Evaluation of the impact of a continuing professional development (CPD) course for primary science specialists

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wellcome trust

Foreword

Imagine what could happen if all primary school children experienced wonderful science teaching that inspired them, and made them eager to investigate and understand the world around them.

We know that children start to develop perceptions about science towards the end of primary school and that these are indicative of their later interest and performance in science[1]. So imagine how it would be if all children experienced exciting and excellent primary science teaching, helping them to make better decisions for their futures and, for some pupils, igniting the spark that leads eventually towards breakthroughs in scientific research or innovation in engineering. We can continue to dream or we can take action to ensure we have confident, skilled teachers of science in primary schools where science is valued.

Unfortunately, we know that many primary teachers lack confidence to teach science well, and primary science leaders often have little experience of science beyond the statutory requirements (a GCSE or its equivalent in science) so they manage science in their schools rather than lead it. If we want primary schools to deliver excellent science teaching, it is essential that teachers have access to appropriate science expertise in a school system that values science beyond attainment outcomes.

Developing primary science expertise

Expertise can be increased through attracting new entrants into the teaching profession who already have secure science knowledge and can be trained to become primary science leaders[2], and by training those who are already teachers. Attracting new skilled entrants and specifically supporting them to become primary science leaders is highly desirable but it will take time and considerable financial investment to increase capacity by this route alone. Training existing teachers to become expert science leaders could increase capacity more rapidly. A mixture of both would ensure that we have a breadth of experience and skill.

Working with the National Science Learning Centre (NSLC), the Wellcome Trust invested in developing a one-year intensive programme of continuing professional development (CPD) to up-skill qualified teachers to lead and teach successful primary science in their schools. Participants build their pedagogical content knowledge – their understanding of how children learn science, the misconceptions that may arise, and different teaching methodologies that will develop scientific thinking and knowledge. It also directly develops their subject knowledge and leadership skills.

Wellcome commissioned a rigorous randomised controlled trial to collate evidence of impacts at school, teacher and pupil levels, comparing performance between participants who had a 14-or four-day CPD course with those who had no NSLC CPD provided to them. Information gathered from the participants, their colleagues and school leaders helps us to contextualise the findings and consider the implications for the future.

There is no doubt that class teachers and science leaders alike are aware that their science knowledge has limitations, but the very low level of knowledge of some teachers at the start of the trial was concerning. It became apparent during the delivery of the CPD that some teachers were initially unaware of their misconceptions about science phenomena. Other teachers were more aware of their shortfalls in knowledge, which led to a lack of confidence, which, arguably, they might convey to their pupils – perhaps adding to children's perception that science is difficult or not for them[3]. We hoped that pupils' attitudes to science would become more positive as their teachers developed confidence, new skills and enthusiasm through the CPD.

Impact of the professional development

There was no doubt for anyone observing CPD sessions that the participants were transformed into an enthusiastic network of teachers who wanted their pupils to enjoy doing science as much as they now enjoyed teaching it.

Although teachers reported that their subject knowledge had improved, this was not captured in the assessments used (Key Stage 3 science SATs). At the end of the first year, however, pupils in their classes showed significant improvements in their attitudes towards science. That improvement in attitude was not sustained when the children had new teachers in the following year; the science leaders still had work to do to share their new skills and confidence with their colleagues.

Some teachers who received the shorter CPD course also strengthened their practice and there was qualitative evidence of increased enjoyment of science in their schools.

A year after the CPD course finished, there were measurable impacts on the pupils in the science leaders' new classes: improved subject knowledge and improved attitudes. Qualitative data also revealed examples of wider impacts – a rise in the profile of science in school, improved standards of work, better and more robust leadership rather than management of science. Importantly, science leaders needed support from school leaders to disseminate their learning; without this their endeavours were less impactful.

Our findings are consistent with the significant correlations noted in Ofsted's recent science report[4] between outstanding primary science and participation in science-specific CPD.

Refining the CPD

Feedback from the evaluation and the course participants themselves enabled the NSLC to refine the CPD, condensing it into fewer days, providing options for more modular delivery, and it has now been matched to the newly published curriculum. The CPD has also been enhanced by the inclusion of an i-book that provides a reference library of materials and videos and supports dissemination of learning to colleagues across the schools[5].

One teacher on the new course commented that "achievement has increased and science has become a focal point of celebration throughout the school. We have been used as a model of good practice for teaching students specialising in science." We couldn't ask for a more promising outcome.

> "We have seen improvements in science across the school, teachers and children alike are more enthusiastic and we are now able to show evidence of improvements to visitors, such as Ofsted, through photography, planning and data."
>
> **Course participant**

Achieving the dream

So what does this mean for primary science?

We can continue to dream or we can take action to ensure we have confident, skilled teachers of science in primary schools where science is valued.

It is clear to us that if we want to improve primary science then aspiring primary science leaders should be able to access the CPD they need as a priority. They should have the support from their school leadership teams to attend all the sessions, additional time to lead science in their schools, and dedicated staff development time to support their colleagues. And they, like all teachers, should be encouraged to continue that professional journey with on going access to subject specific CPD[6]. The text box (right) summarises the recommendations from *Primary science: is it missing out?*[7], which sets out how our dream can be achieved.

Science is a core subject that can be a vehicle to raise achievement for all pupils. When used well, and given the status it deserves, it can be amazing. But we need the commitment from everyone involved in primary education to make that happen.

Clare Matterson
Director, Strategy, Wellcome Trust

Recommendations from *Primary science: is it missing out?* Wellcome Trust, September 2014.

The UK should champion primary science:

- Policy makers should ensure that education leaders at all levels are accountable for the provision and quality of primary science teaching.
- School leadership teams (including governors and head teachers) should value and aspire to excel in primary science.

Primary schools should have access to science expertise:

- Policy makers should require that all primary schools have, or have access to, science leaders with expertise in primary science, and ensure that the resources and infrastructure to enable this are provided.
- Science subject leaders must regularly access high-quality continuing professional development (CPD) to ensure that their expertise is sustained.
- Class teachers must take responsibility for their professional development in science.
- School leadership teams should prioritise access to high-quality science-specific CPD.

Primary science should be well-resourced:

- School leadership teams should use recommended benchmarks to guide their resourcing of science.
- Science subject leaders should have strategic responsibility for a dedicated science budget.

Executive summary

Context

This is the final report[8] evaluating the impact of a continuing professional development (CPD) science course for primary school teachers. The course was developed by the Wellcome Trust and the National Science Learning Centre, and was designed to train primary teachers to become primary science specialists. Whilst the report mainly focuses on the impact of the course one year after its end, it also summarises findings from the start of the course and its end[9].

Methods

We ran a randomised controlled trial, using both quantitative and qualitative methods. The primary quantitative measures were teachers' and pupils' science subject knowledge; the secondary measures were teachers' confidence in the knowledge they were tested on, and pupils' attitudes towards science. The teacher measures covered the science specialists and also one nominated colleague in each school. We collected quantitative data at three stages: to provide a baseline at the start of the CPD course, at the end of the course, and to examine legacy effects one year after the end. These data were supplemented by a more qualitative evaluation, using case-study visits to a sub-sample of schools to assess implementation, effects on classroom practice and pupil reaction.

The baseline research initially involved 96 schools randomly assigned to three groups:

- **full CPD group** with science specialists receiving 14 days of directed CPD over a school year, with the equivalent of 10 further days of network support, online work and dedicated time in school
- **partial CPD group** with science specialists receiving four days of CPD over the school year
- **control group** with science specialists not receiving any of the CPD provided to either group above (but still able to access other CPD).

Attrition removed some schools from the study – not unexpected in a trial of such length and intensity. In all, 16 schools dropped out: eleven withdrew soon after random assignment and we removed five for not meeting the conditions of the study (either not teaching the correct Key Stage or not returning tests).

Of the remaining 80 schools, four were excluded from the legacy study looking at impacts in the year after the CPD had finished, because we did not receive pupil test data from the same individuals who had been tested at baseline. In total, the legacy comparisons with the baseline are based on test returns from 1582 pupils at 76 schools.

Data on pupils' attitudes were analysed for the 965 pupils who replied at all three stages.

The teacher sample was lower than the possible maximum of 76 specialists plus 76 nominated colleagues. This was because of a combination of factors, mainly staff turnover. In total, science subject knowledge tests were returned by 43 specialists and 35 colleagues, although because eligible tests had not been received from all the teachers at baseline, the analysis was based on 40 specialists and 32 colleagues.

We also conducted an extension study that involved sending pupil test papers and attitude surveys to those science specialists who took over a new Key Stage 2 class at the start of the academic year after the CPD course had finished. These schools were drawn from eligible volunteers from the main study and enabled us to follow any effects upon not only the previous classes but also the specialists' new classes.

Key findings

Analysis of the quantitative data showed no statistically significant impact of either the full or the partial CPD course on the teachers' test results or their confidence in answering the test questions. This was true of both the science specialists and their nominated colleagues. However, there are two caveats. First, as a result of under-recruitment of schools and attrition over the two years of the study, the sample of teachers remaining at the third stage may have been too small to show an effect at a statistically significant level. The findings, therefore, are indicative only. Second, the tests were previous Key Stage 3 science test papers (designed for students aged 13-14) and were deliberately not tailored specifically to reflect the topics covered by the CPD.

Despite this lack of quantifiable impact, almost all of the science specialists who gave their views – in case-study interviews or in self-evaluation forms completed at the end of the full CPD course – said that their subject knowledge had improved and that they felt much more confident about teaching science.

Multi-level modelling, carried out on pupils' subject knowledge scores across the three stages, found no statistically significant differences between the three groups. In other words, the subject knowledge scores of the full CPD group pupils were not significantly higher than those of the other groups. However, the extension study found that the scores of the full CPD group were significantly higher than those of the partial CPD group and those of both other groups combined. One possible explanation for this might be that the full CPD course ended in late June, with the order of topics covered being independent of the order in which teachers taught the topics to their classes. This may have meant that the teachers did not have the chance to revisit their course notes and materials and use these to improve their teaching until the following academic year.

Findings from primary science specialists

1. Participants' subject knowledge (and that of teaching colleagues also tested) was relatively weak, with an average baseline test result, on a Key Stage 3 paper, of only 59%.
2. Participants were generally positive about both of the CPD courses.
3. Participants in the full CPD course said that it had made them more enthusiastic about teaching science.
4. Participants in the full CPD group had a range of different views about the value of the subject knowledge component.
5. The full CPD course had more reported impact than the partial course, though some participants in the latter felt that it provided the optimum balance between the benefits of the course and competing factors such as the practicalities of attending.
6. Participants in both CPD courses reported gaining new pedagogical subject knowledge and skills that improved both their performance as subject leaders and their classroom practice.
7. Whilst more than half of the full CPD group said that their subject knowledge had improved, this was not supported by the findings from the quantitative analyses.
8. Participation in the CPD was reported to have raised the status of, and increased support for, science in many of the full CPD schools and some of the partial CPD schools.
9. Participants in both CPD courses said that their teaching approaches had changed, to feature more practical, hands-on, open-ended, outdoor, and inquiry-based science activities.

Findings from pupils

10. The main study found no evidence that the full CPD course produced any statistically significant impact on pupils' science understanding. However, the extension study found that scores of pupils in the full CPD group were significantly higher than those of the partial CPD group and those of both other groups combined (although there were no statistically significant differences between the full group and the control group, or between the partial group and the control group).
11. There were a few instances where the surveyed opinions of pupils in the full CPD group appeared to have changed in a different way, or more extensively, than those of all other pupils.

Findings from schools

12. There was no evidence of CPD impact on colleagues' science subject knowledge.
13. A number of factors external to the CPD provision appeared to influence its impact, e.g. the support of the head teacher or the commitment of the teacher.
14. Views on the use of randomised controlled trials were comparatively neutral, and many participants did not have any idea what such a study design involved.

Overall, in terms of 'soft' measures, the CPD impacted positively on teachers of science in primary schools. The intervention raised teachers' confidence in teaching science and trying out new ideas, introduced teachers to new sources of teaching materials (such as the National STEM Centre) and also helped to foster and develop networks of primary science teachers who have remained in contact, sharing ideas and resources, beyond the lifetime of the intervention.

In terms of 'hard' measures the evaluation has found that the CPD (both the longer and shorter courses) had no statistically significant impact on teachers' subject knowledge or confidence in answering the tests. Results from the extension study found statistically significant differences in pupils' test scores, potentially indicating that some 'hard' measures of impact might require more time to manifest. Whilst some statistically significant changes were found in pupils' attitudes towards some very specific areas of science, the value of such changes would depend on whether they are transitory or enduring.

While feedback from teachers was generally positive, some considered the duration of the full CPD course to be too long. Such views, taken in conjunction with the 'hard' results of the RCT, lead us to suggest that for a national roll-out a shorter hybrid programme should be considered.

This study also demonstrates the importance of using a mixed-methods evaluation of an educational intervention in order to provide a mixture of both 'hard' and 'soft' evidence.

This report was undertaken by a team from the University of York (Department of Education and Institute for Effective Education) and is available from **wellcome.ac.uk/primaryscience**

References

[1]Aspires. Young people's science and career aspirations 10-14. London: King's College London, Department of Education and Professional Studies; 2013.

[2]Definition of a primary science leader can be found at http://www.wellcome.ac.uk/Education-resources/Education-and-learning/Our-work/Teacher-training/WTS052326.htm

[3]Economic and Social Research Council. 'What influences participation in science and mathematics?' A briefing paper from the Targeted Initiative on Science and Mathematics Education (TISME). London: ESRC/TISME; 2013.

www.tisme-scienceandmaths.org/wp-content/uploads/2013/04/TISME-Participation-Report.pdf

[4]Ofsted. Maintaining Curiosity: A survey into science education in schools. Manchester: Ofsted; 2013 https://www.gov.uk/government/publications/maintaining-curiosity-a-survey-into-science-education-in-schools

[5]Wellcome Trust, Researching the use of the i-book within the Primary Science Specialist Programme. London: Wellcome Trust, 2015.

[6]Ofsted, Maintaining Curiosity. Manchester: Ofsted, 2013. https://www.gov.uk/government/publications/maintaining-curiosity-a-survey-into-science-education-in-schools

[7]'Primary Science: Is It Missing Out?' Wellcome Trust, September 2014

[8]Wellcome Trust, Evaluation of the impact of a continuing professional development (CPD) course for primary science specialists. London: Wellcome Trust; 2015.

[9]There are two additional companion reports.

Wellcome Trust, Impacts of Professional Development on the Primary Science Classroom Qualitative Comparisons. London: Wellcome Trust; 2015.

Wellcome Trust, The Wellcome Trust Case Study of the Implementation of a Randomised Controlled Trial (RCT) in Education. London: Wellcome Trust; 2015.

Notes

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