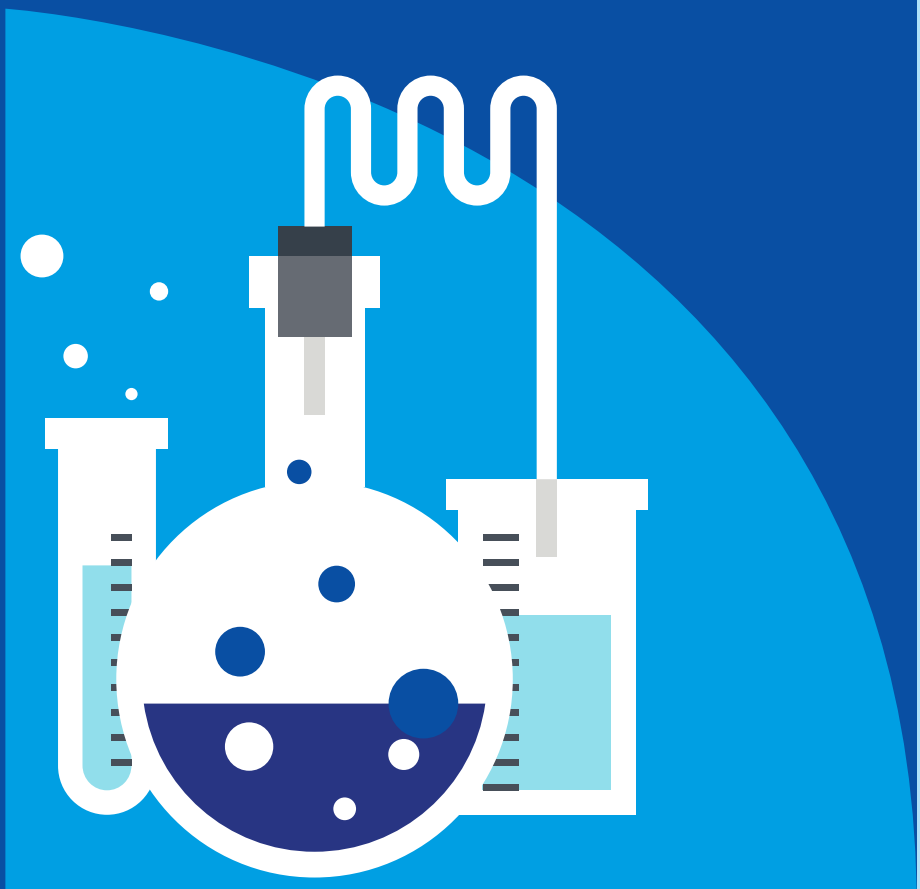
Good Practical Science - making it happen (benchmark 1)

A project evaluation report by the Association for Science Education to the Gatsby Foundation - December 2020



The Association for Science Education
Promoting Excellence in Science Teaching and Learning

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The Association for Science Education (ASE) is the largest subject association in the UK. As the professional body for all those involved in science education from pre-school to higher education, the ASE provides a national network supported by a dedicated staff team. Members include teachers, technicians and advisers. The Association plays a significant role in promoting excellence in teaching and learning of science in schools and colleges. For more information, go to www.ase.org.uk

In 2017, the Gatsby Charitable Foundation launched Good Practical Science by Sir John Holman. The report provides a framework for good practical science in schools and colleges. Using international visits, surveys and literature reviews, ten benchmarks were identified, which schools and colleges can use when planning their own approach to delivering practical science.

The Association for Science Education
Promoting Excellence in Science Teaching and Learning

Benchmark 1: Planned practical science

"Every school should have a written policy that explains why teachers use practical science, the outcomes they expect from it and how they achieve those outcomes. The process of producing the policy is as important as the policy itself [1]."

Project Aims

To promote the importance and value of effective practical science, and support secondary schools and academies to provide planned and purposeful practical science learning for all their students.

Project objective

To provide guidance with professional learning strategies and activities to enable science departments and school leadership to develop, and evaluate the impact of, their own written policy for practical science (*Good Practical Science* report recommendation 9 and benchmark 1).

Project description and methodology

The project team worked directly with science leaders, teachers and technicians from 12 secondary schools and academies (covering a range of geographical locations and profiles including those in challenging circumstances) to develop, trial, evaluate and refine the guidance and supporting professional learning strategies with activities.

Selection criteria for the 12 state-funded secondary schools or academies included not having a written policy in place before taking part in the project, not having been involved with ASE projects previously and those for whom practical work did not appear to be a high priority.

These 12 secondary schools or academies were identified as **Wave 1** schools, and at least two representatives, including the science leader, attended a full-day workshop to introduce our draft online guidance resources, professional learning strategies and activities, prior to their science teams working with these resources (available in the project's Google Drive folder), to produce and publish a written policy.

See Appendices 1 and 2 for a sample workshop outline and the workshop evaluation form.

1: Good Practical Science report (Gatsby Charitable Foundation)
http://www.gatsby.org.uk/education/programmes/support-for-practical-science-in-schools

Benchmark 1: Planned practical science

Some representatives of these schools also attended an online discussion forum several weeks after they had been working with our resources, to share experiences. The forum considered these questions:

1. Which aspects of practical science is your policy focusing on, and why?
2. Which resources have you found most useful, and how have you used them with your science team?
3. What is working well, and why?
4. What challenges, if any, have you experienced when developing your policy with your science team?

To ensure that a wide range of secondary schools and academies and their science departmental colleagues in different circumstances and locations were able to engage directly with the project, and indirectly with the project's resources during and beyond the duration of the project, ASE collaborated with STEM Learning, CLEAPSS and our Education Policy Alliance partners[2] in raising awareness of the project.

There was a high level of interest in this project. Learning from previous experience to ensure that our selected 12 Wave 1 schools were committed to the project, all interested individuals were invited to complete a number of short online SurveyMonkey forms, each subsequent form providing further details of the project's expectations. The third of these forms was a survey of 20 statements[3] designed to collect views on what should and should not be included in a school or academy policy on practical work in science. Responses to this survey were used by the project team to identify the areas of focus for the guidance, professional learning strategies and activities, and to determine, amongst other factors, which schools or academies would be invited to be a Wave 1 school.

As interest in taking part in the project was high, we made efforts to accommodate the additional schools and academies indirectly, through providing opportunities to review the developing resources remotely (available through the project's Google Drive folder) and to produce and publish their policies. These additional schools were not invited to attend the full-day workshops described above. They were identified as **Wave 2** schools.

Taking into account feedback from Wave 1 science leaders, teachers and technicians attending the full-day workshops and follow-up online discussion forums, the **guidance resources, professional learning strategies and activities** (output 1) were published as Supporting Resources[4] on the ASE Good Practical Science – making it happen webpage in January 2019.

From the policies that were completed and published on their school/academy websites by March 2019, five were selected to form the basis of **case studies** (output 2). The case studies illustrate how five very different departments went about creating

2: The Association for Science Education, Institute of Physics, Royal Society, Royal Society of Biology and Royal Society of Chemistry work in partnership to promote high-quality science education in schools as an Education Policy Alliance

3: Survey of 20 statements to determine what should be included in a policy on practical work in science https://www.surveymonkey.co.uk/r/DSBYGX2

4: Project's Supporting Resources pdf https://www.ase.org.uk/resources/good-practical-science-making-it-happen

their policies, and the impact that these processes had on their teaching. Each case study includes a copy of their policy, and draws on plans, diaries and descriptions of the issues faced by schools, the discussions undertaken and the construction of policy from agreed position statements. The case studies[5] were published on the ASE Good Practical Science – making it happen webpage in May 2019.

The eight remaining policies (out of a total of 13) were completed and published on their school/academy websites by July 2019. Each policy described (more or less successfully) the intended impact of enacting the policy on the school, science team and students; when and how this impact would be measured; and what would be considered successful.

As agreed by all Wave 1 and 2 schools/academies at the beginning of the project, from a minimum of six months after having their policy in place, science leaders were asked to reflect on the policy's impact by responding to three questions, by email or via an interview:

1. What is the intended impact of your policy on your school, science team members and/or students?

2. How have you measured this intended impact?

3. What is/was the impact (if any) of the policy on your school, science team members and/or students?

The evaluation process was designed not to be onerous, as we recognise that these committed science leaders are very busy and it is important that we recognise this in any requests that we make. Responses to these questions, the full-day workshop evaluation form, and anecdotal feedback from delegates attending short workshops at ASE events and elsewhere contributed to our understanding of the extent to which the project met its intended outcomes.

A table summarising the different engagement activities and their uptake during the project is provided in Appendix 3.

Outputs

1. A freely available set of online **guidance resources, professional learning strategies and activities**[6] focused around key stimulus discussion questions to prompt science departments (with the support of school leadership) to develop their own vision and policy for what effective practical science looks like in their own school (or group of schools). Additionally, the guidances enable the school's science leadership to evaluate the impact of their policy at regular intervals over time (including annually, in line with departmental improvement cycles), through activities designed to identify relevant data collection in apprising intended outcomes and levels of impact that are informed by research, including Kotter[7], Guskey[8] , Joyce and Showers[9]. The development of these resources was informed by science leaders, teachers and technicians who took part in the trial phase workshops of this project to illustrate benchmark 1.

The resources are structured as seven modules: (1) Introduction; (2) Purposes; (3) Planning; (4) Progression; (5) Inclusion; (6) Support; and (7) Producing a policy. Each module contains presenter's notes, for use by a subject leader or others when using the module, a presentation containing information, questions for reflection, links to activities and suggested next steps, and various files containing questionnaires, activities and resources needed to complete the module. Each module is designed to take an hour of departmental discussion time, yet could also be used flexibly if less time is available.

2. Five **case studies**[10] of best practice resulting from engagement with the online guidance resources, professional learning strategies and activities by science leaders, teachers and technicians who took part in the trial phase of this project to illustrate benchmark 1. The case studies illustrate how five very different departments went about creating their policies, and the impact that these processes had on their teaching. Each case study includes a copy of their policy.

3. **A stakeholder engagement and communications plan**, with corresponding promotional materials and activity at regular intervals during the project (see Appendix 4).

4. A project evaluation report, using Guskey's five critical levels of professional development evaluation.

5: The project's Case Studies pdf https://www.ase.org.uk/resources/good-practical-science-making-it-happen
6: The project's Supporting Resources pdf https://www.ase.org.uk/resources/good-practical-science-making-it-happen
7: Kotter, J. (1996) Leading Change
8: Guskey, T. (2000) Evaluating Professional Development
9: Joyce, B. & Showers, B. (1980) Improving Inservice Training: The Messages of Research
10: The project's Case Studies pdf https://www.ase.org.uk/resources/good-practical-science-making-it-happen

Intended outcomes

- All schools that have participated in the project will have a written policy in place, a 'sponsor' for practical science amongst senior leaders and will have made commitments to review the impact of the policy annually.

- All members of the science department have ownership of the school's practical science policy and can describe the features of good practical science in their school.

- All science teachers can explain why they use practical work in science, the outcomes they expect and how they will achieve those outcomes.

- The science leader and the majority of science teachers can explain their plans for progression in practical science, using different approaches with different age groups and for all students, including those with special educational needs and disabilities.

These intended outcomes were developed from the benchmark 1 criteria within the Good Practical Science report.

Evidence to give an indication of the extent to which participating science teams met these outcomes was gathered through questionnaires to science leaders, teachers and technicians who attended Wave 1 full-day workshops towards the beginning of the project, plus survey questionnaires and interviews with Wave 1 and 2 science leaders towards the end of the project. Additional anecdotal feedback from delegates attending short workshops at ASE events and elsewhere was also considered.

This evidence was analysed using Guskey's five critical levels of professional development evaluation. It was anticipated that the majority of science leaders, teachers and technicians from schools that had participated in the project would demonstrate Guskey's critical levels of professional development evaluation at levels 1 (participants' reactions to their professional learning experience – the Wave 1 full-day workshops), 2 (participants' learning – Waves 1 and 2) and 4 (participants' use of new knowledge and skills – Waves 1 and 2), and the majority of their science departments (Waves 1 and 2) would demonstrate aspects of level 3 (organisational support and change) in working towards or achieving benchmark 1. Guskey's level 5 (students' learning outcomes) would also be explored, although it is recognised that any direct impact from engaging with this project would be difficult to ascertain.

In the medium term, we would expect a realistic increase from the 23% of schools[11] that have a written policy for effective practical science as a part of their science policy and integrated with whole school policies on teaching and learning, which are reviewed (annually) against practice. However, measuring any changes in percentages as a result of this project goes beyond the scope of the project.

11: Good Practical Science report (Gatsby Charitable Foundation) http://www.gatsby.org.uk/education/programmes/support-for-practical-science-in-schools

Reporting on the project's outcomes

Using Guskey's five critical levels of professional development evaluation:

Level 1 (participants' reactions to their professional learning experience – the Wave 1 full-day workshops).

Although the agenda for the workshops was necessarily tight, the feedback from participating was positive. In response to questions on satisfaction regarding the structure and content of the workshop, as well as opportunities for discussion, the large majority of responses were 'very satisfied' followed by 'satisfied'. Representative examples of responses included:

> *Needed more time (although I enjoyed the practical tasks).*
>
> *Not a lot of time to physically do this, but the whole day stimulated lots of ideas.*
>
> *An excellent range of activities for delivery.*
>
> *Activities promoted thought about policies. Demonstrations were great!*
>
> *Clear and concise aims, informative.*
>
> *Fantastic resources for stimulating discussions around supporting staff.*
>
> *Great card sorts, protocol cards helpful to those who don't have experience [of creating policies].*
>
> *Lots to think about. I feel the follow-up online discussions will be important in helping define the policy as we go.*
>
> *Great discussion – stimulated ideas and thoughts on how to move forward on this.*

The very small proportion of 'partially satisfied' responses indicated small areas for improvement to the resources, which were addressed when the resources were finalised.

In response to a question on 'how prepared are you to lead or contribute to sessions, using these resources and activities, with your science team on developing your school's policy?', the large majority of responses were 'very prepared', followed by 'prepared'.

> *More time might enable us to do more but I feel armed with resources to take back to the department.*
>
> *With the aid of the resources used today I would be happy to lead activities.*

Reporting on the project's outcomes...

Level 1 (participants' reactions to their professional learning experience – using the project's resources – Wave 2 science leader):

> *It has been excellent to focus the department on the best use of practical activities within lessons, and the materials provided have created some of the best departmental CPD sessions we have had for a while.*

Level 1 (participants' reactions to their professional learning experience – short workshops at ASE events or elsewhere):

Feedback from a group of Norwegian student teachers attending a workshop at ASE's Annual Conference 2019:

> *This lecture was absolutely amazing. Both I and my Norwegian colleagues were baffled by the knowledge and passion that the lecturers possessed. They asked really good questions related to good practical policies, as well as presenting well-constructed and reflected answers to these questions. After the session we all agreed that this was hands-down the best lecture we attended at ASE. The knowledge we gained is definitely going to be implemented in our own practice as teachers in Norway. The handouts were also extremely well-constructed and clever, which we all are taking with us home. It became quite clear during the lecture that their research had undoubtedly taken an immense amount of time: this is not a strange conclusion when you take into consideration the sheer quality of the presented data. If I could give this lecture 11/10 I would. Outstanding work to everyone involved!*

Interview feedback from an experienced science leader who attended a workshop at ASE's Annual Conference 2020:

> *What I hadn't appreciated was the need to focus on one of the practical work purposes instead of trying to get as much as possible out of a practical activity. I can see now why this could be confusing for our students. I'll make sure that we have a science team meeting to explore this some more.*

Reporting on the project's outcomes...

Reflective feedback after the policy is in place

A minimum of six months after having their policy in place, 15 science leaders reflected on the policy's impact by responding to three questions by email or via an interview:

What is the intended impact of your policy on your school, science team members and/or students?

Responses indicated that all the science leaders, with their teams, had carefully considered the intended impact of their policy. Representative examples of responses included:

To ensure that practical science is an integral part of the science curriculum and that it is taught well and consistently across the department. We wanted to maintain and raise the profile of practical science by sharing a progressive approach to the skills that each student will acquire whilst studying science. In addition, it was to make sure we involved all stakeholders in the science department with this process so policy becomes a vision of the science teachers and the technician to then provide a better quality practical science provision in comparison to what was previously in existence.

To improve the delivery of practical science at Elthorne Park High School so that students are better equipped to carry out practical work, can answer practical-based examination questions and are more motivated to study science.

To refine the purpose of practical work; that is, why teachers were opting to use practical work and what the purpose is within the context of the lesson, and what students should learn from doing it. Secondarily to that was how students should be assessed within the practical work, not usually quantitatively but with an emphasis on how skills are developing, and how feedback from teachers is used by students to improve their practice.

To elevate practical science beyond what the pupils perceived it to be: an easy or fun part of a science lesson. We needed the pupils to see value in the investigations they were doing, and be able to 'hang' scientific content on the activities, which they could then access in exams and assessment. We were keen to ensure there was progression between key stages with students and staff noticing a clear demand increase up the school.

Reporting on the project's outcomes...

With changes to specification we wanted to develop an approach to practical science where there was a specific skill foci, which would give students a greater emphasis on the type of skills they need to develop through their learning journey. Having the practical policy in place has meant that we are able to shift focus and maybe reconsider outcomes and deliver practical science in a slightly different way to minimise pressure on our senior (and currently only) technician.

We wanted to develop a more consistent approach to practical science, where lessons were planned around specific purposes, and developing the policy together, as a team, allowed us to explore this in a way that meant we made good progress quite quickly. Having a document produced has then helped us refer back to that learning in future terms, as well as share it with new members of staff.

The intended impact was that science practicals would be run more frequently and staff would feel more comfortable in the running of the practicals. This would of course impact the pupils as they would have a more consistent experience. Furthermore, the pupils' practical skills would increase in line with their curriculum skills.

To make sure that we are better at practical work. The key thing is that we were clear about why we were doing the practical work and what the intention was. Changing teacher practice is very difficult – so I was not expecting major changes quickly.

How have you measured this intended impact?

Responses indicated that the all the science leaders had put in place mechanisms, as part of their usual monitoring practices, to measure the intended impact of their policy. Representative examples of responses included:

Lesson observations and specific planning documents focusing on research groups of pupils show that the policy supports what is being done in lessons. Minutes from department meetings include discussions regarding the progress of practical work, and qualitative comments from teachers indicate that they are noticing that their delivery of practicals is more focused with better outcomes.

We have measured the intended impact through lesson observations, learning walks and scrutiny of student responses to practical-based examination questions.

Reporting on the project's outcomes...

Implementation of the policy is a key part of the science operational plan for this year.

We have carried out several learning walks into practical lessons and collected first-hand evidence as to the implementation of the policy. We have also carried out student-voice work to look at their perceptions of how practical work is carried out and its purpose.

Through lesson observations and discussions with teachers. I shared the policy with our SLT line manager who is also now able to judge the quality of practical lessons better than previously (he is not a science specialist). Speaking to the technicians, and reviewing practical order requests, the range and quality of practical work has increased in the past year.

The impact has been measured by the use of subject surveys that are collected at 2 points during the year. Furthermore we have spoken to the pupils and asked their opinions on how practical science is used in their lessons. When creating the SEF, the leader of science uses data also from staff surveys, which have an aspect relating to how practical science is used.

We now have incremental coaching where staff develop a pedagogical theme or a skill over a number of weeks or months and all science staff have had at least one cycle of developing practicals in science to deepen understanding and learning. This has been observed by senior staff. We have also now included a skills section on all of our assessments from KS3 and KS4. The skills are all taken from required or important practicals and include all aspects of practical work from observation, planning and evaluating to errors, mistakes and invalid procedures. Students are tracked by the departmental systems.

What is/was the impact (if any) of the policy on your school, science team members and/or students?

Responses indicated that all the science leaders were able to identify positive impacts of having a policy for practical science in place on their school and science team members and, in some cases, on students too. Representative examples of responses at Guskey's levels 2, 3, 4 and 5 included:

Reporting on the project's outcomes...

***Level 2** (participants' learning – Waves 1 and 2) and **level 4** (participants' use of new knowledge and skills – Waves 1 and 2)*

My confidence has increased greatly when planning for practical work. I have a deeper understanding of how to prepare lessons to ensure that students get the best out of each practical (NQT).

It has meant I have put more thought into the planning of a practical. Instead of the plan being 'complete... practical' I now think about the exact purpose of it. Sometimes there is a better way to reach that aim, or I spread the practical work over two lessons if there is more than one objective (NQT).

It's really refreshing to be thinking about the skills and the activity we are doing and challenging me to think what is its purpose (experienced science teacher).

It has changed the way I view practical work. It is no longer about completing the method itself, but about what I want students to learn from the lesson. For example, if the aim is to help students understand a concept better, I worry less about naming equipment and explaining the method so we have more time to discuss the ideas and concepts (experienced science teacher).

I have started to more actively consider the purpose of the practical I am planning – it has helped me to identify specifically what I want students to learn from it. It has also pushed me to consider when I introduce equipment to students, e.g. introducing light gates before they get to the F=ma practical (experienced science teacher).

I've already observed more focused discussions surrounding practical work and seen lessons where the focus on skills has been shared with students.

I have seen reflections on our scheme of work and meaningful forward planning as staff are deciding that key practical skills need to be taught in lower school to help underpin the progress students need to make practically when they undertake their GCSEs.

Staff are more confident that they can use practicals as a resource to engage and stimulate understanding rather than just to do a particular practical because it's on the list to do. Staff are happier now to make links to the real world, for example, waves through a solid (vibration generator) and links to guitar strings.

Reporting on the project's outcomes...

Level 3 *(organisational support and change – Waves 1 and 2)*

I have adapted the materials to make them fit the needs of my department and, in my visits to lessons, I can see a greater clarity and explicitness in the planning of practical activities for specific aims, which is great to see.

The policy has become an official part of our curriculum rationale, which has been approved by governors. This is significant in terms of what the students will get from practical science at our school. It is a clear set of statements that sets the baseline for practical teaching.

The science team have been reminded that practicals have a clear place in the skill set that we deliver and, in a way, the workload has decreased because we are clearer about what needs to be done to facilitate good progress though each year.

We believe the policy has had a positive impact as it has allowed teachers to reaffirm their commitment to practical science, developing the students' curiosity. Most importantly it has allowed teachers to reflect on the delivery of key scientific ideas, such as energy. This is then reinforced in discussion about the findings in the data within the practical element of the course.

There have been clear, tangible gains as a result of implementation of the policy. Staff are clearer about the purposes of practical work and significant progress has been made in the delivery of practical work that has one clear practical purpose, which reduces cognitive load on the students and allows them to make progress. Teachers new to the profession find the policy guidance very helpful. The school benefitted as a whole during our March Ofsted inspection where the outstanding grade was awarded and the high quality of practical work in science was recognised by the inspectors and mentioned in their report.

Certainly the time spent putting the policy together as a faculty was very useful in gathering opinions and creating a united picture of purposeful practical work. We also effectively employed IOP support in physics practical work, using our policy to frame this input and consider how best to teach practical work that students have traditionally found difficult.

We discussed the impact of the policy with staff in a department meeting. Staff felt more comfortable in understanding the aims of the practical activities, and felt the

Reporting on the project's outcomes...

policy re-focused them on the importance of progression in practical science at different key stages.

We feel this was a good stepping-stone for further work. It led to us redesigning some of the work we do around practicals in the department, to have a much narrower focus on associated skills. This work also led to tracking of skills across Key Stages 3 and 4 to ensure we were exposing the pupils to all of the practical science requirements equally. We foresee this having an attainment impact over the next year or two, particularly with the new GCSE required practical focus.

The policy has gone some way to supporting the team through changes to the school structure (we are moving to a 2-year KS4) and lesson length as we have needed to consider retrieval and interleaving of specific skills throughout our long-term plans and schemes of work.

Practical work is done to a higher standard than previously. Teachers are better at planning and evaluating practical lessons; we are able to discuss them as a team in a way we couldn't, or didn't, previously.

We have found that the amount of practicals being completed to a high standard has increased significantly. Furthermore, staff have become more confident in completing practicals that they previously have struggled with. This has led to staff, with the support of the technician team, completing more advanced experiments with their pupils, which, in turn, has increased the working scientifically level of the pupils in their care.

We now have greater consistency across the team, particularly in supporting new and inexperienced team members.

Practicals at my school had mostly been add-ons and were done because it was expected or just to break the writing up. The intention of this project was to make practical science an integral part of the learning process. Over the period of the last few months we have explored the 'Intent' of the practicals, why we do them, what is their purpose, and have made a concerted effort to make the practicals uncover facets of the science that theory or book work alone could never uncover. We have also made the scientific method a key objective with skills being acquired and developed for their own sake (reading scales, fine motor skills). Additionally we have developed a practical transition unit to span KS2

Reporting on the project's outcomes...

to KS3 to further develop practical skills in Yr6 before they come to secondary.

It's been possible to see a soft change in the department culture. There has been much more discussion along the lines of 'I was doing this practical because...' and when I asked teachers why, they were able to give a better answer than their previous standard answer of 'it's on the scheme of work'.

Level 5 (students' learning outcomes – Waves 1 and 2)

- *Students are better motivated during practical lessons and there has been better engagement particularly with lower ability students. Question level analysis of examinations has shown better responses to practical-based questions.*
- *When pupils transition between year groups, the practical skills of the pupils are stronger and they are more independent scientists.*
- *Although not the purpose of this policy but an interesting outcome nonetheless – our 2019 GCSE students performed significantly better in practical work-based questions in the exams than the previous cohort.*
- *Early indications show attainment in practical-based questions is improving at KS4, but what is really interesting are the classes at KS3 who have not known anything else other than this progression of skills born from the policy. These students have a better skill set and we can plan more effectively each year because we know for certain the experiences they have had in the previous years – this is going to be really positive when they get to their GCSEs.*
- *Through student surveys, the majority of students now identified as 'feeling comfortable linking practical tasks with scientific knowledge'.*
- *Students are learning more from having better planned lessons, and we can see that in assessments, where they perform well on questions assessing different aspects of practical work.*
- *Students are far more aware of the skills they are building up whilst doing practical work. They will often say things like 'Oh, so that's what you mean by a zero error' when looking at a worn-down ruler and then starting at 1cm and subtracting afterwards. Students are far more aware than they were that skills are also transferable and many aspects are common to most or all practicals.*

Reflections

Summarising the project's outcomes

The evidence presented above indicates that participation in this project has had positive impacts at school level, with senior leaders and governors recognising the importance of practical work and efforts to enable effective practical work; at science departmental level indicated by strong leadership, shared understandings, team work in planning and measuring impact; at individual teachers' level, who are clearer about purposes and are better at planning, teaching and assessing for impact; as well as at students' level, who show improved progression of skills and can link practical work to their understanding of the underlying science content.

From the outset, the project's guidance with professional learning strategies and activities were designed to be accessed online and used without intervention or support from ASE, so extending our reach greatly and beyond the need for face-to-face interventions. Responses from three experienced Wave 2 science leaders throughout the project indicate that our resources work very well when accessed online.

The demands of the project on science leaders and their teams

This was a demanding project for all the science leaders and their teams to remain engaged and productive throughout the duration of the project. Whilst we made efforts to keep our requests and expectations to a minimum, we also needed to be sure that the schools that were invited as Wave 1 or Wave 2 schools understood their commitments from the beginning, and remained actively engaged, particularly in the six+ months following publication of their policies, in order to benefit from any intended impacts; and report as such to the project team.

Allowing for adequate time to develop the policy, and the six+ month period following publication of the policy for it to impact on practice, necessitated a long period of engagement – typically starting from January to May 2018 (sign-up process) through July to December 2018 (professional learning with the project's resources), through January to May 2019 (completion of policies) and ending from November 2019 to March 2020 (feedback on impact).

The overall process was rather longer than we had planned for, as we accommodated requests for flexibility with our deadlines, particularly for science leaders and their teams to engage with the project's resources and lead the development of their policies through departmental professional learning and development meetings. Ongoing discussion with science leaders during this time indicated that there is very little opportunity available for this type of departmental professional learning, which the more experienced science leaders with a clear vision for the benefits of this project understood and planned for. At this point, we lost some schools where it became clear that juggling with not uncommon issues such as changes in staffing (including science leaders moving on), illness within the science team, etc. understandably needed to be given a higher priority.

Reflections

A second common time when we lost some schools was after six+ months following publication of their policies, for broadly the same issues as outlined above.

The importance of science leaders with the vision and commitment to engage with the project

The science leaders who worked with the project team throughout the project shared the following qualities of effective leadership that enabled them to be successful:

- A clear vision for what they wanted to achieve, and an understanding of the role of practical work in achieving their vision;
- The leadership skills to engage with their team, to support them and work towards a shared vision that is owned by all;
- An understanding of the strengths and weaknesses of their practical science provision, enabling the shared process of identifying manageable and measurable impact, putting in place the mechanisms to collect evidence of impact and the time to reflect critically on the evidence as a team;
- Engagement with senior leaders to achieve buy-in, support and commitment by focusing on the quality of learning that effective practical science brings; and
- Recognition of success in terms of students' learning and achievements, and a belief that teaching science effectively involves much more than achieving examination success.

The process of producing the policy is as important as the policy itself

The process of engagement with the project's professional learning strategies and activities appears to demonstrate that producing a policy was an effective vehicle to enable significant departmental professional development and changes to pedagogical practice. Individual teachers, and technicians, doubtless benefited from the process but, overall, this project was concerned with the establishment or development of an effective science department. The project and its resources provided the context that enabled a receptive science leader to bring about change.

Common starting points for developing policies

Although each science team had different starting points, strengths and weaknesses identified in discussions and completion of radar charts at the beginning of the project, the majority worked with the project's resources to focus on the purposes of practical work, progression in practical work and planning for effective practical work (modules 2, 3 and 4).

12 Percentage of schools with a policy Good Practical Science report page 44 https://www.gatsby.org.uk/uploads/education/reports/pdf/good-practical-science-report.pdf
13 https://www.ase.org.uk/news/new-ase-report-highlights-concerns-over-practical-science-post-lockdown

Reflections

Differences between policy and procedural documentation

When completing the 'expression of interest' form, respondents were asked to indicate whether their school already had a policy for practical work in science. Those who responded 'yes' were requested to share their policy with the project team. It became clear that many science leaders were uncertain as to the function of a policy, as their documents were an outline of health and safety procedures. This suggests that it would be difficult, and probably not desirable, to measure any increase from the 23% of schools[12] that have a written policy for effective practical science. Whilst it is encouraging that 68% of respondents to a recent ASE survey on practical work indicated that their school had a policy for practical work[13], the content of these policies is unknown.

Simplicity of the project's messages

The simplicity of one of the project's key messages – on the importance of determining the purpose of any particular practical activity and ensuring that this purpose is focused on when planning work to enable students to make progress – means that it is an easy message to take home, one derived from Robin Millar's research work[14] underpinning ASE's earlier Improving Practical Work in Science (Getting Practical) project[15] and explored within modules 2, 3 and 4 of this project. It was perhaps surprising that most science teachers and science leaders, including those with significant experience, found plenty of food for thought around this key message, and the project's resources worked well to support this thinking and collaborative planning to effect change.

Engaging less experienced and less effective science leaders

Our observations through this project begin to raise questions about how to best support less experienced or less effective science leaders, and those aspiring to the role of science leader, as well as individual science teachers who could also benefit from interaction with the project's resources. This would be in addition to extending the project's reach to larger numbers of experienced science leaders.

The findings of this project suggest the following:

- ASE should use this report to further promote the project's guidance, professional learning strategies and activities plus case studies to school and science leaders, with a continued emphasis on reaching schools and academies in challenging

14: https://www.ase.org.uk/bookshop/analysing-practical-science%C2%A0activities-assess-and-improve-their-effectiveness and http://www.gettingpractical.org.uk/documents/APS-sampleJan2010.pdf
15: http://www.gettingpractical.org.uk/

circumstances. ASE's recent experience, in partnership with the Geographical Association, with the Teaching and Leadership Innovation Fund[16] suggests that ASE would be well placed to engage these schools and their leadership.

- To encourage science leaders to actively engage with the project's resources and to work with their science teams to produce a policy and go on to measure the impact of the policy over time, it is recommended that ASE seeks support to develop and run an online professional learning and development course (potentially repeated), with 'plan, do, review' elements over several sessions, based on the existing modules. Promotions of the course should focus on reaching less experienced and aspiring science leaders and those working in challenging circumstances.
- More broadly, ASE should use this report alongside our other reports and commitments to ensure that frequent, purposeful and impactful practical work characterises the rich science curriculum offering we expect for all young people. ASE should continue to take a leading role in discussions with policy makers and other key stakeholders such as the Gatsby Foundation in ensuring that practical science remains valued and a key part of formal assessment in science. This stance is particularly important currently as the impact of COVID-19 continues to unfold.

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16: https://www.geography.org.uk/Critical-thinking-for-achievement