

Evaluation of professional development strategies for bringing contemporary science into the classroom

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Abstract

Much has been written about frameworks of continuing professional development focusing principally on improving teachers' pedagogical skills (e.g. Joyce & Showers, 1988; Loucks-Horsley et al, 1998; Darling-Hammond & Youngs, 2002; Adey, 2004). Such research suggests that targeted professional development should be implemented over a long time scale, include in-class coaching and opportunities for teachers' reflections on any change in classroom practice that they make. Adey (2004) proposes that there are a number of factors which influence the effectiveness of professional development in its ultimate aim – improvement of student learning. Besides the quality of the professional development programme itself, the nature of the innovation to be made, the support of school senior management and collegiality of the group of teachers engaged in the professional development are all important. In many professional development programmes, the innovation is pre-determined in being focused on particularly teaching programmes. In England, regional Science Learning Centres have been set up with government funding to provide professional development which focuses as much on improving teachers' knowledge of contemporary science and its implications, as on appropriate pedagogical content knowledge which follows. The Centres are charged with CPD provision across a wide target audience - teachers of science to ages 5 to 19 and technicians - and a wide geographical area. Teachers' needs are thus diverse and the 'innovation' is not necessarily linked to the teaching of a common scheme. This paper describes the methods adopted by the Science Learning Centre South East in considering established principles of effective professional development and evaluates the outcomes from the first groups of teachers undertaking professional development through the Centre. The research considers the question: What are the strengths and weaknesses of the format of professional development in promoting the use of contemporary science in the classroom?

Introduction

Much has been written about frameworks of continuing professional development focusing principally on improving teachers' pedagogical skills (e.g. Joyce & Showers, 1988; Loucks-Horsley et al, 1998; Darling-Hammond & Youngs, 2002; Adey, 2004). Such research suggests that targeted professional development should be implemented over a long time scale, include in-class coaching and opportunities for teachers' reflections on any change in classroom practice that they make. Adey (2004) proposes that there are a number of factors which influence the effectiveness of professional development in its ultimate aim – improvement of student learning. Besides the quality of the professional development programme itself, the nature of the innovation to be made, the support of school senior management and collegiality of the group of teachers engaged in the professional development are all important. In many professional development programmes, the innovation is pre-determined in being focused on particular teaching programmes.

Much of the research evidence on the effectiveness of CPD programmes has, of necessity, been the result of evaluations of particular, sometimes small, cohorts of teachers' change in practice (e.g. Luft, 2001; Jeanpierre et al, 2005). Such groups of teachers have usually been working on a programme dedicated to change in a specific area. For example, from teachers' engagement in a year long project with two intensive weeks of professional development related to skills of scientific enquiry in a real scientific research project, Jeanpierre et al (2005) argue that 'excellent professional development should (1) provide "deep" science content and development of science processes and research skills; (2) include teacher accountability requirements so that they demonstrate competency in a tangible and assessable way and (3) include developers and providers that possess high expectations for teacher learning and are capable of facilitating multi-faceted experiences.'

In England, nine regional Science Learning Centres have been set up with government funding to provide professional development which focuses as much on improving teachers' knowledge of contemporary science and its implications, as on appropriate pedagogical content knowledge. The nine regional centres and the National Centre together constitute the National Network of Science Learning Centres whose purpose is to help fulfil the shared vision of government and the Wellcome Trust: 'To bring exciting contemporary science into the classroom and to enable teachers to refresh and extend their skills, so that young people gain the knowledge and understanding they need – both as the citizens and scientists of the future'. (DfES, 2003)

Several studies of the effects of professional development on students' achievement have demonstrated that a focus on subject specific pedagogy rather than general pedagogy has a more positive effect on students' attainment (Cohen & Hill, 1998; Kennedy, 1998). From a large scale survey in the US, Garet et al (2001) present results that 'indicate that professional development that focuses on academic subject matter (content), gives teachers opportunities for "hands-on" work (active learning), and is integrated into the daily life of the school (coherence), is more likely to produce enhanced knowledge and skills'. They note that 'teachers who report enhanced knowledge and skills are likely to report changing their teaching practices as well'.

The Science Learning Centres are charged with CPD provision across a wide target audience - teachers of science to ages 5 to 19 and technicians - and a wide geographical area. Teachers' needs are thus diverse and the 'innovation' is not necessarily linked to the teaching of a common scheme. This paper describes the methods adopted by the Science Learning Centre South East in considering established principles of effective professional development and evaluates the outcomes from the first groups of teachers undertaking professional development through the Centre. The research considers the question: What are the strengths and weaknesses of the format of professional development in promoting the teaching and learning of contemporary science in the classroom?

In this research 'contemporary science' relates to the vision espoused by DfES and the Wellcome Trust. In particular it is construed as one or more of the following:

- The processes and practices of contemporary scientific research;
- The use of contemporary contexts and strategies for promoting knowledge and understanding of science concepts;
- The consideration of social and ethical implications of scientific and technological progress.

Some CPD is conceptualised as sharing, and developing further, expertise which currently exists within schools or groups of teachers brought together for a particular purpose. In the case of ‘contemporary science’, there is a limited pool of existing expertise within the profession. Thus some of the models of CPD which rely on teachers sharing practice through in-school sessions are inappropriate for developing effective strategies for teaching and learning of contemporary science. Science Learning Centre provision focuses on groups of teachers, with identified needs, working alongside experts in ‘contemporary science’.

Methods and sample.

One day workshops by themselves may not fulfil the expectations of quality professional development as they do not feature opportunities for reflection on any changes in practice resulting from teachers’ actions. Yet the development of Science Learning Centres has encouraged short workshops due to a number of factors including the need to engage a large number of teachers in professional development, combined with lack of funding and willingness of school senior management to allow teachers release of time to undertake extensive professional development. The general model of professional development adopted by the Science Learning Centre South East acknowledged these constraints, but attempted to implement established principles of professional development as much as possible. Thus a normal ‘course¹’, or workshop comprises: pre-identification of teachers’ expectations in relation to the course’s learning goals for teachers; one day (day 1) face-to-face in which development of content or pedagogical content knowledge is combined with consideration of teaching strategies, with the outcome being activities for teachers to put into practice; online or other support for teachers as they use such strategies; and a further half day face-to-face (day 2) in which teachers reflect on their experiences and strategies are extended. Day 1 and day 2 are separated by a period of about two months. The model thus allows reflection on practice. Teachers are encouraged to share experience from the outset. (Different courses focus on, for example, strategies for peer group discussion of socio-scientific issues; teaching of advances in astronomy; using forensic science as a context for students’ investigations; new approaches and resources for teaching ecology.)

Alongside our two-day workshop model, we have operated some one-day sessions. Despite this not being our preferred model, one day workshops have been run for a number of reasons:

- a) demand from teachers for one day rather than longer workshops because of the difficulties of being released from school to attend workshops – this may represent a view of professional development as one-off training that needs challenging and is counter to research evidence of effective CPD
- b) preferences by some contracted providers for a one day model despite our encouragement to support professional development over a longer period.

In order to examine the strengths and weaknesses of the model, teachers’ experiences were evaluated by the following means: completion of evaluation questionnaire at the end of day 1; completion of evaluation questionnaire at the end of day 2; discussion with teachers; follow-up of a few targeted individuals. Questionnaires contained a mixture of open and closed questions, with closed questions using a four-point Likert-type scale, where 1 is the optimum response and 4 the weakest.

¹ We do not like the term ‘course’ as it implies a time-limited and possibly non-participatory experience. We tend to use workshop as a more appropriate term to indicate the participatory nature of CPD.

Findings

This paper reports the findings from attendees on ten two-day workshops (n=96) and ten one-day workshops (n=127). Responses to open-ended questions showed teachers had a range of motivations for attending the workshop. The main reasons focused on improving teaching (around 20% of comments for both one and two day workshops) and increasing content knowledge and understanding. Less common motivations (about 10% of comments) were a declared interest in the topic, being required to attend, and (for some workshops) the opportunity for a free workshop. Several also mentioned requirements of current or future roles – particularly for the one-day workshops (13%). Those on single days were also more likely to be there because of being sent or recommended (9% vs 4%) whereas those attending two-day workshops mentioned knowledge/understanding more often (21% vs 15%).

Teachers' expectations of how they would benefit from the workshop mirrored their motivations for attendance but showed a higher anticipated impact on pedagogy. Most expectations (50% for both one and two day workshops) indicated a focus on better teaching materials or strategies. Increased understanding of the workshop topic (17% one day; 20% two day) was the other most frequent expectation, with some indicating an expected increase in confidence (5%). Intriguingly, few comments related to improving students' learning (9% one day, 4% two day). Although no-one indicated that collaborating with other teachers was their reason for attending, several teachers highlighted linking with other teachers as an expected outcome (5%). The population was thus mainly, but not exclusively, interested volunteers with a focus on their own development rather than an immediate concern for students' learning. They saw development both in terms of improved pedagogy and understanding of content. The focus on content knowledge from some teachers supports an approach which puts contemporary science at the heart of the workshop.

Teachers responded to their experiences of the first day / one day workshop through closed and open questions. No aspects of the workshops had mean ratings less than 2.0 (good) (Table 1). Teachers rated the following very highly: expertise and responsiveness of the workshop leader; appropriateness of the teaching approach, course materials and their presentation. On a key question - What is the likely usefulness in the classroom of what you have learnt? – the ratings were particularly high (less than 1.5) on completion of the relevant workshop.

Teachers exemplified the impact on classroom practice, in open responses, by their intended use of new strategies and materials (29% one day; 26% two day); their introduction to a wealth of resources (16% one day; 13% two day) and through their increased confidence to teach the content (4% one day; 8 % two day). A quarter of one-day attendees were looking forward to using new ideas in their practice (24%) and a similar proportion of 2-day delegates spoke of the impact of techniques/skills (26%). However, as with responses to their expectations, very few teachers' comments (7%) focused on students' learning. Thus teachers saw a positive impact on their teaching and own development, rather than students' learning.

Table 1			
Summary of workshop ratings	N=127	N=96	N=46
	1 day workshop	2 day 1 st day	Workshop 2nd day
clarity of learning objectives	1.68	2.03	
appropriateness of content	1.43	1.70	1.61
appropriateness of teaching approach	1.30	1.57	1.59
usefulness of course materials	1.27	1.61	

presentation of content	1.26	1.59	
expertise of presenter	1.14	1.37	
responsiveness of presenter	1.25	1.39	
overall enjoyment	1.32	1.57	1.46
amount learnt about subject	1.51	1.95	1.76
change in interest	1.71	1.81	
likely usefulness in class	1.46	1.82	1.42
Day 2			
confidence in sharing ideas			*1.52
overall rating: content			1.53
overall rating: management			1.58
overall rating: teaching			1.47
overall rating: overall			1.48
Overall rating relate to the complete 2 day workshop			
Likert scale 1-4 (1 very good – 4 poor) *1-3 point scale			

It was anticipated that the two-day experience would allow the principles of good professional development to be embedded and change in teachers' practice to develop. However, there was considerable attrition from day 1 to day 2 on some of the workshops. Follow-up by telephone to those who did not attend indicated that the reasons were mainly due to inability to gain release from school rather than lack of interest. Those who were able to commit for the full workshop rated the experience very highly (table 1). Just over half reported an impact on their teaching between day 1 and day 2 and were able to share some experiences with others. Those who reported no impact cited lack of time or opportunity. The provision of online support was a novel aspect which was included to extend participants' experiences, provide timely access and allow consolidation for participants across a wide geographical area. About a third of the two day participants reported use of the online support between day 1 and day 2, mainly for accessing resources. For those not using the online support the major issues were time constraints and limited internet access (45%) rather than the online support not being seen as relevant to their needs (26%).

We have been able to undertake a very limited follow-up interview study with participants on the two day workshop model to ascertain its longer term impact. Although we set out to sample both those who had attended the full two days and those who had not, seeking those with both positive and negative experiences, we were only successful in gaining access to four teachers predominantly with positive experiences of the full two days. Nonetheless these interviews give useful insights into successful CPD experiences. The interviews sought these participants' previous experiences of professional development and how Science Learning Centre experiences fared.

Altogether, the four teachers had experienced a wide range of training, from subject-specific (e.g. sharing nature in science) to context-specific (e.g. special needs) to issues such as classroom leadership and behaviour management. Most, though not all, courses had lasted a single day, usually in the school week. The respondents cited a number of criteria they use in deciding what development is worth attending, including:

- subject matter

- how it fits with whole-school development
- recommendation
- cost (particularly, is it free)
- whether head/seniors approve.

These criteria are similar to those reported in a DfES commissioned survey of how CPD is evaluated (Goodall et al, 2005). Interviewees were asked how easy it was to sustain the professional development initiatives. This depended on the workshop itself and time pressures. Sometimes the latter prevented what they have learnt being trialled or disseminated to colleagues, unless material is in a readily-useable form:

a course which is of use in the classroom is more effective than one heavy on theory

One teacher specifically mentioned the format of the Science Learning Centre workshops as goading him into action:

Pretty easy if a follow-up activity has been set or if there's a follow up day to the course - you feel obliged to complete the activity. That was the case with the course I went on at the SE Learning Centre, you know the half day to report back findings.

For these teachers the two day model was very positively received - participants welcomed the opportunity to try out material between sessions and subsequently get advice on problems, as well as input from other delegates. One teacher had managed to disseminate across her school the learning from the first day and was then able to feed back other people's difficulties as well:

You get a chance to play with materials and put them into action, then to discuss what's worked and what hasn't worked and pick up new ideas ... the second day can be more valuable than the first

I think it's excellent. It gives you enough time in between to actually try various things before the second block of support, and then reflect on it and have some review and maybe adapt something before you all meet up again so it's definitely the best way so far that I've experienced of actually doing it. Because you're not forced to go away and in two weeks' time come back and share something ... it didn't give you any pressure. You could fit it in your curriculum, your teaching if you could, if you couldn't then it still gave you a breathing space to do something.

The online support got mixed reviews, as illustrated by the two quotes below:

Having the initial phase, then having the online bit where you can chat, review and reflect, and then adapt anything, and then to have that further space where you can trial it before you go back and share it with everybody else, it's a very good model ... excellent way to keep a log of what you've done as a personal development record

I didn't find it a great help to be honest [Why's that?] ... it's a snowball effect. I went on it expecting other people to have gone on it logging their opinions and all this sort of thing and they hadn't. I went on it a few days before the second day of the course to see if I could pick up anything that people had been doing in their schools and nobody else had really logged on to it. Or maybe I'm just a luddite, I'm not that good with technology ... if I wanted to email (course leaders) that would be just as easy as having this special log in page, it's just another password you've got to remember – no offence to the people who set it up, I'm sure it's very good

Another delegate had found the email forum an excellent way of contacting others and discussing things they had tried out for one workshop, but competing priorities (e.g. writing reports and parents' evenings) had made it less successful the second time round.

The workshops have led to changes within the teachers' classes and more widely. Schemes of work and lesson plans have been adapted to include ideas, materials and skills picked up at the workshops:

I rewrote plans around [tutor's] materials and got positive response from the kids

Every lesson I'm using the techniques I picked up

In one case, the delegate has disseminated what he learnt both within the school and among coordinators in the local school network. He had also used input from both the workshops he had attended to make a successful bid for a science education award from Rolls Royce:

...coming back and being really enthusiastic it's actually motivated other teachers within the school as well ... snowballs, really

Another teacher has liaised with a private school teacher who attended the same workshop and as a result they are getting together to hire equipment they saw demonstrated.

The results from these interviews point to very high impact on practice, triggering and maintaining change. Although from a very small and skewed sample of participants, the responses show what can be achieved by participants who embrace the philosophy and practice which are being encouraged.

Conclusions and implications

The results show that the quality of delivery of the professional development experiences is very high. Both one and two day workshops are reported as having an expected impact on classroom practice. There are some differences between responses to one and two day experiences which are worthy of comment in light of the expectations of good professional development.

Despite the overwhelming body of research which supports professional development for change as that happening over a long time period, linked closely to locally circumstances and providing opportunities for reflection, it is clear that there is support for experiences which trigger change as much as those that embed change. Our move from solely a two-day model with opportunities for extended support and sharing to also offering one day workshops was driven by demand from teachers.

An interesting issue resulting from our experiences at the Science Learning Centre is that of changing the culture of teachers' expectations. It was hoped, on two day workshops in particular, that teachers would start to take ownership of the experience by sharing their teaching and evaluating their practice. This certainly happened for many two day participants. However, teachers on one day workshops also reported great satisfaction with strategies and resources which they felt would be immediately useful in their classrooms. The experience for the vast majority has been of immense benefit in introducing new resources or pedagogy. Ideally, we would like Science Learning Centre experiences for the individual to fulfil the features of effective professional development, providing and realising the potential for reflection and collaboration. However there are barriers to longer-term professional development. Finance and disruption to teaching are the major ones cited by teachers and senior managers in our discussions with stakeholders across the region. However, there is an emerging issue relating to the culture of CPD from our experiences so far. Despite our efforts to involve teachers from the outset in setting the agenda for 'courses', our workshops can be

seen as being 'delivered' by 'experts' with attendant connotations of participant as passive recipient. (Admittedly, the evaluation format tends to reflect this view.) Those participants who take this view are perhaps unlikely to take ownership of strategies and seek to change their practice. These are the participants who sought lesson resources of immediate use in the classroom without their own input and, perhaps, those who did not attend the second day of the two day workshop. It is encouraging that the vast majority viewed the presenter as being responsive to their needs, suggesting that skilful presenters can encourage participants to share, reflect and start to take ownership. Nevertheless there is still work to be done in encouraging participants to take a longer term view of their professional development.

The framework of professional development was developed in recognition of the financial and practical constraints within which the Centre operates and the current use on ICT within schools. Modifications were made to offer one day workshops as a result of demand. At present, both types of workshop appear to be effective in promoting the teaching of contemporary science, with two day workshops providing a clear opportunity for embedding and sharing changes in practice. As more teachers have access to, and use, ICT and video-conferencing, we anticipate a greater use of these technologies in being able to enable the crucial sharing of teachers' reflections and evaluations of practice.

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