2010; awaiting publication, Harrison et al., 2010b; Shaw et al., 2010).

From these applicant schools, 5 were drawn by lottery in order to fill the available laboratory space with 75 students. The 5 chosen schools were contacted and offered their places. Three of the original group gave up their places for several reasons and their places were filled from the reserve list.

In the end one of the five schools cancelled at the very last minute so could not be replaced. The teacher did not give a specific reason for their inability to attend, other than "circumstances beyond their control". It has been noted that free events in the past have witnessed schools either cancel at the last minute or just not show up. At this late notice it was not possible to invite another school to take their place. The final list of schools (Table 1) was Schools G, H, I and K, all from 30 miles away or less with driving times of less than an hour.

2.2 Ethical Considerations

For the perturbation experiment it was important to offer the same outreach opportunity as secondary schools would ordinarily be able to book for, but make it free of charge to mitigate the funding barrier. The teachers were not given the day's activities free with the condition of being interviewed, but rather were asked, after accepting the place for their school whether they would consent to being interviewed. The teachers were emailed before the event, asking for their consent to be interviewed during the morning and giving information as to the use of the data obtained. It was made very clear that they were under no obligation to do so. All, including some additional staff from the schools, were happy to participate and be interviewed on the day. Teachers from the same school were interviewed together. Raw data has been stored securely in encrypted, password protected files stored only on university servers. The teachers were given a hard copy of the data use agreement at interview.

2.3 Research Instruments and Data Collection

The teachers were interviewed during the morning's practical activities in the laboratory. The interviews were semi-structured in order to facilitate more natural conversation and allow clarifying questions to be asked. Copies of the interview questions were given to the teachers to look at during the interview. Since the purpose of the perturbation study was to explore which schools applied for the event when it was offered at no cost, and then also to ask attending schools about the impact of making the event free, the questions centred on asking teachers why they signed up, and what effects they thought the day would have on them and their students. They were also asked about the impact of making the event free on their decision to apply and asked about other barriers they face in visiting Bristol ChemLabS.

Apart from schools D and K, most that applied had not been to the Bristol ChemLabS for several years prior to this visit. Two of the schools who had previously engaged in the past had never done a practical activity of any description at the university. Unlike practical activities, lectures and conferences held at Bristol ChemLabS are often free of charge, or very low cost per head and the demonstration lectures held at schools are good value for money (their opinion). The charges to bring one of the Outreach team in to lecture to the whole school has a big impact and reaches every child. This is in contrast to a day at the laboratory which will involve cover/supply teacher costs, transport costs, students missing other subjects to attend and a much greater overall cost per child. The cost of cover for two science teachers missing a day of classes could be more than the cost of the demonstration lecture. This is without all the other time and administration costs associated with arranging a day

away from school. If the Top of the Bench Competition, Analytical Competition (both Royal Society of Chemistry sponsored) and the Salters' Chemistry Competition (Salters' Institute sponsored) are discounted because they are out of hours, involve a small team of students, and are arranged and funded by outside organisations; then 3 schools have never engaged in a Bristol ChemLabS practical activity. Thus out of 11 applicants, 4 schools have never done a practical activity and only 2 applicants have done a practical activity that is not an outside sponsored competition in the previous academic year (2012/2013). These circumstances, coupled with the fact that previous regular engagers in multiple activities are decreasing their frequency of engagement and have changed the type of outreach activities they participate in, to cheaper activities with wider reach, suggests that schools and teachers are becoming ever more stretched and constrained in terms of time and budget. It may be that whole school activities which reach every child and free evening activities are more easily justifiable to school finance and administration than more intensive practical experiences that reach less students directly.

There are no independent schools in this sample, whereas independent schools are known to be a significant proportion of the long term engagers at approximately 30% (Glover, 2016). This also suggests that making the activity free has caused it to appeal to a different group of CHeMneT members.

It could be argued that funding and finance cannot be the only barrier to school attendance at practical events and that teachers might for various reasons not be motivated to come, or perhaps do not see the value of attending. There removal of the funding barrier has attracted applications from teachers who, to a large extent, have never or have not recently been involved with practical activities at Bristol ChemLabS, despite being previous engagers. An implication is that these teachers are not disinterested in arranging a day out of the classroom, but rather that some other factor has prevented them from attending practical activities. These applicant teachers must be active CHeMneT members who read their newsletters properly and are willing to arrange the visit for the good of their students, by the very nature of the method of the offer. This may be because the teachers have changed schools in the meantime and their new position does not leave time to organise such activities or the management in the new school has a different opinion of out of the classroom learning opportunities. Most likely the biggest cause is the funding challenge. Lack of finance is the most likely reason for these applicants' lack of engagement in practical activities in recent times, rather than any other factors. There is the possibility that the practical activities have no value, but this can be discounted because there are numerous engagers who bring their students year on year and report how valuable they are, irrespective of paying a small cost to attend (Shaw et al., 2010), in particular this regular caffeine extraction activity.

The perturbation experiment was thus successful in attracting applicants for whom funding is a major barrier to attendance. The idea that funding is a major factor stopping schools from engaging in practical activities at Bristol ChemLabS is corroborated by the responses of the teachers at interview. In many cases the perception is that practical activities are expensive although many teachers don't have a real idea of the actual cost per child. Many of the nearby schools that applied for this activity have far less affluent intake than an independent school and many teachers spoke about how they could not ask the students to pay more than £5-£10 for an activity as they would need to pay for it themselves—higher costs would be beyond their students' reach. The full economic cost of a practical day at Bristol ChemLabS is nearer £55 per student.

Table 1. School groups eventually attending Bristol ChemLabS' Caffeine Extraction Day

School Code	Teachers	School Type	Geographic Designation	Choice of Students Attending
School G	Teacher G1 and G2: interviewed together	Academy Mixed (no Post 16)	Town and Fringe	Highly academically gifted students were picked to attend.
School H	Teacher H	Academy Mixed (mixed Post 16)	Urban	School allowed anyone from the Y9 science class to apply, and picked the names out of a hat.
School I	Teacher I1 and I2, interviewed together	Foundation Mixed (mixed Post 16)	Village	Gifted and enthusiastic students picked to attend.
School K	Teacher K	Foundation Mixed (mixed Post 16)	Urban	Whole "triple science" Y10 class as the class was quite small. All bar one student attended.

3. Teachers' Interview Responses and Discussion

3.1 Question: "Why Did You Sign up for This Event?"

3.1.1 School G

Their perception of the value of a practical experience for their students and their desire to give them the kind of chemistry experience they could not get at their school (which has no Post 16 provision) was the first reason. Teacher G2: "We are very keen for students to … go further in their science education. We don't have a sixth form (Post 16 provision), so, we can't provide them with the sorts of experience with, what I would call, "proper chemistry". …We have the sort of apparatus you would expect in GCSE science, which is fairly limited … and although I think we do reasonably well at the GCSE level … if we are trying to enthuse students to go on and choose chemistry at A-level, we can't give them any kind of experience to say, "this is what is going to be like". So this is the perfect opportunity for us to do that for them. The second reason was that the event was fully funded. They would not have been able to afford it otherwise. Teacher G2: "obviously money is an issue. We've received details of these days on many an occasion [but have not been able to attend] … we live in an area where it's very rural, and although you might think that that would mean that families are quite well-off, it's often the other way … a lot of families struggle … to come up with the money to bring … us out [to Bristol ChemLabS] … So we have to prioritise, and when something like this comes up, knowing that it's going to be subsidised, that's a fantastic opportunity and one that we can't afford to pass up".

3.1.2 School H

Teacher H's reasons for signing up included the fact that the event was free and the benefits that she felt her students would gain from being in a university, both in general and, more specifically in terms of seeing the equipment and facilities available in the School of Chemistry. In addition she stated that she had been wanted to bring her students for some time, but that financing the trip had been a barrier. "We've wanted to do one for a while, but … it's just the price was a barrier. And I don't think it's overpriced what you do, [the STF] said it was 27 pounds or something, but we cannot charge students 27 pounds, we really can't afford to do it with any number of kids. So as soon as I heard there were free places, I sort of, return of email, "yes!" … because I think that things you do are brilliant, and I think that there is huge value in taking kids to University … they walk into the lab, and I've tried to big it up, you know, "you're going to a really cool lab and you're going to get to use this equipment at A-level, you're going to get to use this equipment to go and do a degree", and they get quite excited by all the sort of equipment and flasks, you know, all the stuff they've never seen before … and I try make it big and exciting and try and really enthuse them. I think that's really valuable".

3.1.3 School I

The major reason given was that the event was offered and was free, "I just thought yeah let's do it, brilliant! And of course it was free and of course that was a major, major factor (Teacher I1)", and the other was that they were excited about the chance to enthuse and challenge their brighter students. As Teacher 1 states, "it's brilliant to be able to bring your elite kids and give them the chance to do this. There are some very excited kids in there now, doing some stuff they've never seen before"!

Unlike the other teachers, these teachers don't mention the experience of the university itself as being a reason to sign up.

3.1.4 School K

Teacher K is the only teacher in this sample who did not mention the fact that the activity was free as the main reason to attend. He had attended once previously with some of his Year 12 and 13 students who had a great time and so his reasoning revolved around the experience that the students would have; their exposure to the university itself, a chance to raise aspirations for HE, and inspiring them to take science, particularly chemistry, to degree level through giving them an experience of chemistry in a new environment with new equipment they would not see at school.

3.2 Question: How did You Find Out about the Event?

All the teachers found out about the event through the CHeMneT newsletter email. This was the only place this was advertised, and this shows that they read their newsletters thoroughly. It is possible that they could have heard about it through some other network to which a CHeMneT member was linked.

Teacher G1 also mentioned her link with the School Teacher Fellow (STF) (Shallcross & Harrison, 2007a; Shallcross & Harrison, 2007b; Shallcross et al., 2014; Harrison et al., 2016) and the fact that as a school they had previously arranged lecture demonstrations at the school on a more regular basis, but due to funding problems

this was no longer possible, "I … have a link with [the STF]. I know [the STF] quite well, so [the STF] tends to email me and say … whatever … is going on. But we used to have, we used to have a big pot of money that came into school, and it came into school under a thing called the Aimhigher (Passy et al., 2009) ... and all that money has gone. So we could say, "yes! We'll go here". We used to go, we used to do loads of stuff [not necessarily only with Bristol ChemLabS] … and because it's [the money] not there we can't do it. So, I think money is unfortunately, our major issue … I'm sorry to say that, but it is".

3.3 Question: What Are Your Expectations of the Day? Why Are You Here? How Does Coming Here Help Your Students? Does it Help You? How?

This question was asked generally, along with the first sub-question in order to obtain a general sense of why teachers had decided to bring their students and what they were expecting them to gain from the experience. The rest of the specific sub-questions were then asked afterwards if the teachers' answers were not covering both them and their students. The results are reported here in general rather than by sub-question, as most teachers' responses were covering at least the first 3 sub-questions within their answers. The last sub-question, concerning the event being free-of-charge is reported separately.

3.3.1 School G

These teachers spoke about the opportunity for their students to be enthused and inspired about chemistry, and their expectation that the day's experience would help their students to grow in confidence, be inspired to study chemistry or a science at university and get a great experience of practical chemistry they would not have at school. In their opinion they thought this would lead to a better classroom atmosphere and better teaching on their part as their students would be more interested and engaged with the subject. Teacher G2: "I expect the students to go back, first of all feeling more confident about their chemistry … Which obviously helps us in the classroom, with students being more enthusiastic and more confident in what they're doing. And I also want some of them to go back with, just a little seed in their minds thinking, "Maybe I will choose to do chemistry" or "maybe I will end up at University doing that". If you've got only a few students thinking that, then it changes the atmosphere in the classroom … and it spreads … a little bit of enthusiasm will start to spread through a class … and it makes your life as a teacher a whole lot easier because you can … try more things; you can … be more imaginative in what you plan to do, and know that the students are going to lap it up and … throw themselves into it … whole heartedly. So I hope some of these guys will come into chemistry or a science related subject at University in a few years' time".

By way of illustration of the kind of impact attending the day could have on their students, Teacher G1 mentions one of the boys in the class who initially did not want to attend the event, but who was really enjoying himself, "we did have one student [name], who said he wasn't coming, so three females have pressurised him into coming, and his mum did, and then I just asked him how he was getting on and he said: 'I'm loving it Miss' … so, you know, he's now sort of changed his whole attitude even though we did pressurise him to come".

Teacher G2 also mentioned the importance of their students leaving the small town in which they are located and visiting a big city, "I think, one of the issues with living in [name of town] is that a lot of them just never leave … it's very insular … and they wouldn't think of going to university in a big city because big cities are scary, because they're only used to little [name of town] … and just getting them out there … in a reasonably safe way … it just helps to open up their eyes to what is possible".

There is an idea that the Bristol ChemLabS visit doesn't just broaden the students science horizons, but their general ideas about HE, and what's out there for them is broadened too, and that this is something the teacher feels the students will gain from the visit.

3.3.2 School H

Most of Teacher H's expectations for the day were related to her students. As a scientist herself (prior to teaching) and a veteran of many Science Technology Engineering and Mathematics (STEM related school trips, her expectations for herself were minimal, "not much", with her perceived role as simply to "facilitate the kids", although she expressed "looking forward to seeing the lecture demonstration". When then asked about whether she thought that the kids' excitement helped her as a teacher, she said "a little bit. I think our kids are fairly motivated anyway", showing the difference between the circumstances of School G and School H.

School G's teachers seem to feel they are fighting against a small town mentality, but this doesn't appear to be the case with School H. Teacher H's hopes that the day will enthuse students and give them an experience of chemistry that they cannot get at school. "It's a really good opportunity for them to, sort of, burn off some of that enthusiasm a little bit and feed it. And for them to get to see, to get to use some stuff and do a real proper

experiment and see what practical chemistry is all really like because we are very limited in school in what we can do". Like Teachers G1 and G2 she also hopes that the experience will inspire them to study science and inspire them about university in general. As her students are not from a small town, it is less of a horizon broadening experience for them, in the sense of them experiencing the city, but she values the exposure to a university that the visit gives them and expects that this will have a big impact on her students. "I think the most important thing is them coming to university and seeing what university is. You know, they live in Bristol, live in Bath. They know the names of the universities … they might have been around. But there's a big difference with coming in, and I mean their eyes pop out of their heads when they come in to here … I had a load of kids up at [Name] University last week, the week before, doing genetic engineering. Similar thing, big teaching lab … that just about did their heads in, I mean that's just a teaching lab not even a research lab … So that's what they get out of it".

Teacher H goes on to speak about the enthusiasm that trips like this create, and in the context of getting bright children to choose science, she says, "I think the people who it really helps are them [the students], and if I put myself in their shoes … You know if I had had the opportunity to do this, when I was a school student, I would have been so excited. I'd have exploded! (Laughter) … It just makes them interested in things and enthusiastic. These kids are, you know they're bright, they are multi-talented, they could do lots of different things … what you want them to do is science. And again get bright girls into science".

Although the teacher says that the main benefit is for the students, you could argue that her students choosing to do triple science in Year 10 is actually a benefit for her—she says she wants them to do science, so her expectation that they will be enthused enough to make those decisions is an obvious expectation she has that the day will also benefit her, although she doesn't seem to be aware of this. She made the point that not everyone in attendance would necessarily do a degree in chemistry but that keeping them interested and non-excluded due to ability would enable them to consider training for related careers like science technicians. Therefore, their attendance benefited children of all abilities as long as they wanted to attend.

3.3.3 School I

Like the other teachers from school G and H, School I's teachers were expecting the day's event to inspire and enthuse their students, "we are here, because … these are our elite students, and we want to excite them in science, and we want to excite them especially, in chemistry (Teacher I1)", and, "It's like an inspiration thing, isn't it (Teacher I2)?" Teacher I2 added that their time at Bristol ChemLabS would help anchor science in real-life, "it puts science into context … because science lessons can be so abstract (Teacher I2)", "and because there is a bunch of grubby teabags there, that they are working on, it's real-life (Teacher I1)".

The teachers expected their students would have a science experience that they would not be able to get at school, "they've never seen some of this equipment before. And it's so different to what we have. It's really interesting for them (Teacher I2)", that their ideas about chemistry would be expanded, "they would not have known any of the stuff [the STF] just told them outside (Teacher I1)", referring to the STF's welcome and safety talk where he explains about the research happening in the School of Chemistry, the value of the equipment that they will be working with, and that their horizons would be broadened in having a greater understanding of what university research looks like as well as challenging their brightest students. It was these effects on their students they felt would be most helpful to them as teachers, particularly in convincing students to study chemistry at A-level, "we want to excite them especially, in chemistry. Selfishly, you know … we would love it if lots of these were turned on to chemistry and did chemistry A-level in 2016 (Teacher I1)".

When asked how they thought the day would be helpful to them, Teacher I1 answered, "Inspiring them like that … it helps us because, it really is the same answer, isn't it? ... it puts science in a real context … it makes them think … it'll be something that we can refer back to, I mean we'll take loads of photos, you know, put them on the school website, and use them in lessons too ... if we can". Showing an expectation that the effects on students will be directly applicable to the classroom and that the event will be referred back to and useful to the teachers to extend and reinforce their teaching.

3.3.4 School K

In the first instance Teacher K focuses on the enjoyment and inspiration he hopes his students will get out of the day. It is an opportunity for them to work in lab with "equipment they don't normally work with … in an environment they are not used to working in", and a chance to experience "what it would be like if they wish to study science at university, particularly chemistry", as well as generally inspiring them to think about university, "they may not have the aspirations yet to come to university and hopefully a day like this might inspire them".

Uniquely, Teacher K sees the value for himself in attending an event like the practical day, as creating and maintaining a link with Higher Education, as well as inspiring his students to take chemistry at A level (UK national examinations taken typically at 18 years of age), "it is good to keep in contact with higher education, particularly with my A-level students … and it's good to have that link with the GCSE students … hopefully they're thinking about the future a little bit".

3.4 Question: What Did the "It's Free" Aspect Trigger? Or Was It Some Other Aspect That Had the Most Impact on Your Decision to Apply?

3.4.1 School G

For school G, the fact that this event was free was the biggest trigger for their application. The date was also convenient, as the teachers had few classes that needed covering, but Teacher G2 stated that they would have attended nonetheless, although other, "cheaper" teachers may have accompanied the students if he had, had a full day's teaching load that day. "I think we would have accepted even if we had needed five periods of cover … [although] it might not have been me that came".

Teacher G1 added that she had been "squirreling" money away where she could with school finances for trips and the money she had saved paid for her and Teacher G2's cover for the day.

Teacher G1 also mentioned that the limited number of free places offered to each school ensured that they could all fit on the school minibus which had kept their transport costs down, and that they had chosen their brightest students to attend as they felt that they would get the most out of it.

3.4.2 School H

Teacher H was very clear that the date was a not an issue because her school was so supportive of STEM related trips and activities. The fact that the activity was free was the deciding factor. "The date wasn't a problem because … I consider, and the school considers actually, but I consider this outreach to be really important. I'm supposed to run two trips a year and I've run … This is my 13th! (laughs) … anything that comes up, I think that it's really important and so we will just deal with the dates … I've had outreach on consecutive days and on the same days before. We can do that we can push that. It's not a problem … and I will push hard for it. But, the 'it's free' was all-important. We couldn't have done it if it wasn't free, because we do not have £27 per student … And neither do the kids. And, you know, when I arrange trips I try and get it down to about a fiver, because then it's inclusive".

3.4.3 School I

The fact that the event was free was a major factor influencing their decision to apply. Teacher I1 said, "The free bit was massive, and I replied within a minute (Teacher I1)", but the choice of day was also part of the decision making process as it was the last day of school when students are essentially on holiday and teachers wouldn't be missing too much teaching time.

3.4.4 School K

Teacher K seemed less affected by the fact that it was a free event than the other teachers. He said it was a good thing which opened it up to everybody, but it wasn't the main thing that had affected his decision to bring the students, who, he said were all very keen to attend, which surprised him. Being a Bristol-based school, travel costs and organisation was not a factor—all the students had got public transport to the University, which he said, "makes it a bit more of a day for them, [makes them] a bit more independent … and the fact that it's free and they can just turn up is great". He felt a small cost would not be a problem, that the majority of them would not have minded paying something towards the day. He also was of the opinion that a visit to Bristol ChemLabS could be funded or at least subsidised by the school, "there are funds available … I think if there was an opportunity to do a trip like this it could be subsidised [by the school]".

3.5 Question: What Would You Flag as the Barriers to Coming out to Bristol ChemLabS with Your Students?

3.5.1 School G

Money was the biggest barrier: the cost of cover for the teachers, the cost of transport (coach costs), and any cost for the activity itself. Secondly, interesting the students in attending, and to see beyond the small town in which they live was also cited. The teachers felt that their school was quite supportive about trips and that their paperwork and risk assessments to do with any external trips had been streamlined and made simple for them with work done by an administration staff member who sends out the permission letters and chases up money from parents. This support had come about since a change of head teacher.

3.5.2 School H

Being nearer to the University of Bristol than School G, transport costs were not as prohibitive on this particular occasion, but the barriers that Teacher H mentioned were all financial. "Cost. Yeah it's the cost. I mean we have a little bit of trouble getting students here. Students have had to get themselves here because we don't have a minibus … I think that's being rectified. I think we are getting one … If we had a minibus it would be even easier because I'd just bang them all in the minibus and go. But … it can be difficult getting to places sometimes only because of the cost of travel and transport". Her school was, as indicated, incredibly supportive of trips and events in science, so there were no barriers there. Unlike with School G, Teacher H was able to make the trip open to anyone who wanted to come, and didn't choose students, or have to convince them to come. In contrast she picked names out of a hat, and not every student who wanted a place was able to attend because of the numbers limit.

3.5.3 School I

Finances are the biggest barrier to attending, "the biggest barrier to us coming, is not the health and safety forms and the like, because the school's got that all sorted; but it's having to pay for my lessons … to be covered … and the charge for my three lessons today, would be £105 (Teacher I1)". He goes on to say that because of the timing of the day the Year 11s, 12s and 13s are on holiday, which cut down on the number of lessons which needed cover, but Teacher I2 adds, "the last trip I went on that was during the week, it was over £200 between the two teachers, added to the cost … [of the trip]". The cost of cover must be charged to the students or to the school which really means that it comes out of the Departmental budget, already oversubscribed, and greatly adds to the cost of the trip for each child. Thus, without a free place, Teacher I1 stated that they'd be unlikely to come. With the small number of students, fitting in a school minibus, transport costs were considered negligible. For small numbers this was not a significant barrier to School I, which is not as far from Bristol as School G where this was noted as a significant barrier.

3.5.4 School K

Teacher K's responses differ slightly from the responses of the other schools' teachers. For him, "the only real hurdle is the health and safety forms". His other problem was that his students could be, "a bit apathetic sometimes". The group of Year 10s he brought with him on the day had been very keen, but the older students he had brought before were, "just not interested", a similar barrier to that cited by Teachers G1 and G2. Transport was not an issue, but it could become one if he were to bring a larger group, or a group of younger children. On being asked about cover for the teacher she said that since the school had a dedicated Cover Supervisor, cover was not an issue.

3.6 Question: Is Making the Activity Free, Enough?

School G's response to the barriers they faced in arranging external trips shows that the cost of a trip, both to the school and to the students, is quite a significant challenge for them, even with the activity made free. Transport and cover costs for teachers were the significant financial worries, which when coupled with paying for the activity itself meant that ordinarily, trips to Bristol ChemLabS were impossible for them. Making the activity free enabled them to consider coming, and the small numbers meant that transport costs were negligible. Making the activity free had moved the trip from the realm of the impossible to a possibility, but it still cost them to come, and required some financial sacrifice on the part of the science department.

Teacher H never mentioned the cost of cover as a problem, but the cost of transport could be problematic, especially as she would be moving to a new school, which was further away from the university. She said, "Yeah [it is enough] … Possibly, you know, if someone could contribute something towards transport … Because coaches are so expensive ... we've got science specialism [status] so we can usually afford to put 100/150 pounds into a visit … and I usually … try and get it down to about a fiver for the kids because most people can pay that … We will put in a bit, as a Department, but if it goes above that then we just can't go".

The fact that the activity was free made it more accessible to the school although the cost of transport could still be a barrier to attendance. Teacher I1 said that in his opinion there was not much more we could do other than sponsoring the cost of the day, and he felt that the event was so worthwhile that he was bringing his Y12s later in the year for a non-funded trip, "well I think it's fantastic. I don't really think that we can expect you to pay cover, because that's just a step too far. So I don't think that you [Bristol ChemLabS] can actually do more. I've been inspired by this to bring a bunch of Year 12's through in July. We do, I think it's £27 a head, and we are going … to pay half of that from the department budget, which is going to take a lot away from us, but it's worth it … So I'm going to have to ask them to chip in £15 a head ... which I don't mind so much at sixth form".

Teacher I2 adds that at that stage many of them have jobs and so are able to pay for it themselves. So cost becomes less of a barrier in Post 16, both because students can pay for themselves, and also because at that stage they have chosen to do chemistry and will therefore get a lot out of the day. Teacher I1 confides that he has asked colleagues to do favours for him to look after his classes on this occasion to avoid having to pay for cover, which would add another £105 on to the total costs. Teacher K said that what had really helped him, both in wanting to come himself, and getting his students interested, was that he had been before and knew it was a "good day" could therefore "sell" it well. He thought teachers needed to be shown what it was all about to convince them of its value. He thought some teachers might think, "mmmh I'm not too sure it's going to be worthwhile for my students to do, until they actually know what it is like". This is a salient point, because if he felt this could be an issue even when the event was free, how much more might teachers need to be sure of the value of an activity when they must arrange, and possibly fight for the funding to attend.

4. Summary

4.1 Finances

Finances seem to be the biggest issue for the majority of the interviewed teachers. The nearest school had the teacher least concerned with cost, whereas the school furthest away spoke about it throughout the interview. Although this may be related to the distance away from the University of Bristol, it is potentially coincidental, as funding and school support for trips varies from school to school.

Transport costs are certainly a factor affected by the distance that must be travelled, particularly for larger groups, where a coach must be hired, and therefore the cost implications for schools and teachers can be massive even with the activity itself being free. A picture emerges of some teachers needing to scrimp and save and make sacrifices from departmental funds in order to be able to bring their students to outreach events, especially with regard to paying for their teaching cover in the classroom, while others don't seem to have as much of a problem.

4.2 Student Benefits

The perturbation study participants tend to emphasise the value of the inspiration they may get in chemistry and science, with less focus on Higher Education aspiration, or the growth and development this brings.

The way teachers view the benefits of the day for their students are consistent with Shaw (Shaw et al., 2009). In her study, before participating in an outreach activity, teachers say they want their students to have a science learning experience, and they focus on learning and understanding, the effects they expect. However, afterwards the effects they mention are to do with inspiration and motivation rather than understanding. In other research (Glover, 2016) long-term engagers with Bristol ChemLabS have experienced this over many years, and have started to view outreach as an extension and inspirational activity rather than as a curriculum support and learning initiative. The perturbation study teachers have not had the long-term experience in practical events, and they are being spoken to during an event rather than afterwards. Thus they focus on science-specific outcomes, although they tend to be inspiration-based science-specific outcomes rather than understanding-based ones, which is where this study differs from that of Shaw (2009).

None of the perturbation study teachers expressed an expectation that their students would gain in chemistry or science knowledge and understanding through participating in the event, but many teachers did express their desire that their brighter students would be challenged and required to think differently than they would at school. Although these differences are very slight in terms of how teachers view the potential benefits for their children, the differences in terms of their view of the benefits for themselves are more apparent.

4.3 Benefits for Teachers

Perturbation study participants had a less nuanced view of potential benefits for them as teachers. The benefits they cited were twofold—more engaged enthused students meaning more enjoyable, relevant, exciting teaching, and enthused students deciding to continue with science at A-level, or choosing triple science in Year 10 for their General Certificate of Secondary Education (GCSE) examinations at aged 16. There was no sign of the kind of empowerment related changes that are seen with the long-term engagers. This must certainly, as their ideas of benefits for students, be influenced by the fact that only one of the attending teachers had previously attended a practical day. While some are quite regular engagers, the activities they have been involved in have been lectures and the externally sponsored competitions and not day-long events involving practical activities and taking place at Bristol ChemLabS.

Teacher K was unique in his response as he was the only one to mention links with the HE institution as a benefit to him, and he was also the only one of the teachers who had brought his students to a practical day

before. While he did not speak of a relationship with the STF, as such, he did speak at the end of the interview about the fact that he was moving schools and wanted to make sure that the link continued for him at his new school. He also indicated that he was handing all the information over to another teacher at his school and was getting his colleagues to sign up to CHeMneT. He was also the only one to speak about value, rather than simply cost.

4.4 Value Versus Cost

Teacher K's statement that teachers will only bring their students to activities at Bristol ChemLabS once they know how valuable they are, and his use of his own experience as an illustration, raises an interesting point. His desire to sign his students up to the free event being largely motivated by his knowledge that it would be worthwhile, rather than by the fact that it was free, leads to questions about "Value" as assigned by teachers and students to the activities Bristol ChemLabS offers. When the value is equal to or outweighs the cost whether in time, effort or finance, then teachers will continue to engage, and will remain convinced of the importance of these activities in their teaching of chemistry. If the cost outweighs the value, then they will find other activities or change their engagement type to arranging events at their schools because they reach more children with fewer costs.

Thus there is a constant struggle between value and cost. Teachers have genuine problems with funding trips, but when convinced of their value, are often willing to make sacrifices in their budgets and time to arrange trips. For example Teacher K, having come previously made him want to come again, so he took advantage of the free event. For the others it was their first time at a laboratory day and while they were worried about the costs associated with a day in the labs should they have to pay in full, they were talking about ways they could subsidise trips if given a little help, and asking their students to pay a small amount each—which seems to indicate they had begun to be convinced of the value of the event and were willing to pay the associated costs as far as they were able.

While most of the teachers had asked the STF what the cost of the day was per head, and had decided this was too much to pay, especially for their younger students, Teacher I1 went from saying that unless places were funded they'd be unlikely to come, to saying that he had been inspired by this free event to book his Year 12s in later in the year. He felt because they had chosen chemistry they would be willing to pay more and the school chemistry department was sponsoring the other part of the cost. For his older students, the value outweighed the cost of bringing them.

The fact that School C pulled out of the event at very short notice, and that this has happened with schools before at free events according to the STF and previous Director of Outreach, seems to indicate that there is a connection between the financial cost to the school and the value that they assign to an activity. Making an activity completely free may in fact undermine its value, although schools have genuine problems financing and funding trips which could be addressed in a more transparent manner.

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