

USING COACHING TO ENHANCE SCIENCE-SPECIFIC PROFESSIONAL DEVELOPMENT FOR PRIMARY TEACHERS

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Abstract: The research evidence indicates that coaching and mentoring are significant features of effective professional learning for teachers. In science education, coaching is occasionally included in professional development for science subject leaders but only very occasionally used in formal subject-specific training of classroom teachers. This paper is a summary of the research findings from a comparative review of two continuing professional development (CPD) programmes for primary teachers, which combined professional development in science subject knowledge and science leadership skills with training of coaching skills for teachers. The research compared the outcomes of two different approaches to CPD on teacher development and the outcomes on pupils' attainment and progress. In one approach, teachers received coaching training as an integral part of science CPD, whereas in the other programme, teachers received CPD on science subject specific and leadership skills together with skills in coaching.

The findings from this research indicate that the teaching of coaching skills has a positive role in embedding newly acquired science-specific knowledge for teachers and improving pupil outcomes across the school. The research also revealed that many teachers lack an appreciation of how coaching skills can enhance the impact of science-specific CPD but after experiencing coaching CPD and using new skills in practice, they understood the impact of coaching on their professional learning.

Key words: teacher professional development, coaching, science education, primary science

INTRODUCTION

Research Background

There have been a number of systematic reviews about the effectiveness of teachers' continuing professional development (Bolam & Weindling 2006) with coaching and mentoring emerging as significant variables in contextualising CPD, especially for new leaders (Vanderburg & Stephens, 2010). Also the Centre for the Use of Research and Evidence in Education (CUREE) analysed the evidence of what works in professional development for teachers. In their meta-research study, CUREE (2012) concluded that to improve pupil outcomes professional learning has to be: collaborative; sustained over time; focused on aspirations for pupils; and supported by specialist expertise. Their conclusion was that professional development is much more likely to be successful when it involves collaboration between staff and that effective mentoring and coaching is key to this professional development. CUREE indicate that when teachers worked together on a sustained basis (over at least one term but more usually two or three terms), this collaborative and sustained CPD was linked to positive effects on:

- students' learning, motivation and outcomes
- teachers' commitment, beliefs, attitudes, self-esteem and confidence in making a difference to their students' learning

- teachers' repertoires of strategies and their ability to match their teaching approaches to students' different needs
- teachers' attitudes to their students, the curriculum and to learning, and
- teachers' commitment to CPD.

It has been also argued that using coaching as part of collaborative learning helps address individual teacher needs, shows the value of teachers learning with and from one another, contextualises CPD application and helps embed enquiry-oriented learning in day-to-day practice. (Lofthouse, Leat & Towler, 2010; Timperley, 2009).

However, coaching training in schools is often detached from subject-specific CPD. After attending external subject-specific CPD, teachers often lack confidence and skills to put newly acquired subject knowledge and pedagogy into practice and effectively share it with colleagues. This is particularly noticeable among primary teachers, who have limited expert knowledge of science and minimal formal leadership responsibilities to support knowledge transfer.

In this study, we wanted to examine how different ways of teaching of coaching skills alongside science specific content knowledge and leadership skills could affect the outcomes and impact of the CPD on teachers' practice and pupil learning. In particular, we wanted to test out

- a) how the teaching of coaching skills could help primary science subject leaders have more confidence and effectiveness in improving the teaching of science in their schools and
- b) whether different models of blending coaching and subject specific CPD modules make any difference for the outcomes and impacts achieved.

National Science Learning Network

The National Science Learning Network in the United Kingdom provides a range of STEM subject-specific professional development opportunities through a network of 50 Science Learning Partnerships in England, including the National Science Learning Centre in York, and through delivery partners in Scotland, Northern Ireland and Wales. The Network is jointly funded by the UK government, a range of STEM employers and some major STEM charitable trusts.

The network work works with around 5,000 teachers and technicians across the UK annually providing high impact, subject -specific professional development days for teachers, support staff and school/college leaders through face to face and online continuing professional development (CPD), and access to physical (26,000+) and online (10,000+) resources which support STEM teaching and learning through the National STEM centre.

METHOD

This research explored the benefits of teaching coaching skills to primary teachers undergoing science specific CPD. More specifically, we investigated how different models of teaching coaching skills to primary teachers during science specific professional development could improve the impact of CPD, the quality of science teaching and ultimately outcomes for pupils.

We compared data from two different CPD experiences for primary teachers: the first provided science-specific CPD with additional separate CPD on coaching skills whereas the second provided science- specific CPD and integrated the coaching skills with the subject CPD.

Programmes description

Programme one: Coaching Primary Science Scholars to Success (CPSSS)

This programme ran between November 2013 and July 2015 and involved 68 teachers in 22 London primary schools. The teachers had science-specific CPD where the subject content and pedagogical knowledge professional learning was integrated and delivered by primary science education experts. In addition to science CPD, teachers had a separate training module in generic coaching skills. CPSSS overarching objective was to improve primary pupils' achievement and engagement in science by improving teachers' subject knowledge, their confidence and effectiveness in teaching science while also improving their overall capacity and capability for leading the teaching of science in their schools.

Primary science consultants provided the equivalent of 10 days of face-to-face teaching, access to online resources, an on-line community for sharing expertise, and the equivalent of two days of bespoke support in school. The face to face CPD was specifically designed to significantly improve the primary teachers' scientific knowledge, as few of them had science qualifications post16.

Coaching training was provided by expert coaching experts and comprised of equivalent of four days of face-to-face training sessions in instructional and performance coaching, two days of in-school bespoke support and resources together with on-going support via an on-line community group. The instructional coaching was used to help improve teachers' reflective practices, to enable their new knowledge and skills in science to be embedded in their teaching. Performance coaching was aimed at improving the quality of science leadership by developing and extending participating teachers' skills in supporting their colleagues to improve their knowledge and skills in teaching science

Programme Two: New and Aspiring Primary Science Specialists (NAPSS)

This was an eight month CPD programme (October 2014 -June 2015) aimed at primary teachers with responsibilities for science subject leadership, particularly those who were new subject leadership. This programme involved 40 subject leaders from primary schools across the UK, who were provided with subject specific professional development similar to the CPSSS programme. By helping teachers explore common misconceptions in biology, chemistry and physics and giving practical advice on how to teach science in engaging and innovative ways, this science- specific CPD aided the development of teachers' science content and pedagogical knowledge and led to the improvement of their confidence and enthusiasm for science. The delivery of science CPD followed a similar model to that of CPSSS consisting of face-to-face CPD (ten days delivered during three training periods), online training and networking opportunities, provision of specialist resources and consultants' support.

The NAPSS programme also supported the development of teacher coaching skills, but, in contrast to CPSSS, it was delivered in a very different fashion: teachers' learning of coaching and mentoring skills was strictly in the context of science teaching and leadership rather than as 'stand-alone' set of reflective and leadership skills. This training was done by the same education experts, who provided science CPD, and was delivered as part of subject-specific CPD. For the participating teachers this knowledge was an 'organic' element of high quality science teaching and leadership, and many of them remained unaware that they were learning 'coaching' techniques.

There was a range of expertise amongst the teachers in both programmes – from newly qualified teachers to very experienced classroom teachers, but many had limited leadership experience. The main difference between the programmes was the absence of in-school

bespoke visits by consultants, which, due to a wide geography of participants, were deemed impractical and were substituted by additional CPD events held regionally.

Despite difference approaches to coaching, both programmes shared the same ‘theory of change’: progressively improving teachers’ content and pedagogical knowledge of science subjects; enhancing their science teaching while improving pupil learning and enjoyment of science. The coaching elements of the programme were expected to facilitate how teachers shared good practice, supported colleagues’ professional development in science teaching so as to improve pupil outcomes.

Evaluation methodology

The data for this research was collected at various points of each programme, using method and data triangulation and in accordance with the programme evaluation requirements. In both programmes, diverse methods and multiple data sources were used to gather pre/post evaluation feedback and evidence of impact on participating teachers, pupils and schools. They included:

- Evaluation feedback on face-to-face CPD sessions
- Teacher surveys repeated at different stages of the programmes
- Attainment and progress data of pupils directly impacted by the teachers in the programmes
- Qualitative data from teacher and pupil interviews, case-studies and focus-groups
- Teacher knowledge test (CPSSS only)
- Head teacher survey (CPSSS only)

There was consistency of data collection between the programmes, where possible, using identical measuring instruments to assess teacher subject knowledge, confidence and teaching practices, pupils’ interest and academic performance in science, science-specific CPD and knowledge dissemination practices. For example, after each instance of CPD delivery in both programmes, similar evaluation forms were administered to capture participants’ feedback; the same instruments and statistical methods were used for collecting and analysing individual pupil attainment and progress data. However, methodologies were not totally congruent due to different reporting requirements of the programmes, allocated resources and programme timelines.

In the CPSSS programme, data was collected on participating teachers, pupils and schools at the project onset (Dec 2013 – March 2014), its mid-point (July – September 2014), and at the project end (June – July 2015) whereas in the NAPSS programme, the information was collected at similar points: during and immediately after each of the three training periods.

However, the baseline data collected at the start of the NAPSS programme (October 2014) was of different format and standard to the CPSSS baseline data. To address this shortcoming, additional baseline data was gathered retrospectively, i.e. by asking NAPSS teachers at the end of the programme to evaluate their pre-programme science knowledge and teaching practices, as well as their pupils’ engagement and attainment in science prior to NAPSS. This, however, created a methodological problem: NAPSS teachers’ retrospective assessment of their ‘baseline’ position was noticeably lower than the CPSSS teachers’ assessment of their and their pupils’ positions collected in ‘real time’, i.e. before their engagement in the programme. We were able to overcome this limitation by triangulating quantitative and qualitative data collected for both programmes and by using multiple measures of impact and a range of data sources.

A sample of pupils’ attainment and progress in science was collected from the teachers in both programmes including attainment at the start of the key stage (i.e. pupils aged 5 or 7), the start of the school year (September 2014), predicted and de facto end-of-the-school-year

attainment (Sept 2014 and June 2015), Data was also collected on 996 pupils in the CPSSS programme and 350 pupils in the NAPSS programme on gender, year group, indicators of disadvantage.

The Department of Education in England removed a previously used system of attainment levels in 2013. Consequently, schools have been using a range of different methods and techniques to assess pupil attainment in science. This presented a serious methodological challenge and left no alternative but to reduce the measurement to a very simple three point scale that is based on general national guidelines for assessing attainment in science:

- (+) the pupil's attainment exceeds age-related expectations
- (=) the pupil's attainment meets age-related expectations
- (-) the pupil's attainment is below age-related expectations

RESULTS

Impact on teachers

As shown in Table 1, both programmes were successful in reaching the expected outcomes of the programme on teachers: growth in teacher subject and pedagogical knowledge, increase of their confidence to teach science and an improvement in the overall quality of science teaching.

Table 1. Evaluation of outcomes for teachers reported in NAPSS and CPSSS programmes

Teacher Outcomes	Programme	Mean scores (M)		Change*
		Baseline	Final	
Quality of science teaching (from external observation of science lessons) Scale: 1 (requiring improvement) to 5 (outstanding)	CPSSS	3.46	4.00	+0.54 50% of teachers improved one or two levels
	NAPSS	3.17	4.00	+0.83 65% of teachers improved one or two levels
Teachers' confidence to teach science (self-assessment); Scale: 1 (not at all confident) to 4 (very confident)	CPSSS	2.82	3.38	+0.56
	NAPSS	2.5	3.7	+1.2
Subject content knowledge (self-assessment for 14 science subject areas) Scale: from 1 (very low) to 8 (very high)	CPSSS	5.16	6.26	+1.10
	NAPSS	4.30	6.35	+2.05
Science specific pedagogy (self-assessment for 5 science pedagogy areas) Scale: from 1 (very low) to 8 (very high)	CPSSS	4.84	6.17	+1.33
	NAPSS	4.21	6.33	+2.11

* The difference b/n each baseline and final score measures was measured with paired T test and found to be statistically significant with $p < 0.05$

Although changes in teacher outcomes reported in the first programme (CPSSS) appear smaller than in the second (NAPSS) programme, this is mainly due to the difference in teacher assessment of 'baseline', which was significantly low in NAPSS, when it was measured retrospectively. Regardless of this difference, the observed improvements in teacher confidence, competence and quality of teaching in both programmes were statistically significant and the findings were consistent with other quantitative and qualitative measures of impact on teacher participants collected in each programme. When asked directly about the impact of the programme on their knowledge and practice, teachers of both programmes were very positive about in their responses (see also Figure 1):

- *I had gaps in biology, which the course has helped me with. I have a much more practical attitude to science teaching. My knowledge has improved immensely and ... I*

have used many of the activities in the classroom and have started a science club that has been oversubscribed since it began. (NAPSS)

- *My subject knowledge has improved tremendously. We do much more child-led investigations...I am able to use questioning and children to lead the learning. Their questions steer the science. Now I'm not so afraid to move away from set lessons to their investigations. (CPSSS)*

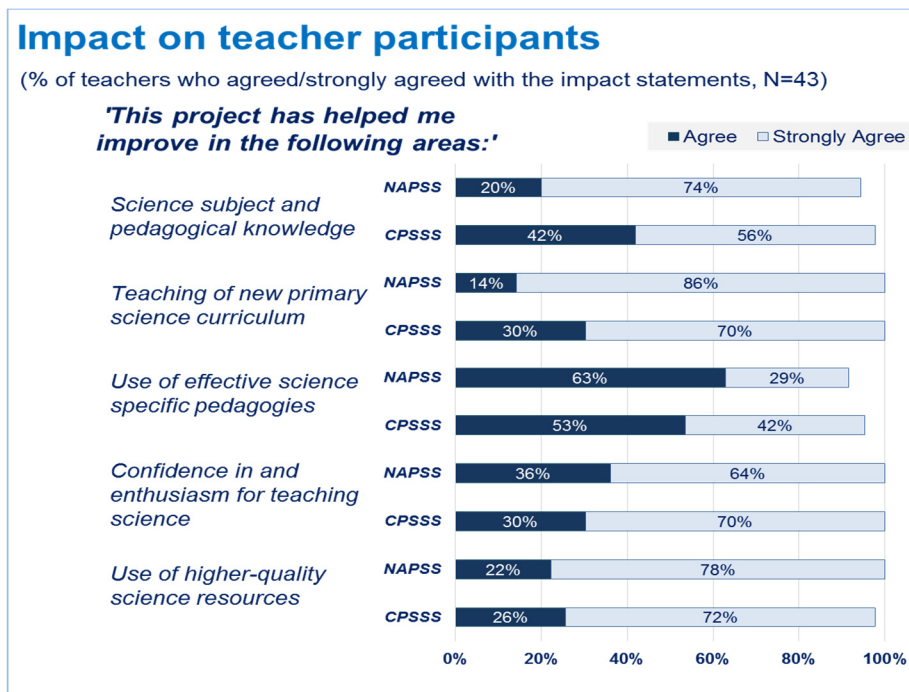


Figure 1. Impact on teacher science knowledge and teaching practice reported in NAPSS and CPSSS programmes

Impact on pupils

We used different measures to assess the impact of the programmes on pupil outcomes: pupil interest in science, engagement in lessons and academic achievement in science. The evidence showed a strong positive impact achieved in each programme on each of these measures: 98% of teachers in Programme one (CPSSS) and 100% of the Programme two (NAPSS) reported significant increase in pupil enthusiasm for science and enjoyment of science lessons in school; most teachers saw impact on pupil attainment and progress in science (95% and 100% correspondingly). Qualitative feedback, collected in interviews and during school visits, supported these findings and provided good illustrations of positive changes in the classroom, which teachers attributed to the CPD they received:

- *Children were always keen to learn science but by encouraging a more practical approach this has increased interest further. Children much more engaged in lessons and taking part in external science activities. (CPSSS)*
- *Planning & resourcing is renewed and improved with a higher practical content which has a positive impact on pupils renewing their interest in science and trying to increase their awe and wonder of the world (NAPSS)*
- *Children now can think scientifically; can ask scientific questions, can come up with their own investigations (NAPSS)*

Individual pupil attainment records collected from a sample of pupils, who were taught by the teachers directly benefitting from the programmes, corroborated teachers' positive

assessment of impact on pupils and provided more rigorous evidence of positive changes in pupil academic performance, which, for most of the pupils in both programmes, exceeded the expected outcomes. Figures 2a and 2b provide graphical representation of the attainment data; while Table 2 shows the same data in a tabular format.

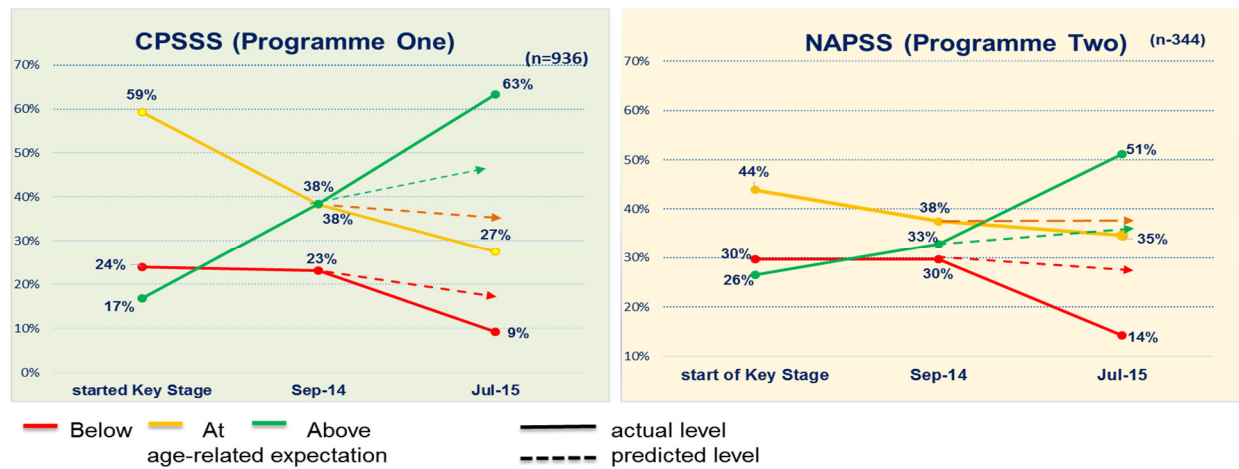


Figure 2a Impact on individual pupil attainment reported in CPSSS programme
Figure 2b Impact on individual pupil attainment reported in NAPSS programme

Assessment of pupils' attainment in science against the age-related expectations (below, at, above)		Percentage of pupils in each assessment category					
		NAPSS (n=344)			CPSSS (n=829)		
		below	at	above	below	at	above
Actual performance	start of Key Stage	30%	44%	26%	23%	59%	18%
	September 2014	30%	38%	33%	26%	52%	21%
PREDICTION for July 2015		27%	38%	36%	23%	43%	35%
Actual performance in July 2015		14%	35%	51%	10%	27%	62%

Table 2. Impact on individual pupil attainment reported in NAPSS and CPSSS programmes

During the 2014-15 school year in which the programme ran, the proportion of pupils whose attainment was initially below age related attainment decreased from 24% to 9% in programme one, and from 30% to 14% in programme two; whilst those whose attainment was above age related rose correspondingly from 17% to 63% and from 25% to 51%. The increase in the number of pupils exceeding age-related expectations at the end of the programmes was mainly due to the improved performance of the middle cohort of pupils, i.e. pupils, whose performance at the start of the programme was at the age-expected level. This is a very significant change, particularly when the expected trajectory of increase for this group was 47% (programme one) and 36% (programme two). This is a very significant change. It indicates that more than half the pupils who were attaining at a level below or commensurate with their age were inspired sufficiently by their teachers to achieve above their age related performance.

Impact of coaching training

As was stated earlier, coaching training in the CPSSS programme was delivered by coaching specialist in separate sessions from the science CPD, and initially many teachers were reluctant to attend separate coaching CPD. In the baseline surveys, while most teachers showed awareness of gaps in their science teaching skills and were keen to undertake

science-specific CPD, they felt less sure about the need and value of coaching. School culture (i.e. attitude to the importance of coaching skills in leadership) played an important role in shaping teacher attitudes. In one school, the leadership was split about the benefits of coaching, which negatively affected the views and the uptake of coaching sessions by teachers.

As the project progressed and teachers heard colleagues talk positively about the coaching training, more teachers took up the coaching offer. As the coaching skills were new to many teachers, it took more time and effort to learn, implement and appreciate the benefits. Not surprisingly in the interim evaluation (half way through the project) teachers were less positive about the value of coaching training than of science CPD: 95% of teachers rated science CPD 'very useful' or 'quite useful' and only 66% of them said the same about coaching. By the end of the programme, this number grew to 82% and nine in ten teachers said they saw at least some benefits of coaching training both in the classroom (e.g. questioning techniques and inquiry-based learning) and in leading/supporting colleagues' professional learning:

- *Coaching courses allowed me to look at the way I am managing my responsibilities at school and gave me time to discuss problems with other people in similar situations. I also feel more confident teaching science and have a bigger bank of ideas to draw upon.*

This was corroborated by head teachers, who completed the final survey (n=17): three quarters of them rated the coaching element of the programme as 'very useful'.

However, despite enjoying this part of training and acknowledging its value to professional and personal development, some teachers experienced problems integrating coaching and science CPD and also considered that the two parts of the programme at times were like two separate programmes:

- *... The coaching courses were useful in my professional (and personal!) life and I feel coaching skills were taught very well on the course. However, I was unable to see or forge a link between the two, particularly as coaching was based on not being an 'expert' and the science courses were designed to increase expertise. Both have helped me improve my practice as a class teacher and Age Phase Leader but not in conjunction with one another.*

We could not ask teachers from the second programme explicit questions about the value of coaching CPD because it was taught implicitly as part of leadership training within subject-specific. Teachers in this programme did not report any problems with learning or difficulties in implementing coaching skills in practice. We also compared the impact of both programmes on leadership skills (Figure 3a) and their effect on science teaching and learning in participating schools (Figure 3b). Both programmes showed very good results and if anything, NAPSS showed slightly better figures than CPSSS.

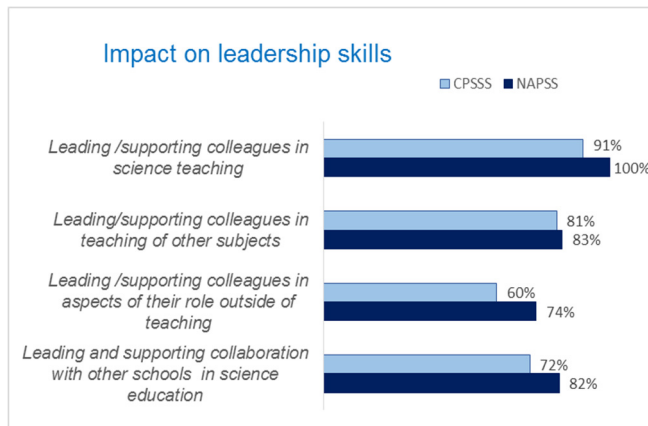


Figure 3a. Impact on teacher leadership skills reported by teacher participants

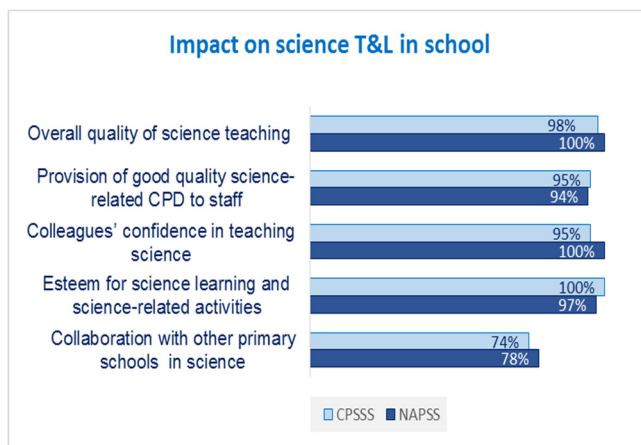


Figure 3b. Impact on science teaching and learning in school reported by teacher participants.

DISCUSSION AND CONCLUSIONS

After comparing the effects of the two CPD programmes on the teaching and learning of science in primary school, we concluded that

- Teaching coaching skills helps embed newly acquired science-specific knowledge and improves pupil outcomes across the school, as teachers are more skilled at working with colleagues to help disseminate their learning for the benefit of other teachers and ultimately pupils across the school.
- Many teachers lack an appreciation of benefits of coaching training, but after experiencing coaching CPD and using new skills in practice, they understand the impact of coaching on their professional learning and practice, as well as on their personal skills.
- School culture plays an important role in shaping teachers' attitudes to coaching: where head teachers and senior staff understand the value of coaching in building teachers' leadership skills and sharing effective practice across a school, teachers are more likely to value and use coaching effectively to improve pupil outcomes
- When coaching skills are embedded within subject specific CPD, it appears to be more effective in supporting improvements in science teaching and learning than when science CPD and coaching are delivered separately. However, explicit training in coaching skills may have a wider long-term impact as teachers can then understand how to use the skills across all subjects and thus improve school capacity and capability in the longer term.

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