

A Scoping Study into the Long-term Impacts of Additional Subject Specialism Professional Development

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Acknowledgements	1
1. Introduction	2
2. Approach	4
3. The policy background	6
4. Findings and discussion	8
5. Further research	18
6. Conclusion	20
7. References	21
Appendix: SASP overview and content	23

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1. Introduction

We are in the midst of a teacher recruitment and retention crisis. In England in 2022-2023, recruitment for new entrants to the profession was 17% of target for physics, for biology it was 85% and chemistry 86% (Department for Education, 2022a). Shortfalls in teacher numbers lead to significant proportions of teachers teaching outside their subject specialism, often without appropriate subject and pedagogical knowledge (Walker, 2023). Compounding these problems, the prospect of teaching outside specialism may further harm teacher retention and recruitment (Rentala, 2023).

In the past, one solution to teachers working outside their specialism was the provision of government-funded, long-term professional development programmes to support the development of additional specialist knowledge in subjects such as physics and chemistry (see, for example, de Winter, 2011; Inglis et al., 2013). The forty-day Science Additional Specialism Programmes (SASP), and the shorter Subject Knowledge Enhancement (SKE+) courses which replaced them, were extended, highly structured programmes which aimed to enhance teachers' subject and pedagogical knowledge (Appendix A).

A few studies have explored the design, implementation and impact of these programmes (for example, Campbell, 2011; de Winter, 2011; Inglis et al., 2013; Tynan et al., 2016). These studies have indicated that these programmes supported many participants to build their confidence and practice in a new specialism. For some participants, these programmes were transformative (de Winter, 2011). Being part of a community with other teachers and regular in-person contact with programme tutors added to the value of the professional learning experiences (Hobson et al., 2012). However, despite the significant investments of money and time they required from the government, participating teachers and their schools, to our knowledge no large-scale or longitudinal study of these programmes has been carried out.

Since the end of those government-funded programmes, little equivalent extended support for those teaching outside their specialism has been implemented. Although subject associations and other professional development providers offer support for teachers working outside their specialism, studies of teacher professional development consistently demonstrate that many teachers of science lack access to subject specific professional development (Allen et al., 2024; Royal Society of Chemistry, 2022). We propose that it is imperative to now revisit the potential for implementation of sustained, subject-focused professional development initiatives such as SASP and SKE+ to mitigate the challenges described here.

The focus of this report is a small-scale scoping study in which we explored the experiences of teachers who participated in extended, subject-specialist professional development initiatives with a particular focus on SASP and SKE+. We sought to understand the impacts of participation on teachers' practice and careers, to identify the design features which led to these impacts and to consider whether and how these programmes might be implemented in today's educational landscapes.

In this report, we begin by describing the approach taken to this study, including data collection through interviews with past participants of these programmes. We then move on

to an exploration of the policy background which led to the implementation of those programmes. Next, we present the findings of the data collection and analysis, including the ways in which teachers changed as a result of participation, the features of the programme which supported those changes and their views of whether these programmes are still needed. We end with an outline proposal for a larger-scale study looking in more depth at the impacts of these programmes, their costs and benefits, and how they could work to support today's teachers.

Our hope is that we can gain greater understanding of previous provision in order to inform future professional development policy and practice, such that it supports the long-term retention of science teachers and thereby the quality of science teaching.

2. Approach

The intention of this small-scale scoping study was to gain understanding of the long-term impacts of participation on the teachers involved, the programme components which generated those impacts, and of the benefits and challenges of implementing similar programmes in the current English education system.

Our research questions for this scoping phase were:

- What are the long-term impacts of participation in additional subject specialism professional development programmes on participants' professional experiences, attitudes and career pathways?
- What features of the programmes led to these impacts?
- How could current and future science teachers benefit from similar programmes, and how could they be supported to participate?
- How did SASP, SKE+ and similar programmes relate to the policy and professional development landscape at the time they were on offer?

We focused on those who participated in forty-day Science Additional Specialism Programmes (SASP), and who were, at the time of interviews, still teaching or in a teaching-associated role (for example, initial teacher education or education research, professional development provision, school or Multi-Academy Trust leadership). We were interested to explore, through individual interviews, participants' experiences of the programmes, the impacts on their practice, their careers since participation and their views of how current teachers might benefit from similar approaches.

For this scoping phase we did not attempt to seek representation in the sample of participants, rather, we used a convenience sampling approach to gain insight into a selection of participants' experiences. Using informal and formal networks of contacts in the teaching profession, we contacted past participants by email to invite them to participate. Those who were happy to participate completed a brief online survey where they provided some demographic information and availability for interview.

Interviews were conducted online or over the telephone, by experienced researchers from Sheffield Hallam University who had not been involved in the development or delivery of the professional development programmes. They were recorded and transcribed. Transcripts were then analysed thematically using a framework (Table 1) based on the research questions.

The study received ethical approval from Sheffield Hallam University (approval ER55887396).

To support understanding of the context of the empirical findings, we also mapped the policy and professional development landscape as it related to science (and, where relevant, other 'Strategically Important and Vulnerable' subjects (HEFCE, 2009)) teacher professional development at the time. We thereby provide in the next section an account of these and other programmes, which includes information such as how they were initiated and - where

the information is available from published reports and evaluations - their rates of participation, costs, approaches and impacts.

Theme	Examples
Participant role and engagement in the programme	While participating in the programme Since participating in the programme
Programme impacts on participants	Knowledge of science Approaches to teaching science (e.g. more practical activities) Attitudes to teaching science (e.g. confidence) Career
Important features of the programme	Talking to other participants Facilitators Programme content Programme structure Funding Support from school leaders Assessments
The potential use of the programme in today's system	The programme's utility for teachers Things needed to implement the programme Barriers to implementation or participation

Table 1. Thematic analysis framework

3. The policy background

The Education Reform Act of 1988 changed the landscape significantly for biology, chemistry and physics teachers. The National Curriculum's requirement for all students to study science as a core subject increased the demand for teachers to teach out of specialism. In some cases they may not have had any qualification in the non-specialist science subject(s) that they were now required to teach.

Most significant changes occurred for chemistry and physics, between 1992-1996, shortly after the introduction of the National Curriculum. There were further reforms to streamline the content of the National Curriculum in 1995, their implementation adding further to teacher workload. The decline in the proportions of science teachers with a degree in a science subject was highlighted by the Royal Society's state of the nation report (Royal Society, 2007). In 2002, the Institute of Physics identified the shortage of specialist physics teachers as a key factor in the declining popularity of physics at the A level in England.

In 2003, the Teaching Training Agency introduced Subject Enhancement Courses to address the shortfall of subject specialist teachers, providing non-specialist graduates with subject knowledge pre-training before starting an Initial Teacher Education (ITE) course. The Physics Enhancement Project (PEP) was developed by the Institute of Physics with support from the Gatsby Foundation (Angell et al., 2005). It ran from 2004 to 2009, aiming to be compatible with various initial teacher education providers, with each centre providing the pre-training as a central service for their region. Approximately 260 participants completed the programme.

Smithers and Robinson (2004) reported a longstanding decrease in the numbers of physics and chemistry teachers over many years. The same authors (2005) suggested increasing the annual training of physics specialists from 450 to 750 to address the imbalance of physics teachers across the sciences. Chemistry and physics were identified as 'Strategically Important and Vulnerable Subjects' by HEFCE in 2005. The IOP developed the Stimulating Physics pilot which included physics professional development for non-specialist teachers across partner schools and summer schools, in addition to student-based initiatives. Following the success of the pilot, in partnership with the national network of Science Learning Centres, the Stimulating Physics Network was launched in 2009. The network continues to be funded by the Department for Education (STEM Learning, n.d.). The Training and Development Agency for Schools (TDA) extended PEP to a similar programme for in-service teachers, the Science Additional Specialism Programme (SASP). This was piloted with over 60 teachers in three centres around the country before rolling out across the national network of Science Learning Centres from 2009 – 2011.

These longer-term programmes allowed teachers to embed their learning in their regular classroom practice, with additional opportunities for reflection and formative feedback built into the programme design. The implementation and funding models for the programmes varied (Table 2). For example, some professional development programmes for teachers were offered via the Science Learning Centres aligned with the school academic year. SASP also included an intensive 'summer start' to the programme which gave participants an opportunity to meet with their peers and the course leaders. The Stimulating Physics

Network (SPN) provided bespoke professional development on-site for non-specialist teachers and other staff members with a dedicated teaching and learning coach. Teachers in SPN partner schools were offered two residential summer schools as part of the 2 year programme of support. Buy-in from senior leaders at the recruitment stage was an essential requirement for the programmes to succeed alongside the demands of active classroom teachers and allow for dedicated time away from teaching responsibilities.

Programme Name	Duration	Target Audience	Financial Incentives	Number of participants
Physics Enhancement Programme	26 weeks (full-time)	Graduates with some experience of the subject post-16	£225 per week bursary	260
Science Additional Specialism Programme	40 weeks (1 day per week)	Serving teachers of physics in schools or colleges who have completed their NQT year.	Supply cover paid to schools, £5,000 bonus upon completion	Approximately 700
Extended PGCE Courses	18 months to 2 years	Those who want to teach science or mathematics, needing additional subject knowledge training	Supplementary bursaries totaling £16,000	N/A
Stimulating Physics Network (2009 - ongoing)	2-year programme of support, 6 x CPD visits per year and residential summer school	SPN partner school science departments (mostly non-specialist CPD)	N/A	Approx. 400 partner schools per 2-year phase of support

Table 2. Government funded initiatives to boost physics teacher supply alongside traditional ITE routes (Smithers and Robinson, 2008 - apart from SPN data)

This summary describes the background to the implementation of the Science Additional Specialism Programme which forms the focus of this scoping study. It demonstrates that, at a time of significant investment in teacher professional development, additional funding was provided to support teachers of science as a vulnerable subject area. In the current environment, the importance of teacher professional development remains high and initiatives continue to be funded, including the Early Career Framework professional development programme, specialist NPQs and subject Hubs (Department for Education, 2020, 2022b, 2023). However, there is widespread concern over a lack of investment in subject-focussed teacher professional development (see, for example, Royal Society of Chemistry, 2019). We hope that the study described here will add further evidence about the need for this investment.

4. Findings and discussion

In this section, we present the outcomes of our data collection and analysis. We begin by summarising responses to the initial survey of previous participants in additional subject specialism professional development programmes, which provided some basic demographic information alongside availability for interview. Next, using the data from interviews with participants we identify the main impacts of participation, on participants' knowledge, their colleagues and their careers. Following this, we consider participants' experiences of the features of the programme which supported these impacts, and explore their opinions about whether and how similar programmes might be beneficial today. We end this section with a brief consideration of the limitations of this scoping study.

Participants

Using professional networks and contacts, around sixty past participants in additional subject specialist professional development programmes were contacted to gather interest in this study and invited to complete an initial survey. Nineteen completed the survey (Table 4).

All respondents stated that they had taken part in a SASP Chemistry or Physics programme, with the majority participating in 2009-2010 and 2010-2011. On joining the programme, their teaching experience was split roughly equally between those who had been teaching fewer than five years and those who had been teaching for six years or more. Most were currently still in teaching, sometimes with other responsibilities such as head of subject. The regional distribution of respondents was largely concentrated in those areas where the project team has strongest professional connections (Yorkshire and the Humber, East Midlands, East of England).

Eighteen respondents volunteered for interview. From those, we sampled eight for interview, with roughly equal distributions across regions and subject areas, and a range of roles (Table 3). The majority were still in teaching, in some cases with additional responsibility. Some participants had, between taking part in a programme and being interviewed, held positions of responsibility, but had chosen to step away from these for parental leave and career breaks.

Participant role	Number of participants
Head of sixth form science	1
Head of science	2
Science teacher	4
University researcher	1

Table 3. Interview participants' roles

Since participating in a programme, all participants had taken on significant teaching of their additional specialist subject at least up to GCSE level, and some had developed this as their main subject focus. We explored this further in interviews.

Programme¹	SASP Chemistry	SASP Physics	Both ²	Other		
	5	13	1	0		
Year of participation	2005-2006	2006-2007	2008-2009	2009-2010	2010-2011	Not sure
	1	1	1	10	6	1
Programme region	East of England	Yorkshire and the Humber	East Midlands	South-East		
	10	5	3	1		
Years since qualification on joining the programme	0-2 years	3-5 years	6-15 years			
	4	5	10			
Teaching qualification	Science	Science: biology	Science: chemistry	Science: physics and chemistry		
	9	6	3	1		
Age (now)	35-44	45-54	55-64			
	6	9	4			
Gender: How do you identify?	Man	Woman	Other/prefer not to say			
	10	9	0			
Current role	I work in a school or Multi-Academy Trust	I work in another role in education	Both			
	17	1	1			
Description of current role³	Head of science	Deputy head of science or equivalent	Head of subject (physics, chemistry or biology)	Science teacher	Retired	Other
	3	2	2	10	1	1

Notes

1. SASP, the Science Additional Specialism Programme, existed in several iterations before the most extensive version ran from 2009. For simplicity we have only differentiated them here by date of participation rather than by name or content.
2. One respondent stated that they participated in both 2005-2006 and 2006-2007, in physics and chemistry SASP respectively.
3. One Head of science and two science teachers also held roles of additional responsibility, e.g. head of year, assistant principal.

Table 4. Respondents to the initial survey and invitation to participate

Impacts of participation

All interview participants, as mentioned above, engaged in one or more 'Science Additional Specialism Programmes' (SASP), rather than any other subject specialism professional development programme. However, in order to avoid undue focus on the specifics of the SASP programme, we refer to the programmes throughout by the more general term 'additional subject specialism professional development programme'. Meanwhile, we use 'non-specialist subject' to refer to the subject which formed the focus of their participation in the additional subject specialism professional development programme, and 'specialist subject(s)' to refer to the one where the participants were most highly qualified and/or experienced before participation.

All the interview participants, regardless of their subject, region or background, were consistently positive about their participation in an additional subject specialism professional development programme and the impact of participation on their teaching. They spoke about how participation had improved their subject and pedagogical knowledge, their knowledge of teaching and positively influenced their career pathways.

For all participants, knowledge of their non-specialist subject improved. Their learning included knowledge of concepts they had not previously understood well and topics that they had not previously studied or taught, and greater understanding of their own and pupils' misconceptions. For several participants, this also included greater understanding of connections between subjects and how the non-specialist subject progressed to A level and beyond.

"[I started] feeling like I actually have an understanding of physics, because I really didn't when I first started teaching it."

Participant C

"You know you're secure enough in your subject knowledge to answer questions but to be able to explain things in a good depth so that students really do understand the content, the course content."

Participant E

"This is where the story goes with what you are currently teaching. That was really beneficial because I would go back into the classroom and say, 'Well, at A Level, you go on and do this and this is how it fits together,' so with our higher ability sets you could project forward and say, 'If you can take this into A Level, then we'll go on to do this.' I felt that was really beneficial."

Participant G

Participants' gains in subject knowledge were complemented by a focus on pedagogical approaches, shared and modelled by the programmes' facilitators, and practised by the participants. This enabled them to develop not only their knowledge of the subject but also their knowledge of how to teach it. As a result, participants adapted their teaching practice to use these approaches and resources, during and beyond the duration of the programme. Several said that they had continued to draw on these ideas throughout their careers.

"It changed the way that I approached the lessons and that I could design my lesson so that they were more active for the students rather than just delivering information at them and I thought that was really good. So the students really seemed to enjoy the lessons ... It developed my confidence across the course but also my skills in delivering practical work and my skills as well in guiding students to take a more analytical approach, an evaluative approach with their practical work."

Participant E

"Everything I did I used. Nothing was unhelpful. Nothing felt like a waste of time. I still refer back to my work, my folders. I've got them here. It's not something I shoved on a shelf and I never look again. I occasionally think of something and look it up and I know there's an example in there. So really incredibly helpful and completely changed the way that I did everything."

Participant D

"I was being given tools and resources and different ways of explaining things because it's very difficult when it's not your subject to sort of think outside the box and have other bits of information that you can say 'I can draw that in and make it easier to understand' ... So that was amazing to have that wealth of resources and understanding myself as well. I felt like things were clicking into place and I could make links with different parts of physics."

Participant C

The participants' increased subject and pedagogical knowledge led to greater confidence in their ability to teach their non-specialist subject, especially at A level, and in their ability to respond to unanticipated questions from pupils. Several participants also shared their learning with colleagues, directly and through writing curriculum materials for their schools. Further, some participants reported feeling more confident to provide cover for absent colleagues, challenge others' practice and suggest alternative approaches.

All participants reported feeling more motivated to teach their non-specialist subject, with one stating that they had a greater desire to continue learning more about the subject and several commenting on how they felt happier in their teaching.

"It made me feel comfortable in how to take the knowledge and then teach that to a group of people ... I came away from the course, from thinking, 'Yes. Physics is something that I'll have to teach,' to, 'Physics is something that I want to teach.' ... I felt like I could become a physics teacher. I felt like a physics teacher at the end of it, rather than somebody who knew a little bit about electricity."

Participant G

"You know, this year I haven't taught physics on my timetable, but there have been times where physics teachers have been absent and I'm free and they're like, 'Right, you can go and teach that lesson' and I've had to sort of pick it up on the hoof and just go with it and I feel confident that even now I can still walk in, 'Right, you're doing waves, I know about that, let's go' and I can run the practical skill ... And confidence goes a long way to sort of helping you to convince a class that you know what you're talking about. So I still have the confidence from that course and the background knowledge to do that and to be able to field questions."

Participant C

Participation in an additional subject specialism professional development programme had long-lasting impacts on many participants' career pathways, derived from their ability and confidence to teach an additional specialism. Several said that after participation they felt like a specialist teacher in their previously non-specialist subject. In the survey, one current head of science stated that they did not wish to pursue a senior leadership role, since this would reduce their close connection to their subject, a key driver for their work.

"I would definitely class myself, even now, ten, fifteen years later, as a physics specialist, rather than a biology specialist."

Participant F

Several participants described how involvement in the programme had opened up opportunities which would not otherwise have been possible. These included new roles and responsibilities, jobs at new schools, relocation out of England to teach in other education systems, leadership of extra-curricular activities, and participation in wider networks and out-of-school activities such as examination marking and working with universities.

At least three participants felt that being an established specialist teacher of two science subjects, with in-depth knowledge of more than one subject, led to them gaining promotions that they might not otherwise have considered or achieved. Other participants described how, as a result of participation, the emerging opportunities (such as the ability to teach A level in their non-specialist subject), and their own renewed interest in teaching, meant that they stayed in the profession when they might otherwise have decided to leave.

“I also write GCSE papers for one of the exam boards now in chemistry, which I wouldn’t have done otherwise, and I do a lot of chemistry tutoring. I do some work with the university for chemistry, and so none of that would have come about if I hadn’t done the conversion. So yeah, it’s pretty much all down to that really ... It completely changed my career path and it changed everything about what I was doing. I didn’t enjoy teaching biology previously. I don’t know whether I would have stayed in teaching. I definitely have stayed in teaching and I’ve also pursued other opportunities. I work part time now four days so I can do other things, so that my day off, I do other chemistry related things and that wouldn’t have come about if I hadn’t done it. Particularly my work with the exam board I really enjoy. I am a mentor for chemistry teacher trainees. Possibly I would have done that for biology but I don’t think so. I probably wouldn’t have stayed in teaching to be honest.”

Participant D

Enabling features of the programme

Next, we consider the features of the additional subject specialism professional development programmes which led to the impacts described above. Here it is worth noting again that all participants engaged in a Science Additional Specialism Programme (SASP). These programmes went through several iterations, with the most extensive version running from 2009; this is the version most interview participants engaged in.

Again, participants were very positive about their experiences of the programmes, including:

- the content
- the programme facilitators
- the connections made with other participants
- the programme’s structure
- the support participants received from school leaders

Looking at each of these in turn, above, we described the programme’s content in terms of its impact on participants’ knowledge and practice. Participants recognised this content as important and useful in offering examples of effective, evidence-based practice.

In addition to choosing the programme content, the programmes’ facilitators played essential roles in modelling these teaching approaches and ensuring participants had time to explore them. In the participants’ opinions, the facilitators had credibility derived from their knowledge of the subject and their experience of teaching. Importantly, the facilitators built safe learning environments where participants were actively engaged in their learning, able to ask questions and identify their development needs without fear of criticism.

"The way that they structured the course, it wasn't just sit and listen. It was sit and listen and then do and during the do bit you had the opportunity to discuss ... It was an open structured thing where they delivered stuff and then you went and did some practical work and then discussed it. So, it was much more of an informal teaching process and, as a consequence, it was much more beneficial because you didn't feel restricted in the ability to actually ask a stupid question. "

Participant G

Through these supportive conditions, the programme facilitators also ensured that groups of participants were able to share experiences and resources with each other. For many participants, these collaborations and networks went beyond the immediate subject focus of the programme and lasted beyond the lifetime of the programme. In one case, following the programme, one participant gained employment at the school of another.

"We were swapping ideas and resources, not just for physics but for all sorts of different things, and having that resource to tap in to all these other people who were at various stages of their career ... Everybody was there to sort of support and help everybody else."

Participant C

"I really enjoyed it, I enjoyed going there. There was so much I could learn and I got so much experience just by talking to the different people on the course, talking to the people who were running the course, and getting lots and lots of opportunities to just get as much experience as I could and learn as much as I could."

Participant D

The SASP programmes required regular engagement, effectively one day a week for a full school year. The sustained nature of the programme was highly valued by participants. Because the contact days were regular and set out well in advance, participants were unlikely to have timetabled lessons for the days of the programme. They were therefore able to participate without concern that they were leaving their classes. Being away from school for the day meant that they could focus on their own learning. Meanwhile, the sustained engagement meant that participants were able to try out activities from the programme in their teaching and then return to the programme to share their experiences with the facilitators and other participants, build on this learning and revisit it.

"It was a weekly course, not one of these one-off courses where you learn a couple of things and then you might use it once or twice and drift into obscurity somewhere in the back of your mind you might remember, but because this was ongoing all the time it was embedded in to practice, the things that we were doing."

Participant A

"When you go on a course every week there's reinforcement. Even though the topics were different each week, you begin to change the way that you actually do things as a consequence of that regularity of contact."

Participant G

Participants' school leaders were very supportive of their involvement. Undoubtedly, this was at least in part because of the generous government funding for SASP, where there was no

cost for participation and payments were offered to schools to cover the time needed to engage in the programme. The participants in our interviews recognised that, at least in part because of this, school leaders were able to support full participation in the programme, often by timetabling the participant for four days a week, leaving one day for attendance at scheduled programme sessions.

There were other examples of schools supporting participation through scheduling. For example, Participant B reported that their school gave them opportunities to teach A level so that they could practise activities from the programme. Participant C said that, to facilitate travel back to school from programme sessions, they were able to arrive late for parents' evenings.

Beyond scheduling, school leaders were supportive in other ways too, recognising the potential value of involvement in the programme to both the participant and the school. For example, participant G said that their school wanted to build a positive relationship with the participant, in the hope of leading to their "longevity there at the school", while participant H negotiated participation in the programme as a prerequisite for taking on a new post.

Would the programme be appropriate today?

In our interviews we asked participants to consider whether similar programmes of additional subject specialism professional development could be of benefit in today's education system in England, and what might be the enablers and barriers to their implementation.

All participants agreed that there is still a need for sustained programmes like those explored in this study. The reasons for this were, primarily, the need to address the shortage of science teachers, especially physics, and to support teachers teaching outside their specialisms. Other reasons given included the benefits of extended professional learning within a community of teachers, as described above, and to improve teacher career progression and retention.

"There is a desperate need for physicists and chemists, but physicists especially in schools are lacking everywhere ... It's no good sending somebody on a three-day course and hoping that they can teach physics ... I think a lot of non-specialist physics would jump at the opportunity for a day off of school, to go out for a year, to go and develop their specialist knowledge in physics just on the basis that they know they would get better career progression there than they would as a biologist for instance."

Participant A

"There's less specialists in school full stop now. I know from a physics point of view usually there is only one in a school and I think that that can put a lot of pressure on somebody ... there are significant challenges I think for these people that are non-specialists teaching these subjects in school. I think that the bigger challenge is the lack of support that they've got in schools because of the lack of specialism there, and I think that with physics it is particularly that, that you don't find many physics specialists in the schools anymore."

Participant E

While participants felt that school leaders would be supportive of teachers' involvement in similar programmes, they identified potential barriers to this, such as the cost, the requirement for time away from the classroom, and the potential to increase teachers'

workload. One participant identified how difficulties in teacher recruitment are currently exacerbated by a lack of supply teachers who can cover lessons for absent teachers, thereby limiting the potential for teachers to be released from their classrooms for participation in professional development programmes.

"The school would like you to do the course but not if it's going to cost them any money. And, you know, teachers aren't maybe necessarily willing to take – you can do the course but you're going to have to go down to 80% of your pay. Those are going to be the challenges in terms of running it, but I definitely think that there's a place for them if the funding is there because I found it invaluable."

Participant C

"It's difficult to release teachers one day a week because we have a crisis. We cannot get supply teachers at school. We can't get specialist supply teachers at school, but I think that's a really short-term issue that if we overcome that the benefits will be massive because it's really, really difficult to recruit."

Participant D

One participant mentioned a potential negative situation, in which, given the current crisis in teacher recruitment, schools require teachers to operate outside their specialism, and therefore require participation in such a programme. They felt that, in contrast to their own experience of choosing to take this route, this might adversely affect those participants' involvement with the programme.

"I chose to do the course. I wanted to do it. I wanted to change my specialism and I feel like a lot of people working out of specialism at the minute have been forced to do so because of recruitment and retention in schools so, for example we have a massive shortage. We can't get cover, so we've had to get people teaching science from PE, we've got someone who is doing this, and she really struggles. She has obviously got some knowledge from other areas, but I know anecdotally from meetings that I go to, from exam meetings, that we've noticed a massive decrease in the amount of chemistry knowledge that people have because they've been told they've got to teach something out of their specialism so it's not a choice. I think that's the difference. Mine was a choice. I wanted to go in to [an additional specialism] but I didn't feel I had to."

Participant D

Despite the challenges, participants felt that similar programmes could be implemented in today's system. All were clear that funding would be needed to support schools, and that well-planned programme structures, such as regular programme scheduling, would support participation.

"If there was the possibility of having it timetabled right from the beginning of the year, well previous to that, so that it could be timetabled, so that you knew that it was always going to be on a Monday and you had somebody in who could job share, so that it wasn't disruptive to the learning."

Participant H

Some participants suggested options to enable more flexible engagement, such as blending online with in-person learning and optional units of content. One wondered whether facilitators of the same quality would still be available now. Another described the potential benefits of offering support to teachers from a facilitator outside of programme sessions.

"I think that it's good to have that remote support available for teachers if they need it, so potentially a tutor on the SASP programme is there potentially in the week. If somebody could fire ... question[s] to them, maybe something that gets picked up in the next staff session that they can plan for I think that would be really helpful."

Participant E

Limitations

This scoping study was based on a small sample of participants drawn from the project team's professional networks. The study was intentionally small in its approach, designed to gather initial information about participants' experiences of the programme in order to inform decisions about the feasibility and focus of a further, larger study. Given its scale, the findings presented here are not necessarily representative of participants in sustained programmes of subject specialist professional development.

The teachers who responded positively to the request for an interview were, perhaps, more likely to hold strong views about their participation in the programme, compared to those who did not respond. Participants on SASP programmes will have sought and received senior leaders' support for their participation, thereby (as we have described above) contributing to positive views about their participation and their schools' role in this.

There may have been differences in some aspects of programme delivery, in terms of the time of participation, subject area and/or region of participation, and in the impacts of teachers' prior experiences and backgrounds. However, for the purposes of this scoping study we treated all programmes and participants the same, asking the same questions and using the same analysis framework.

Three members of the team who carried out this scoping study were part of the design and delivery of the Science Additional Specialism Programme (SASP) from 2009 onwards. Our positionality, based on the experience of working with several cohorts of participants, is that SASP was successful in developing non-specialist teachers' subject and pedagogical knowledge in physics or chemistry, and, for some participants, played a transformative role in their professional lives.

5. Further research

In order to influence policy in relation to the need for programmes of professional development such as those investigated here, it is likely that further research is needed to test its findings with a larger group of participants. We also need to better understand, from current school and subject leaders, whether and how the features which made these programmes successful are appropriate and likely to have the same impacts now. Therefore, in this section, we offer an outline for a larger research study.

The aims of this further study are to:

- confirm, with a larger sample of participants, the effects of additional subject specialism professional development programmes on participants' teaching, attitudes and career pathways
- evaluate, as far as possible, the influence of these effects on teacher retention and pupil outcomes, and analyse their benefits against the programmes' costs
- identify the benefits and challenges to the implementation of similar programmes in the current English education system

Research questions

The proposed research questions for this proposed study are:

- What are the short, medium and long-term impacts of participation in additional subject specialism professional development programmes on participants' teaching, attitudes and career pathways, and on the educational outcomes of the pupils they taught?
- How did the programme achieve these impacts?
- Compared to the cost of programme implementation, what benefits have been achieved through the long-term positive impacts of the programme?
- How could similar programmes be implemented in the current system and what could be their benefits?

The proposed larger study takes a mixed-methods approach (Table 5), combining a survey, interviews, analysis, where possible, of longitudinal teacher retention and pupil outcome data, and a cost-benefit analysis of the value of these programmes. Initially, we will look back at previous programmes. A wider group of participants of SASP and SKE+ programmes will be invited to participate in an in-depth survey. This will take findings from the scoping study as a framework to test and further explore participants' perceptions of the relative impacts of the programme on their professional learning and career pathways, alongside the relative importance of the identified enabling features of the programme. The data from this survey will be analysed quantitatively to enable identification of the most significant impacts and enablers, with the wider scope including different modes of programme delivery, such as its duration, to potentially yield additional insights to inform future provision.

Focus	Methods	Outcome
Teachers' perceptions of the impacts of participation on their of practice and careers, and the enabling features of the programme	Survey of programme participants	Identification of the most significant programme impacts and its enabling features
The benefits of participation on teacher retention and pupil outcomes	Comparison of teacher retention and pupil outcomes to national data	Analysis of the positive impacts of programme implementation against costs
Implementation of these programmes in today's system	Interviews with heads of department and/or senior leaders in secondary schools and Multi-Academy Trusts	Identification of enablers, barriers and impacts of similar programmes in the current system

Table 5. Data collection methods

To complement these findings, we will further analyse, as far as possible, the impacts of participation in these programmes on teacher retention and pupil outcomes. Using teacher and school identifiers from survey participants, we will compare the identified impacts to national data, to generate a heuristic assessment of the value of participation. In turn, through comparison with the costs of programmes such as SASP, we will offer a broad cost-benefit assessment of the societal benefits of such a programme.

Finally, to gain further insight into the enablers and barriers to their implementation, we will carry out interviews with current heads of science departments, and school and Multi-Academy Trust leaders with oversight of science to explore whether and how similar programmes could benefit today's teachers and their schools, and the barriers and enablers to their implementation in today's educational systems.

Outcomes

The intended outcomes of this larger-scale study are to shape policy and practice with recommendations for policy makers and school and Multi-Academy Trust leaders, using the findings to identify how additional subject specialism professional development programmes can be implemented in today's education system. Therefore, following data collection and analysis, we will produce:

- a report detailing the study's aims, methods, findings and implications for the implementation of similar programmes in the current education system.
- recommendations for policy makers, including the potential benefits of implementing additional subject specialism professional development programmes in tackling the current retention and recruitment crisis in science teaching.

6. Conclusion

Notwithstanding the limitations of this small-scale study, our findings indicate that, for those we interviewed, participation in the Science Additional Specialism Programme had profound positive impacts on their careers as science teachers.

The participants in this study identified benefits including:

- Better knowledge and understanding of teaching the non-specialist subject, including subject and pedagogical knowledge
- Greater confidence and positivity about teaching
- A toolkit of new approaches to teaching, which were still in use by participants throughout their careers
- Connections with programme facilitators and teachers from other schools, which, for some, lasted beyond the programme
- Enhanced and new opportunities for career progression

The programme's benefits derived from a range of factors including:

- Sustained, regular programme sessions throughout a school year, providing opportunities to trial, revisit and review learning with other teachers
- Experienced facilitators who chose evidence-informed content relevant to practice
- Opportunities to collaborate with teachers from other schools, thereby widening their professional support networks within and beyond the programme's duration
- Financial support for schools, enabling participating teachers to be released without significant additional workload to either themselves or colleagues

All participants felt that such programmes would be of benefit in today's education system, providing a route to tackling teacher shortages and, potentially, promoting greater retention and career progression. To support this, funding would be needed to ensure schools are able to release teachers without increased workload.

Programmes such as those explored in this study require a significant government investment. To push for such initiatives to be implemented, additional evidence may be needed of their benefits and impacts, and the ways in which they might be embedded in schools' and teachers' practice. In the previous section of this report, we proposed further study to gather evidence from a wider range of past participants and current stakeholders to explore how such programmes could be implemented in current systems.

The investment in sustained professional development programmes designed to support teachers working outside their specialism brings major benefits. We have shown that these programmes previously had significant positive impacts on teachers' practice, confidence and, longer-term, their career pathways and retention, and would bring the same benefits to teachers, schools and pupils today.

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Appendix: SASP overview and content

The main Science Additional Specialism Programme (SASP) ran in the 2009-2010 and 2010-2011 academic years. It was a national government-funded initiative designed to support teachers of physics and chemistry¹ who were not subject specialists. Its aim was to develop and improve their teaching of those subjects at Key Stage 3 and 4 and additionally start developing the knowledge and skills required for A level teaching. Anyone teaching physics or chemistry in a state-funded school without a matched degree or an initial teacher training specialism in that subject could apply. The programme was provided through a network of regional Science Learning Centres with no fee to the schools and funding for the cover costs. In the 2009-2010 year there was a bursary for participants on successful completion of the course.

The programme was 40 days in length, with 30 days allocated for direct in-person teaching and 10 days for self-study and classroom observations of expert subject teaching. In addition to the taught component of the course, there was a written assignment which awarded 60 H-Level credits (undergraduate level) accredited by the University of York. This assignment required participants to write reflectively about their own practice as well as teaching and learning in their chosen subject. There were also smaller, formatively assessed tasks completed during the year.

Tutor guides for programme providers, produced in collaboration with the Institute of Physics and the Royal Society of Chemistry, included a proposed programme outline, detail, and some teaching materials. Providers had flexibility with some of the course content in organisation and detail². Indicative programme content is shown in Table 6.

¹ There was an equivalent programme for Mathematics that does not form part of this study.

² Some providers arranged teaching by content (e.g., Forces from KS3 to A level, then Electricity from KS3-A level) and some by age range (e.g., Physics at KS3, then Physics at KS4, then Physics at A-Level).

Physics	Chemistry
Forces	Particle model
Mechanics in 2D, circular motion and SHM	Elements, compounds and the periodic table
Momentum and collisions	Chemical properties and patterns
Simple electric circuits	Chemistry in the real world
DC circuit theory	Chemical change (oil and polymers)
Magnetism and electromagnetism	Chemical patterns (reactivity, rates and energy changes)
Waves, sound, light and the electromagnetic spectrum	Materials (new and natural, properties and uses)
Kinetic theory and the behaviour of gases	Formulae, equations and amount of substance
Energy and energy resources	Atomic structure and bonding
Radioactivity	Energetics (inc. Enthalpy)
Fields: Electric, gravitational and magnetic	Kinetics
Atomic, nuclear and particle physics	Equilibria
Quantum physics	Redox reactions and electrochemical cells
Mathematics and physics (inc. Exponential processes)	Inorganic chemistry
Astronomy and cosmology	Organic chemistry
Thermodynamics	Thermodynamics – free energy & entropy
	Modern analytical techniques
	Organic synthesis
Content addressed in both programmes throughout the year:	
Diagnostic testing (for participants and for use in class teaching)	
Practical work	
Assessment and Examinations (including supported question practice)	
Assessment for learning	
Special topics and units (specification dependent)	
Enrichment and enhancement, clubs, visits	
Other sources of support (e.g., learned societies)	

Table 6. Indicative programme content

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