Research Report 2013

"How can teachers and musicians work together to improve the learning of KS3 students in STEM subjects?"

Contents

Executive Summary

This report presents qualitative research findings from a Nesta[1] funded programme undertaken in partnership with Sage Gateshead[2] and four secondary schools in North East England between September 2010 and November 2012.

The programme involved community musicians, from Sage Gateshead's Learning and Participation team, working alongside STEM[3] teachers from each of the four schools to devise and co-deliver activities that enabled them to explore the following question:

'How can teachers and musicians work together to improve the learning of KS3[4] students in STEM subjects?'

In doing so they explored a range of new approaches designed to motivate the learning and inspire the engagement of students.

195 students, 12 teachers (11 science teachers and 1 performing arts teacher) and 4 community musicians were involved in the programme.

[1] Nesta (National Endowment for Science, Technology and the Arts) is an independent charity with a mission to help people and organisations bring great ideas to life. http://www.Nesta.org.uk/

[2] Sage Gateshead is an international cultural organisation and venue dedicated to performance and participation in music. http://www.sagegateshead.com/

[3] STEM is a term used to describe Science, Technology, Engineering & Maths subjects in secondary schools.

[4] KS3 is an abbreviation of Key Stage 3. This term is normally used to describe Years 7, 8 and 9 of secondary school education when pupils are aged between 11 and 14.

This report is based on findings generated from semi-structured interviews that took place with teachers, musicians and students involved in the programme. The findings were considered in relation to relevant learning theories in order to add further insight into the results.

This research aims to support teachers, school leaders, teacher training agencies and policy-makers to innovate and advance teaching and learning practice in STEM subjects at KS3. Many of the findings are applicable to other subject areas and year groups.

Summary of findings

An analysis of the data revealed a number of significant, often overlapping themes, which have been considered and distilled into four key areas for discussion in this report. They are as follows:

1. Collaborative relationships

Students believed that working in small groups led to better learning outcomes. They also said they wanted more open and active group learning in school.

The emphasis on collaborative group work in the projects led to a shift in classroom dynamics. Increased student agency and voice, and changes to teachers' roles and their relationships with students were evident in some projects. Students expressed how much they enjoyed it when teachers became participants and collaborators in the classroom activities. There was further evidence that the fun and collaborative elements of shared learning were important to teachers as well as students.

Some clear contrasts were experienced between the control and management required for working with large groups and the relationships that could develop between teachers and students in small, informal groups.

2. Choice-making and ownership of learning (and motivation)

There was evidence that where choices were given to students and outcomes were more open-ended that they were more engaged. Giving students the choice of who they worked with or what they did was a positive motivating factor, sometimes supporting students to take risks and accept challenges.

The trust shown by their teachers in giving them more choice and responsibility was enjoyed by some of the students. Others enjoyed the opportunity to express themselves more freely and bring wider strengths and talents to bear on their learning. However, there was also some evidence that a minority of students found this approach de-motivating.

There was also evidence of increased motivation, enjoyment and ownership of learning where the focus was on exploring alternatives as opposed to heavily proscribed and predetermined methods and outcomes.

3. Active, multi-sensory learning

Students often expressed the view that physically doing something was 'more fun' than the more theoretical (out of a textbook) and teacher-led approaches to learning. They linked fun and enjoyment to the idea that doing things practically via experiment or participatory activity also made it more memorable and helped the learning to *'stick'*. They also made links back to the benefits of being able to construct understanding together through interactive group work.

Teachers and musicians also reported the benefits of active, multi-sensory approaches in helping students to connect with their work and learn in a different way.

4. Challenge, risk and the unknown

There was evidence that anxiety over risk was eased by trusting relationships. This was apparent in smaller groups where teachers could model risk-taking more easily. This feature also links back to their collaborative group work in that learning challenges were better met by individuals pooling their understanding and experiences.

There were risks and challenges for project teams too, including the challenge of making the best use of limited time and, for the teachers in particular, the risk of time lost in *'getting through'* the science curriculum.

Affective issues permeate all four areas, which participants believed at times had powerful emotional and cognitive consequences for learning.

Summary of conclusions

The following conclusions have been drawn from an analysis of the findings:

1. Seeing teaching and learning practice through a different lens, in this case from the perspective of community music educators and KS3 science teachers, resulted in the provision of motivating and stimulating activities for students. This process promoted greater understanding of the different approaches adopted by the practitioners and encouraged greater experimentation in classroom practice.
2. The project reinforced the significance of small group activities where more active, embodied and autonomous learning can be supported. In these groups shared dialogue was more possible, and positive relationships and confidence were supported. These active group contexts, at times injected with the excitement of performance,

mirrored the strategies associated with musicians' work in less formal contexts rather than those of schools.

3. This study reaffirms the importance of motivation in learning and draws parallels with the pleasure and excitement related to making and performing music and the excitement generated by science communicators[5]. The data suggests that it is an enthusiasm for science (rather than the being a scientist *per se*) that is critical to securing the engagement of students in science learning, and that potentially activates their interest in pursuing science at a higher level in the future. It also suggests this approach could be emphasised and enacted more regularly in the science classroom.

4. Delivering more student-led, enquiry-based activities caused teachers to feel concerned about whether the students were gaining the knowledge required of the curriculum.

   Practical challenges, including finding appropriate work spaces and time for planning and reflection, were also features of a number of the projects. Such challenges were found to be alleviated as a consequence of high level support and active engagement of senior school leaders.

5. The strategies that the teachers and musicians experimented with are well-known and established in good practice literature and in theories of learning. The evidence generated from this study reiterates the impact that student-led enquiry, practical exploration and staff/student ratio has on the quality of learning and relationships in classrooms.

[5] Science communicators include 'personalities' such as Brian Cox but also teams working in science centres and museums who present science to groups of young people and visitors on a daily basis.

Summary of recommendations

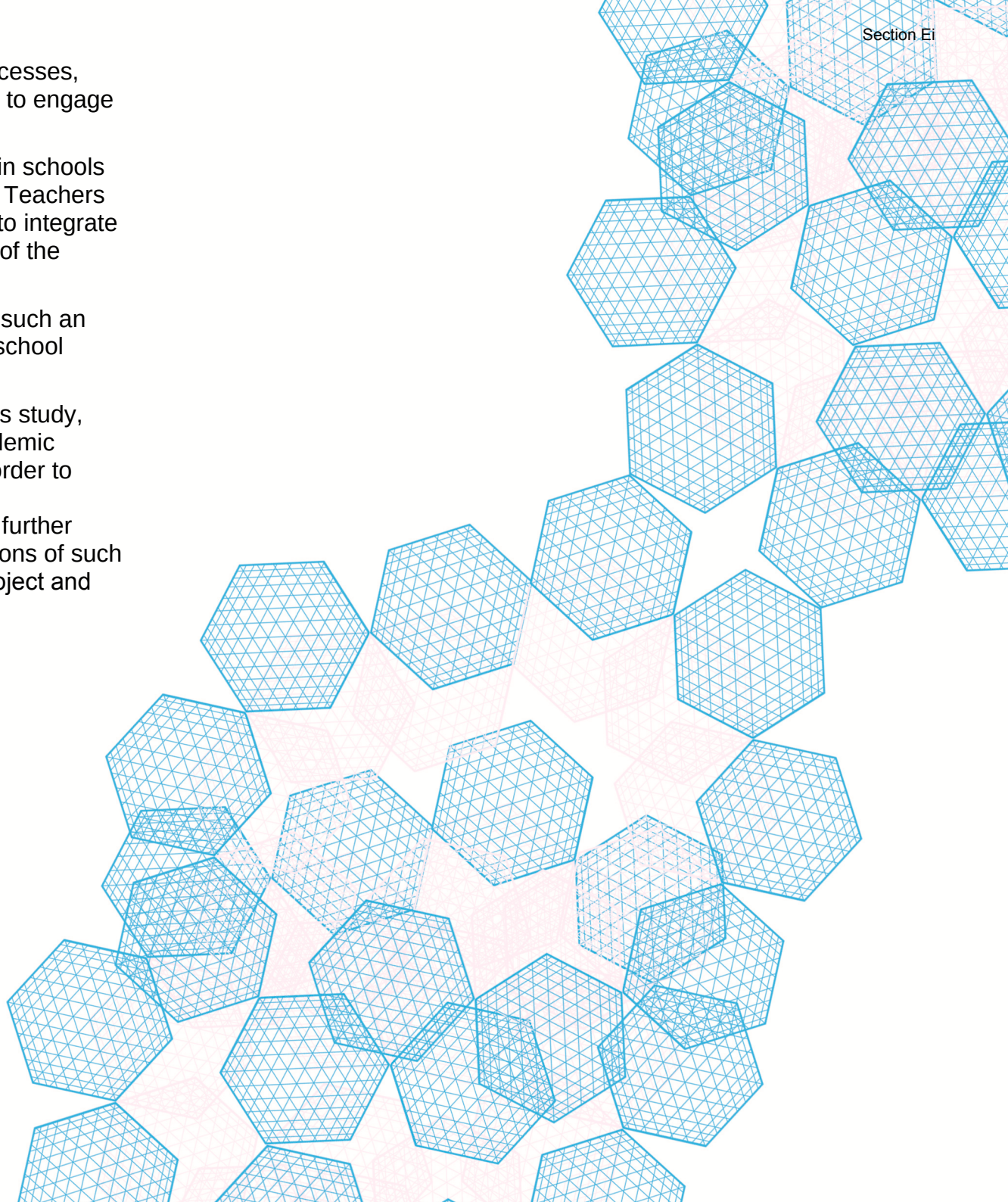
The following recommendations have been made in order to support the advancement of teaching and learning practice in relation to STEM subjects at KS3:

1. Schools should disrupt (invigorate or revitalise) established practice (whatever is regularly practiced) and generate new insights by creating opportunities for other subject practitioners from outside the school setting[6] (with a strong track record in learning and participation) to work alongside teachers as a means to innovate, stimulate and inspire new approaches to delivery in the classroom. Consideration should also be given as to how this approach could be utilised as a feature of CPD provision for teachers.
2. Schools should use small pupil-led enquiry teams to build relationships with teachers and enable students to share their learning experiences.
3. Teachers should encourage active engagement with learning by introducing more ‘hands on’ exploration or making processes into lessons. This will help students’ engagement with the subject and turn abstract ideas into more memorable experiences and knowledge.
4. Connected to the point above, teachers, school leaders and policy-makers should consider how to use a range of techniques to create opportunities for students to be active, rather than passive, participants in the learning process and think about the implications in relation to assessment methodologies.

[6] This might include practitioners from the arts and cultural sector as well as science communicators from museums or science centres; the critical factor is that they are external agents.

5. Teachers should use active collaborative learning processes, which support opportunities for challenge and debate, to engage and build students' confidence in the subject.
6. School leaders need to create a culture of innovation in schools that is less risk adverse and more open to innovation. Teachers need more strategic support, training and permission to integrate these new approaches into the core work and culture of the school.

   Policy-makers should ensure the benefits of adopting such an approach are fully understood and recognised within school assessment processes.
7. All stakeholders should consider how lessons from this study, consolidated with further evidence from previous academic research, can be actively promoted and endorsed in order to encourage greater application within the classroom. Consideration should also be given to commissioning further research that would consider the longer term implications of such approaches in relation to attainment and students' subject and career choices.



1. Introduction

This report presents qualitative research findings from Music Lab, a project funded by Nesta and developed in partnership with Sage Gateshead involving four secondary schools in North East England between September 2010 and November 2012.

The project was established to explore the impact and implications of new collaborative approaches to learning involving STEM teachers and musicians from Sage Gateshead's Learning and Participation team. Their aim was to find new ways to deliver aspects of the STEM curriculum that had the potential to motivate learning and inspire students to remain engaged in STEM subjects at KS3 and beyond.

During the course of the programme the musicians and teachers worked together to devise and co-deliver a range of lessons and activities that tested their ideas and explored the following research question: *'How can teachers and musicians work together to improve the learning of KS3 students in STEM subjects?'* This question was devised by the teachers and musicians in collaboration with the Music Lab Advisory Board[7].

Following the initial period of consultation it emerged that the majority of teachers (11 out of 12) involved in the programme were science teachers. One performing arts teacher also participated. Consequently many of the references in this report emphasise connections to science rather than the other STEM subjects - technology, engineering and maths.

The findings, associated conclusions and recommendations have been presented to support teachers, school leaders, teacher training agencies and policy-makers to innovate and advance teaching and learning practice in STEM subjects at KS3. Practitioners will appreciate that many of the findings are relevant to teaching and learning practice across other subject areas and year groups.

[7] The Music Lab advisory board, made up of experts from the field of community music and science education, was established to inform and support the programme. See Acknowledgements for details of the membership of the board.

1.1 Context and background

The initial incentive for the programme was Nesta and Sage Gateshead's mutual interest in understanding the implications of combining two different pedagogical approaches as a means to improve the learning of KS3 students in STEM subjects, i.e. those regularly (not exclusively) applied in the teaching of science subjects in schools and those being developed by Sage Gateshead in the context of community music practice.

This interest was fuelled by the following factors:

Science context

The ongoing future advancement and application of science knowledge, which is a key driver of technological and social wellbeing, is dependent on instilling understanding and interest in the community as a whole and the related take-up of science subjects at school.

Over the past two decades successive UK governments have made significant investment in school education in order to improve levels of interest in science. Although it is difficult to clearly identify direct causal relationships, there is evidence that indicates improvements in the uptake of science subjects (National Audit Office, 2010). Positive trends in the overall attitude of young people to science (The Wellcome Trust, 2010; NFER, 2011), or at least particular aspects of science, has also increased.

However, recent findings from the Aspire Project (2013) underline the reluctance of young people to see themselves as scientists or to follow careers which involve science.

Finding ways to drive up interest and engagement in science subjects in schools will remain an important priority not only for reasons of innovation

and economic growth but also from the point of view of accepting science as an integral part of our cultural heritage.

Science curriculum

Several revisions to the science curriculum designed to reduce the overload of content and increase the emphasis on setting scientific ideas in 'real life contexts' have also been introduced since 1989. The current coalition government also deems change necessary. Plans to reform the schools education system, as set out in The White Paper, *The Importance of Teaching* (Gove, 2010) published in 2010, are progressing. This includes the introduction of a new curriculum in 2014, followed by an overhaul of GCSEs and A Levels from 2015. The impact on the science curriculum at the time of writing was still unknown; however, initial indicators would appear to confirm clear plans to separate 'what should be taught', which are set out in the National Curriculum, from the 'how it should be taught', which is for teachers to decide.

Despite the fact that this may appear to signal greater freedom for teachers, the fact is that there has never been any statutory requirement as to how a subject should be taught. However, influence of the assessment arrangements and the associated accountability measures, which led to school 'league tables', has been such that schools have felt more and more restricted in the way they approach subject teaching, particularly at Key Stage 3 and 4.

Cultural learning context

Engagement in culture as a route to more engaged learning is a well-established practice in many schools across the UK. The key research findings from the Cultural Learning Alliance published in *The Case for Cultural Learning* (2011) highlight some of the main benefits and impact of this practice:

1. *Learning through arts and culture improves attainment in all subjects.*
2. *Participation in structured arts activities increases cognitive abilities.*
3. *Students from low-income families who take part in arts activities at school are three times more likely to get a degree.*
4. *The employability of students who study arts subjects is higher and they are more likely to stay in employment.*
5. *Students who engage in the arts at school are twice as likely to volunteer and are 20% more likely to vote as young adults.'* (Cultural Learning Alliance, 2011, p. 1)

Sage Gateshead

Since opening in 2004, Sage Gateshead has built a national reputation on its commitment to high-quality participatory practice as well as performance. The organisation has continued to strengthen its position in the field by underpinning its entire participatory programme with a strong pedagogical approach and commitment to the notion of dialogic learning where listening to participants and their interests is critical in designing learning to support their progress.

This manifests itself in the teaching and learning practice adopted by Sage Gateshead musicians where particular emphasis is placed on active participation and dialogue as a mean to engage participants in music and learning.

See Appendix 1: Additional context reading for more information on the background to this programme.

1.2 Delivery approach

Music Lab was led by Sage Gateshead's Learning and Participation team and supported by the Music Lab Advisory Board. Four secondary schools with a track record of working with external partners to develop teaching and learning practices were selected to participate in the programme. Four musicians from Sage Gateshead Learning and Participation team were appointed to work in collaboration with teachers, mainly from STEM subjects, in each of the four schools. These teams were responsible for co-devising and co-delivering a cycle of three projects in which practical strategies and approaches for enriching learning in KS3 STEM subjects were explored. This involved combining insights and approaches from science teaching and community music practice. The cycles enabled insights to be captured and incorporated into the programme as it progressed.

By the end of the programme, 4 community musicians, 195 students, 11 science teachers and 1 music teacher had been involved.

Further details about the schools and individual school programmes can be found in Appendix 2.

1.3 Research approach

The research aimed to capture and put into context the experiences and reflections of the project participants. Their individual school enquiries were directed in response to the following question:

> *'How can teachers and musicians work together to improve the learning of KS3 students in STEM subjects?'*

This question was devised and revised by teachers and musician working with members of the Advisory Board.

See Appendix 3: Defining the enquiry and understanding the brief for further information on the development of the research question and delivery of the brief.

Generating data

The research used qualitative methodologies to generate findings. This involved using semi-structured interviews designed to encourage teachers, musicians and students to reflect on the work they had undertaken and share their perspectives on their experiences. Between September 2011 and November 2012, 12 teachers, 4 musicians and 195 students from the four project settings were interviewed at the end of each project cycle by members of the Flo-culture team in 27 separate interviews. This generated over 15 hours of audio recordings. These recordings were then transcribed and used as the primary source of data for this research report.

Analysing data

Grounded theory methodology was used to analyse the transcribed interviews. This allowed significant and common findings from across all four school programmes to be identified and considered in relation to relevant theories on learning, policy and practice.

See Appendix 4: Research methods for further information on the research approach deployed.

2. Key findings from the interviews

This chapter sets out the key findings from an in-depth analysis of the transcribed interviews. Rigorous analysis of all the data produced a number of significant, often overlapping themes, which were further combined and refined into four key areas for discussion which have been considered below:

2.1 Collaborative relationships

Of all the themes the significance of collaborative relationships appeared to be the most consistently and clearly evidenced, and accorded with the social constructivist literature and the literature on group work and interaction (Vygotsky, 1978; 86; Day et al 2008; Muijs, and Reynolds, 2010; James & Pollard, 2006). Although students were not asked any direct questions about shared or collaborative learning, it was the most commonly referred to theme in their interviews. According to the students, when working in groups they could pool and share their ideas and work things out together, which they believed led to better learning outcomes:

> *'[…] if you just sit there, independently, answering questions and all that, it doesn't give you much confidence […] when you're in a group, you talk and negotiate with the members of your group and ask them for help.'* (Year 8 boy, School 2)

In contrast, the approach where *'[…] you got to write, sit down and just put what you think yourself'* was seen as a poor alternative that did not support understanding or instil confidence, though some students thought this was a more legitimate approach in some subjects than others. Nevertheless, it was clear that students felt that their learning was better supported in small group situations. This is in accordance with the work of Muijs and Reynolds (2010), cited in a recent review (Rowe et al, 2012) mapping research reports on good teaching:

> *'Pupils' learning within a group situation was said to be greater than that afforded to pupils working individually as a result of their interactions in that group […] a social constructivist approach where groups construct shared meaning and knowledge.'* (Rowe et al, 2012, p.10).

One of the teachers involved in School 4's project[8], where science teachers learned to play the steel pans, also reflected on the quality and intensity of their own group learning experience, contrasting it with the normal experience of a child in a classroom situation:

> *'You do have to work a lot harder and I always felt really exhausted when I got home, mentally, because there's that kind of inter-dependence, whereas in a classroom you can hide and you can disappear a little bit.'* (Science teacher, School 4).

Active learning

When students were asked what they felt would improve teaching and learning not only in science but across other subjects, the most common response was more open and active group learning. In making this point, one Year 8 boy said he would like more opportunities for interactive ways of working, like they have in music lessons with five or six people in a group making music together.

Most of the students interviewed in School 1 emphasised the purposeful and inclusive nature of the small groups that were the foundation of the second cycle of their project. Some commented that not everyone was extrovert enough to perform on stage but that the 'support' roles (i.e. stage setting, cueing, etc.) taken by the others were just as valid and important to the success of the whole group. Some talked about some of the frustrations they encountered during the Cycle 2 'performances', but they also talked about

[8] Please note that details about each of the school projects can be found in Appendix 2.

how they were able to solve problems together, which then increased their enthusiasm further.

Evidence suggests that the competition element had been a motivating factor in that regard, generating excitement between the groups and consolidating a sense of the importance of working collaboratively. Positive peer pressure and momentum pulled along some of the more reluctant learners, making it harder for them to choose not to participate:

> *'[…] there was quite a big difference because some people are normally just sitting, being really quiet and they won't put their hand up or anything. But when it came to this, everyone had their own ideas and everything got done. No-one's ideas got left out.'* (Year 8 girl, School 1)

> *' […] I saw everybody working hard to do these things as best they could and I thought I might as well just […] for my exams.'* (Year 8 boy who identified himself as a reluctant learner, School 1)

In School 2 during the 'inquiry-led' sessions in Cycle 2, there was some soul-searching amongst the adult participants regarding the relationship between collaboration and competition, as their project drew on both simultaneously. They were not entirely comfortable with the competition element, yet it did appear to have a positive effect on the level of engagement of the students.

The musician spoke about the arguments that ensued when the young people assessed the success of their own experiments at the expense of the others, which they 'marked down'. The musician wondered whether the passion that was generated was down to the fact that the experiments involved making objects and whether this process of making had caused the students to invest emotionally in them.

The musician who was working with School 4's teachers also saw evidence of informal learning support mechanisms within the group, stressing the supportive relationships being created through the collaborative tasks:

> *'They developed coping strategies […] so J and C would […] make eye contact so that they could help each other get through and they would get in that bond that they had within that.'* (Musician, School 4)

Changes in teacher behaviour

The relationship between teachers and students changed in the Cycle 2 investigations at School 1 as the groups were given control over the content and form of their performances. In this context teachers became facilitators of the process. Some of the students who were interviewed said they enjoyed the responsibility and the trust the teachers had shown them, and hinted at the potential for relationships with teachers being on a more open and collaborative footing:

> *'I think it took a lot of trust from the teachers to believe that we would be able to do this well … if he's trusted us with that responsibility then it means he can trust us and it means the lessons are better. Yes, I think things have changed a bit now from before.'* (Year 8 girl, School 1)

Again these findings concur with the literature on group work and collaborative relationships and how the teacher roles change when the classroom dynamics shift to increase pupil agency and voice (James and Pollard, 2006; Alexander, 2008; Cooper, 2011).

Two other Year 8 students saw the class's normal relationship with their teacher as an unnatural one in some respects, in that teachers play a role:

> *'Teachers really need to show their personality as well, because they're always dead quiet and serious about everything but really they're not.'* (Year 8 boy, School 1)

This difference between the teacher role and the more affective human one is brought out again and again in research, particularly in Cooper's (2011) work on empathy in teacher/student relationships and in the work of

Noddings (1986), Watson and Ashton (1995), and Klein (cited in Clark, 1996).

Drama and music teachers were given as examples of the kind of teacher behaviour the students liked to see because they are *'expressive'* and *'[…] always shout really loud and free.'* They understood the need for the teacher role in order to maintain acceptable standards of discipline and behaviour, but they also conveyed a sense in which they enjoy it when teachers become participants and collaborators in the process too:

> *'Because when they do practical [activity] all the teachers have fun as well. They weren't just standing watching; they were taking part in it with them and helping out. But with theory they just tell [us] how to do it and then we do it.'* (Year 8 boy)

Expressiveness and the shared learning and fun feature significantly in the literature on empathy and excellent teaching. The importance of non-verbal communication and fun is central to Cooper's understanding of profound empathy, and the shared nature of learning with teachers and peers is essential in promoting dialogue and relationships (Muijs, and Reynolds, 2010).

One of the teachers said that he enjoyed giving the students more freedom and allowing them to express themselves, while another teacher in School 2 talked of wanting to *'learn together'* with young people and of the need for schools to change from treating young people as *'vessels'* to be filled with information. According to the teachers in School 2, giving students the choice of who they collaborated with engaged them more and meant they were more likely to take risks and accept challenges. Here the security of existing relationships supports the risk-taking of new learning. For the musician in School 2, allowing students to choose their own groups signified a respect for the knowledge they had, however imperfect, and a trust that they would be able to think for themselves and work things out, which was a key principle behind his inquiry-led approach.

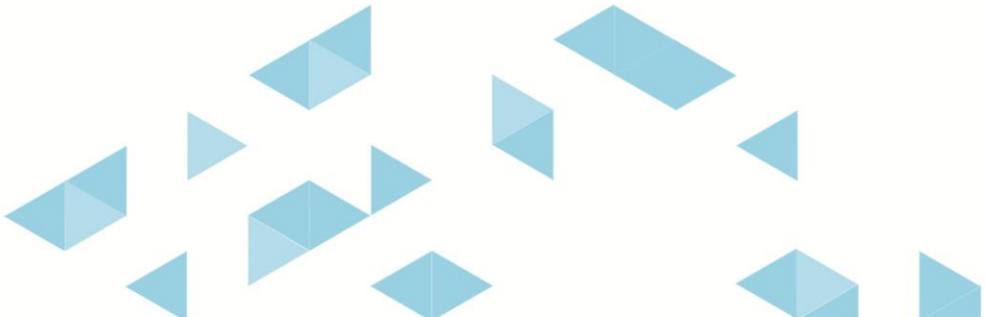
Creating space and time for relationships to develop

From the musician in School 3's point of view, the small group sessions in Cycle 1 at Sage Gateshead were *'much richer'* than the sessions in the school, simply because they had more time than the school timetable allowed and this enabled relationships to develop and for the musician to find out more about the young people. This in turn engendered a more informal, relaxed atmosphere in which trust could develop along with willingness amongst the young people to take risks and to engage with fewer inhibitions. Working with a class of more than thirty in Cycle 2 involved having to move a lot further along the continuum from *'facilitator'* to *'instructor'* than she, as a community musician, felt comfortable with.

This change for the musician from relaxed, informal small groups to the teacher-dominated classroom where control and management becomes more central, institutes a key difference in the learning environment, which has clear implications for the quality of learning and mirrors the findings of Cooper (2011; 2013).

However, some teachers do manage to overcome this problem. During Cycle 3 in the School 3 project it became clear that despite the constraints of numbers and time, the experienced science teacher and music teacher, who were observed by the musician, were successful in developing positive relationships with the students and saw this as being essential to their engagement in learning:

> *'Well, I think it's just largely treating them like they're human – "What have you done last night?" Knowing something about them. Knowing them as a person … It makes a huge difference the way they are with you and their capacity to want to do the work.'*
> (Teacher, School 3)



2.2 Choice-making, ownership of learning and motivation

This theme follows on naturally from the previous one and is interlinked, in that group work often entailed more choice and decision-making on the part of students.

Increased levels of engagement

There was agreement in School 1 and School 2, where choices were given to the students and outcomes were more open-ended, that:

> *'[…] when students have the opportunity to be creative, where they actually have more control over the learning process, they have more input into it, they're more engaged […]'* (Science teacher, School 2)

In Cycle 2, students from School 2 worked in small groups for the inquiry-based lessons taught by the musician and they were allowed to choose who they worked with. Within the confines of the tasks set, it was up to the group to negotiate how they went about it and what designs and materials to use. Having the choice of who they worked with was a motivating factor for the students: *'I hate when teachers put us in groups […]'* (Year 8 girl, School 2). The competition element (groups were competing with each other for the best design) meant that the students were more careful to choose people they felt would be scientifically competent rather than automatically choosing to work with friends, although this can have its own implications for students not chosen.

It was agreed by both adult and student participants that choosing who they worked with meant that the students were more engaged from the start. Their curiosity having been stimulated by the challenges set, they were observed asking each other questions and challenging each other. One of the teachers observed that some of the quieter class members who normally *'take a back seat'* were pushing themselves forward in the competitive team situation, challenging the people they had chosen to work with and engaging more. For the project coordinator, the benefit of giving students some control was that it opened up the possibilities for learning:

> *'Things become more possible, because you haven't put labels on people, you haven't made assumptions about what they will or won't do in that situation.'* (Project Coordinator, School 2)

Observations of these lessons showed they were noisy and could be *'chaotic'*, but the energy in the room was more likely to be focused on the task, whereas in lessons where they were working from books the energy that was present seemed to come from outside the focus of the lesson (conversations about friends or social life). Some students didn't take the open-ended tasks seriously at first and even tried to sabotage the experiments, but the fact that they had made a choice about what to make gave the musician an opening:

> *'One group thought [they] would be really funny and for the sinking object they made a snail. That actually happened to be the second most streamlined object, just by accident. But we were able to then talk about that and because they had the choice to make the snail, they were then able to learn the science anyway, because they had to work out why it was that that actually worked, even though they were trying to disrupt the lesson.'* (Musician, School 2)

Students from School 1 had also been given a choice over who they worked with in Cycle 2 and, in addition, they had a more open-ended choice over what material they presented to their peers and how they presented it in their 'performances'. There were then individual choices to be made within each group as to who would take which parts or perform which functions. Agency and choice seem to be key motivators, as confirmed by other research (Day et al 2008; Muijs, and Reynolds, 2010).

The interviews revealed a general enthusiasm for this process and the element of choice. As one student commented:

'It gave us a little bit more freedom in what we wanted to do instead of sitting there listening and [the teacher] saying "you have to do this; you have to do that." We had more freedom, which made it more fun.' (Student, School 1)

This element of fun, the general excitement it generated, and the competition element between the four classes meant many students chose to rehearse outside the allocated lesson times, in their lunch times and breaks. There was a general 'buzz' created by students from different groups talking to each other outside lessons about their planned performances, which concurs with the theory on agency and motivation (James and Pollard, 2006; Pollard, 2010; Schiefler, 1991).

Teachers as facilitators of learning

Giving students control over choice and decision-making changed the relationship with the teachers, and students described how their teachers became facilitators rather than directors of learning: *'teachers helped you along and if we had an idea they would help to build it.'* (Student, School 2)

This element of teacher support and scaffolding seemed particularly important to the students from the lower ability set, whereas students from the higher ability sets seemed to enjoy the trust and responsibility they had been given to get on with it and also the opportunity to express themselves more freely. Cooper (2011) argues that more needy students often require more teacher support and scaffolding, which is more available in the increased interaction time in small groups.

Implications of freedom and choice

The enthusiasm was not universal, however, and it is interesting to note that one class out of the four, involved in the second cycle of School 1's programme, effectively opted out of experimenting with sketches, song, dance and demonstrations and fell back on using PowerPoint presentations, with which they were familiar. This example perhaps emphasises the innate security needed for risk-taking. With reference to choice-making, the feedback from their teacher was that these students had felt forced to participate in something they did not want to do, though the students did not express this view when interviewed. See Theme 4 on Challenge and Risk for further comments.

By contrast, the teacher of another group felt that giving students more choice also gave them the opportunity to use other strengths that would not normally be evident in science and that this had immediately engaged them. Another teacher talked about the evident enjoyment of the 'vast majority' of students and that *'[…] it wasn't just pointless enjoyment … there was a substantial amount of accurate science.'*

Interestingly, in Cycle 3, the project teams in School 1 and School 2 both elected to work with one small group of young people, supporting them to deliver sessions to their peers. In both cases it involved a narrowing down of choice-making and more of a focus on organisation and planning. In School 2, the young people delivering the session *'reverted back to a kind of stereotypical teacher delivery method where they wanted to make sure that everybody was learning certain things […]'* (Project Coordinator, School 2). They did, however, deliver some open-ended challenges similar to those delivered by the musician in Cycle 2.

In School 3, there was more choice-making for students in the first cycle, where the small group had choices about the composition of songs. The musician also felt that she could to some extent give students choices by asking them if they would be prepared to do things rather than telling them. This was part of relationship and trust-building. In the second cycle, because of the increased group size, the style became much more instructional and choice was much more limited. Group size has consequences for delivery but also for achievement (Mosteller, 1995; Blatchford, 2009).

The same effect of higher levels of energy and engagement were noted in the School 4 project when the teachers were given the choice of a tune they would like to learn in the first session:

> *'And I think that created a bit more of a buzz in the room and increased energy levels because they were involved […] so they were taking ownership of what was going on.'* (Musician, School 4)

This contrasted with the second session when the musician felt they had *'tried to be more like the teachers'* and impose control and structure, resulting in a drop in levels of energy and engagement and a less successful outcome.

This concurs strongly with Cooper's findings (2011). The primary school children interviewed in her research revealed great sensitivity to non-verbal signals and identified both empathic and inauthentic teachers. They identified the importance of body language and facial expression and voice tone, good humour, friendliness, and personal knowledge of and sensitivity to students - in other words, as one child put it, they, *'behave more like ordinary people than teachers'* (p. 48), whereas in large classes teachers use a weaker form of empathy called 'functional empathy', which is less personal, more group focused and more controlling. In emulating the teachers the musician would have modelled teaching a large group, which produces a more impersonal and managerial approach to learning.

Sustained engagement

The science teacher in School 2 spoke about the *'functionality'* and *'content-driven'* aspects of the science curriculum. As a result, teaching approaches can become *'regimented'* and focused on passing exams, with little scope for choice-making and student ownership of learning. This was likened to the teacher's own experience of learning music, which had been formal and regimented, only allowing for experimentation once the skills had been mastered.

The danger in this approach is that the student becomes *'switched off'* before reaching the stage of mastery. In contrast, he believed there was evidence from the project that the approach of his musician colleague has the potential to keep young people engaged while at the same time developing skills that will not only deliver exam results (because learners remain engaged) but also the motivation to learn the higher level skills of scientific enquiry:

> *'I met up with most of the parents of the class and they were saying how enthused [their children] were with the subject … absolutely loved trying all these different activities within the subject and being allowed to explore… as teachers we are programmed if we see something being done wrong, to stop it and that's not always the best way for pupils to learn.'* (Science teacher, School 2)

Reflecting separately on the same issue, the musician expressed the view that teachers need the freedom to work in whatever way they want, providing it is successful, and saw the requirement to work to predetermined learning objectives all the time as a *'big problem'* for schools and teachers.

2.3 Active, multi-sensory learning

Students often made the point that physically doing something was *'more fun'* than the more theoretical approaches to learning. However, as one of the teachers said:

> *'Their articulation around "they enjoy it" is very quickly followed up with "and it helps me to learn". They connect these things.'* (Science teacher, School 2)

One Year 8 girl said it was fun to act out a play in English and more engaging than just reading it off the page. With specific reference to science, another Year 8 girl made the case for more experiments, claiming that a few experiments were worth several weeks of writing out of textbooks. This was echoed by one of the musicians, who said that many students had identified

an *'affinity with subjects where they are doing'* and where they experience creativity, fun and variety, including experiments in science.

Here the physical, affective and cognitive are clearly linked. Active learning which is enjoyable supports learning in the students' eyes. It is well-established that physical activity (Matthews, 1998) and positive emotional climates (Kyriacou, 1986) support engagement and memory.

One of the musicians explained that in her project students expressed a dislike of teacher-dominated modes of delivery. This is formally recognised in School 3 where the policy is to *'[…] really limit the teacher instructions at the start. It's just like get them on, get them doing as fast as [you] can.'* (Music teacher, School 3)

The students interviewed in Schools 1 and 2 were consistent in voicing their preference for working in groups and for practical activities as opposed to book and theory-based lessons. The lack of access to a lab for all their science lessons was seen as a disadvantage by students in School 2, because it meant that too many lessons were focused on the use of textbooks. This was not just a moan about theoretical lessons being boring; they were able to articulate the view that doing things in an experiment or practical activity means that:

> *'It stays fresh in your memory as well. If you're working out of a textbook, it goes in one ear and out of the other.'* (Year 8 boy, School 2)

> *'I've got a really bad memory, but when you're doing an experiment … you just might remember what you did. But if you're working out of a textbook you hardly remember it.'* (Year 8 girl, School 2)

Students from School 1 were consistent in claiming that the performances of their peers made what they were learning more *'memorable'* because they were interesting, funny and entertaining and had helped consolidate knowledge and understanding. The teachers on this project reported evidence of scientific learning and agreed that the performances had definitely engaged the students emotionally, though the short-term gains claimed by the students in terms of subject knowledge were not borne out in the tests that followed soon afterwards; neither did their knowledge levels drop.

According to their teacher, one of the groups displayed emotions associated with anxiety, which is unlikely to support learning (Hinton et al, 2009) [9] and there were individuals from other groups who might not have engaged. Generally, however, it was agreed that students experienced excitement and enjoyment and showed their engagement through animated discussions, rehearsals outside lesson time, and determination to complete the task well. One science teacher commented that doing something physical as a *'whole person'* through dance or comedy sketches helped them to engage more and therefore to learn better.

Humour is a key element of profound empathy that supports learning (Cooper, 2011). Extreme emotions are remembered strongly and relived rapidly in memory according to Damasio (2003). Emotions are central to motivation (Salovey et al. 2008) and improve attention and problem-solving, according to Isen (2008).

Most of the students in School 1 who were interviewed linked their perceived learning gains to the nature of the activity and an awareness of how they learn. One student said he had discovered that he was *'[…] better off learning by doing things than listening and reading',* whereas previously he had always thought of himself as *'a listener'*. Several students made reference to the way in which the information seemed to *'stick'* or *'click'*

[9] Other academic theories suggest that this would also be an indicator of high levels of arousal, which are the same conditions for excitement, which would make learning engaging. The pedagogical skill is in knowing how far to set challenges so that students are optimally enthused without being over-stimulated, and will vary from moment to moment, student to student and activity to activity: "Very often the same situation will be experienced from within different states at different times by the same person." (Apter, 2000)

better because there had been a visual or interactive element, especially where it had been entertaining as well:

> *'It helped because it was quite fun to watch and you took it in and you could remember what happened.'* (Year 8 boy, School 1)

Students in one of the groups talked about the wider benefits of being able to *'express ourselves'* as opposed to *'just sitting in the corner and being quiet'.* They felt it had helped with other subjects like art and drama where generating their own ideas is an important element. They generally compared these 'practical' subjects favourably (including the practical elements of science) to subjects that rely more heavily on reading and writing.

While the context at School 2 was different, the students made much the same points about learning:

> *'[…] having fun helps, like, knowledge unlocking your brain and it stays there […] but if you're writing it down … you just write it down and then move on'.* (Year 8 student, School 2)

An interesting point made by a Year 8 girl was that in science the inquiry-led methods should be reserved for the *'harder'* science topics, suggesting that, for her at least, the combination of practice and theory is a more effective learning method.

All the project teams talked about wider learning gains such as social, organisational and presentational skills. One teacher said young people had benefited from having to think through how their audience learns best and that it *'helped them to learn in a different way and connect with their work.'* The musician on the same project agreed with this view, saying that they had to think about themselves as learners before applying that to others in their performances.

There were many references from students as to the benefits of being able to construct understanding together (see 'Collaborative Relationships' above) in an active and interactive manner, and this was strongly contrasted with the limitations of working in an isolated learning situation in class or at home, which it was implied is an ineffective way of learning:

> *'[…] when you're reading in your head, you get sick of hearing your own voice. When you have other people talk, it's just easier to understand.'* (Year 8 girl, School 1)

> *'[…] you'll just drift away and start staring at a wall or something. When you're doing this, you're engaged in it and you want to look at it and you want to watch it and you want to be part of it.'* (Year 8 boy, School 1)

Learning in context

When asked in separate interviews what they believed would improve science teaching and learning, there was a strong degree of similarity in the responses of science teachers and musicians, as they almost all focused on the need for more *'hands-on'* experiences and opportunities for linking science learning to *'real-life'* contexts.

Separate examples were given of science lessons in which it became evident, when talking about bluebells or quarries, that some young people had never seen a bluebell and didn't know what a quarry was. This lack of knowledge of the natural world because of limited life experiences was perceived to be a real barrier to science learning.

Musicians and teachers alike spoke of the need for greater freedom to take young people out into the world to gain the first-hand experiences they lack. It was believed that expanding their horizons and contextualising their learning in real-life situations would make it real and therefore more meaningful and engaging (Ausubel, 1963). Having experiences to draw upon would enable young people to form and share opinions, think for themselves, ask the right questions, and take greater responsibility for their learning,

rather than being passive recipients of largely theoretical information. As one of the musicians said:

> *'[…] we didn't start from reading textbooks, we started from discovering the thing, then we wrote the textbooks; and we forget that – now we just go to the textbook […] Within music, if you want young people to be musicians, they've got to be playing the instruments.'* (Musician, School 2)

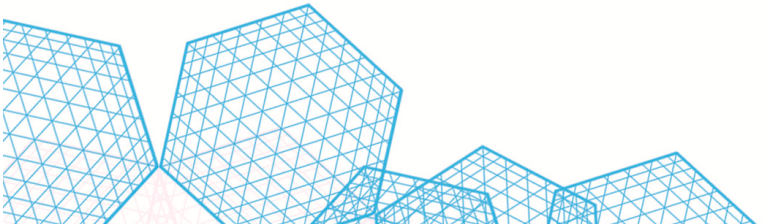
One of the musicians, a disengaged science learner themselves at school, said they only experienced successful formal science learning as an adult when their teacher related it to *'real-life and stories'*.

For the musician involved in the School 4 project, the flexibility to embrace a more hands-on 'embodied' learning style was more important to progress than previous musical experience, which links to Matthew's research (1998). The musician discouraged the teachers from writing things down while learning the steel pans and to trust instead to learning through 'muscle memory', which some, perhaps because of their training, found difficult to do.

2.4 Challenge, risk and the unknown

Teachers and musicians in the second cycle of the project in School 3 agreed that getting one group of thirty-two Year 9 students to sing and play percussion together had pushed the students too far outside their 'comfort zone' and left them feeling 'exposed' to the risk of looking stupid and making fools of themselves. While not actively refusing to co-operate, the students had responded with lethargy, lack of engagement, and evident signs of embarrassment:

> *'Just getting them to stand up was hard… you felt like you were really making them do something they didn't want to do, which felt awful.' (*Musician, School 3)



When the teachers from School 4 were asked about what challenges or risks they anticipated being exposed to in their own learning, group size was mentioned (feeling comfortable in a smaller group but possibly more exposed in a larger group with people they didn't know). Anxiety over risk is eased by trusting relationships, which are more likely to be formed in small groups where teachers can also model risk-taking more easily (Cooper, 2013). One teacher emphasised being able to see *'some sort of progress'* and reiterated the idea of being able to have a *'laugh and a joke'* as elements that would make for a comfortable and positive learning experience.

Supporting challenge

Setting challenges for students was at the centre of Cycle 2 activity in School 2. One of the teachers observed the benefits of students approaching the challenge in groups, as those who have had wider 'life' experiences can bring those experiences to the group:

> *'You've got one or two kids in there who really have... been out and done a lot of things and their input is vital... whereas somebody maybe hasn't had those experiences. And it's sharing those experiences as well.'* (Science teacher, School 2)

He also observed that the group challenge had proved particularly beneficial for a quieter group of girls who used it more effectively to challenge each other and test each other's hypotheses. Gender was also mentioned by another member of the team in relation to initial concerns that the competition element might favour boys. In fact, the experience had shown that the girls were as motivated, if not more motivated, than the boys.

For the project co-ordinator, an essential element of this approach was the plenary afterwards in which students had to present their findings and the process of theorising from practice could begin. This provided clear expectation of an outcome and an incentive for groups to do their best. Reflecting on the risks of exposing young people to failure at this point, the

musician expressed the view that the 'right or wrong' nature of science actually helps here in that students are more likely to accept scientific reality as a fact of life.

The School 2 project team did not assess scientific learning more formally, but one of them reported that the young people had become more comfortable about risk-taking and less worried about getting things wrong.

The research team at School 1 agreed that there had been a significant degree of challenge and risk-taking in the performance event, to which the students had generally responded very positively. It was likened to putting on a musical or a show where:

> *'there's lots of hard work and slog, etcetera, but once you've done it and achieved it, people feel really proud of them[selves] and it boosts confidence a lot.'* (Musician, School 1)

This was a view echoed by the students, who also talked about the challenges of researching and presenting accurate material and of the challenge of presenting it in ways that a mixed ability audience would understand.

Teaching staff commented on the challenges for young people of performing or presenting in front of such a large audience and also the challenge of having to cope with that degree of freedom of choice over such a period of time. In the end, however, for one group at least, the problem had been one of paring the material down to twenty minutes, not filling the time.

There had clearly been challenges for the teachers too, not only in terms of the scale of the event and the time pressures it added, but also in terms of control and trust when the responsibility for learning was placed in the hands of the students. With reference to time pressures, some teachers expressed concerns that while there were benefits accruing from the project, these had to be set against the time lost in getting through the science curriculum.

One of the musicians spoke of the challenge in supporting students to have *'real scientific understanding'*. This wasn't only in relation to the current project but to science learning in general, including experiments, which she saw often went wrong because there are so many variables or because the young people have not yet acquired the skills. This was perceived as one of the differences between music and science learning – the outcome is often more open in music, which emphasises the creativity, whereas in science it is more likely to emphasise right or wrong.

Practical considerations

Other challenges for some of the projects included the everyday pressures on teachers and the constraints of timetables and appropriate spaces to work. Some of the participants reflected that the time required for joint discussions and planning meetings between musicians and teachers had been a problem in maintaining the impetus of their project.

There were also significant challenges for the science teachers and musicians in making sense of the 'brief' and devising projects that would lead to new learning about practice. However, through the process of testing ideas the practitioners were able to challenge some of the assumptions underpinning the project's initial research question. This led to the research questions being redefined.

Further details about the development of the brief and research questions are described in Appendix 3: Defining the enquiry and understanding the brief.

In their reflections at the end of Cycle 3, most of the science teachers were aware that the emphasis of these projects on active student engagement and greater ownership of learning was something that the new Ofsted framework was seeking to promote, and they felt that ultimately schools would need to embrace such approaches.

The School 2 research team agreed that the inquiry-led approach they had developed in Cycle 2 had the potential to deliver positive and sustainable

changes to learning across the school, but the question remained whether teachers who had not been involved in the project and seen its benefits would be prepared to accept the risks. These risks include the amount of time it would take to build up trust and confidence in the method and the different relationships and skills required, time that would inevitably impact upon delivery of the curriculum. There was also the unanswered question of whether this approach can at the same time deliver the exam results required and this remains untested[10]. As a start, this team was asked to present the findings and recommendations from their project to the rest of the staff in a whole school CPD session.

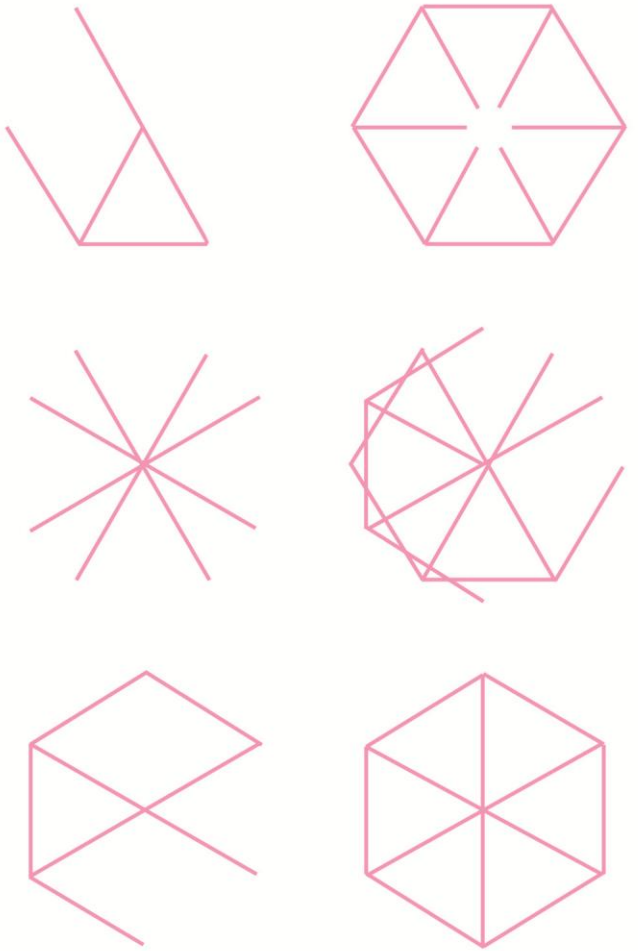
And finally, there was the challenge associated with maintaining such a high level of 'alternative' intervention. As one of the project team recognised, teachers generally would be *'terrified about having to keep that up for five days a week'.* However, according to the Project Coordinator of School 2, their project had shown that helping students to be more engaged, active learners does not require every lesson to be packed full of *'all singing and dancing'* activity and that it was also possible to set up a framework that supports active learning with regards to the theoretical aspects of the curriculum:

> *'It's about how you set something up and how the young people see that … it's almost like challenging that sense of what's my role as a learner? […] one of the things that [the musician's] process did was allow them to see themselves and their peers in that role of explainer and presenter… so again it's about making it real [rather] than pretend. I think that was the thing.'* (Project Coordinator, School 2)

[10] See section 4.7 Consolidate the findings […] for further thoughts on future research

And finally, as the science teacher from School 2 commented:

> *'In many ways this [giving students more responsibility for their learning] makes it easier for me. It allows me to move from the front of the class, to the side and even to the back. This allows me to see better where my support and intervention is required rather than feel I have to 'perform' and take the lead on every occasion.'* (Science teacher, School 2)



3. Conclusions

This study set out to capture how the various participants - teachers, students and musicians - perceived what has taken place as a consequence of their engagement with the project and consider how this has impacted on their learning and our understanding of the processes involved.

The study identified the following conclusions from an analysis of the findings:

3.1 New insights into teaching and learning practice

By bringing community musicians, with their practices built on dialogue and participation, together with science teachers engaged in the daily demands of a school-based curriculum, the project successfully 'disrupted' traditional thinking and practice. This led both teachers and musicians to consider more deeply their usual practices and assumptions about teaching and learning.

Looking at the teaching of one subject through the lens of another discipline (which usually inhabits less formal contexts and seeks to promote teaching-learning situations which are broadly 'dialogic' in that they *"always begin with those questions and challenges that motivate and engage [learners]"* (Wegerif, 2012)) enabled experimentation and thinking, which led to examples of more active, collaborative learning, sometimes involving performance and 'teaching' by students, to a wider audience. Such methods of working are well documented and appreciated, both in the academic literature on good teaching and in the practice communities and reaffirmed here.

3.2 Empowering collaborative learning and building new relationships

A strong feature of the Music Lab project was the creation of small groups that enabled some teachers to release control, step back and allow students more autonomy. This also allowed teachers to 'see' the students in a new light. Increased teacher understanding of students can lead to improved assessment of both the affective and cognitive responses to learning, followed by more appropriate teaching and higher quality relationships and communication.

Context seems to be very important here. Collaborative activities in smaller groups, a key factor in this data, appear to facilitate such processes and provide more autonomy, enjoyment and social interaction for students, which can build confidence and make learning memorable and interesting. Learning can become more active, multi-sensory and embodied.

Such activities can be challenging, even too challenging for some, but where they work well they can improve and equalise teacher/student relationships and bring a greater sense of shared understanding and humanity to the learning process, making it more meaningful and enjoyable, affording variety and relief from more traditional, text-based or teacher-dominated activities.

The findings suggest that teachers do not need to make wholesale changes to the way they work and continuously provide small group, inquiry-led activities; rather that they plan to provide periodic opportunities to enhance and extend the range of learning opportunities for KS3 science. They indicate that such approaches to learning could invigorate the dominance of routine lessons and improve teachers' relationships with their students and students' relationships with each other. They also demonstrated that science could become more frequently a topic for debate rather than asserting 'truth', with students' emerging understandings valued and challenged in shared constructive dialogue.

The data suggested that one of the consequences of this approach was that students could start to see teachers as lovers of science as well as teachers; individuals who revel in the exciting, creative and debatable aspects of their subject. This may have more chance of impacting on students' perceptions of and identity with science as a potential career over the longer term[11].

3.3 Motivated learning

Lip service is often paid to the importance of the affective climate in learning in the literature, with a much stronger emphasis given to curriculum and cognition, but this study reaffirms the importance of generating enthusiasm and motivation for learning. Realised in practice through this project, these processes are often associated with the process of making and performing music, but are equally recognisable in the approaches adopted by public science communicators in informal learning contexts, e.g. in museums, science centres and on TV programmes, etc.

An example of this was the time set aside during projects for exploratory engagement. This practice reflects the way community musicians encourage participants to explore instruments or reactions to types of music, or science communicators may mix two liquids to bring about an unexpected outcome that raises the curiosity of the participants. This approach provides new ways to draw students into an investigation, increasing their sense of wonder at what they have experienced.

3.4 Delivery implications

Despite the fact the project activities were co-designed by the musician and the teachers, the findings revealed that in some school settings the practical delivery of projects was problematic. This included difficulties *'fitting'* activities into the timetable or indeed finding spaces to work. Finding time to plan and reflect on the processes and connecting theory to practice had also been a challenge for some teachers but not all.

Another pressure was a lack of confidence and concern that the benefits of adopting these approaches might not offset potential difficulties *'getting through'* the curriculum. However, some teachers reflected on the fact that the type of teaching approaches tested through the project, where the students had greater ownership of their learning, was an approach that Ofsted inspectors and school leadership teams would welcome.

These difficulties are symptomatic of many school-based research projects. However, this study would indicate that these challenges were mitigated where senior school leaders were activity involved and the necessary resources (time and teacher support) were available.

3.5 Nothing new. More needed?

This study has reaffirmed much of what is known already about what type of approaches and conditions that support engaged learning. As one science teacher commented, the projects are only finding out what is already known:

> *'[...] which is that when students have the opportunity to be creative, where they actually have more control over the learning process, they have more input into it, they're more engaged and possibly learn better'.*

As such, the project adds further evidence as to the value of such approaches. However, as the science teacher went on to add, further data is needed to make a more convincing argument that students learn better.

This project did not set out to directly influence or measure the immediate impacts of these activities on achievement through assessment. It was understood by all practitioners that the impacts of such interventions would not be immediate. However, in one school the test results of a group of students were reviewed following their participation in one of the projects.

[11] Although these findings open up a debate on the complex relationship between being a scientist and being a science educator (a topic not explored in this research), it does represent a key conclusion of the project.

The findings indicated that despite the fact that the students believed their learning and subject knowledge had improved, this was not reflected in their assessments. This finding poses a number of new questions worthy of further investigation. Does the student's belief that they have knowledge (and thus greater confidence) help them 'keep' the knowledge for longer or allow them to apply it better to different circumstances?

Connections to learning theories

Many of the approaches devised and tested by the teachers and musicians would be endorsed by academics in teacher education as they reflect well-established learning theories and those emphasised by practitioners at Sage Gateshead (Bakhtin, 1981; Elliott, 2009; Freire, 1970; Linden and Renshaw, 2010) which marry well with those such as Vygotsky (1978; 1986) and those who focus on affective education (Best, 2000; Lang, 1998; Noddings, 1986; Cooper, 2011). They might even argue that the nature of dialogue whilst involved in active learning in education also involves simultaneous listening and response through constant non-verbal feedback, developing the emotional bonds between teachers and students in the same way that Barenboim (2009) argues happens between musicians when making music.

Literature on excellent teaching also recognises the importance of teachers learning constantly with and from their students. Teachers prefer to enjoy their learning and their relationships with students (Hobson et al, 2006; Hoban, 2006; Noddings, 1986; Nias, 1996; Cooper, 2011). Consequently, both here and in other research, where opportunities are created for one-to-one and small group interaction, where the teacher comes alongside the students in a more natural human interaction, a more dialogic approach can be facilitated (Cooper, 2011).

4. Recommendations

Building on conclusions and the practice identified as part of this study, the following recommendations have been highlighted to support teachers, school leaders, teacher training agencies and policy-makers to innovate and advance practice in relation to STEM subjects at KS3.

4.1 Create opportunities to disrupt or invigorate established practice to generate new insights

One of the most valuable outcomes of the four projects was the opportunity they afforded for professionals from different teaching disciplines and subjects (in this case science teachers and community musicians) to work together on a co-designed enquiry into teaching and learning practice.

The study highlighted the value of this approach, particularly in terms of enabling new insights to be generated. As one of the science teachers stated *'[…] as teachers [in schools] we are programmed, if we see something being done wrong, to automatically stop it, and that's not always the best way for pupils to learn.'* He went on to say that some of the best school teachers find it difficult to *'step back'* and not interfere, and that it was about having the confidence when things go wrong not to *'panic'*. Allowing himself to *'step back'* during the project had reduced the pressure on him to *'perform'* and he had become more aware of what was going on in the classroom and where support was required.

In the same way, some of the projects gave young people opportunities to look at things in a different way, especially when they had been given permission and time and space to work things out for themselves. As one of the teachers pointed out, if young people always follow a set method or set of instructions, they won't learn what happens if you do it differently.

- **Schools and teachers should consider prioritising the creation of opportunities for other subject practitioners from outside the school setting (with a strong track record in learning and participation[12]) to work alongside subject teachers as a means to innovate, stimulate and inspire new approaches to delivery in the classroom.**
- **Initial Teacher Training (ITT) and training providers should consider how this approach could be utilised as a feature of their teacher training and CPD provision.**

4.2 Use small pupil-led enquiry teams to build relationships and share experiences of learning

One of the study's main conclusions was that working in smaller groups and with new levels of autonomy was key to building new positive types of relationships with students. It is well-established in academic literature that positive emotions and relationships are critical to learning (Kyriacou, 1986; Day et al, 2008).

The projects demonstrated that teachers work very hard to establish relationships and have many strategies for doing so within the constraints of secondary school timetables and classes of thirty pupils. They also showed that giving students some control and choice in their learning changes the relationship with their teachers. As one of the science teachers put it:

> *'[…] it's a different way from me sitting at the front and me spouting forth. I can see there's a way of us learning together, exploring the subject and the learning together.'*

Interviews with the students showed that they also value this kind of relationship and the sense of trust and responsibility that goes with it.

It is acknowledged that many schools provide this experience through science clubs, and other research (Cooper, 2013) shows that young people

[12] This might include practitioners from the arts and cultural sector as well as public science communicators.

are very positive about such clubs, where they have a little more time and freedom and the relationships with teachers are more informal. However, these activities only reach a proportion of students, and building in time and space in the curriculum for such relationships to be formed through shared experiences may help more young people to identify with science and see themselves as potential scientists.

It is also suggested that being given the space to learn by trial and error, with a teacher facilitating rather than directing, allows students to develop an understanding of scientific method that is based in experience and allows them to develop a lifelong learning skill.

- **Schools and teachers should consider creating more opportunities that develop genuine, shared experiences of exploring science between teachers and students where smaller groups and more collaborative activities are possible. Knowing teachers more personally supports identification and enables teachers to act more effectively as role models.**

4.3 Encourage 'hands-on' engagement with learning

Another feature of one of the report's main conclusions relates to the importance of physically *doing* something as a means to enhance the learning process. *Doing* turns learning from abstract to concrete, something that the students said frequently they valued in their interviews because it made things memorable.

It also changes the nature of the learning dialogue of students. The evidence suggests that giving students something to do or experiment with, even if it is only for five minutes in a lesson before questioning them, will enable them to talk about what they are *doing*, which will make it more accessible than questions and answers based purely on theoretical thinking.

- **Teachers are encouraged to consider how they can introduce 'hands-on' exploration or making processes into their classroom experiences in order to support more engaged and *'memorable'* learning. The examples utilised in the Music Lab were low-tech, e.g. making paper airplanes. They did not require significant preparation or expensive materials.**
- **School leaders and ITT providers should also consider how the learning of their student teachers could also be enhanced through the use of more 'hands-on' exploratory and making processes.**

4.4 Alter the perspective on learning from passive to active

Building on the conclusions above, the study did indicate that exploratory student-led activities did increase engagement and activate enquiries, but students (even by their own account) also needed subject knowledge (scientific concepts and theories) to build upon, test and codify their discoveries, perceptions and ideas. A critical aspect of the success of the inquiry-based methods explored in one of the projects was a purposeful plenary in which theoretical sense was made of the practical activity.

Participants from one of the projects suggested that it is more about how teachers frame things and set situations up so that students' roles are switched from passive to active. This can take place in the context of discussions about theory too, and students do not necessarily need to be doing something physical to be active. Asking them to 'imagine' situations can be a useful activity.

As in the case of looking at science through the lens of music, it could be just a matter of changing the perspective on learning. Participants from this project suggested the work should be followed up with further work on how questioning and language can be used more effectively to engage and enable the learner to feel more active. If the emphasis is shifted from 'what

do you know?' to 'how do you know it?' schools would need to think about new forms of assessment to capture this kind of knowledge.

- **Teachers should use a range of techniques to create opportunities for students to be active in the learning process.**
- **School leaders and policy-makers need to consider the implications of altering the perspective on learning from passive to active in relation to assessment methodologies.**

4.5 Build confidence through engagement, challenge and debate

Engaging students and motivating their learning by using processes more readily associated with making and performing music or public science communicators was a key conclusion of the study.

Active participation in learning processes that require team work, planning, problem-solving and reflection enabled the students to have experiences and form memories that they could bring to bear at a later date. It is suggested that this approach is likely to make learning more robust and applicable in different contexts. Again, further research into this area would be beneficial.

The findings also suggested that students who are engaged and enthusiastic are often more confident. One project, in particular, made them sufficiently enthusiastic to talk to their parents about their science learning at home in a way they had not done before. Other findings also showed that students with more confidence are more open to being challenged, because they won't be *'knocked back'* as easily by being perceived to be 'wrong'.

Introducing a sense of enquiry and debate into the process of teaching science is shown to increase engagement and allowed the science teachers to share their passion for the subject.

- **It is proposed that a combination of these approaches and interventions will simulate students to identify with science as a subject for further study and possible career.**
- **Teachers should consider how they can disrupt the *routine of learning* with the introduction of more active collaborative learning processes, which include opportunities for debate and challenge. It is also suggested that this approach will help students and teachers to establish new types of good relationships that will be carried forward into other lessons.**

4.6 Establish a culture of innovation in schools

Findings from the research confirmed that as some of the curriculum–related research activities took more time than conventional lessons, the science teachers felt under pressure to *'get through the curriculum'*. This meant they had to weigh up the unknown potential learning benefits against the much more tangible problems of *'getting behind in the curriculum'*.

The pressure of external monitoring also made it difficult for the teachers to feel at ease and confident experimenting with different ideas and approaches. One of the science teachers explained how a lesson which had been set up to encourage students to explore their own answers and share them with each other had been criticised by an Ofsted inspector because the students spent too long drawing diagrams.

Other factors, including commitment of school leaders, relationship with pupils, relationship with other teachers, understanding of the brief, and varying levels of commitment and engagement with the project, also influenced the extent to which participating teachers felt comfortable about taking risks.

The study also indicated that the kind of student-led enquiry learning that was initiated in some of the projects does not need to be kept up for five

days a week to become valuable. Indeed, it would be very challenging and inappropriate to adopt this approach on a continuous basis. Students need a mix and balance of teaching and learning methods because while some - most even - may have enjoyed the more extrovert activities, others did not or would not for long if it was the staple diet.

- **Schools need to create environments that are less risk adverse and more open to innovation. Teachers need to be encouraged to develop a broader view of what the curriculum is and given more strategic support and permission to adopt and adapt new approaches to teaching and learning in their classroom.**
- **Schools should note that the findings indicate that it is not necessary for teachers to continuously utilise these approaches, rather they should be planned interventions that help the students to connect to the subject in new ways.**
- **ITT and further education institutions should consider how they support teachers to remain open and adaptive to new ideas in teaching and learning, and how they help them develop the skills required to be a leader and creator of new ways of working.**

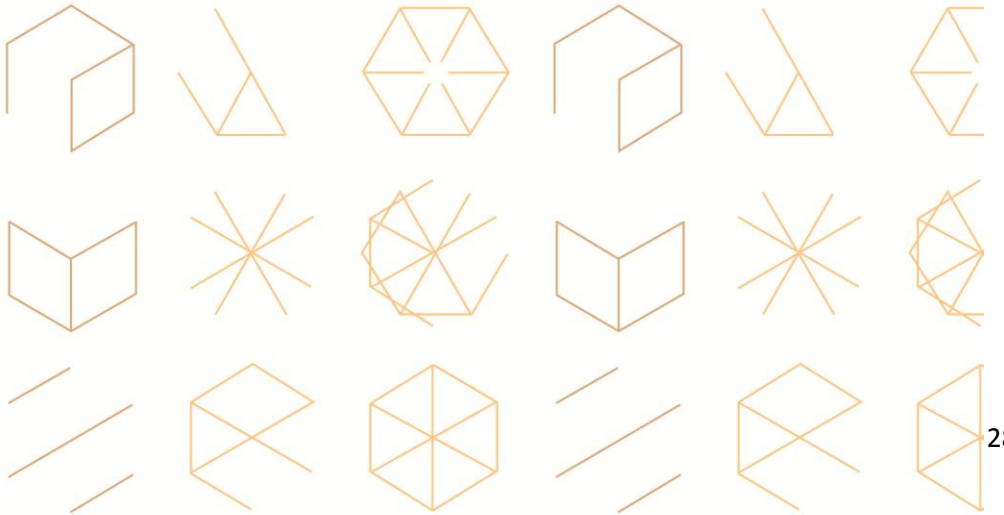
4.7 Consolidate the findings and initiate further research

The four Music Lab projects have been by their nature exploratory, yet they have revealed (and therefore reinforced) existing knowledge about the value of engaging students through small enquiry-led activities where they have had the opportunity to take ownership for their own learning, and build new types of relationship with their teachers.

However, despite the weight of evidence, further supported by this study, there is a lack of clear policy or practical guidance on how to support the mainstream application of these approaches in schools.

Feedback from teachers suggests that more evidence connected to achievement would be required to build a stronger case for these types of interventions, as this would give them greater confidence about using them in the context of ever-increasing pressure to increase attainment. Understanding the implications of students believing their knowledge has increased, and the impact of these approaches on long-term memory, recall and application is also worth pursuing.

- **Policy-makers, ITT agencies and higher education institutes need to consider how to increase awareness about the validity and value of these approaches in order that they become an integrated part of mainstream delivery.**
- **Further research is required to assess the benefits of the approaches in the context of attainment, long-term application of knowledge, and students' subject and career choices. This could involve a longitudinal study of a cohort of learners starting in Year 7 and running through to 'post-16'.**



Additional research considerations

It would be interesting to understand more about:

- The extent to which the pedagogies are applicable across different disciplines and what is to be learnt by looking at different disciplines through the lens of others. This would include further examination of the pedagogical approaches adopted by the community musicians and science teachers to better understand the similarities and differences between the disciplines and to explore further potential links; and
- science's 'image' amongst young people in schools could be further explored, along with young people's self-image in relation to science, paying close attention to gender.

Focusing on the teachers' pleasure in their interactions with students and equally the creative and awe-inspiring aspects of the subject could also be an interesting area to explore further.

Also, in one of the projects the concept of 'performance', familiar in music and other performing arts, was explored as a way of generating engagement and excitement about science. In a similar way, 'public engagement science' focuses on making science exciting, whereas it can be argued that in schools there is more of an emphasis on getting scientific theory right. Science communicators in the public sphere often use performance techniques to capture their audience's attention and hold it. Good teachers also do this, but perhaps they do not always realise what they are doing or how they are doing it. There may be more to be learnt from science communicators and teachers working together rather than separately, with a focus on the 'performance'.

And finally

Reflections on the process of undertaking this research project have been included in Appendix 6. This provides some insights into the types of issues that schools and partners can face when conducting this type of research.

References

Alexander, R.J. (2008), *Essays on Pedagogy*. London: Routledge.

Aspy, D. (1972), *Towards a Technology for Humanising Education.* Champaign, Illinois: Illinois Research Press.

Archer, L.; Dewitt, J.; Osbourne, J.; Dillon, J; Willis, B.; Wong, B' (2010), '"Doing" Science Versus "Being" a Scientist: Examining 10/11-Year-Old School children's Constructions of Science Through the Lens of Identity.' *Wiley InterScience* **(www.interscience.wiley.com).**

Aspires Project (2013), *Science Aspirations and Career Choice: Age 10-14*. Available [online[: **http://www.kcl.ac.uk/sspp/departments/education/research/aspires/index.aspx** [accessed February, 2013].

Ausubel, D. (1963), *The Psychology of Meaningful Verbal Learning.* New York: Grune & Stratton.

Ball, S. (2000), 'Performativities and fabrications in the education economy: towards the performative society?' in *Australian Educational Researcher,* 27, (2), 1–23.

Bakhtin, M.M. (1981), *The Dialogic Imagination: Four Essays*. Austin, Texas: University of Texas Press.

Barenboim, D. (2009), *Everything Is Connected: The Power of Music*. London: Phoenix.

Barbour, R.S. (2008), *Introducing Qualitative Research*. London: SAGE Publications Ltd.

Barsade, S. G. (2002), 'The ripple effect: emotional contagion and its influence on group behaviour' in *Administrative Science Quarterly, December.*

Beard, C. (2005), *Student Achievement: The Role of Emotions in Motivation to Learn –*

Emotional Maps. *Pedagogic Research Project Report.* Sheffield, UK: Sheffield Hallam University.

Beaty, L. (1997), *Developing Your Teaching Through Reflective Practice*. SEDA.

Best, R. (2000), 'Empathy, experience and SMSC (Spiritual, Moral, Social and Cultural Education)' in *Pastoral Care, December.*

Blatchford, P. (2009), 'Class size', in Anderman, Eric (ed.), *Psychology of Classroom Learning: An Encyclopedia* . Detroit, MI: Macmillan Reference USA.

Bolton, G.E.J. (2010), *Reflective Practice: Writing and Professional Development,* Third Edition. ed. London: SAGE Publications Ltd.

Bonwell, C.; Eison, J. (1991), *Active Learning: Creating Excitement in the Classroom AEHE-ERIC Higher Education Report No. 1*. Washington, D.C.: Jossey-Bass.

Boud, D., Cohen, R., Walker, D. (1993), *Using Experience for Learning*. Buckingham: Open University Press.

Burgess, R.G. (Ed.) (1982), *Field Research: a source book and field manual.* London: Allen and Unwin.

Burton, N., Brundett, M. & Jones, M. (2008), *Doing your Education Research Project*. London: SAGE Publications Ltd.

Calderhead, J., Gates, P. (1993), *Conceptualising Reflection in Teacher Development*, 1st ed. Routledge.

Clark, D. (1996), *Schools as learning Communities*. London: Cassell.

Cohen, L., Manion, L. & Morrison, K. (2007), *Research Methods in Education* (6th Edition) London and New York: Routledge.

Cooper, B. (2013), *Supporting outstanding student progress in areas of deprivation*. Final project report. (Available from author).

Cooper, B. (2011), *Empathy in education: engagement, values and achievement.* Continuum, London.

Cooper. B. (2005), *A model of immorality: how the education system can destroy empathy.* AERA April 11th -15th 2005, Montreal.

Cultural Learning Alliance website, Available online: **http://www.culturallearningalliance.org.uk/page.aspx?p=100**, [accessed May, 2013].

Damasio, A. (1996), *Descartes Error*. London: Macmillan.

Damasio, A. (1999), *The Feeling of What Happens: Body, Emotion and the Making of Consciousness.* London: Vintage.

Damasio, A. (2003), *Looking for Spinoza: Joy, Sorrow and the Feeling Brain*. London: Heinemann.

Day, C., Sammons, P., Kington, A., Regan, E., Gunraj, J. and Towle, J. (2008), *Effective Classroom Practice: a Mixed Method Study of Influences and Outcomes. Interim report submitted to the Economic and Social Research Council*. Swindon: ESRC. Available [online]: **http://www.esrc.ac.uk/my-esrc/grants/RES-000-23-1564/read**[accessed December, 2012].

Department for Education, 2004. The Music Manifesto. Department for Education.

Devonshire Royal Commission, 1875, quoted in House of Commons Science and Technology Committee, 2002. *Science Education from 14-19*, Third report of session 2001-2002, Volume 1 para 1. London: The Stationery Office Limited.

Devonshire Royal Commission, 1875, quoted in House of Commons Science and Technology Committee, 2002. *Science Education from 14-19*, Third report of session 2001-2002, Volume 1 para 1. London: The Stationery Office Limited.

Dunne, M., Humphreys, S., Sebba, J., Dyson, A., Gallannaugh, F. and Muijs, D. (2007), *Effective Teaching and Learning for Pupils in Low Attaining Groups (DCSF Research Report 011*). London: DfES [online]. Available [online]: **http://www.northamptonshireobservatory.org.uk/docs/doclowattaininggroups070928145340.pdf** [accessed December, 2012].

Dweck, C. S. (1999), *Self Theories: Their Role in Motivation, Personality, and Development* . Hove: Psychology Press, Taylor and Francis Group.

Education Scotland website: *What is Curriculum for Excellence?* Available [online]:**http://www.educationscotland.gov.uk/thecurriculum/whatiscurriculumforexcellence/index.asp** [accessed, May 2013].

Elliott, D.J. (Ed.), (2009), *Praxial Music Education: Reflections and Dialogues*. USA: OUP

Fielding, M. (2007), 'The human cost and intellectual poverty of high performance schooling: radical philosophy, John McMurray and the remaking of person-centred education'. *Journal of Educational Policy*, 22, (4), 383–409.

Freire, P. (1970), *Pedagogy of the Oppressed*, 2Rev Ed. ed. Penguin.

Galanouli, D. (2010), *School-Based Professional Development: a Report for the General Teaching Council for Northern Ireland*. Belfast: General Teaching Council for Northern Ireland. Available [online]: **http://arrts.gtcni.org.uk/gtcni/bitstream/2428/96693/1/School_Based_Report_April2010.pdf** [accessed March, 2013].

Gray D.E. (2004), *Doing Research in the Real World.* London: SAGE Publications.

Green, J. (2005), 'The Music Curriculum as Lived Experience: Children's "Natural" Music-Learning Processes' in **Music Educators Journal**, *Mar.2005, 91: 4* (pp.27-32).

Goleman, D. (1996), *Emotional Intelligence.* London: Bloomsbury Publishing.

Guzetti, B.J. (2000), 'Learning Counter-intuitive Science Concept: what have we learned form over a decade of research?' in *Reading & Writing Quarterly, 16* (pp.89–98).

Hallam, S., Creech, A., McQueen, H. (2011), *Musical Futures: A case study investigation*. Institute of Education.

Hersch, R. H., Miller, J. P., and Fielding (Eds.) (1980), *Models of Moral Education*. New York: Longman.

Hewett, D. and Nind, M. (1998), *Interaction in Action, Reflections on the Use of IntensiveInteraction*. London: David Fulton.

Hill, A. L., Rand, A. G., Nowak, M. A. and Christakis, N. A. (2010), 'Emotions as infectious diseases in a large social network: the SISA model'*. Proc . Biol . Sci . 277, (1701),* pp. 3827–3835.

Hinton, C.; Miyamoto, K. & Della-Chiesa, B. (2008), 'Brain Research, Learning and Emotions: implications for education research, policy and practice1' in *European Journal of Education, 43:1, 2008.*

Hoban, G. F. (2002), *Teacher Learning for Educational Change*. Buckingham, Philadelphia: Open University Press.

Hobson, A. J., Malderez, A., Tracey, L., Giannakaki, M. S., Pell, R. G., Kerr, K., Chambers, G. N., Tomlinson, P. D. and Roper, T. (2006), *Becoming a Teacher: Student Teachers' Experiences of Initial Teacher Training in England*. Nottingham, UK: Department for Education and Skills.

Houlahan, M. & Tacka, P. (2008), *Kodaly Today: A Cognitive Approach to Elementary Music Education.* Oxford UK: Oxford University Press.

Isen, A. M. (2008), 'Some ways in which positive affect influences decision-making', in Lewis, M., Haviland- Jones J. M. and Feldman- Barrett, L. (eds), *Handbook of Emotions*. 2nd edn. New York: Guildford Press, pp. 548–573.

Hume, A., & Coll, R. K. (2008), 'Student experiences of carrying out a practical science investigation under direction; in *International Journal of Science Education, 30:9*, pp.1201-1228.

Hume, D. (1739), 'A treatise of human nature', in *Honderich, T. (ed.), (1995), Oxford Companion to Philosophy*.Oxford: Oxford University Press.

James, M. and Pollard, A. (Eds) (2006), *Improving Teaching and Learning in Schools: a Commentary by the Teaching and Learning Research Programme.* London: TLRP [online.] Available: **http://www.tlrp.org/pub/documents/TLRP_Schools_Commentary_FINAL.pdf** [accessed December, 2011].

Klein, J. (1987) *Our Need for Others and its Roots in Infancy*. London: Tavistock

Kyriacou, C. (1986), *Effective Teaching in Schools*. Hemel Hempstead. Hertfordshire,UK: Simon and Schuster.

Lang, P., Katz, Y. and Menezes, I. (eds) (1998), *Affective Education: A Comparative View*. London: Cassell.

Lave, J., Wenger, E. (1991), *Situated learning: legitimate peripheral participation.* Cambridge: Cambridge University Press.

Linden, J. van den, Renshaw, P. (2010), *Dialogic Learning: Shifting Perspectives to Learning, Instruction, and Teaching,* Softcover reprint of hardcover 1st ed. 2004. ed. New York: Springer.

Macmurray, J. (1935), *Reason and Emotion*. London: Faber and Faber.

Matthews, J. C. (1998), *Somatic Knowing and Education.* Educational Forum 62, no. 3 (Spring 1998): 236-242.

Matthews, B. and Snowden, E. (2007), 'Making Science Lessons Engaging, More Popular, and Equitable Through Emotional Literacy' in *The Science Education Review, 6:3, 2007 pp.1-16.*

Mehrabian, A. (1971), *Silent Messages*. Belmont, California: Wadsworth.

Mezirow, J. (1990), *Fostering Critical Reflections in Adulthood: A Guide to Transformative and Emancipatory Learning*. New Jersey: John Wiley & Sons.

Miller, F.P., Vandome, A.F., McBrewster, J. (2011), *Reflective Practice: Practice-Based Professional Learning, Professional Development, Organizational Learning, Jean Piaget, William James, Kurt Lewin, Donald Schön. Online:* Alphascript Publishing.

Mosteller, F. (1995), 'The Tennessee study of class size in the early school grades: the future of children'. *Critical Issues for Children and Youths, 5:2,* available on line from Princeton.edu [accessed 3 April 2010].

Mueller , A.; Le Clair, J.; Kechaidis, M.; Swain, W. and Macdonald , J. (2004), 'Playing with Pitch, Exploring and investigating the Science of Sound' in *Science Activities: Classroom Projects and Curriculum Ideas 40: 4 pp.11-20.*

Muijs, D. and Reynolds, D. (2010), *Effective Teaching: Evidence and Practice*. Third ed. London: SAGE Publications Ltd.

Musical Futures [WWW Document], (n.d.) available [online]: **https://www.musicalfutures.org/about** [accessed March, 2013].

National Audit Office (2010), *Educating the next generation of scientists (for DFE).* London: National Audit Office, Stationery Office.

National Foundation for Educational Research (2011), **Exploring young people's views on science education**, Available online: **http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtvm052732.pdf.** [Online]: Wellcome Trust [accessed March, 2013].

Nias, J. (1996), 'Thinking about feeling: the emotions in teaching'. *Cambridge Journal of Education*, 26, (3), pp.293–306.

Noddings, N. (1986), *Caring – A Feminine Approach to Ethics and Moral Education* California, USA: University of California Press.

North Music Trust [WWW Document],(n.d.) Sage Gateshead. Available [online]: http://thesagegateshead.org/about-us/north-music-trust/ [accessed March, 2013].

Perryman, J. (2007), 'Inspection and emotion' in *Cambridge Journal of Education 37:2 June* 2007.

Pollard, A. (ed) (2002), *Readings for Reflective Teaching.* London: Continuum.

Pollard, A. (2010), *Professionalism and Pedagogy: a Commentary Opportunity* (A Commentary by TLRP and GTCE). London: TLRP. [online]. Available: **http://www.tlrp.org/pub/documents/TLRPGTCEProf&Pedagogy.pdf** [accessed March, 2013].

Powney, J. and Watts, M. (1987), *Interviewing in Educational Research.* London: Routledge and Kegan Paul.

Prendergasta, M.; Gouzouasisb, P.; Leggoc, C. and Irwin, R.L. (2009), A haiku suite: the importance of music making in the lives of secondary school students*. Music Education Research, 11:3, September 2009,* pp.303-317.

Preston, S. D. and de Waal, F. B. M. (2002), 'Empathy: its ultimate and proximate bases'. *Behavioral and Brain Sciences, 25,* pp.1–72.

Renshaw, P. (2008), *REFLECT Evaluation Report.* Sage Gateshead.

Renshaw, P., Smith, W. (2008), *Reflect Co-mentoring Framework*. Sage Gateshead.

Renshaw, P., Smith, W. (2010*), REFLECT Lab Handbook*. Sage Gateshead.

Rogers, C. R. (1975), 'Empathic: an unappreciated way of being' in *The Counselling Psychologist, 5:2, 2.*

Rowe, N., Wilkin, A. & Wilson R. (2012), *Mapping of seminal reports on good teaching*. (NFER Research programme: developing the educational workforce) Slough: NFER

Salovey, P., Detweiler- Beddell, B. T., Detweiler- Beddell, J. B. and Mayer, J. D. (2008), 'Emotional Intelligence' in Lewis, M., Haviland- Jones, J. M. and Feldman- Barrett, L. (eds), *Handbook of Emotions* . 2nd edn. New York: Guildford Press, pp.534–535.

SCAA (1996a) *Consultation on Values in Education and the Community*. London: SCAA.

Schiefler, U. (1991), 'Learning, Interest and Motivation' in *Educational Psychologist. 26 (3&4)* pp.299-323.

Schön, D.A., (1984), *The Reflective Practitioner: How Professionals Think in Action*, New edition. Ashgate Publishing Limited.

Schön, D.A., (1986), *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions*, New Ed. ed. John Wiley & Sons.

Siraj-Blatchford, I., Shepherd, D.L., Melhuish, E., Taggart, B., Sammons, P. and Sylva, K. (2011), *Effective Primary Pedagogical Strategies in English and Mathematics in Key Stage2: a Study of Year 5 Classroom Practice*

Drawn from the EPPSE 3-16 Longitudinal Study (DfE Research Report 129). London: DfE [online]. Available: **https://www.education.gov.uk/publications/eOrderingDownload/DFE-RR129.pdf** [accessed December, 2011].

Skinner, B.F. (1956), 'A case history in scientific method' in *American Psychologist*, 11, 221–33.

Strauss, A., and Corbin, J. (Eds.) (1997), *Grounded Theory in Practice*. London: SAGE Publications.

Tesch, R. (1990), *Qualitative Research: Analysis Types and Software Tools*. Basingstoke: The Falmer Press.

The Royal Society, 2004. 'Response to the Treasury's consultation' in *Science and innovation: working towards a ten-year investment framework* The Royal Society Policy Document 11/04 available at: **http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2004/9708.pdf** (accessed May, 2013)

The Wellcome Trust, 2010. *The Wellcome Trust Monitor (Wave 1),* Available [online]: **http://www.wellcome.ac.uk/About-us/Publications/Reports/Public-engagement/WTX058859.htm** [accessed March, 2013].

Vygotsky, L.S. (1978), *Mind in Society.* London and Massachusetts: Harvard University Press

Vygotsky, L.S. (1986), *Thought and Language*. Translation newly revised by Alex Kozulin. Cambridge, MA: MIT Press.

Watson, B. and Ashton, E. (1995), *Education, Assumptions and Values*. London: David Fulton.

Wegerif, R., 2012. Dialogic: Education for the Internet Age. London: Routledge.

Wilson, E. (2009), *School based research: a guide for education students*. London: SAGE Publications Ltd.

Appendix 1: Additional context reading

1. Science context

Science and its constituent disciplines, Technology, Engineering and Mathematics (STEM), are considered to be crucial to the future wellbeing of the UK, European and global economies. Successful development is dependent upon both an adequate supply of scientists and engineers at all levels of industrial activity and on populations which recognise and value the contribution that STEM makes to the society in which we live.

Achieving these goals depends on the quality of education in general, and science (the focus of this report) in particular, in schools and colleges, concerns about which have been expressed in many quarters for more than a hundred years. *"The present state of scientific instruction in our schools is extremely unsatisfactory."* (Devonshire Royal Commission, 1875). The challenges facing us today are no less troubling. *'There is now considerable evidence that children's interest in school science declines from the age of ten onwards.'* (Aspires Project, 2013).

Students' lack of identity with science continues to give serious grounds for concern, not only in terms of the economic challenges but also from the point of view of accepting science as an integral part of our cultural heritage.

2. The science curriculum

Prior to 1989, science was taught and taken by the majority of young people in all secondary schools, usually through one or more of the three constituent subjects of biology, chemistry, and physics. Many students stopped studying any science at the age of 14 and only a minority continued study beyond 16. The introduction of the National Curriculum in England, Wales and Northern Ireland in September 1989 made it a statutory requirement that all young people should study science up to the age of 16 through programmes of study set out in Key Stages (KS) 1 to 4. (KS1 includes children aged 5 to 7; KS2: children aged 7 to 11; KS3: children aged 11 to 14; KS4: children aged 14 to 16). Assessment was conducted through national assessment tests (referred to as 'the SATs) at the end of Key Stages 1, 2 and 3. GCSE examinations were taken at the end of Key Stage 4.

3. Teaching and Learning in Science

There is a strong tradition of curriculum development in both primary and secondary science education and a continual quest for improving approaches to teaching and learning. The list of initiatives, both big and small, is extremely long, but there are clear strands running through them, the most prominent of which are:

- The drive to improve the quality of scientific investigations, practical work and 'hands-on' activities;
- the desire to set scientific ideas and concepts into contexts to which young people relate and consider to be of relevance to them; and
- the increasing demand to ensure a high quality science education for all young people.

The extent to which these elements are incorporated into teaching and learning in science depends on an understanding of what is meant by 'science'. For many people science, and school science in particular, is seen as a collection of facts which are fixed and that science provides 'answers' that are 'right' or 'wrong'.

This is a misconception of science. Science is not a collection of facts; it is a process of investigation, collection and interpretation of evidence building on existing knowledge to better understand the natural, made and social worlds in which we live. It is about asking questions, experimentation and curiosity which adds to, and modifies, the body of existing knowledge. Ensuring that science is seen in a way that is relevant and inspiring (context) is as

important as acquiring breadth and depth of science-subject knowledge (content). Individual scientific disciplines, alongside mathematics, are vital ingredients in developing a conceptual understanding of the world.

Providing experiences which incorporate the above elements into day-to-day teaching and learning in school is not easy given the overall pressures of accountability on schools today. However, it is possible, and to a large extent it requires a change in mindset as much, if not more, than a change in actual activities. It is about the way in which such activities are approached and the levels of challenge through questions and opportunities for developing productive lines of enquiry over which pupils have some degree of control.

The Music Lab project offered a unique opportunity to look at teaching and learning in science from a very different perspective – that of community musicians.

4. Learning Science and Music: Some questions

Space does not allow an extensive discussion of the similarities and differences between the philosophies and practices in teaching and learning of music and science. However, bringing these two disciplines together, as has been the case in the Music Lab project, does raise a series of questions that are worth reflecting on in order to better understand the background and context of this project.

Four issues seem particularly pertinent: How do we present, think about, do, and share science? And how do they differ in relation to music?

Presenting science

In presenting science, most initiatives emphasise the ‘excitement’, ‘fun’, ‘wow factors’, the ‘bangs and the flashes’. All are important, but there are other aspects which get less emphasis and perhaps need to be given a higher profile. For example:

- How often do we talk about the ‘beauty’, ‘fascination’, ‘meaning’, ‘feelings’, ‘intrigue’, or the ‘stories’ of science (terms frequently used in relation to the arts)? And why are the descriptions we use important? Is it because they relate more to our emotions and are, as a consequence, somehow more engaging?
- How often do we present the different ‘genres’ of science? Science is not homogeneous. It has different aspects, not necessarily the different disciplines, which appeal to different groups of young people in a similar way that they prefer different types of music.

Thinking about science

We tend to think about science as being ‘thoughtful’, ‘systematic’, ‘logical’, and that it ‘proves things’ thus getting ‘right’ answers. How often do we think about science as being ‘imaginative’, ‘creative’ or involving the exploration of ideas’? All are essential elements of science but are rarely made explicit. There are of course aspects of music education that require a high level of technical skill and understanding. For example, there are absolutely ‘right’ and ‘wrong’ ways of constructing harmony in tonal systems.

The issue therefore is about pedagogy and not subject. But is there more of a tendency to apply pedagogical approaches that are more aligned to concerns about stimulating more creative, participatory and collaborative approaches in music than in science?

Doing science

In school, doing science and practical work are almost synonymous. Teachers and students do experiments to ‘prove’ things, to ‘test’ something, and to investigate phenomena in a controlled manner. How often are there discussions about, for example, the need to practice techniques in order to ensure that the equipment is being used properly and the need to repeat measurements and experiments in order ensure that findings are reliable? Does this approach function to diminish a sense of curiosity?

The equivalents in music would be the process of learning particular pieces of music or tonal scale where the emphasis is on the development and application of taught skills and knowledge. However, does the freedom afforded by the opportunity to then apply these skills in new, experimental and unfettered ways make a difference to the motivation of the learners?

Sharing science

Traditionally, science is shared through formal written papers and lectures, a practice that is consistently replicated in schools. Opportunities to discuss the outcomes of investigations, exploring alternative viewpoints or conflicting evidence are used infrequently. However, the use of different media and performances to convey particular ideas are frequently used by science communications in science centres or television. Music and the arts in general have a tradition of using 'performance' as a means to communicate ideas. They also have a strong track record of participatory-led practice that focuses on engagement (in the subject) through active participation where the outcome may or may not be a performance or an exhibition. In these circumstances the quality of participation is measured by:

- The extent to which everyone in the space is involved in it; and
- how they feel about their involvement.

So what lessons can be gleaned from these approaches in the context of KS3 science and how do they impact on the student's engagement and motivation to learn about the subject?

5. Sage Gateshead and approach to music participation[13]

Motivating and engaging young people in learning through engagement with the arts has for many years been utilised in many learning and school settings. Sage Gateshead has particular expertise in pursuing the development of participatory music practice in this context.

Sage Gateshead is a dynamic 'learning organisation', which has quickly become a leader in the UK cultural sector since it opened in 2003. Recognised for its high-profile physical premises and the international programme of performance housed therein, the organisation's overall artistic programme is diverse, centred around a mission to *"entertain, involve and inspire each and every person we meet through engagement with outstanding music and creative events."*[14]

It expresses its artistic vision as being equally constituted of both *performance* and *participation*, emphasising the value of immersion by participation in specific musical practices as a key factor in developing an appreciation of musical practices in general.

The organisation's performance programme spans inspirational music events across all genres in its internationally acclaimed concert halls, with a particular feature of the Northern Sinfonia, orchestra of Sage Gateshead, and an associated classical programme alongside an ambitious programme of folk, jazz, popular and contemporary music.

The organisation also delivers an extensive programme of Learning and Participation, including undergraduate music degrees, a Weekend School for talented young musicians alongside a Youth Music-funded programme, Foundation Learning, Creative Apprenticeships, aspects of the national Sing Up programme, as well as extensive participatory programmes for schools, early years and adults, including the over-50s.

Sage Gateshead opened around the same time as the Music Manifesto (Department for Education, 2004) was published. This important policy document emphasised the importance of recognising the value of musical learning that children and young people undertake outside of the formal

[13] Thank you to Dave Camlin, HE & Research Programme Leader, Sage Gateshead, for writing this section of the report.

[14] Follow link for further information about the mission and values of The Sage Gateshead. http://www.sagegateshead.com/about-us/who-we-are/north-music-trust/

curriculum. In response, Sage Gateshead has developed its music education offer for young people (with a variety of funding partners) to ensure there are opportunities in the region for children and young people from all backgrounds and musical interests to progress and develop musically.

With support from Youth Music as far back as 2000, before the building opened, Sage Gateshead had established a comprehensive regional network of music education opportunities for children and young people of all ages and backgrounds through its Youth Music Action Zone (YMAZ) and other initiatives.

By 2007, the organisation had established itself well enough in the UK music education sector to successfully lead the national singing initiative Sing Up, with Youth Music. In recent years, with the advent of music education 'hubs', it has established itself as an important part of the regional music education landscape, an aspirational venue for musicians of all ages and abilities.

Pedagogical approach

While the specific practices of its educational projects and contexts remain diverse, there are a number of pedagogical features which are emphasised within its overall programme. The principles of access and inclusion strongly characterise its educational offer, with many projects targeted at particularly excluded, disaffected or hard-to-reach groups of participants.

Similarly, the notion of dialogue and of dialogic learning (Bakhtin, 1981; Elliott, 2009; Freire, 1970; Linden and Renshaw, 2010) is emphasised within its practices, where listening to participants and their interests is critical in designing learning to support their progress. It implies a particular kind of teacher-student relationship, one where at its extreme *"the teacher is no longer merely the-one-who-teaches, but one who is himself taught in dialogue with the students, who in turn while being taught also teach. They are jointly responsible for a process in which all grow." (Freire, 1970)*

Initiatives like Musical Futures (Hallam et al., 2011; "Musical Futures," n.d.), which promote *"a set of pedagogies that bring non-formal teaching and informal learning approaches into more formal contexts"* ("Musical Futures," n.d.) might be seen to arise from similar such principles.

Of course, this notion of dialogue as a pedagogic principle is not exclusive to music education, but is emphasised within musical practices because of the nature of musical interaction. As Daniel Barenboim observes:

> *"In a spoken dialogue between two human beings, one waits until the other has finished what [they have] to say before replying or commenting on it. In music, two voices are in dialogue simultaneously, each one expressing itself to the fullest while at the same time listening to the other. We see from this the possibility of learning not only about music but from music – a lifelong process."* (Barenboim, 2009)

Sage Gateshead Musicians

For Sage Gateshead, the process of dialogue has also been a significant factor in the methodology for growing its own workforce to deliver its educational programme. Mentored in-house training programmes have resulted in over 100 musicians being trained by the organisation over the last ten years to become a significant core of its workforce, establishing dialogue between 'newcomers' and 'old timers' (Lave and Wenger, 1991) as a means of supporting such 'newcomers' to become full members of the many and diverse *communities of practice* found within the organisation's educational programme.

The value of individual and peer-assisted reflection is exemplified in a number of learning theories (Beaty, 1997; Bolton, 2010; Boud et al., 1993; Calderhead and Gates, 1993; Elliott, 2009; Lave and Wenger, 1991; Linden

and Renshaw, 2010; Mezirow, 1990; Miller et al., 2011; Schön, 1984, 1986) and is considered of great importance within the organisation.

This emphasis on reflective dialogue as a valuable means of professional development led to Sage Gateshead's successful delivery for Creative Partnerships of their national co-mentoring initiative, REFLECT (Renshaw and Smith, 2008; Renshaw, 2008), and subsequent bespoke professional development project REFLECT Lab (Renshaw and Smith, 2010).

All of these developments were significant in Sage Gateshead's development of the pedagogical model of the UK's first BA (Hons) in Community Music with University of Sunderland, launched in 2009. On the course, students develop their musical skills at the same time as learning how to apply those skills to support others' musical development. Conceived as 'Situated Learning' (Lave and Wenger, 1991) in its purest sense, students learn about how to facilitate and lead an effective group process by participating in, and reflecting on, their own experiences of being part of a group, where everyone's perspective is to be accounted and everyone's voice is worth hearing.

Appendix 2: Description of the schools and their projects[15]

School 1

An 11-18 mixed, sponsor-led academy, with 1,500 students on roll, serving a town of approximately 35,000 in Northumberland. Just over 10% of students are eligible for free school meals. The percentage of pupils with a Special Education Needs statement or on School Action Plus is just under 5%. The proportion of students who do not have English as their first language is very low at less than 1%.

The participants

The three cycles of the project involved 4 science teachers, a community musician and 100 young people from Year 8. Their programme involved the delivery of 29 sessions.

The project

The project explored the relationship between music and science education from a number of perspectives: initially by considering the impact on science-subject learning of listening to music, which extended to include the impact of composition on subject engagement. Emotive music and images were used to accompany the introduction to different topics, including creating a graphic score for a chemical reaction and asking the students to select their own music for their presentation.

In the second cycle, the notion of 'performance' was explored, with students creating and presenting short performances around agreed areas of the KS3 science curriculum. Four classes devised performances on one topic to help the other classes revise, and performed them for the rest of their half-year group in the school's lecture theatre. The young people were encouraged to be as creative as possible in their performances, drawing on music, drama, and visual arts, as well as ensuring scientific accuracy. By having a half-year group involved in a process of devising, rehearsing and performing in the lecture theatre in front of a large audience, it was hoped that a level of excitement, and possibly competition between classes, would be generated, leading to the emotional engagement of participants.

In the third cycle, a smaller group of students used their previous experiences to devise and rehearse a creative science activity session for Year 6 pupils.

School 2

A mixed 11-16 comprehensive foundation school with 700 students on roll, serving a town of over 25,000 inhabitants in County Durham. The proportion of students on School Action Plus or with a statement of Special Educational Needs is just over 9%. Just over 17% of students are eligible for free school meals. 1% of students do not have English as their first language.

The participants

A science teacher, a community musician and 28 Year 8 students were involved in the project, participating in a total of 13 sessions. The school's community arts coordinator acted as project coordinator.

The project

The first cycle was concerned with investigating how giving students opportunities for choice and decision-making affected engagement. The science teacher delivered a series of lessons varying from a highly structured teacher-led approach through to an open-ended lesson where students were invited to engage in a process of exploration.

[15] Thanks to Sage Gateshead Music Lab team for providing the information included in this section.

The second cycle involved investigating whether it was possible to tap into students' intrinsic motivation beneath what was perceived to be the more commonly promoted motivator in schools, that of exam success. The team were also interested in finding out whether a community musician's pedagogy of practice coming before theory, as in the Kodaly method (Houlahan and Tack, 2008), could work in a science learning context in a school. The musician and the science teacher alternated lessons, with the musician delivering content via a series of open-ended investigative 'challenges', while the science teacher retained a more formal and structured teacher-led pedagogy.

In the third phase, the focus was on whether engagement would be greater when lessons were led by the young people themselves. Planning sessions were held between the project team and a group of four students, who then went on to deliver two lessons to their peers.

School 3

An 11-18 mixed academy with just under 1,200 students on roll, serving a town of approximately 200,000 in Tyne and Wear. Over 9% of students do not have English as their first language. 25% of students are eligible for free school meals. The proportion of students with a statement of Special Educational Needs or on School Action Plus is 7%.

The participants

This project involved both a science teacher and a performing arts teacher from the school, working with a community musician. A total of 19 sessions were delivered for 67 students from Years 7, 8 and 9.

The project

The music teacher had been recognised within the school as providing particularly engaging lessons for KS3 students. By involving this teacher in the project with a community musician from Sage Gateshead and a science teacher from the school, it was hoped that the three would support each other to critically reflect on their practice and thus begin the process of dialogue about student engagement across all departments, which was one of the school's aims.

In Cycle 1, the musician and the music teacher delivered a series of musical composition sessions with a small group of six KS3 students. The aim was to investigate what impact learning science through music had on levels of engagement and whether the 'embodied' nature of the learning had any impact on retention of the information.

In Cycle 2, this approach was scaled up to two community musicians working with a class of thirty Year 9 science students and their teacher, but the activity was stopped part-way through as staff were concerned that the young people felt too exposed by the activities.

In Cycle 3, the musician observed a series of lessons taught by the science teacher and the music teacher to Year 7 students. At the end of the observations a three-way conversation was facilitated in which the three participants reflected on what they do to successfully engage young people in learning.

School 4[16]

The school

An 11-18 mixed community comprehensive school with 1,400 students on roll serving an area of Newcastle-Upon-Tyne. The proportion of students known to be eligible for free school meals is 18.5%. Just fewer than 10% of students have a Special Educational Needs statement or are on School Action Plus. A small minority (just over 4%) do not have English as their first language.

[16] The school originally recruited to participate in the programme had to withdraw thus the time allocated for the 'replacement' school (School 4) was limited to one term.

The participants

Five practical sessions were delivered to 4 science teachers by the community musician in one cycle of activity.

The project

The project provided opportunities for KS3 science teachers to reflect on their approaches to teaching and learning through participation in a musical learning process. The musician worked with teachers at various stages in their teaching experience, teaching them, as complete beginners, to play the steel pans.

The teachers were supported to reflect on their learning during the activity, gathering reflections through an online *Posterous* site, as well as video, audio and photographic data. The reflective activities supported them to develop insights into how they learn in an unfamiliar setting, which in turn informed their approaches to designing learning for their KS3 students.

The project culminated in a final performance for teaching colleagues.

Appendix 3: Defining the enquiry and understanding the brief

From the start, the programme was guided by a clear point of enquiry and a commitment to reflect on feedback from the programme to inform the trajectory of the enquiry.

The initial enquiry question, established by Music Lab Advisory Board[17], was:

'How can we engender the levels of emotional engagement and personal passion for STEM subjects in young people at KS3 that we typically see in their relationship with music?'

However, discussions between the teachers, musicians and advisors following the end of the first cycle revealed concerns about the apparently one-sided nature of the exchange implicit in the question.

There was a questioning of assumptions behind the research questions, including the nature of young people's relationship to music and the nature of science teaching. One of the musicians expressed the view that the initial research question was based on a mistaken assumption about young people's relationship to music because young people's *'emotional engagement and personal passion'* for music is much more to do with issues of identity and their *'alignment with particular social groups'* and thus cannot be easily transferred to the learning situation. However, Archer et al (2010) argue that the same applies to the students' identities in relation to science.

A science teacher on one of the projects expressed the view that a mistaken assumption that science teaching was didactic and uninspiring lay behind the overall rationale for the project. Other participants said they had assumed that science students would be disengaged but that their projects had shown this not to be the case.

Consequently it was felt that this would impede a collaborative spirit of enquiry and, as a result, the question was reviewed to reflect a more equal exchange of perspectives:

'How can teachers and musicians work together to improve the learning of KS3 students in STEM subjects?'

This dialogue also resulted in the design of an overall evaluation framework that was used by the project teams to help plan and reflect upon the outcomes of their final two enquiry cycles. It was also used to inform the design of the semi-structured interview schedules.[18]

Challenges associated with the brief

Feedback from the musicians and science teachers indicated that many of them found it difficult to make sense of the research 'brief' and devise projects that they felt would lead to new learning about practice. Some struggled with the role of music in the projects and what links to science needed to be shown. Some were comfortable with the idea that as long as musicians and scientists were exchanging ideas and engaging in a dialogue it didn't matter if the presence of music in the methodology was overt, while others felt the need for the connections with music to be apparent.

[17] See Acknowledgments for membership of the Music Lab Advisory Board.

[18] See Appendix 5: Sample Music Lab interview schedule for further details.

Appendix 4: Research methods

The findings in this report are based on a qualitative methodology. The key data collection method chosen was semi-structured interviews, which were designed to capture the thoughts and feelings of school staff, musicians and students, and to identify significant and common findings across all four research projects.

1. Data generation

Semi-structured interviews are often considered the 'gold standard' of qualitative data-collection methods (Barbour, 2008). They were chosen in order to give participants more freedom to voice their views (Cohen et al 2007; Powney and Watts, 1987; Burgess, 1982). Although time-consuming to transcribe and rigorously analyse, they support participant voice and value their opinions while systematically considering all the relevant issues.

The more open-ended questions can generate original and unexpected data (Wilson, 2009), which can challenge the existing literature and shed new light on previous theory with the potential of generating novel theory. More especially the data is rich and often explanatory, offering greater understanding of why educational strategies are or are not effective from the participants' perspectives and can give insight into human motivation and experience in learning contexts.

The interviews took place between April and November 2012, at the end of the second and third cycles of three of the projects and at the beginning and end of a single cycle of activity in the fourth project where there had been a change of schools. Two teachers who were not available to be interviewed wrote written responses to the interview questions, which were incorporated into the data set.

Questions were designed to be flexible enough to allow a deeper exploration of individuals' perceptions, feelings and practice (Cohen et al, 2007). Participants were encouraged to be honest and say what they felt in as much depth as they felt necessary (Gray, 2004). Most interviewees were happy to talk at length about their feelings and experiences. The interviewers did not know the participants before the start of the projects, but efforts were made to create a relaxed, friendly and informal approach in the interviews, all of which took place in the schools, a setting that was naturalistic from the point of view of the participants.

The interview schedule (see Appendix 5), was mainly based on five key areas that had been identified in facilitated reflections at the end of the first phase of the project, namely Choice-making, Deep Learning, Exploration and Risk/Challenge, Emotional Learning, Knowledge.

Questions were adjusted to account for the different perspectives of the participants and interviewers were given licence to probe with follow-up questions, as appropriate to the situation. The interviews produced a very rich data set through which to understand and clarify the research issues and from which to build theory. Interviews generally lasted between fifteen and fifty minutes.

In order to ascertain the students' views in greater number, the interviews were conducted in groups of two or more depending on the projects and schools. Paired or small group interviews can build dynamic interactions, which can enable deeper exploration of issues and improve participants' confidence (Wilson, 2009). Larger groups, which are more susceptible to 'group think' or over-domination by leading characters, were avoided.

Due to the different nature and phases of the projects, some teachers and musicians were interviewed or wrote written responses to the interview schedule twice. Ultimately there were thirteen interviews or written responses from nine teachers; seven interviews from four musicians; five group interviews with students, involving seventeen young people and two interviews with the extended learning coordinator from one school who was responsible for coordinating that project.

2. Data analysis

Grounded theory methodology was adopted to analyse the overarching interview data in this exploratory study because of its appropriateness for evaluating participants' perceptions systematically (Strauss and Corbin, 1997) and for gaining an in-depth understanding of complex human interactions in educational environments (Tesch, 1990). At the same time, it is important to be aware of the limitations of small-scale qualitative research and its generalisability (Robson, 1993).[19] However, detailed exploratory studies involving rich descriptions and multiple perspectives can illuminate educational issues both for the current participants to help evolve their practice and also more widely for practitioners in similar educational contexts, provided the research context is clearly explained. Additionally the theoretical discussion and understanding developed through the study can help illuminate understanding of relevant educational issues more generally.

The interviews were recorded, transcribed and analysed manually. The transcripts were coded minutely initially and then the codes were reviewed and revised into over seventy separate categories. Eventually the categories were merged and synthesised into a more coherent set of sixteen themes, the four most significant of which are examined in detail in the Key Findings section, with minor themes integrated where significant.

A series of discussions with the 'critical friends' in the project research team, around both emerging themes and later the relationship to the theory, helped to increase the depth of thinking and the validity of the data (Burton et al, 2008).

3. Research support

Flo-culture, an organisation specialising in research and learning in arts and cultural engagement, was appointed to support the school-based research teams to develop their action-led enquires. Flo-culture was also responsible for conducting a programme of qualitative research (the subject of this report) based on the reflections of the project participants, which connected their experiences to relevant theories to add depth and understanding to the field work.

[19] Bearing in mind the approach was not to find generalisations in the findings, rather capture similarities and differences in the views expressed by the participants that help us understand the consequences of their experiences.

Appendix 5: Sample Music Lab interview schedule

The schedule below was used to direct the interviews with teachers. This schedule was adapted to accommodate interviews with students and musicians.

Music Lab: Interview schedule for teachers

Introduction

Confirm how the information will be used and that it will be anonymised etc.

Confirm on record: Date / Interviewer / Teacher(s) / School

Background

M or F

Age range: under 29 | 30 – 49 | over 50

How long have you been a teacher?

How long have you been teaching at this school?

What are your specialisms or main interests as a teacher?

1. Introductory questions

1.1 When and how did you get involved in Music Lab?

1.2 What has been your role in the project?

1.3 What were you interested in finding out initially?

Probing questions:

- Was this shared?
- Did you all have the same ideas?

2. What are you actually finding out?

Probing questions:

- What do you mean by that?
- Can you elaborate on that?
- Why is that important?
- How do you know?
- Can you give me an example?
- Why did that work?

3. Moving on to the specifics

3.1 **Choice making** - Can you tell me about any aspects of the project that have involved giving the student more choice in their learning? Also in what way has this choice impacted on their learning/ attitudes to learning? Why is that?

3.2 **Deep learning** - was there anything different about the quality or depth of learning in this project compared with usual lessons? (E.g. has there been any impact on levels of enjoyment; motivation, sense of purpose?)

3.3 **Exploration and risk/challenge** – Can you tell me about any aspects of the project that has involved you in facing a challenge or exploration of new ideas or ways of working?

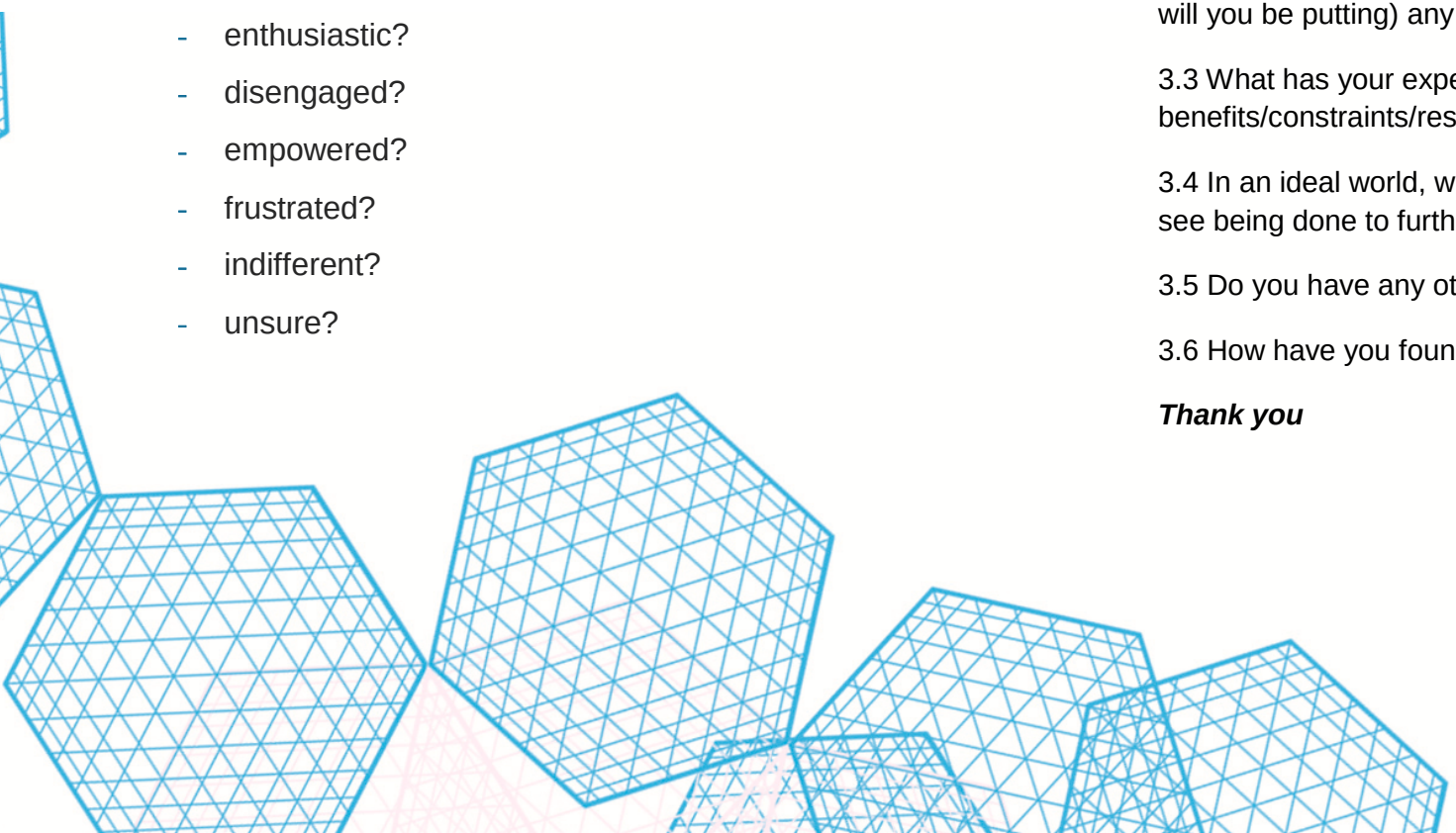
Probing questions:

- How did you feel about that? Why is that?
- Has this had an impact on your attitudes towards teaching? Why is that?
- Do you think it has had an impact on the pupils' attitude towards learning? Why is that?
- Can you tell me about any aspects of the project that has involved your pupils (s) trying something new or facing a challenge?
- Do you think it had an impact on their learning? Why?

3.4 **Emotional learning** - What did the student involved feel about the things you have been doing and how did they show their feelings? How do you feel about the things you've been doing on the project?

Prompts:

- enthusiastic?
- disengaged?
- empowered?
- frustrated?
- indifferent?
- unsure?



3.5 Knowledge - What have the students learned from the project?

Probing questions:

- What have they learned in terms of factual knowledge?
- What have they learned about themselves as learners?
- What new skills have they learned?
- Has the learning been different in any way from learning in usual lessons?
- How do you know?

4. Winding up questions

3.1 What have you so far learned or done differently as a result of being involved in this project?

3.2 And how has this been reflected in your own practice? (Have you put (or will you be putting) any lessons learned from this into practice?)

3.3 What has your experience been like in trying to do this? (What are the benefits/constraints/results/barriers?)

3.4 In an ideal world, without any constraints, what would you do or like to see being done to further develop the science teaching in school?

3.5 Do you have any other comments on the project so far?

3.6 How have you found this interview?

Thank you

Appendix 6: Good Practice identified in developing research partnerships in schools

Through the delivery of the project, the project teams learned a good deal about the process of 'situating' research processes inside school environments. This learning highlighted a number of issues of good practice that are worth noting in the context of future research programmes of this nature. They include:

1. Research approach

Nature of the enquiry

a) As highlighted in Appendix 3: Defining the enquiry, it clearly helps the research project's progress when all those involved in the delivery of it (as well as those directing the project, i.e. an advisory board) share a clear understanding of the brief and the nature of the research;[20]

Data collection and analyses

Continual reflection and learning is vital to progressing the development of practice and generation of findings in relation to this type of project. Therefore, projects of this nature are more effective when:

b) A commitment to data capture, reflection and evaluation is built into the project from the start,

c) those involved have the necessary skills to undertake the work required;

d) Roles and expectations around the above - as well as the research proposition - are scoped out and built into the partnership agreements and contracted at the outset;

e) In particular, being clear about who will be responsible for gathering and analysing primary data is critical, and whether this is something that school research partnerships have the time and capacity to accomplish, or if they don't, what levels of support are required to manage this effectively;[21]

School-based research

The project faced a number of challenges associated with conducting research in schools, which in turn highlighted areas of good practice to help overcome such challenges and ensure the maximum benefit to all parties, including:

f) Ensuring teachers have enough dedicated time to read, interact and collaborate with others effectively;

[20] Believing the task to be about 'proving' something rather than 'understanding', 'reflecting on' or 'discussing' something can significantly alter the design of the activities undertaken. In the case of Music Lab the 'emergent' nature of the Action Research in the early stages of the programme led to some anxiety amongst some of the project teams about the specific function and nature of the research and disparities in how the teams approached designing their projects. This was exacerbated further due to different levels of experience and knowledge amongst the teams about different research approaches, as discussed below.

[21] In relation to Music Lab, it had been the intention that the individual project research teams would be responsible for gathering and analysing primary data from each of their projects. Unfortunately, in the main, the project teams didn't have the necessary experience (and possibly time) to enable them to undertake this task in a rigorous and consistent manner. Support for the teams was offered via a data capture workshop, but unfortunately attendance was low so the impact was minimal. As a result, semi- structured interviews were introduced in order to ensure appropriate data was generated to inform the research element of the project. Adopting this approach ensured that the necessary rigour and consistency in data capture was secured.

g) Early establishment of guidelines and clear commitments, built into delivery agreements.

h) Researchers and external agents similarly being aware of the relentless nature of the teachers' role and the continuous pressure and constant deadlines they work to.

2. Leadership and management

Securing the strategic commitment of all partners involved in a project such as this is crucial. It is possible that in the context of MUSIC Lab an inconsistent strategic commitment by some schools resulted in some delivery challenges. This manifested itself in one of the schools being withdrawn and in other cases may have contributed to delivery delays. Key issues to ensure effective leadership and management of projects such as this include:

i) Securing senior level 'buy in' to the project at an early stage in negotiating participation in a project such as this; Securing senior management commitment and knowledge about the project may increase the effectiveness of the school to learn from these experiences and embed some of the approaches explored.

j) Supporting and guiding heads and teachers unfamiliar with research processes, not only in the methods and approaches, but also to ensure teachers are aware of the time and commitment required to do it well. School-based research can be carried out poorly if sufficient guidance is not available.

k) Ensuring that as part of this commitment those who are given the responsibility to lead on the delivery within the school are afforded the time, freedom and authority to do so.

l) Ensuring that other delivery partners - in Music Lab's case the musicians - are also given the necessary space and time to reflect on their practice in collaboration with the teachers.

m) Negotiating and agreeing clear roles and responsibilities at an early stage, and giving due consideration to the range of skills and level of influence required to undertake the roles identified. [22]

n) Appointing a project co-ordinator at school level where possible - this results in significant benefits at a strategic and project delivery level.

3. Shared ownership and learning

Developing a strong sense of shared ownership and collective ambition is key to the success of any cross-disciplinary, cross-sector project. Participation in group meetings with peers involved in other strands of the project helps to strengthen the collective ambition and drive of the programme, and therefore participation in these joint activities should be a key requirement of any partner's involvement in a project such as MUSIC Lab.[23]

[22] In a project such as MUSIC Lab, for example, although the musicians and teachers had clear roles to play in the management and research elements, feedback confirmed that in some cases they found it difficult to undertake these roles effectively alongside their primary role as practitioners.

23 Despite a clear programme of joint project and advisory board meetings being established early on in the project, teachers found it difficult to attend these meetings. This reduced the number of opportunities for teachers to learn from one another's experiences and connect the work they were undertaking to established theories on learning.

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