Building a bridge

towards progression in science teaching and learning (7-14 years)

Bridging the primary and secondary transition by focusing on curriculum and pedagogical progression in the science classroom.

Reflecting on the Inclusive Science Teaching and Learning Project by the Science & Engineering Education Research and Innovation Hub (The University of Manchester) supported by Trafford Teaching School Alliance and the Comino Foundation

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> *Language shapes the way we think and determines what we can think about.*
>
> **Benjamin Lee Whorf**

Foreword

This was a key question I asked of myself, my organisation and the sector a few years ago, as we embarked on teacher development project focused on bridging the primary and secondary transition. We asked this question many times when thinking about how we teach science, how we plan for inclusive science learning and how we support pupils to make progress in science.

The answers often left us wanting to do more!

So, no sooner was the 'Shining a Light on inclusive science teaching and learning (7-14 years)' off the press, that this new study was initiated. With the inspirational commitment of Trafford Teaching School Alliance, Trafford Council and the Comino Foundation, we have continued to unpick and professionally challenge what happens at the critically formative stage of learning between primary and secondary school.

Giving teachers time to talk about the way they teach and what influences the way that learning is curated is still too poorly supported. Teachers talking about how pupils' science learning progresses between school settings is even more poorly supported, often with little or no time between science teachers to explain or communicate.

In this project, we had the time to give, the time to talk, the time to be inspired, the time to challenge, the time to forge partnerships, the time to forge friendships. Over two years of brokered interactions, we went back to ask, 'Are we doing enough?'

Hard to quantify in metrics, this reflection tells stories of insight, influence and action. Teachers in Trafford local authority working together over time to unravel the nuances of their practice. Enlightened by what each did, they came together to make a difference. To learn with and through each other's experiences – not to hold one up as better than the other – but to appreciate each other's approaches and understand them. By building understanding they developed confidence and knowledge about how they could weave their own practice to develop or support the experiences pupils had in science lessons.

Take the time to stop and ask yourself the question, 'Are you doing enough?'. Are you a senior leader who could do more to facilitate teacher time to talk? Are you a science teacher who could exploit the use of digital platforms or spaces to share your practice with teachers in partnership schools? Are you an influencer who can inspire others to look beyond their own field of work, and stimulate activity to build bridges between primary and secondary science teaching and learning?

My request is to do what you can – little and often.

It is through such a sector commitment that we may then harness stories of change like those you will read here. We need to do more. We need to influence progression in science learning for the benefit of each and every pupil we have in our care.

Professor Lynne Bianchi
SEERIH Director
The University of Manchester

Read the *Shining a Light on inclusive science teaching and learning (7-14 years)*

Project Aims

The Inclusive Science Teaching and Learning (ISTL) project built on the Smarter Choices project in which teachers engaged in collaborative reflective practice to focus on pupils' science learning experiences across the primary to secondary transition with a specific focus on disadvantaged pupils.

In a similar methodology, the ISTL project involved primary and secondary teachers working collaboratively to identify and address factors that influence pupils' progression in science across the transition from primary to secondary education. The project sought to enable teachers to:

- identify and understand the features and impact of educational disadvantage on pupils' science learning
- plan for and monitor progression in the science curriculum and its practice between primary and secondary schools
- use a range of inclusive science pedagogies to support pupils to make meaningful progress in science between primary to secondary school.

Two key areas of outcomes are expected (as aligned to DfE Standards of Professional Development Guidance 2017):

1. Improving and evaluating pupil outcomes
    - Scientific concepts are taught effectively at primary school to ensure that pupils' scientific understanding is robust
    - Teachers use a range of data (e.g. assessment, progress measures, pupil voice, lesson observation, work scrutiny) to improve understanding of pedagogy and assessment of progression in science between primary and secondary transition
2. Collaboration amongst colleagues
    - Teacher-to-teacher collaboration will be fostered and opportunities given for primary and secondary teachers to interact

Project Process

The project was developed and managed by the SEERIH team at The University of Manchester and involved schools from within Trafford Local Authority, with the primary schools' science subject leads working alongside secondary science teachers.

The group of teachers met 12 times across two years. The delivery took a hybrid approach with six face-to-face sessions and six online twilight sessions.

Each session included inputs from relevant experts in the field, links to research evidence and opportunities to collaborate in small groups. Other gap tasks included trialling different approaches, collecting pupil voice data, and activities to maintain the close links between primary and secondary, for example, by attending the annual Great Science Share for Schools event at The University of Manchester. At the end of the first year, each group planned their own enquiry question to work on collaboratively during the second year, as well as develop within their own setting.

Face-to-face sessions	Twilight sessions
1. Introduction and observing practice	2. Science Capital Teaching Approach and inclusion
3. BEST (Best Evidence Science Teaching)	4. Powerful ideas and curriculum design
5. Curriculum progression and vocabulary	6. Evaluation of Year 1 and plans for Year 2
7. Funds of Knowledge and inclusive practice	8. Inclusively inspiring all pupils in STEM
9. Developing an understanding of transition	10. Support writing reflective case studies
11. Celebration event – presenting case studies to Headteachers	12. Support writing reflective case studies

Project Outputs

- A CPD programme supporting teachers' understanding and practice about educational disadvantage and curriculum progression from KS2-3 in Trafford
- School collaborative portfolios evidencing learning and impact
- A report on outcomes, drawn together to identify key themes and impact on teachers and pupils

CASE STUDY

Help or hinder?
How knowledge of scientific language impacts transition from Key Stage 2 to Key Stage 3

Context

The schools involved in this case study included Broadheath Primary School, Park Road Academy and Altrincham Grammar School for Girls. Broadheath and Park Road are both feeder primary schools for Altrincham Grammar School for Girls. Broadheath has a high number of pupils with English as an Additional Language.

> *We were struck by the high level of key terminology used in the lessons with staff using key language of which we didn't realise the pupils had competent use of at Key Stage 2.*

The issue

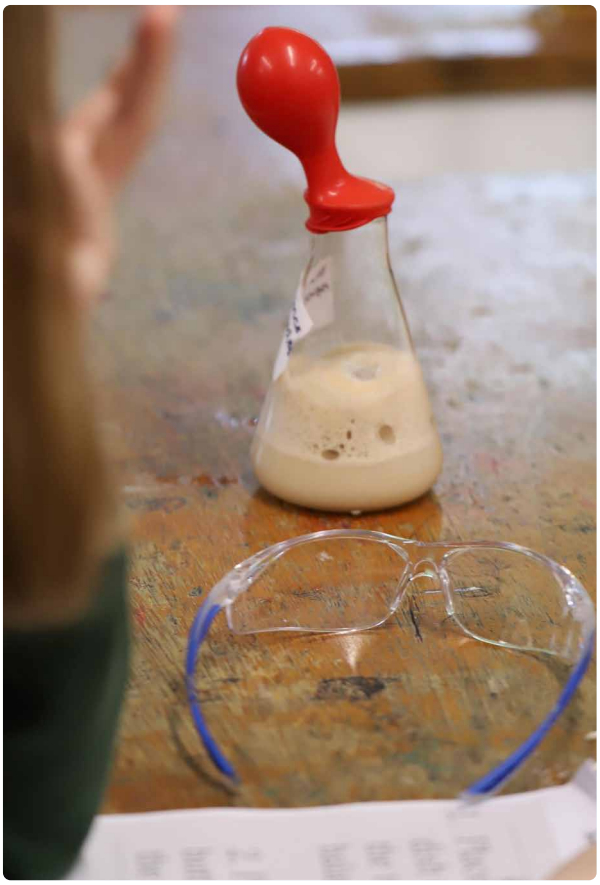
From the secondary teachers' perspective:
"When we initially visited the primary schools, it was obvious the staff had an excellent understanding of the science being taught and the pupils were more independent learners than we had expected. We were struck by the high level of key terminology used in the lessons with staff using key language of which we didn't realise the pupils had competent use of at Key Stage 2. For example, whilst talking about magnets, pupils were able to discuss poles and magnetic fields as well as using the terms attract and repel."

From the primary teachers' perspective:
"Something I noticed when we conducted our observations within each other's classrooms, was that the actual structure of our lessons is quite similar, which is great for transitioning to secondary school science. I also noted that the content we teach in primary is revisited and revised before building upon, even if the teachers don't quite realise that is what they are doing. As primary school teachers, it gave us a much clearer idea of where the pupils will go with what they are being taught in primary. However, we noticed the terminology used within investigations was different to the language we used. Key Stage 3 teachers no longer referred to fair testing but instead discussed validity and reliability of data and conclusions."

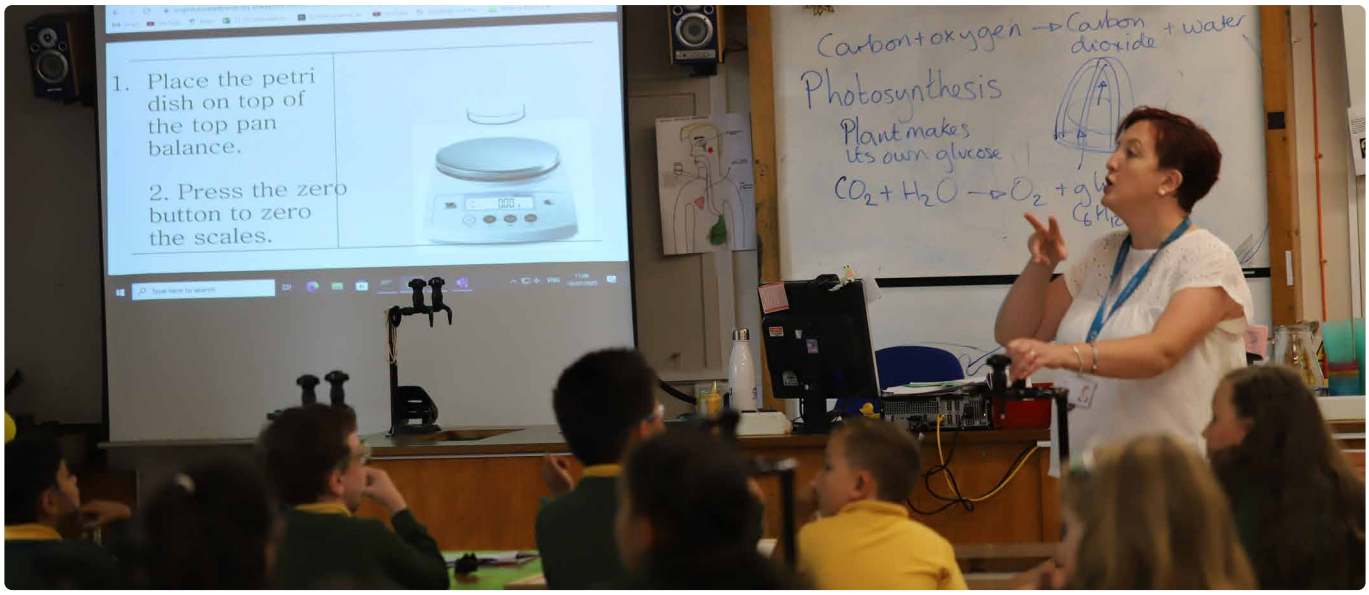
We decided to focus on the scientific language teachers used and the curriculum bridge from Key Stage 2 to Key Stage 3. Many of the Key Stage 3 teachers were not aware of the five types of scientific enquiry used in primary science (research using secondary sources, comparative and fair testing, observation over time, pattern seeking and identifying, classifying and grouping). They make no appearance at all in the Key Stage 3 science curriculum. This lack of progression in key terminology from primary to secondary school causes a gap, making it more difficult for pupils to transition from the zone of comfort they had within primary science. The transition also comes with adjusting to a new environment, usually a laboratory, with new equipment, such as gas taps, so when teachers use new terminology to describe an aspect of science pupils previously felt confident in, this compounds the transition issues.

Pupil voice activity carried out with Year 6 pupils highlighted that they enjoy science at primary and look forward to moving on to secondary school science. By the time they started in Year 7, pupils claimed that they didn't remember much about science and hadn't done much science at primary school. This may be due to the issues regarding when and how often science is carried out in Year 6 due to SATs in English and maths, but also due to pupils' lack of recognition regarding what science was. Science is awarded a higher status at secondary school, often due to parental expectations, and the fact that science GCSE is compulsory, so it now finds itself 'up there' with English and maths. This may in part explain why pupils forget to recognise the high level of competency that they held at Key Stage 2. Science at secondary school is 'new'.

Bridging the primary-secondary divide: Josh from Park Lane Academy working on enquiry skills with Ben Stutchbury from Altrincham Grammar School for Girls.



Pupils settling into secondary school encounter lots of new experiences – from the labs they are not taught in to handling equipment they don't have in primary school.



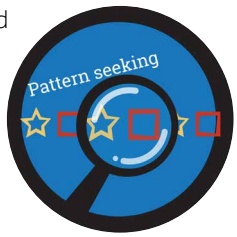
Zoe Hulme, teacher from Altrincham Grammar School for Girls, teaching a class of primary pupils as part of the project.

Next steps

Meeting regularly for the Inclusive Science Teaching and Learning project has strengthened the relationship between primary and secondary teachers of science. We have agreed on the following steps to support transition in science:

Secondary teachers:

- Deliver in-house science training for our staff to develop their understanding of the five types of science enquiry from the primary curriculum, so that Key Stage 3 teachers understand the language used. This will support pupils' confidence and understanding, and it will strengthen the curriculum bridge, enabling pupils to link their prior learning to a new context.
- Use the logos associated with the five enquiry types on posters in our labs as pupils recognise these from KS2. The logos will also be added to pupils' note booklets and teaching PowerPoints. These will be integrated into the Year 7 schemes of learning as a scaffold for transition, then gradually removed as pupils become more familiar with the KS3 curriculum.



Primary teachers:

- Include the Key Stage 3 terminology of validity, reliability, repeatability, accuracy and precision into our Year 5 and 6 schemes of learning to ensure a smoother transition into secondary school science.
- Speak to the pupils about how the content they are learning in Year 6 is going to be built upon in secondary, and how we are building a good foundation of scientific knowledge now.
- Maintain the closer relationship with secondary school colleagues to talk as science leaders, ask questions and communicate/highlight important aspects of our curriculum.
- Benefit from sharing resources when available and organise visits to the secondary school so pupils can experience working in a lab setting before starting Year 7.

The relationship now between primary and secondary science colleagues is much stronger and is definitely a partnership we are keen to continue. There is the potential to work with other feeder primary schools and across other secondary subjects to extend and support transition in the future. We are currently working on another science project together that has stemmed from this one and is providing even more opportunities for scientific enquiry and transition opportunities. Everything we have mentioned above is having a significant impact on the pupils' retention of scientific knowledge, their use of scientific terminology and reducing their anxiety of transition to secondary.

CASE STUDY

Striking a balance. Would science be more interesting to pupils if they lead the learning?

Context

Zoe Tarry is a class teacher and science subject leader at Moss Park Primary School, Stretford. Through her involvement in the Inclusive Science Teaching and Learning project, Zoe was inspired by learning about the Great Science Share for Schools and used the campaign to pursue a line of enquiry surrounding pupil-led learning.

> *Having the pupils so engaged made the day less hard work, I expected it to be hard to make it last all day, but actually the enjoyment made the hours fly by.*

The Issue

Since becoming a teacher 9 years ago, I have become more and more aware of how the profession has faced an increasing amount of pressure, much of which comes from sources beyond my control. I would feel confident stating that the biggest pressure class teachers in a primary school feel is time. How can we fit all of these lessons into one week, into one day? Sadly, my colleagues and I all feel that this pressure often results in lessons being more prescriptive than exploratory, especially in science. As science subject leader in my primary school, I have seen this result in experiments being modelled by the teacher rather than carried out by the pupils. Often videos are used to supplement the practical task and many more time saving hacks, which teachers have adopted to fit in the bursting curriculum. This thought, and discussion with staff in monitoring feedback meetings, led to my enquiry question:

Would science be more interesting to pupils if they lead the learning?

I was taking part in a primary to secondary transition project and during one of these meetings, I was introduced to the Great Science Share for Schools. I was able to coincide this with a mock Ofsted I was participating in on science. I provided staff with numerous resources to support them with carrying out the Great Science Share for Schools (GSSfS), which matched the age range they taught. Interestingly, staff were incredibly nervous and unsure of GSSfS. Through discussions,

I discovered that this was due to the pupil led aspect. They were 'scared' about what the pupils would decide to focus on. In the days leading up to GSSfS, I had half of the members of staff in our school approach me asking questions about how to carry out the GSS, as opposed to one member of staff who wanted to ask a question about the mock Ofsted deep dive in science. I found this of great interest, and this reinforced my feeling that staff were nervous about the pupil led aspect. However, when the GSS was introduced to the pupils and it was explained this would be pupil led and they could lead experiments on what they wanted, based on the story we watched, there was a wave of excitement across the school. I was filled with joy; the school was suddenly filled with budding scientists eager to get started. To support my colleagues, and to ease their nerves, I had given them the most precious asset: time.

I took away their boundaries and constraints from other lessons. I gave them the whole day dedicated to science, nothing else to be squeezed in, no 'quick readers' to be heard...nothing but science. Resoundingly, this reassured some staff. With our resources ready, pupils eager and 5 hours at our disposal, we were off. I was lucky enough to be able to walk through the school across the day and see all the amazing discussions, science enquiry and excitement going on. Pupils would proudly want to talk to me about their work and discoveries. There was a buzz. More importantly, pupils were engaged and motivated by their learning.

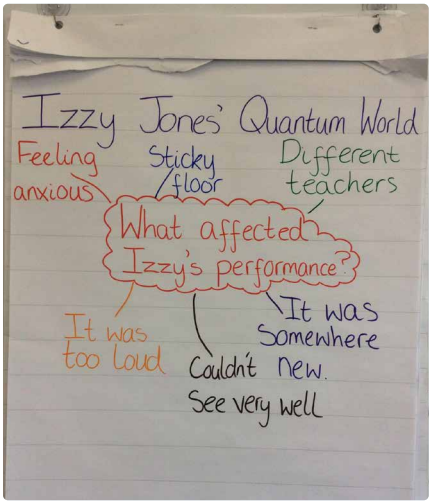
I felt like my enquiry question was being unequivocally answered. Yes, science would be more interesting to pupils if it was pupil led. The following day in our staff meeting I asked my colleagues for feedback on the day and it was an overwhelming success. All staff had enjoyed the day, and more importantly saw the benefit from letting pupil lead their own learning.

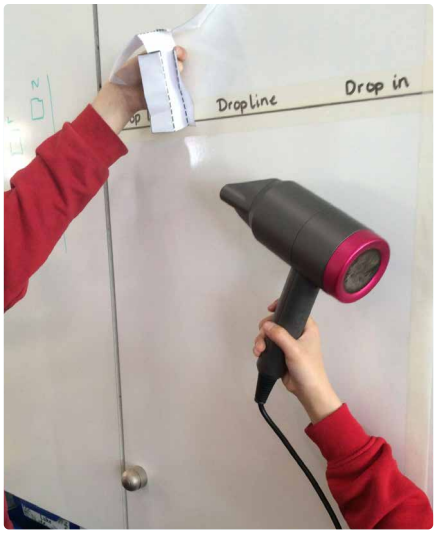
Following on from our first experiences of GSSfS, we have now decided to use the GSSfS Toolkit resources such as the Prediction Prompt and Conclusion Creator as common practice in our lessons all year round. Staff commented that they found them useful in knowing how to ensure pupils' disciplinary knowledge was developed.

> *I have never seen every pupil in my class so engaged with science and want to be involved in the discussions. I couldn't see their faces for a sea of hands when I asked a question.*

'The sentence starters in the Prediction Prompts really helped the pupils unlock any prior scientific knowledge. The 'because I know that.... I predict that....' one. Also, the Conclusion Creator helped them be concise and to focus on using their investigation data and scientific knowledge to evidence their conclusions.'

When reflecting on the Great Science Share for Schools with the pupils, something which they referenced time and time again was the sharing aspect. Every pupil loved not only sharing their findings and investigations with their peers, other teachers, our headteacher and even parents but they loved seeing other pupils' work.





Next Steps

- As a school, we will continue to use the GSSfS resources all year-round. The GSSfS Toolkit resources provide staff and pupils with excellent scaffolds for all aspects of science enquiry.
- Due to the enthusiasm of the pupils and staff, an annual STEM week will be organised. This will include opportunities to involve parents/carers and will look at ways in which STEM subjects can be more cross-curricular.
- Links with our local high school will be strengthened and secondary teachers will be delivering some science lessons to some of our primary classes.

Final reflection

I am not naive enough to think that as a school we can now do every science lesson pupil led. However, this enquiry and these findings have changed the culture in our school. Staff now have less fear in allowing pupils the opportunity to lead their learning. But just as importantly, we now see the importance in linking our science with the community and especially with our family and friends. I have seen classes working together and swapping findings. I have seen a class present their STEM topic work to a younger class to excite them for what they have in store next year. By having family in school to engage with STEM in our STEM week and bring their careers into the classroom, we have opened up the world of science to all our pupils.

CASE STUDY

Why don't they know why they are doing it?

Context

Stretford Grammar is a co-ed secondary grammar school. Wellacre Academy, Flixton is a secondary boys' school with academy status. Moss Park Primary School, Stretford participated in the middle of a merger and change of staff. Here, Lucy Wallis, Director of Science at Stretford Grammar, reflects on her learning from the Inclusive Science Teaching and Learning Project.

The issue

I saw independence in practical activities in primary settings, with pupils given choices and showing good understanding of tasks. I wanted to promote choice and independence in Key Stage 3 practical activities, so pupils develop a deeper understanding of the tasks they are completing. After the visit to Moss Park Primary School, several thoughts and reflections lingered:

"I was blown away by metacognition practices; the pupils were very independent"

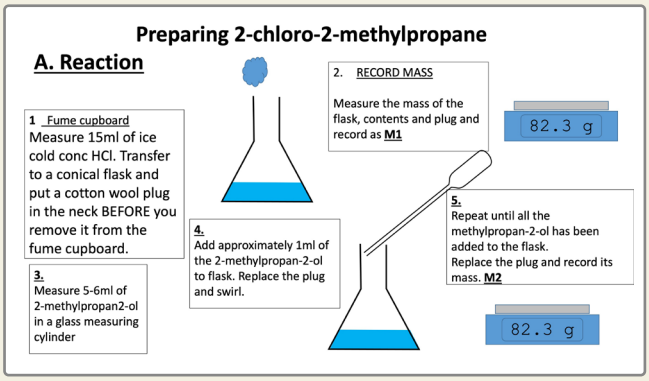
"We have our pupils for an hour per lesson in secondary. How can I ensure the whole science department engage in the same style?"

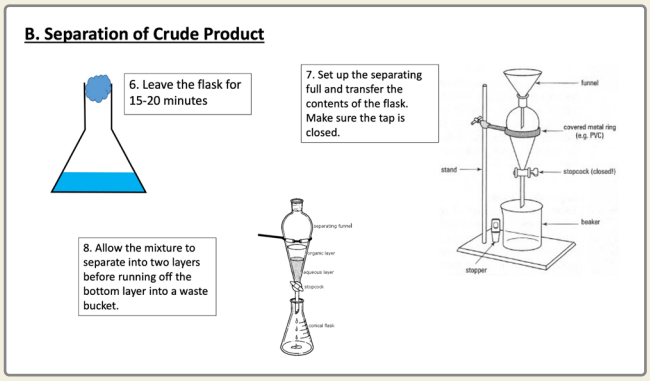
"We 'baby' the Year 7s and we'll think twice now about this. Lots of our pupils are more capable than we have given them credit for."

My enquiry question was therefore an obvious one and a line of enquiry I was motivated to explore:

To what extent does allowing greater independence enhance understanding of practical activities in Key stage 3?

Letting pupils make decisions during their practical work leads to richer dialogue and debate (Casserly and Wood, 2023). For example, pupils justified their choice of equipment and took notice of small details, such as, measurements and meniscus. Pupils can use preliminary results to decide on a range and to understand that you don't always get perfect results. Therefore, pupils appreciated the benefit of taking repeat readings and getting the same outcome.





Examples of integrated instructions resources developed

Limitations to giving pupils greater independence:

- Time – the process had to be done over three lessons
- Safety limitations – there are some practical activities where it is not possible to give greater independence

Being part of the Inclusive Science Teaching and Learning Project meant I had dedicated time to focus on my enquiry question, and this led to a piece of research around a strategy called integrated instructions

(Altieri, 2017; Paterson, 2019). This strategy involves pupils being provided with diagrams and step-by-step details. Here I could see that independence could be built in, such as pupils making choices about the science equipment they choose. The authors also claimed that it cut down the time for the practical, which could lead to further discussion of the 'why'.

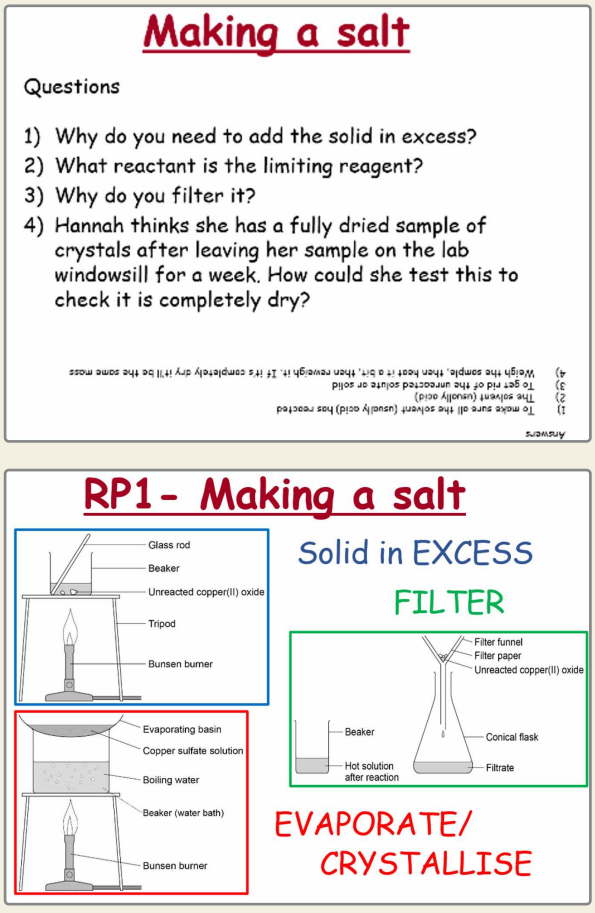
After a visit to Moss Park Primary School, I began to consider which practical activities in Year 7 could be adapted to increase pupils making decisions, and to enable increased choice and freedom with variables. However, since pupils have come from a variety of feeder primary schools, many had not practised the skills required for this level of freedom. In short, it didn't work. Practical activities took too long for the time in lesson they had been assigned, pupils didn't know what they were doing. I felt precious learning time was being wasted and more misconceptions were being formed.

Next steps

After our initial foray into the use of integrated instructions, it was clear that thought is needed to determine where this strategy can be used effectively. Now I am looking at different practical activities and which lend themselves to integrated instructions. This isn't always possible and shouldn't be 100% of practical activities because pupils do need to learn how to follow written instructions in prose also.

However, I am now looking at Key Stage 4 where required practical questions mean understanding must be clear, and Key Stage 5 where endorsement shows capability of pupils.

I have also made practical sheets to keep hands-on and minds-on for KS3, including questions to show understanding of the practical. I have these for KS4.



Examples of Key Stage 4 resources

CASE STUDY

Are we making Year 7 pupils backpedal?

Context

Wellacre Academy, Flixton, is an all-boys secondary school with academy status. Christine Siddall, teacher of science and second-lead of the science department, reflects on the learning as a result of her involvement in the Inclusive Science Teaching and Learning Project, with a particular focus on pupils' independence.

The issue

In Trafford, each secondary school can have up to 20 feeder schools, so there is a great variation in prior learning experiences and therefore this can pose challenges regarding primary to secondary transition. As part of the project, I visited Moss Park Primary School where I quickly observed that the largest difference between pupils at KS2 to KS3 was the level of independence in their learning. The pupils in the Year 5/6 mixed ability class appeared to have more responsibility of their own learning, using knowledge organisers to retrieve large amounts of information about the cardiovascular system. The pupils were producing large amounts of written work and worked efficiently and calmly under very little instruction from the teacher.

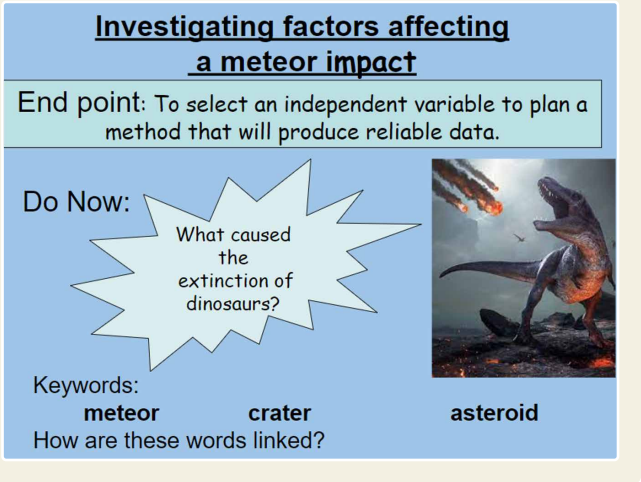
This visit made me question why as a secondary teacher I had often treated our Year 7 pupils almost like they haven't already worked in this way. For example, we would make allowances to help them write longer answer questions or use problem-solving skills. It made me question why we sometimes hold back scientific concepts such as reversible chemical reactions when this can easily create misconceptions, why we produce assessments requiring one-word answers or tick boxes or why we limit their time to write a piece of written work. My enquiry then led to the question: **Are we making Year 7 pupils backpedal?** Why do we do this and is it causing pupils to disengage as they don't feel like they are making progress?

I can understand that this may have been happening to ensure that all pupils sat in a Year 7 class were at the same starting point, however, I knew from many years of teaching in multiple schools, it was likely down to the lack of time given for teachers to visit other schools to see how and what science content is taught in primary. The curriculum content for KS3 is vast and takes several years for teachers to teach confidently. It would often be the case that the prior learning in KS1 and KS2 is not prioritised for a KS3 teacher.

My observation and questions led to the project to make changes in KS3 to mirror the independence in KS2, to ensure that teachers in my department could easily access the prior learning that every pupil should have received, to build up resources to quickly identify gaps in learning to consolidate learning, and to change some our KS3 units to project based learning to promote independence and bring back the core value of asking questions and exploring ideas in science.

Engaging with the research base, I enjoyed reading research from Casserly and Wood (2023) who advocate for the benefits of giving pupils choice in their science practical and learning. This article supported me to get the correct balance of choice and safety in the classroom. I altered a Year 7 unit on forces to replicate the lesson written about in the article, allowing pupils to choose which variable they were going to investigate. The lesson is called 'Investigating factors affecting a meteor impact'. The pupils first discuss reasons why dinosaurs became extinct, and meteor impact is discussed. They then look at craters on the moon and discuss what could affect the size of the craters, then produced and followed their own method, working out control variables through trial and error, rather than just

being told or instructions followed regimentally to avoid behavioural issues. The pupils were allowed to select their own equipment and easily gave a justification for choosing that piece of equipment when asked.



I collected staff and pupil voice to see what the impact had been on changing the way the practical was taught. I was concerned that some behavioural issues may have arisen, however all teachers reported that all pupils were engaged and wanted to solve the problem. Pupils were asked to recall their learning and what they had done in the pupil voice and the pupils spoke with confidence and excitement, happy to tell me what variable they had chosen, what was difficult to control and what the outcomes were.

Next steps

Based on this success, we altered other units in our scheme of work and created a unit for Year 9 where pupils independently run five investigations to consolidate disciplinary knowledge in preparation for GCSE.

I was proud to present the findings of my enquiry, and reflections on the project, at the Association for Science Education International Conference in Northampton to an audience of teachers and experts from the science education sector.

Lessons learned from the project were to ensure that the questioning element of science is prioritised in KS3 science to maintain engagement in science. This will result in pupils being active learners as opposed to passive learners.

I now want to ensure that all teaching staff in my school are able to visit and work collaboratively with our local primary schools. We have also continued to alter schemes of work to base substantive knowledge on questioning and investigating.

Impact

I joined this project in its second year and attended a number of the sessions. I found them all incredibly useful, in particular, the session delivered by Maria Rossini from British Science Association in which she discussed inclusively inspiring all students in STEM.

Maria discussed science attributes and these have subsequently formed the foundation of our whole school science display. Also included as part of the display were the SEERIH posters which outline the 5 science enquiry types, matched to evidence of children's work and progression throughout the school.

As a result of my involvement in the project, I conducted a follow up 'learning walk', the purpose of which was to observe and report on the progression of science skills and the achievement of National Curriculum objectives throughout the school.
Primary teacher

I feel like less of a teacher and a bit more of a researcher in my classroom because I'm going, right, how did the pupils respond to this question? What are their misconceptions? Why did you think that, even though it's the wrong answer? So, I say, "Why? Why are you thinking that?" So, I'm collecting that information and then teaching from that, rather than assuming what they know.
Secondary teacher

By allowing more choice in the scheme of work, pupils have developed their ability to use empirical methods confidently to investigate a scientific question, the pupils appear more engaged and have transitioned from being passive learners to active learners in science.
Head of Science

Following our involvement in the project, there are plans in place for ongoing collaborations with the secondary school and for teaching strategies and approaches used to be implemented into teaching and long term plans/schemes of work between primary and secondary settings.
Primary teacher

Closing reflections

Transition remains to be a complex issue but when time, thought and professional reflection are devoted to it, transition can be viewed as a time of social and educational opportunity for pupils moving into the next phase of their education.

What this project has ensured is dedicated time for primary and secondary teachers to communicate, to collaborate, and to thoughtfully consider the issue of primary to secondary transition with a specific focus on science teaching and learning.

There has been a legacy of real change for the teachers and schools involved. It has been heartening to see the professional relationships forming within the group with many using these as a springboard to work collaboratively on other projects, including hosting joint Great Science Share for Schools events. Teachers have reflected that they will continue to nurture these professional alliances after the project has ended.

The teachers involved in this project brought expertise, enthusiasm but most importantly openness to learn about, and from, each other. It has been inspiring to see their driving force was ultimately to improve the experiences and outcomes for their pupils.

It has been invaluable to have the support of the Headteachers throughout the project, along with the commitment of Trafford Teaching School Alliance, Trafford Council and the Comino Foundation.

At a time when the National Curriculum is under review, we will continue to have dialogue around transition and understand the importance of our role in supporting teachers to navigate this complex yet important point in a pupil's science education.

Grace Marson
SEERIH Specialist Lead
The University of Manchester

> *It has been heartening to see the professional relationships forming within the group with many using these as a springboard to work collaboratively on other projects*

Acknowledgements

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- St Hugh's Catholic Primary School, Timperley
- Stretford Grammar
- Wellacre Academy, Flixton

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