



# BRINGING CUTTING EDGE SCIENCE TO THE CLASSROOM PROGRAMME

**Evaluation Report May 2016**

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## Contents

<b>Acknowledgements.....</b>	<b>2</b>
<b>Executive Summary.....</b>	<b>3</b>
<b>Introduction .....</b>	<b>5</b>
<b>Chapter 1. The impact of the Bringing Cutting Edge Science to the Classroom programme on teaching and learning.....</b>	<b>8</b>
<b>Chapter 2. Bringing Cutting Edge Science to the Classroom programme: case studies of effective practice .....</b>	<b>19</b>
<b>Chapter 3. Maximising the delivery and effectiveness of the Bringing Cutting Edge Science to the Classroom programme .....</b>	<b>30</b>
<b>Conclusion .....</b>	<b>36</b>
<b>Appendix .....</b>	<b>377</b>

## Graphs

Figure 1 Impact on participants .....	8
Figure 2 Impact on students .....	12
Figure 3 Impact on colleagues and institutions .....	14
Figure 4 Impact of RCUK funding .....	17
Figure 5 Recommending the Cutting Edge course.....	30
Figure 6 Accessing other CPD and online resources.....	31

## Acknowledgements

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During the evaluation, we were privileged to be able to hear from teachers who took part in the Bringing Cutting Edge Science to the Classroom Programme (henceforth referred to as “Cutting Edge Programme” or “the programme”) and the facilitators and researchers who designed and delivered the CPD (continuing professional development). Some specific examples that we drew from these conversations are highlighted in this report, providing illustrations of some of our key findings. We are extremely grateful to them for giving their time and insight so generously to this project.

# Executive Summary

## Background

The Bringing Cutting Edge Science to the Classroom programme evaluation was commissioned in Autumn 2015 to analyse the success of the Cutting Edge programme in delivering its stated aims, and to assess the impact of the programme on participants, their students and colleagues. The evaluation sought to provide recommendations to further improve the delivery and impact of the programme.

The Cutting Edge Programme, run by STEM Learning, was created with leading scientists to support the teaching of science subjects at GCSE and A level (and equivalent qualifications in Scotland) in order to deliver the latest knowledge, new contexts and practical activities to teachers. It is delivered via the National STEM Learning Network in England, and strategic partners in Scotland, Wales and Northern Ireland. The programme aims to:

- Develop and update teachers' knowledge by engaging with scientists involved in cutting edge research;
- Use authentic contexts for the effective delivery of science content; and
- Deepen teachers' understanding of how science works, including controversies and ethical issues;
- Engage teachers with active and inspiring teaching approaches and learning activities.

The evaluation covers courses delivered between November 2013 and March 2016, with the majority of respondents having taken a course between January 2015 and January 2016.

## What is the impact of the Bringing Cutting Edge Science to the Classroom programme on teachers, their students and their colleagues?

The Cutting Edge programme has a demonstrable positive impact on the majority of teachers. More than 88 percent of teachers who responded to the evaluation reported being more inspired by the new content they had learned, more confident to be able to teach it to their students, and having improved their knowledge of the subjects they studied. The Cutting Edge programme brings additional benefits to course participants, with just over half of teachers reported a positive impact on their teaching skills and an increased likelihood of them continuing their career as a STEM teacher.

The evaluation also found a positive impact on students:

- 86 percent of teachers reported improved knowledge and understanding of cutting edge concepts among their students;
- 80 percent said that students were more enthused and interested in STEM subjects;
- In addition to exposing students to cutting edge concepts, 71% of teachers reported more students showing an interest in continuing in STEM subjects in their study and career; and
- Just over 66% reported that students feel inspired to act as informed and involved citizens.

Course participants were also asked in the evaluation about the impact of their attendance on their colleagues and schools. 78% of the teachers had already shared the learning and resources from their course with other staff (either in their own institution or via subject networks) with 68% of those reporting the learning had also been used by other colleagues in their teaching. Where the resources had not been shared it was usually because they were the sole subject teacher or had just completed the course. Teachers reported that their senior leadership or subject leader was aware and supportive, of them attending the course in 92 percent of cases. In addition, the Cutting Edge programme also

helped to increase positive attitudes towards subject specific CPD within their school for 72 percent of teachers.

The evaluation also explored teachers’ awareness of the availability of the associated RCUK bursary for Cutting Edge Programme courses, and, where it was accessed, its impact. 7 out of 10 teachers were aware of the bursary and had applied for it. Only 8 percent of teachers would have been able to access the Cutting Edge programme course without funding. Half of the respondents reported that the CPD had greater impact on them, their students and school as a result of their making use of the bursary. Where this was not the case, teachers generally said this was because the funding had a positive impact on them being able to attend – but the funding did not increase the course impact.

## Maximising the delivery and effectiveness of the Bringing Cutting Edge Science to the Classroom programme

The evaluation makes recommendations which focus on two areas: key elements of the programme that STEM Learning and RCUK should continue; and ideas to maximise the impact of future programme courses:

<b>In order to maintain, and build upon the success of the programme to date, STEM Learning and RCUK should:</b>	Continue to facilitate access to experts in cutting edge fields, and combine their input with that of educationalists
	Continue to deliver the Cutting Edge Programme in inspiring and relevant scientific and University-based settings
	Continue to enable teachers to understand the most challenging aspects of the STEM curriculum, by teaching them about the latest cutting edge developments
<b>STEM Learning and RCUK should consider the following recommendations to maximise the impact of future delivery of the Cutting Edge programme:</b>	Facilitate better collaboration across the Network to ensure better recruitment to courses
	When promoting the programme, articulate the link between the inspiring cutting edge content and the new curricula and specifications in each country
	Give teachers more resources and practical activities to use when they return to school.

## Introduction

### Background to the Bringing Cutting Edge Science to the Classroom Programme

The Cutting Edge Programme, run by STEM Learning, was created with leading scientists to support the teaching of science subjects at GCSE and A level (and equivalent qualifications) in order to deliver the latest knowledge, new contexts and practical activities to teachers. It is delivered via the National STEM Learning Network in England, and strategic partners in Scotland, Wales and Northern Ireland. The programme aims to inspire teachers and their students aged 14-19, through learning about advances in scientific research and improving their knowledge and understanding of the science concepts underlying the research. In each course, a scientist works alongside a course facilitator to explain recent advances and provides an insight into their own current research, linking cutting edge science with today's classroom. It aims to:

- Develop and update teachers' knowledge by engaging with scientists involved in cutting edge research;
- Use authentic contexts for the effective delivery of science content; and
- Deepen teachers' understanding of how science works, including controversies and ethical issues;
- Engage teachers with active and inspiring teaching approaches and learning activities.

Initially there was a suite of twelve CPD opportunities available to teachers, covering topics ranging from Biodiversity to Climate Change. These have been updated and are being expanded into a suite of 22 opportunities, to ensure the programme offer meets teachers' CPD needs, is relevant to current programmes of study at GCSE and A level (and equivalents) and keeps pace with recent cutting edge science developments.

The new suite of CPD started running from January 2016 onwards and covers a range of STEM topics, expanding from the initial science focus. From January 2016 the name of the programme also changed to "Bringing Cutting Edge Research into the Classroom".

The CPD is available in a range of formats, typically including twilight sessions, one-day courses, conferences and modules embedded into National STEM Learning Network courses. They vary in length, but are generally between half a day and a full day per course. The main exception to this is Expedition Iceland, which is 5-day intensive fieldwork-based course with a preparation weekend beforehand.

In addition to courses, the programme also develops a number of cutting edge science resources. Where appropriate, the courses sign-post to these resources. Additional new resources were also being developed for March 2016 which will tie into the new courses.

The programme contributes to RCUK's strategic aim of helping secure and sustain a supply of future researchers and enabling the next generation to act as informed and involved citizens. This programme is a continuation of a previous 2012-2015 programme which followed a very similar remit.

### The aims of the evaluation

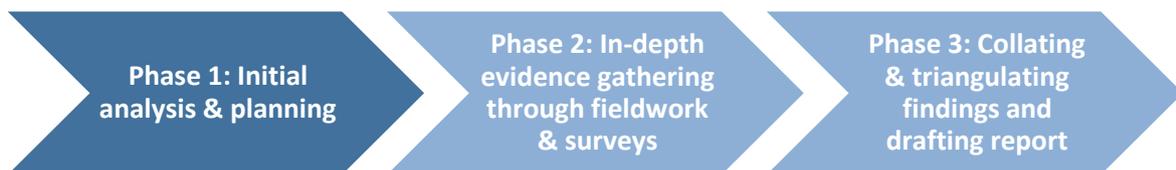
This evaluation predominantly focused on the effectiveness and impact of the Bringing Cutting Edge Science to the Classroom Programme delivered between September 2015 and March 2016. Specifically, the evaluation had three main aims, which were to:

- (a) **Analyse the success of the Cutting Edge Programme – assessing how successful the programme is:**

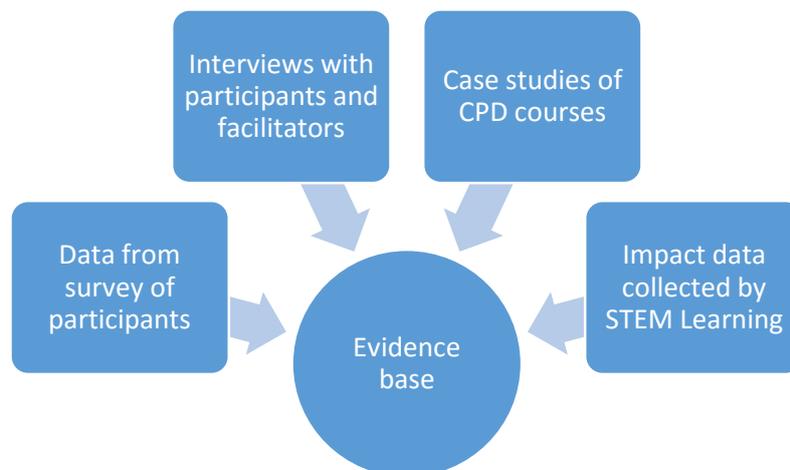
- in inspiring teachers and their students (aged 14-19) through learning about advances in scientific research;
  - in improving teachers' and students' knowledge of scientific concepts; and
  - in securing a supply of future researchers and informed citizens.
- (b) Assess the impact of school and college engagement in the programme** – on improving knowledge, skills and retention of participants, student attitudes towards STEM, and its wider impact on their school and beyond, and assessing the value of the RCUK funding support on participant outcomes and impact.
- (c) Provide recommendations to further improve the delivery and impact of the future programme** – how to maintain the quality and impact of the CPD for participants, students and their school.

## Our approach

During the evaluation there were three phases to our work:



We have sought to collate and triangulate evidence from four different sources. These are shown in the next diagram:



One of the main forms of evidence gathered for this evaluation was qualitative feedback via in-depth discussions with, and surveys of, participants, combined with interviews with facilitators (course tutors and researchers/scientists) from a range of the Bringing Cutting Edge Science to the Classroom CPD courses:

- ✓ **Survey of CPD Participants** – 79 teachers responded to an online survey. The survey gathered quantitative and qualitative feedback on the impact of the CPD on respondents themselves, their students and schools. The research initially focussed on courses delivered between September 2015 and March 2016, but due to low volumes of survey responses it was extended to include to participants from any Bringing Cutting Edge Science to the Classroom course that had been delivered from November 2013 onwards. A complete course list and number of survey responses can be found in the Appendix.

- ✓ **CPD Participants** – in-depth telephone interviews were conducted with 12 teachers who had attended a range of different Cutting Edge Programme courses exploring the impact that the CPD had upon them as individuals, on their students and on their colleagues and wider schools. It should be noted that recruitment of participants was more challenging than expected and the report should be read in that context.
- ✓ **CPD facilitators** – interviews were carried out with 9 facilitators (both researcher/scientists and facilitator/educationalists) focusing on how the courses were developed and delivered.
- ✓ **Number of courses covered** – responses were gathered from participants of 29 of the Cutting Edge Programme courses delivered between November 2013 and March 2016.

We have triangulated our findings with the data collected by STEM Learning as part of their Impact Toolkit processes.

### **The structure of this report**

Our findings are set out in three main chapters. **Chapter 1** analyses the impact of the Cutting Edge Programme on participants, their students and their colleagues and institutions. It also looks at the impact of the RCUK funding which supports participants to access this programme. **Chapter 2** looks in-depth at the impact of the programme via four case study courses: Astrophysics, Genetics, Expedition Iceland and Case Studies: Geographical research. **Chapter 3** outlines how to maximise the delivery and effectiveness of the programme – focusing on the key components of the programme that participants value and suggesting areas for future development to further improve its impact.

## Chapter 1. The impact of the Bringing Cutting Edge Science to the Classroom programme on teaching and learning

This chapter draws upon data from course participants who have been surveyed and interviewed, and considers the impact that the Cutting Edge Programme had upon three distinct groups:

- Participants – teachers who have attended at least one Cutting Edge Programme course;
- Their students; and
- Their colleagues and institutions.

It will also investigate whether the provision of the RCUK funding bursary has an effect on the impact of the course.

The survey responses are taken from the online survey carried out between January 2016 and March 2016. The STEM Learning Impact data covers courses delivered between June 2015 to February 2016 (n = 98 unless stated otherwise).

### The impact of the Bringing Cutting Edge Science to the Classroom Programme on participants

Cutting Edge courses have a demonstrably positive impact upon teachers who undertake them.

The evaluation survey asked teachers to consider whether they were more inspired by, and interested in, science and STEM by having learned about advances in scientific research. Teachers were also asked to reflect upon whether the CPD had improved their subject knowledge and confidence in teaching the cutting edge science content and finally whether it had an impact on their teaching skills and career plans. The quantitative survey data is shown in figure 1.

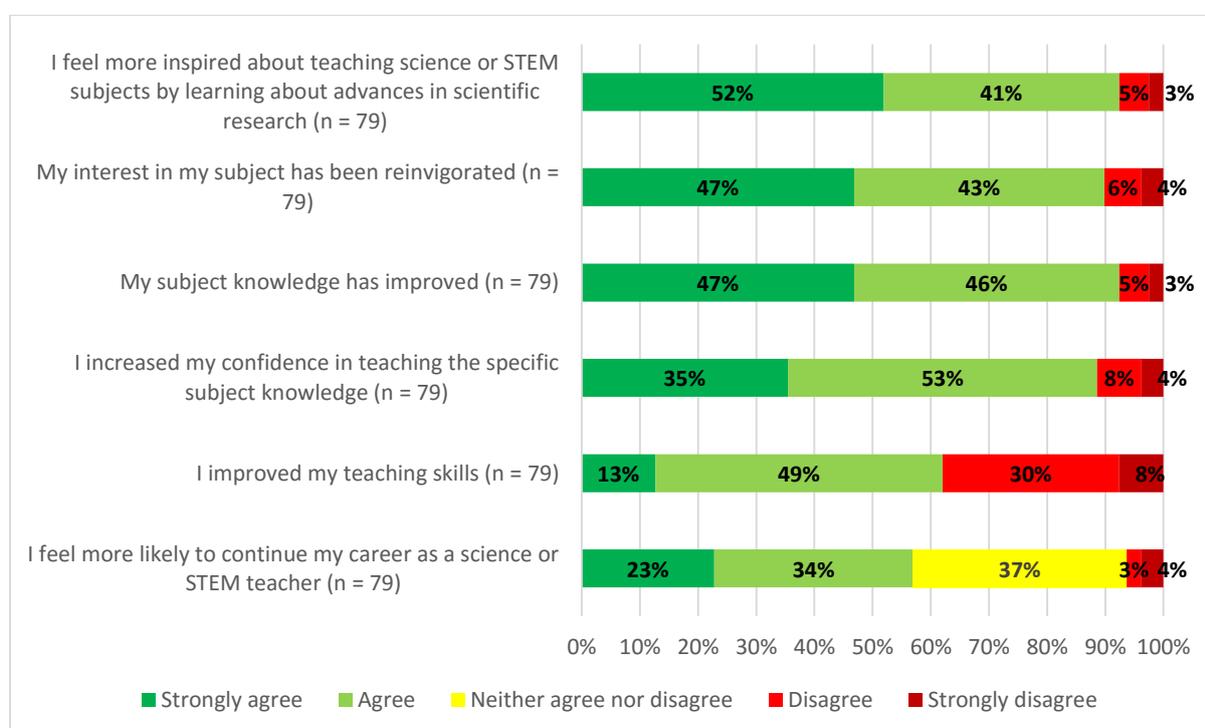


Figure 1 Impact on participants

**Teachers are more inspired as a result of their experiences on the course.** 92 percent of survey respondents reported that they were more inspired about teaching science and STEM subjects as a result of learning about advances in scientific research, and that their interest in their own subject had been reinvigorated. This was also demonstrated by the Impact data from STEM learning with nearly 9 out of 10 participants reporting greater enthusiasm and confidence. Teachers articulated the effect that the course had upon them by describing their increased enthusiasm, enjoyment and motivation to teach and learn, and explained they were intrigued, engaged, mystified and fascinated in the topics they had studied. Teachers reported that this enthusiasm was infectious when they returned back to school, and they said that their students and colleagues were in turn inspired. Inspiration was drawn from a number of aspects of the course. These ranged from the research areas covered by the courses and the inspiring facilities used to host the courses (such as an observatory or a life science centre), to the access they were given to researchers conducting real, relevant research. Teachers particularly welcomed the way that courses were jointly delivered by a facilitator or educationalist, who was able to make connections with the curriculum, and a researcher/scientist who was able to answer the toughest questions posed by participants. The presenters were described in many cases as being very responsive, and *“always happy to take discussions in directions teachers wanted”*. Where participants did not report greater enthusiasm for their subject resulting from attending the course, the majority still made positive comments about the course overall and one person particularly wanted the course content to be more tailored to the specification they were teaching.

A biology teacher, who attended “Support for CfE higher biology at Roslin” in March 2015, described her experience of the course:

*“It was a fascinating day which opened my eyes to some of the research going on in our country [of] which I was previously unaware. I felt a little like a child taken to a sweet shop for the first time when we really saw the investigations that were going on inside Roslin, as a lot of the subject matter we were discussing were the things which inspired me to follow a science route in my career. I could then discuss some of the things I had seen with pupils when I returned and could use my experiences and knowledge to add depth to the new courses I was in the process of developing for the school.”*

The head of geography, at a secondary school in Wales, reflected on her participation on the “Case Studies: Geographical research” course in Cardiff in June 2015:

*“You forget when teaching exam classes that there is more out there than the constraints of the curriculum. It's not so much forgetting (sic) it is more not having the teaching time to include information. It is so refreshing to speak to people outside of school about the wonders going on in your subject. It made me remember why I decided to take my subject in the first place! Using the case studies has inspired one of my top pupils to apply to Cardiff and for geography – hurrah!”*

**Teachers' subject knowledge was improved significantly**, as reported by 92 percent of survey respondents who said that they were now better informed to teach the cutting edge content to their students. The Impact data reported nearly 8 out of 10 respondents having enhanced subject and pedagogical knowledge and understanding. The course content was generally pitched at the right level, and was delivered at the right pace to benefit participants and to take into account their existing subject knowledge. The topics covered reflected the speed of change and development in the field. Teachers said that they left with new ideas for experiments and activities, better ways to explain challenging concepts to their students, and were better able to simplify concepts, *“without destroying the core science”*.

As a result of this improved subject knowledge, 88 percent of teachers also said that their confidence in teaching science or STEM had improved – particularly when it comes to the more complicated or specific topics. They said that they were also better equipped to avoid misinterpretation among their learners and colleagues.

A chemistry teacher, who is also the lead teacher for Astronomy in her school, attended an Astrophysics course in April 2014:

*“As I am enthusiastic about engaging students in science using space as a theme, this CPD provided another new context to deliver aspects of my science curriculum at KS3, 4 and 5 (Key Stages 3, 4 and 5). The session was expertly delivered as always by Paul Roche and Sarah Roberts - always inspiring and enthusiastic. I have made many references in my teaching about the Gaia mission and this raises awareness in my students of the projects currently being undertaken to broaden our understanding of the Universe - a subject they are invariably fascinated with and engage with across all levels. It has enhanced my knowledge about the project sufficiently to speak about it with conviction and confidence in the classroom and to other colleagues in the departments.”*

A physics teacher, after attending “Quantum Physics” in November 2015 said:

*“As a teacher trained in Mechanical Engineering the physics of the very small was not something I ever studied. I felt nervous at (sic) implementing the Quantum part of the CfE Advanced Higher course and the day at Glasgow University provided me with background knowledge, resources and confidence to teach it for the first time. It also gave me ideas for practical illustrations I could use to get ideas across. More importantly it convinced me that there are indeed practical uses of this technology and there is still more to learn about the Quantum World which in no way appears rational to a mechanical engineer. I came away intrigued and mystified and more comfortable with Quantum tunnelling, entanglement, Heisenberg's equations etc. The Quantum Buddy follow up by Glasgow University has also been useful and I have utilised the material they have produced.”*

**Teachers value having a wealth of real-world applications to help them to teach challenging content.**

This was demonstrated by both the qualitative research responses and Impact data with 7 out of 10 respondents saying they had improved ability to enrich STEM teaching with real life applications and career information. By getting exposure to real, current research projects, teachers are able to bring back interesting and engaging examples to illustrate the topics they are studying in the classroom, which in turn serve to enthuse their students. One participant said that, “referring to topical case studies keeps the subject interesting and alive for students.”

A course participant who attended the “Medical Imaging” course, described the applications they were exposed to during the training:

*“Most of the things we were looking at were cutting edge, but we were also able to consider how to use MRI scans in different ways. For example, we looked at scotch eggs when they'd been cooked, finding out how much air was inside them, in order to consider the packaging implications for the manufacturer. They gave us loads of ideas, asking us what we wanted to scan. Students would have loved finding out what's inside a Kinder Egg before you open it – it would definitely spark their interest!”*

A participant on the “Case Studies: Geographical research” course recalled the examples they worked on:

*“We learned about the impact of sporting events, and how they impact on cities. So, for example, the Tour de France and the Heineken cup in Cardiff. It was all to do with researching sustainability, and the researchers shared with us their project websites so we could continue to monitor any of the changes in the research being conducted when we went back to the classroom with our students.”*

**In addition to delivering its articulated course aims, the Cutting Edge programme also improved participants’ teaching skills, and increased the likelihood of them continuing their career as a STEM teacher,** demonstrating that it brings unexpected benefits to course participants. 62 percent of teachers thought they had improved their teaching skills and 57 percent were more likely to continue their career as a science or STEM teacher as a result of taking part in the Cutting Edge Programme. For those who reported they had not improved their teaching skills and were not more likely to continue their career teaching STEM their feedback about the course content and its impact was generally positive with only one or two exceptions. The Impact data showed that 4 out of 10 teachers thought the course had improved their use of knowledge, skills and understanding in teaching and just over 2 out of 10 teachers reported increased motivation to stay in teaching and/or improved prospects for career progression. The only course where all of the respondents said they had improved their teaching skills were the Expedition Iceland courses, which can potentially be attributed to the length of their engagement in the course, the fact that teachers are required to lead investigations while they are on the fieldtrip, and that they continue to work together as a group of teachers after they return, sharing ideas about how to deliver the new content in innovative ways in their classrooms. Survey and interview respondents made less explicit mention of specific skills that they had developed as a result of the course they attended, but were frequently reporting that their ability to devise lessons, activities, experiments and explanations had improved.

A biology teacher who attended “The wonders of PCR: understanding the genome” in November 2015 said:

*“This CPD event was really well delivered and filled a huge gap in my own knowledge about current research and technologies. I have added this information in, along with practical experiments, to my own higher course, which has proved to enhance my students’ understanding of the theoretical knowledge. Something I will definitely put in practice as I am making and updating future course materials, is that I will endeavour to add in details about current research. I am now a lot more confident in doing this, as although I am under time constraints to effectively deliver the Higher course, it is possible to add non-essential practical experiments and theory in, as they will greatly benefit all.”*

Another biology teacher, who took part in the “Genetics: Bringing Cutting Edge Science into the Classroom” course in January 2015 explained that:

*“I thoroughly enjoyed the lectures, and took away some very interesting bits of information and ideas to incorporate into my lessons. I didn't feel it impacted my teaching skills as that wasn't the focus of the session - there was little emphasis on this.”*

## The impact of the Bringing Cutting Edge Science to the Classroom Programme on students

Teachers report significant benefits for their students, having participated in a Cutting Edge Programme course.

Teachers were asked to reflect on their students' subject knowledge and enthusiasm for studying STEM subjects as a result of their own attendance on a Cutting Edge programme course. They were also asked about their students' interest in continuing STEM to the next level of study, or as a career, and whether they were inspired to act as informed and involved citizens. Their responses are summarised in figure 2.

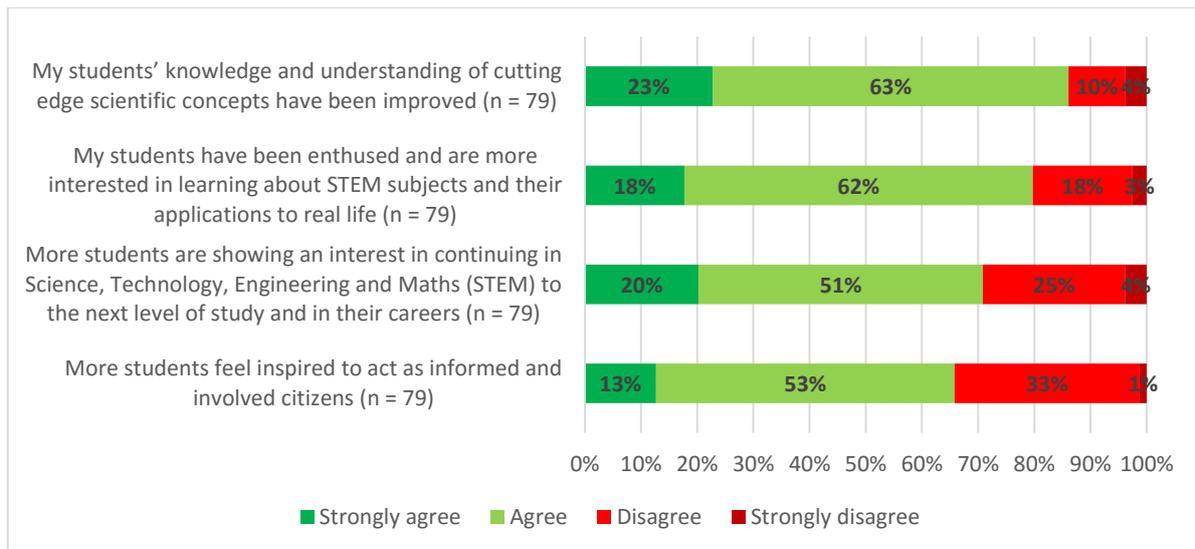


Figure 2 Impact on students

**Students are more interested in STEM.** 86 percent of teachers reported that their students' knowledge and understanding of cutting edge concepts had improved since they had attended one of the Cutting Edge Programme courses. Similarly, 80 percent of teachers said that since the course, their students were more enthusiastic and more interested in STEM subjects and their application in real life. The Impact data showed that nearly 8 out of 10 teachers thought the course had a high or medium impact on their students (n = 106). For the 2 out of 10 teachers who disagreed with these statements, they were positive about the course content on the whole but had not used the material in their lessons yet. Generally, this was because they had not had time to develop materials since going on the course or were planning to teach the topic much later in the school year. There were three exceptions to this: one primary teacher reported that the content was too advanced for her pupils and two other teachers thought the course content was not relevant to the curriculum. Students found the material to be appealing and engaging as it was, "not out of a textbook", but was "real life". Teachers reported that, "if they know [that] what they are doing is relevant, they are more keen to study it, or look into it". Some teachers said that they found that by using material from their course, they were able to engage students who ordinarily would not have been so interested in the subject matter. Students were not only more enthusiastic, but they were visibly better at asking good questions and to participate in deeper discussions about the content.

A vice-principal, who attended the Genetics course in January 2015 said:

*"It has allowed students to understand some of the advances I ask them to read about in biological journals or through the media. Many of the topics relate directly to areas of the*

*specification and allow me to set stretch and challenge work. Since attending the CPD, the students have been engaged in a moral and ethical debate discussing some of the issues raised on the day while reviewing the benefits of point of care treatment.”*

A lecturer, who took part in a Quantum Physics course in November 2015 told us:

*“Students can engage in meaningful discussions with others as they have some knowledge of the area. They can also appreciate the advances more as they see applications of the research. I have students who traditionally wouldn't be interested in Quantum now asking questions.”*

Another Quantum Physics course participant, a teacher of physics and science said:

*“I think my new found enthusiasm has been infectious. [The students] also really seemed to appreciate the effort that I went to to go on this course, to learn new things and bring back new materials.”*

**Students have a greater appreciation for real-world applications of STEM.** 66 percent of teachers reported that more of their students feel inspired to act as informed and involved citizens. By sharing real cutting edge science examples in the classroom, students’ comprehension of challenging topics is improved, and their interest is sparked. Teachers spoke of the beneficial impact on students from having access to current STEM research, conducting practical activities and experiments, and using real case studies to illustrate the concepts they study. Of those teachers who did not think the course resulted in more informed and involved citizens one said:

*“I am able to drip this information into my lessons and I am also refreshed and enthused but as for a direct causal link to the above [impact on students’ questions], that would be hard to prove.”*

A college lecturer, who went on the “Applications of Recombinant DNA Technology” course in February 2014 reported:

*“Most of my students are able to grasp the concepts more thoroughly now - and being able to link it in to the new CRISPR gene technology is useful. Not as many biology A level students as I would like choose to go on to study biology at degree level, but there is a strong interest in biomedical science - where DNA technology is also highly relevant. DNA technology advances are portrayed in the media and so discussion and coverage of this topic within college does allow students to be better informed; for example, depending on the vote in the in-out referendum on Europe in June will there be tighter or more relaxed legislation on genetic research? These are highly topical subjects.”*

A physics teacher, who attended the “Asteroids: detection and deflection” course in March 2015 said:

*“For me it is about keeping in touch with advances in research and changes within Physics and STEM fields so I can pass on this knowledge to pupils and make them aware of advances in technology etc.”*

**Again, in addition to the programme’s core aims, Cutting Edge courses have made teachers and students more aware of the STEM career and study pathways and students’ journeys to take their learning further are kick-started.** 71 percent of teachers said more students were showing an interest in continuing STEM to the next level of study and their careers. Teachers provided examples of their students conducting their own scientific research projects inspired by the Cutting Edge Programme content and of taking on key roles in school science week. Others reported that the links they now

had with university lecturers and facilities had a great impact on students' aspirations, and was making young people ask: "what do we need to do to get onto x or y university course?". Students were increasingly aware of careers that exist within cutting edge science fields, and began to make the connections between what they were studying in school and what they might go on to study once they leave.

A science teacher, who had visited Iceland as part of the Cutting Edge Programme in May 2015, reported that since doing so:

*"More students are wanting to become involved in events such as science week activities within school and a group of students has recently signed up for a science trip to Iceland next February."*

A chemistry teacher, who attended an "Astrophysics" course in April 2014 said:

*"I know that up-to-date knowledge of current discoveries are key to engaging students and opening their eyes to future possibilities for applications of STEM subjects in careers. Since using this type of knowledge and experience in the classroom, every year there has been at least one student who has applied for a university place to study specifically astrophysics, or physics with astronomy where they would have been less likely to before. I have students committing to this pathway as early as year 11 at the moment!"*

## The impact of the Bringing Cutting Edge Science to the Classroom Programme on colleagues and institutions

Teachers do share their learning from successful CPD with their colleagues, and the influence and impact can be wide-reaching.

Course participants were asked to consider how they had used any material or learning they gained from their Cutting Edge Programme course with their colleagues when they return to school, and what impact this had upon their colleagues' teaching and their attitudes towards subject-specific continuing professional development. The survey responses are set out in figure 3.

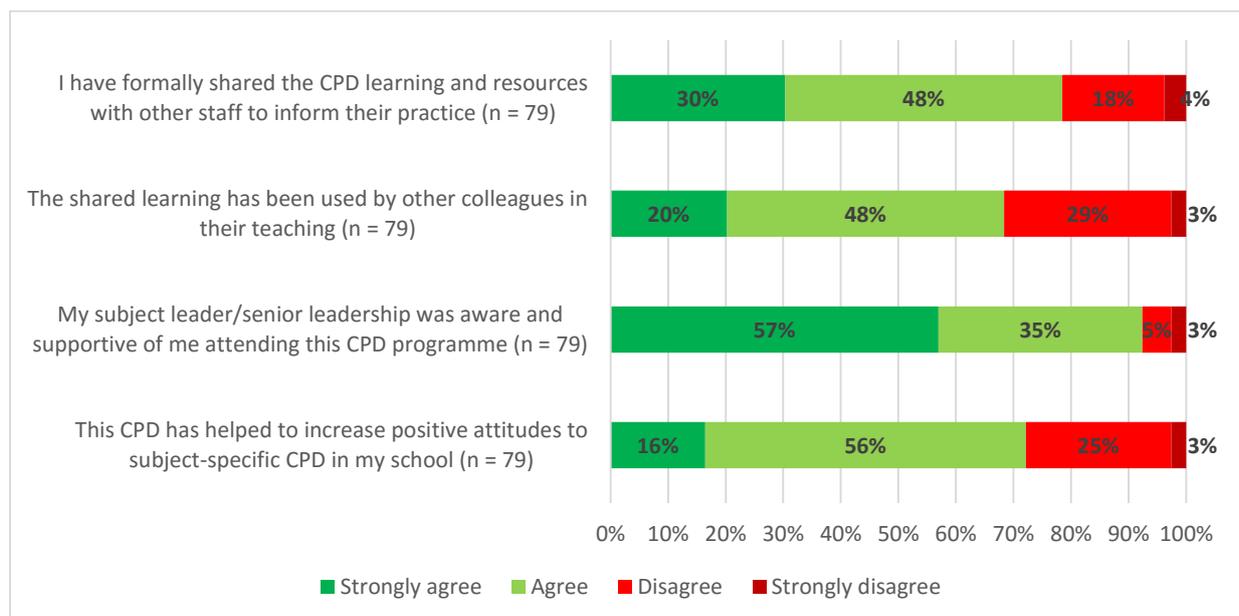


Figure 3 Impact on colleagues and institutions

**Teachers share the resources from the course.** 78 percent of teachers reported that they had shared their Cutting Edge Programme learning with other staff. 97 percent of teachers in STEM learning Impact data reported having shared their learning with colleagues (n = 69). The qualitative data demonstrated the range of ways this was done both formally and informally. Formal examples included making presentations for use in STEM staff meetings or departmental sessions (within their own schools, and more widely within learning partnerships), running working sessions for colleagues teaching same content, and contributing to Local Authority-wide in-service training events. Informally, teachers were sharing resources via local networks, subject-specific teaching pages on Facebook and other social networks. One teacher noted that it was *“important to maximise the cost of the course”*, which is why she ensured that she cascaded her learning to her colleagues when she returned to school. Where teachers had not shared the course material formally, over half of the 22% had shared the materials informally or were the sole subject teacher in their school. One teacher made a suggestion that would help them to share their learning:

*“As often happens I was not given a formal time to speak to colleagues about the CPD and so I haven't shared the knowledge more widely than just through informal conversations to those that seem interested. Perhaps the place on the CPD could be awarded with this sharing of knowledge being a requirement on return - even to at least one other teacher.”*

A lecturer, who attended the “Applications of recombinant DNA technology” course in February 2014 said:

*“I received approval to attend the course, and was given time in a department meeting slot to share the resources - although they were only in the form of handouts rather than a PowerPoint. Other staff have used the resources and due to their currency (and the fact that they are a resource used by the university nearest to us), [it] means that they are considered up-to-date.”*

A biology teacher, who went on the “Stem Cells” course in March 2014 said:

*“[I was] able to pass on the learning activities to staff in the school who were struggling for ideas on how to teach stem cells. [I] also shared the Eurostemcell website resources so they could do their own development too.”*

Having attended the Quantum Physics course in November 2015, a physics teacher reported:

*“As CfE Advanced Higher is being implemented for the first time this session, it was in everyone's interest that professional knowledge in this area be improved. Not every school in North Ayrshire is teaching Advanced Higher physics and I have shared resources with others in the Authority through Edmodo who are also going through implementation. Other departmental colleagues have been updated (they may teach it next year) and the new resources are held centrally on the server. As a department we always value subject specific CPD provided by SSERC as it is always relevant and accessible.”*

**Resources are used by colleagues.** 68 percent of teachers said that the shared learning had been used by colleagues in their teaching. Impact data reports that nearly 6 out of 10 teachers thought that their attendance on the course had improved the quality of subject teaching – in their school and of their colleagues (n = 57). The qualitative answers suggested that many of the those who did not share the materials with colleagues were not able to do so, as they were the only teacher of their subject in their school or college. The majority of CPD participants made use of the resources either provided on the courses or developed as a result of someone attending them. Resources were commonly shared with

colleagues, providing new ideas for how to teach topics, developing materials, practical activities and experiments to use in classroom, or adding new content to schemes of work. One teacher said that they had added the new material into student teachers' lesson plans, to ensure that what they were teaching would be as relevant as possible. Another was responsible for putting together the new curriculum, and was confident that the new material would go on to influence the whole department. Among those teachers who said their colleagues had not used resources, the most frequent reason given (where a reason was given) was that they are the only subject teacher in their school or college, or that they had not yet shared the resources but planned to.

A physics teacher, after attending the "Quantum Physics" course, in November 2015 said:

*"Resources that have been taken into school have immediate effect upon all in the department. [They now have the] ability to access materials that enable pupils to gain greater hands on experiences."*

A Vice-Principal, who went on the Genetics course, in January 2016 reported:

*"The biology department has already met to share the information from this event which has informed and been utilised in the delivery of material both at GCSE and A level. Additional information has been shared with the rest of the department to inform links and use the relevant information to support the understanding of science."*

**Colleagues have increased confidence in teaching cutting edge topic.** Teachers reported that as a result of them having taken part in a Cutting Edge course, there was a knock-on effect on the confidence levels of their colleagues when teaching similar content. In addition, the profile of STEM subjects was raised in some schools. The Impact data reported that over 6 out of 10 teachers thought the course had a high or medium impact on their colleagues (n = 106).

A faculty head, who attended the "Asteroids: detection and deflection" course in March 2015 said:

*"My increased knowledge and enthusiasm builds confidence in colleagues."*

A biology teacher, who took part in "The wonders of PCR: understanding the genome" in November 2015 told us:

*"I went through the CPD event with colleagues in my department and they too have expressed that they feel more confident in teaching the subject next year. In addition, my colleague completed the practical experiment I created with her class, and she said that her pupils also said it helped with understanding the theory."*

**Senior leaders are supportive of teachers attending Cutting Edge Programme courses.** More than 9 out of 10 teachers said that their senior leaders were aware and supportive of their attendance on the course. Further, 7 out of 10 teachers reported that attitudes to subject-specific CPD improved within their school after they took part in the programme (the qualitative responses to the survey did not give any detail of how and why this was the case). In the Impact data 3 in 10 teachers thought the course had resulted in a more positive attitude to subject specific CPD in their school (n = 13).

## **The impact of the RCUK funding for the Bringing Cutting Edge Science to the Classroom Programme**

Teachers were asked whether they had known that RCUK provided a bursary to support the costs of attending Cutting Edge Programme courses, and whether they had used it. They were also asked to

reflect on the impact this funding had had upon them. The quantitative responses to the survey are summarised in figure 4.

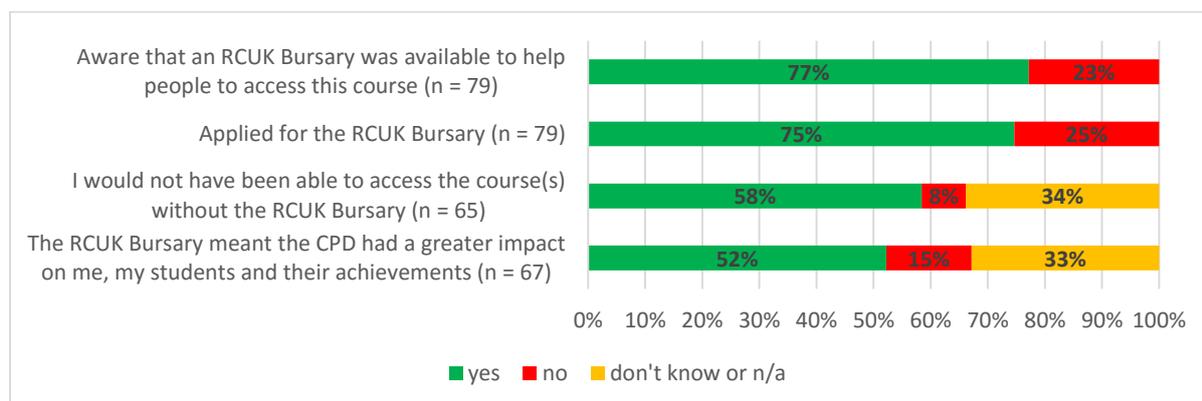


Figure 4 Impact of RCUK funding

**The majority of teachers are aware of the financial support available for the course.** 77 percent of teachers were aware of the bursary and 75 percent had applied for the funding. Nearly all of the participants who were interviewed accessed the funding and said they would not be able to attend without it. The exceptions to this were one teacher from a private school who was not eligible for the funding and another teacher who attended a course over a weekend which was so heavily subsidised that it was inexpensive, and who felt that it was immoral to access funding designed to support the costs of attending the course (i.e. paying for teacher cover costs back in the classroom) when they had not encountered any.

**Funding is crucial for teachers to be able to attend the CPD.** Only 8 percent of teachers would have been able to access the Cutting Edge programme course without funding, 58 percent teachers would not have been able to access the course without the funding and 34 percent did not know the funding was not available. Teachers explained how difficult it is for them to attend CPD in school time, due to a range of factors, but including the lack of funds in schools for external CPD and restrictions on the number of days of CPD they are entitled to attend. Despite this, teachers value the opportunity to attend subject-specific CPD and in many cases would not be able to attend without the funding to cover the various costs associated with that.

A teacher who attended the “York Physics day” in June 2015 commented:

*“The bursary has made the difference between attending and otherwise allowing this CPD to not impinge upon money available for others. Hence my positive attitude [to the course]!”*

**Half of teachers said that the availability of the funding meant that the Cutting Edge programme had a greater impact on them.** Those who gave that response qualified their answers by noting that they would not otherwise have been able to attend without the financial support. Other teachers reported that the course they had attended would have had the same level of impact, with or without the funding support.

## Summary

The evaluation has reported the positive impact the Bringing Cutting Edge Science to the Classroom programme has on teachers, students and their colleagues, both in their own schools and others via informal networks.

92 percent of teachers reported being more inspired and 88 percent were more confident to teach their subject by learning about advances in scientific research. The programme reinvigorated their interest in their subject and their subject knowledge. In addition to these programme aims, teachers also report additional benefits of improving their teaching skills, increasing the likelihood of them continuing in their career as a STEM or science teacher and developing greater awareness of STEM study and career pathways open to their students.

86 percent of teachers said that their students' knowledge and understanding of cutting edge scientific concepts has been improved and 80 percent said they were enthused and more interested in learning about STEM and their applications in real life. In addition, students were reported by most teachers as showing an interest in continuing STEM in their study and careers, and many students feel inspired to act as informed and involved citizens.

Teachers not only use the Cutting Edge programme learning with their students but share their learning and resources with colleagues. 78 percent of the teachers attending the programme had shared learning formally and others had shared it informally via local and virtual networks. In many cases the learning had already been used, and where it hadn't in most cases that was because they were the sole subject teacher or had not yet taught the relevant part of the curriculum. Senior leaders were supportive of teachers attending the programme course. Additional benefits of the Cutting Edge programme include increasing positive attitudes to subject-specific CPD.

The funding from RCUK is critical for teachers to attend the Cutting Edge program. Only 8 percent of teachers would have been able to access the Cutting Edge programme course without funding.

## Chapter 2. Bringing Cutting Edge Science to the Classroom programme: case studies of effective practice

The evidence shows that the programme is successfully bringing cutting edge science to the classroom and increasing students' knowledge and understanding. To illustrate how it is doing so this chapter includes case studies of how four different courses within the programme have been used. These courses are:

- ✓ **Astrophysics**
- ✓ **Genetics**
- ✓ **Expedition Iceland (fieldtrips)**
- ✓ **Case Studies: Geographical research**

These case studies give a snap-shot for each course outlining: how the courses were implemented; the impact each course had upon participants; how the teachers shared their new learning and resources from the courses; and how that new knowledge was embedded within schools. It draws on quantitative data from the survey together with qualitative responses from the survey and interviews with participants and facilitators.

These case studies will explore how well the course delivered the programme aims as well as additional benefits, such as increasing teachers' teaching skills, improving students' understanding of STEM careers and pathways, and inspiring them to pursue those paths.

Teachers who took part in Expedition Iceland chose to extend their engagement with the course by organising a follow-up session, during which they shared practical examples of how they had applied their new learning in the classroom. The Iceland case study that follows also provides some of these examples.

## Case study 1: Astrophysics

This course has been run on a number of occasions during the last 2 and a half years. It is a one-day course, delivered via a partnership between a teacher-presenter and lecturers. It combines astrophysics lectures by academics with demonstration material and signposting to online resources that teachers can take away to use in their classrooms. The topics covered include extrasolar planets, how elements are created within stars, and the big bang. It makes close links to the GCSE curriculum, while maintaining a focus on cutting edge science and techniques.

The course is run in a large laboratory, where teachers listen to presentations at one end, and can take part in demonstrations with laboratory equipment at the other. Teachers leave the course with apparatus to use back in their own classrooms so that they can recreate the experiments and activities, and are sent an electronic pack of the lectures and further resources once they are back in school.

### How the CPD was implemented

Teachers particularly value the strong partnership between the facilitator and the researcher/scientist for this course, highlighting the *“clarity and engagement of the teacher and his humility in approaching the subject”* and noting that the course covered *“helpful specialised content that I would not have been able to easily access elsewhere.”*

One teacher reported that it had been:

*“Really good – something that you don’t really find elsewhere, very bespoke. [You] get the great link between research and how to apply it to the classroom – [it is a] strong combination.”*

Another aspect of the course that has a big impact upon participants is the fact that it is run in a research facility, allowing teachers to get a better, real life understanding of where the scientists work and what they do on a daily basis, which in turn contributes to enhancing students’ awareness of STEM careers and the pathways they need to follow in order to work in similar roles.

The course leaders make careful effort to ensure that the content is pitched at an appropriate level for their audience, so that they can demonstrate a clear fit with the curriculum, and so that teachers are able to grasp the concepts quickly, while also stretching their knowledge and helping them to understand more challenging topics. One course participant reported that, *“hearing the latest research really does increase your confidence in a way other courses don’t”*. The lecturer tends to deliver a core input on a topic, such as exoplanets, and then opens up the discussion to the teachers to allow them to direct the discussions.

Such an approach works well, as one participant reports:

*“It really inspired me. I did go back to school wanting to buy a telescope and set up an after school club... I still feel inspired by listening to the researchers.”*

### How the CPD was shared by teachers

Participants of the Astrophysics courses reported that the content of the course was closely linked to the curriculum they needed to teach. As a direct result, teachers have been empowered to put together new schemes of work for their departmental colleagues on the topics they covered. This approach means that the content is cascaded to multiple teachers and taught to multiple groups of students.

Lots of people who undertake the Astrophysics courses are not trained physicists themselves, but despite that, they report that they leave the session with a good understanding of specialist subjects. They are then able to teach this to higher levels than they previously had, and to pass on this new knowledge to colleagues:

*“My degree had limited astrophysics content in it and as a result I felt a little under-confident in teaching this. The course reinforced the reading I had undertaken and explained the areas I had doubts about. [It] has enabled me to be more confident in teaching physics even to A-levels. I am able to teach and coach other non-physics teacher in my school on key physics concepts.”*

### How the CPD learning was embedded

Teachers made special note of the relevance of the content of the Astrophysics course to the specifications they were required to teach when they returned to school. For instance, one teacher mentioned the close alignment with *“the OCR 21st Century triple science curriculum, and in particular the p7 module”*, and has made extensive use of the materials from the course in her lessons:

*“[It was] an excellent course which has increased my own subject knowledge and provided takeaway strategies for use within the classroom.”*

One teacher explained how much of an impact the fact that the course focusses on cutting edge science has had upon her, and her students. She has been able to demonstrate how well she has embedded the learning she took away from the course by putting it into her lessons, and the effect that has in turn on the students:

*“I know that up-to-date knowledge of current discoveries are key to engaging students and opening their eyes to future possibilities for applications of STEM subjects in careers. Since using this type of knowledge and experience in the classroom, every year there has been at least one student who has applied for a university place to study specifically astrophysics, or physics with astronomy where they would have been less likely to before. I have students committing to this pathway as early as year 11 at the moment!”*

### Overall impact of the CPD

Nearly 9 in 10 course participants reported that as a result of attending the Astrophysics course:

- their subject knowledge had improved;
- their confidence in teaching the cutting edge science had improved;
- their interest in teaching their subject had been reinvigorated; and
- their students’ knowledge of astrophysics had improved.

One head of science, who attended the course, summarised its impact upon her in the following way:

*“It was really good – it was great to see cutting edge research, but also how to apply it to the classroom, how to teach it, how to deliver it and how to make it relevant to students. It was so valuable to see what the latest research areas are, and to be able to advertise them to kids as career pathways.”*

## Case study 2: Genetics

The Genetics course has been delivered once, so far, in January 2016 at the Life Science Centre at the Bioscience village in Newcastle. This one-day course was delivered via a partnership between North Tyneside Learning Trust and a network of scientists, one of whom was based in the Life Science Centre. Three keynote speakers, experts in their fields and experienced science communicators, delivered lectures on different aspects of genetics, and this was followed by some informal time for questions and discussion. Finally, there was a plenary session to discuss how to use and apply the learning from the day.

The course gave the scientists free reign over what to present to the GCSE and A level teachers. The aim was to engage teachers with the topic of Genetics, inspire them with work of scientists in the North East and inform teachers about potential STEM employment opportunities for young people locally.

### How the CPD was implemented

The teachers explained that they valued being able to learn from local scientists about Genetics which was both relevant to the curriculum and included cutting edge developments. Teachers said they appreciated:

*“contact with real time science and making the curriculum relevant. It was also great that the speakers were all based locally.”*

*“being exposed to current cutting edge research [which serves] as a reminder of the constant moving nature of biology and how we need to be aware of this in our teaching.”*

They also valued the opportunity to see the labs and research facilities, as this enabled them to talk to their students about STEM developments happening locally and potential related employment opportunities. One teacher reported that following the course they were:

*“Informed of the cutting edge Science and research being carried out in Newcastle, able to discuss this with experts and colleagues. [I was then more] motivated to read around the subject and better able to inform students of local expertise in Newcastle.”*

Teachers attending the Genetics course gave positive feedback about the quality of the scientists presenting, describing them as *“extremely interesting”* and *“very informative”*.

This combination of real life examples and how techniques are now being used inspired and motivated those who attended:

*“It reminded me what I loved about university lectures. It inspired me to talk more enthusiastically about Genetics with real life examples.”*

### How the CPD was shared by teachers

The teachers reported being more confident and motivated in their subject and that *“this enthusiasm is essential in motivating others”*. They also valued being able to use relevant examples and new ideas in the classroom.

Teachers have engaged, both informally and formally, with their colleagues to share the learning from the Genetics course via scheduled discussions which motivated and inspired others, and by sharing notes with colleagues in school and across the local authority.

One teacher, as a direct result of attending the course, has started to develop a school-wide resource of all the science employment opportunities available to their students in Newcastle, including in Science city.

For future courses teachers would appreciate having more resources to take away from the event – either a version of the slides or classroom ready resources on the topics discussed.

### How the CPD learning was embedded

A Vice Principal from one school reported that within two months of the course, their biology department had met to share course information which informed the delivery of both GCSE and A level lessons. He personally reported that:

*“I have accessed their website and utilised resources for the delivery of science and supporting other colleagues in the delivery of their topics”*

### Overall impact of the CPD

All of the nine teachers reported that as a result of attending the Genetics courses:

- they are more inspired;
- their subject knowledge has improved;
- their students have been enthused and are more interested in learning about STEM subjects and their applications to real life; and
- they would recommend the Genetics course to colleagues.

The Vice Principal said:

*“It has allowed students to understand some of the advances I ask them to read about in biological journals or through the media. Many of the topics relate directly to areas of the specification and allow me to set stretch and challenge work. Since attending the CPD the students have been engaged in a moral and ethical debate discussing some of the issues raised on the day while reviewing the benefits of point of care treatment.”*

### Case study 3: Expedition Iceland

This course is run twice a year, and is fieldwork based. It begins with a weekend of orientation and preparation, during which participants learn about the places that they will be visiting, how they will be camping during the trip and the equipment they need to take (and carry themselves), as well as an introduction to the science they will be investigating.

The May expedition covers topics in science, geology and geography, and, for example, includes content such as geothermal energy production, facilitated via a trip to a geothermal power station. It is predominantly enquiry-based, encouraging the participating teachers to come up with something that they want to explore during their trip. The teachers then conduct their own investigations while they are in Iceland. The premise behind this is to let the teachers take the place of their own students, and experience what they go through when they are asked to conduct investigations, activities and experiments themselves at school.

The October trip focusses more on astronomy (and the Northern Lights in particular) and engineering, covering topics such as tectonic plates, earthquakes, structural engineering and disaster planning.

The trips take place during the May and October half term holidays: teachers are not taken out of school during term-time. The topics covered on both expeditions are selected in order to tie strongly into the curriculum. Teachers are expected to work hard during their time in Iceland, undertaking their investigations by themselves, gathering their own data, working closely with the experts who accompany them on the expedition, and who they meet while they are away.

At the request of course participants, teachers often meet up again after their expedition, to reflect on what they discovered, to share their findings, and to demonstrate what they have done in the classroom as a direct result of the fieldtrip. Their networking is further supported by an online community and a shared folder where they can exchange teaching materials and resources.

The costs of the expedition are supported by funding from RCUK and STEM Learning Impact Awards, to make it as affordable as possible for teachers.

#### How the CPD was implemented

The course is delivered using an expedition partner from the UK, who is experienced in delivering fieldwork of this nature. It is led by a facilitator from STEM Learning, who is supported by scientists and researchers who has the relevant expertise for each of the trips. Once in Iceland, there are further academics and scientists who are involved: in running tours of relevant facilities such as laboratories, a power station or an observatory; conducting demonstrations; and working with participating teachers during their visit.

Teachers particularly benefited from this combination of input in such an inspirational setting, as one participant explained:

*“Most useful was having time to talk at length with subject matter experts in many aspects of STEM teaching and learning, while surrounded by inspirational real-life applications of STEM, and the amazing natural geography of Iceland. This has given me confidence to consider planning more aspirational school activities including international travel.”*

Teachers described how their learning was enhanced and extended by being in Iceland, as opposed to learning about it from afar:

*"There were areas of biology and biodiversity I knew already, but it added extra value to see it all first hand and to see the volcanic dust, and see the glacier receding – global warming in action – and to see the degree to which that had changed in just a couple of years – it had moved a couple of hundred meters!"*

### How the CPD was shared by teachers

Teachers invest a lot of their own time in the expedition, and they are also aware of the financial support they are provided with in order to attend. Both of these factors, as well as the experience of the expedition itself, contribute to participants wanting to ensure that they, their students and colleagues, get as much out of it as possible, as one participant explained:

*"You feel quite a bit of commitment as a result of the funding being there: I felt duty bound to make it worthwhile, otherwise you'd feel a bit guilty about getting the trip for nothing. You have got to make sure that the funding is well spent – so you feel a responsibility to get the most out of it and to have the maximum impact on you, your teaching and your pupils."*

There is an embedded expectation among expedition participants, therefore, to share your learning. Each teacher conducts their own investigation, so there are potentially 14 different topics for expedition participants to learn about once they return. One recent group decided to do this face-to-face, and organised a day-long post-expedition review session, during which:

*"...we worked out that this trip probably had an impact on the education of around 3000 pupils which is stunning. With 14 science teachers participating in the trip and taking the impact back to their school influencing 3 or 4 colleagues and their lessons it has become a chain reaction. Literally thousands of resources were shared during this one session and all material will be uploaded onto the course shared area.*

*It was a great opportunity to share good practice and relevant resources with teachers from other schools - a rare chance as it's hard enough to find time to share things with teachers within one's own school!"*

Once back in the classroom, teachers provided a range of examples of how they had used this new learning as the following three people explained:

*"I have planned many lessons around the Iceland trip since my return. This has helped with pupils' engagement. This trip also helped to enhance my subject knowledge and helped to provide resources to take back to the classroom and the department."*

*"I gained information about Auroras and geothermal springs, I took many pictures of the geothermal power station which will be relevant for KS3 and 4 physics. I have completed the visit with more knowledge on key subjects within the Physics curriculum which will help enthuse my lessons."*

*"The project is still ongoing for me in school. I am in the process of putting together resources for use later on in the term for teaching about the uses of geothermal energy in Iceland."*

## How the CPD learning was embedded

Participants reported that they felt that the expedition had a lasting impression on them. It enabled them to expand their subject knowledge, stretch their understanding of challenging concepts and provide exciting examples for their students, all of which have a direct impact in the classroom:

*"All of our intended outcomes were achieved on the trip. I gathered all the primary data, and shared it with the other teachers on the trip. They also shared their data with me. The experience and subject knowledge I gained was phenomenal. I've been using in my lessons every week since I returned."*

Further, this learning is embedded within their own departments and teaching networks:

*"The resources that were made by me and others have been shared within the faculty and built into the scheme of work."*

*"[This has been a real] opportunity to put subject content into a new context, enhancing my teaching and that of colleagues."*

*"I have completed a presentation to teachers across our learning partnership as well as to the department. I have also prepared a presentation for the sixth formers to encourage them to follow a career in science."*

Some teachers have even been inspired to share their learning even further:

*"I have gained in confidence to deliver not only science in the classroom, but to give talks to adults to improve the public understanding of science with organisations such as the Rotary Club."*

## Overall impact of the CPD

All of the seven teachers who attended the Iceland Expedition reported:

- their confidence and motivation had increased;
- their teaching skills had improved (it is the only course where 100% of respondents agreed or strongly agreed in the survey);
- their students had improved knowledge and understanding and were more likely to pursue future careers and education in STEM subjects.

Participant feedback on Expedition Iceland is consistently excellent:

*"The Iceland course in October was exceptional. It was the best CPD I have ever undertaken. The course content was excellent and the organisers were outstanding."*

*"This training was outstanding in every way. The content was very relevant, full of experiential learning and extremely well organised and run by very knowledgeable leaders. I felt confident and included throughout the expedition, and now feel empowered to extend STEM learning both in school and on expeditions outside school."*

**Examples of how teachers have taken their learning back to the classroom:**

- *The geyser activities on this trip enable me to improve students' mathematical trigonometry and literacy skills and I am also able to use this data to improve their graph drawing skills. The talks from one of the experts help with the Geology GCSE that we deliver.*

- *I studied adaptations, river flow and tectonic plates and used the information from these investigations to hold a mock "Iceland Day" at school principally for Key Stage 3 Special Educational Needs students.*
- *I investigated the impact of weather and light conditions on the growth of algae as well as looking at the mechanisms of volcanoes and explaining the geyser with Coke and Mentoes.*
- *As a result of this trip the schemes of work for KS3 and KS4 have been changed in my school. This has also resulted in higher profile for STEM following on from the Iceland Trip. I have delivered a lesson using photos and videos from the trip and have impressed students with our wild cooking experience. It has enabled me to teach hydroelectric power with an additional insight and to explain energy changes down a waterfall. The principles of Geothermal energy are now much clearer to me!*

## Case study 4: Case Studies: Geographical Research

The Case Studies: Geographical Research course is a day-long course focused on science in geography delivered as part of an on-going programme. It utilises the expertise of 35 scientists who have developed case studies for geographical research, the majority of which are STEM focused, while some are from Bachelor of Arts lecturers. Each of the courses offers a selection of case studies and a session on new research methods. The day consists of six interactive presentations and discussions about separate case studies, and is delivered at the School of Ocean Sciences in Cardiff University. The collection of case studies is available free of charge to download.

The course has been refined and developed in response to participant feedback – both in terms of the practical arrangements, the format of the day and its content. For example, the sessions are delivered within school hours, via a series of six lectures, rather than more than that, to allow in-depth of discussion and the easy sharing of case studies online. Future courses will include a 1.5-hour fieldwork element around Cardiff to give teachers ideas and they are videoing lecturers talking about their case study topics to share online.

### How the CPD was implemented

The course is coordinated by the School of Ocean Sciences and draws on the School's scientists to design and deliver case studies which are tailored to the curriculum. The case studies aim to increase teachers' understanding of current research and overcome the disconnect between older curriculum materials and cutting edge developments.

Teachers who attended the course appreciated the opportunity to update their knowledge with "current and up to date and very relevant" content. One teachers said:

*"The course was accessible – it made a change to being stuck in the syllabus – it was great to access the other geographers and the researchers and professors were very approachable and answered any questions."*

Teachers valued the links they could build with the lecturers and Cardiff University – a Russell Group University.

### How the CPD was shared by teachers

The information was shared by teachers both in the classroom and with colleagues. Examples were given of using the cutting edge case studies in discussions with GCSE students, using data and material shared by the University e.g. maps of the Bristol channel and data sets, that teachers would not be able to access otherwise. One teacher most valued:

*"Not just the regular information on the school syllabus – there was lots of information to take away and use straight away in my teaching. [I really welcomed the] diversity of the case studies."*

Examples of sharing with colleagues ranged from teachers sharing the course content with other subject teachers delivering the same material in school, bringing a colleague along to the course and informal sharing with colleagues at other schools.

## How the CPD learning was embedded

The teachers who participated in this course reported on the benefits to their students both in terms of broadening their exposure to STEM:

*“a large number of my students are now seeing the links between geography and science.”*

and motivating and inspiring them:

*“referring to topical case studies keeps the subject interesting and alive for students.”*

Teachers valued the opportunity to invite the lecturers to their schools to speak to their students and one teacher gave an example of a student going on to attend Cardiff University to study Geography because of the links she had built there.

Previous participants are recommending the course to colleagues and many teachers also highlighted the benefits of having information to take away and use straight away in their classrooms:

*“[I] had had feedback from other Heads of Departments that it was worthwhile... I really enjoyed it – it was like being back a Uni (sic) – excellent speakers, really interesting, good pace and all relevant information to use back in the classroom.”*

## Overall impact of the CPD

All of the five participants of this course who responded to the survey reported:

- They are more inspired about teaching STEM;
- They have increased confidence teaching subject specific knowledge and their interest in their subject has been reinvigorated.
- More students are more inspired to act as informed and involved citizens.

One Deputy Curriculum of Humanities teacher said:

*“It's geography, shared by those that have a passion for it!  
The Geography Case Studies day is the best course of the year. Each year the same staff attend because they see the value in it, they bring their colleagues and it's a huge success. This enthusiasm then goes back into the classroom and students have access to up-to-date knowledge.”*

## Chapter 3. Maximising the delivery and effectiveness of the Bringing Cutting Edge Science to the Classroom programme

Through the course of our fieldwork, views have been sought from course participants, course facilitators/educationalists and researchers/scientists to understand how STEM Learning and RCUK might maximise the effectiveness and the impact of any future delivery of the Cutting Edge Programme.

This chapter summarises those findings in four sections:

- Participant feedback on the course they attended;
- Elements of the Cutting Edge Programme that should continue in order to maintain its success to date;
- Facilitator and researcher feedback on the course they delivered; and
- Recommendations for the future development of the Cutting Edge Programme

### Participant feedback on the Bringing Cutting Edge Science to the Classroom Programme

**Teachers would recommend the Cutting Edge Programme to colleagues** (figure 5). More than 8 out of 10 survey respondents said that they would recommend the course. Consistently, teachers reported that the programme is engaging, inspiring, interactive and unique in its delivery approach due to the combination of input from a scientist and an educationalist. They particularly enjoyed the lecture-style format, the opportunities to ask questions, being able to influence the direction of the discussions that took place and getting involved in hands-on, cutting edge activities and experiments.

Closer inspection of the data reveals that of those people who said that they would not recommend the course they attended to colleagues (10 of the 79 respondents), this answer would appear to be in direct contradiction to the rest of their survey responses in 9 cases. For example, four of them said that they would change nothing about the day, and one person described their course as having been “perfect”. Only one person provided answers to the rest of the survey that were consistent with their refusal to recommend the course. These data should therefore be treated with caution.

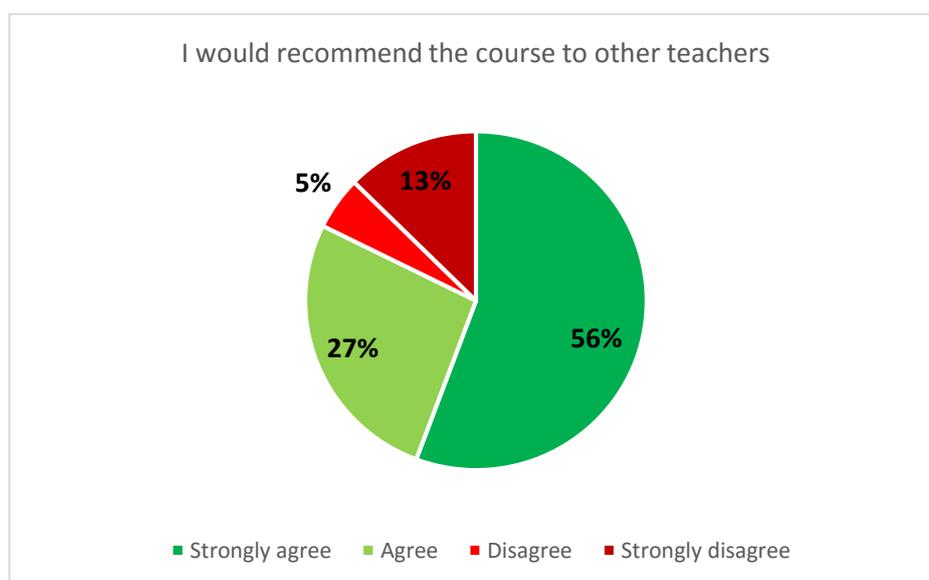


Figure 5 Recommending the Cutting Edge course

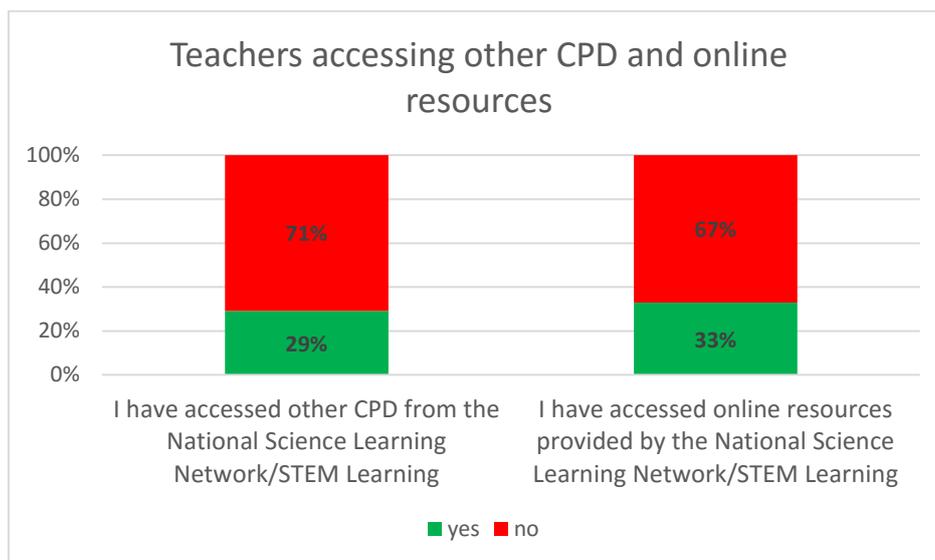


Figure 6 Accessing other CPD and online resources

**30% of teachers had accessed CPD from STEM Learning before** (see figure 6). Only around 1 in 3 course participants had accessed other CPD delivered by the National STEM Learning Network before undertaking the Cutting Edge Programme course. Of those people whose first encounter with the National STEM Learning Network was their attendance on this course (n = 56), 80% would recommend the course to colleagues, given that they had such a positive experience on their course. This shows that among the Cutting Edge Programme course alumni, there is a pool of people the National STEM Learning Network may wish to keep engaged in future delivery of relevant CPD opportunities.

**30% of teachers accessed the associated online resources for their course** (see figure 6). Most teachers reported that they were either unaware of the online forum, or that they had not had time to access online resources. Instead, they had spent time sharing physical take-home resources from their course informally via existing networks they already participated in. Teachers said that they valued resources that they could take away from CPD which, after tailoring them to the needs of their own students, they could use fairly immediately in the classroom. These were used to explain cutting edge (and other) scientific concepts, provide real life examples and to highlight potential career options relating to the science being taught.

## Key elements of the Bringing Cutting Edge Science to the Classroom Programme to continue

Teachers were asked, both in the survey and in the telephone interviews, what they would improve about the Cutting Edge Programme. Almost universally, the feedback from participants about the CPD was very positive, and 4 out of 10 teachers even went as far as saying that they would change nothing about the course.

Teachers identified the elements of the programme that they found most valuable, and which offer the most potential for continuing to maintain the positive impact that the programme has in future. As a result, this evaluation recommends that STEM Learning and RCUK:

- **Continue to facilitate access to experts in cutting edge fields, and combine their input with that of educationalists.**

This is a huge selling point for the programme. Teachers really valued having access to expert researchers and scientists, who were often locally-based, and who were working on real, relevant and interesting cutting edge projects. Such access offers an unmatched opportunity to teachers, and serves both to inspire and engage them, and to help them to get exposure to science in action: *“I loved listening to world-renowned scientists talking about cutting edge science”*. Teachers welcomed the scientists’ willingness to respond to their questions, however challenging, and to take discussions in directions that they may not have anticipated. In addition, the combination of this expert input alongside an educationalist who is also a skilled CPD facilitator means that teachers are able to get even more out of the sessions, as critical links between the scientific concepts and the detailed specifications that teachers have to follow in the classroom are continually being made.

- **Continue to deliver the Cutting Edge Programme in inspiring and relevant scientific and University-based settings.**

Teachers valued having the opportunity to leave their classroom, and to spend time learning in real research facilities and cutting edge science laboratories: *“the science really became alive in an excellent environment”*. The hands-on opportunities were perceived to be particularly valuable, as was their exposure to new technologies, equipment and experiments. In addition, teachers took great value from being able to build and develop links with local Universities and laboratories, both so that they could make use of these facilities in future either with colleagues or their students (or could invite the researchers to make reciprocal visits to their schools), and so that they could draw on these relationships to provide tangible and inspirational STEM careers guidance to their students.

- **Continue to enable teachers to understand the most challenging aspects of the STEM curriculum, by teaching them about the latest cutting edge developments.**

The Cutting Edge Programme has successfully helped teachers to understand and teach the newest and most challenging parts of the STEM curriculum. Teachers reported that their subject-specific knowledge had improved, along with their confidence in teaching such topics. Frequently teachers said that all of these benefits had left them with another unexpected outcome: increased enthusiasm and a boosted morale for teaching, which they said was infectious in the classroom both with students and colleagues alike. As a result of taking part in the CPD, they were now able to provide strong context and real life application for the science they were teaching, and they felt able to expose their students to the most cutting edge techniques in the field. Resources that had been shared by the facilitators and scientists were eagerly welcomed by teachers, and were shared and used over and over again in classrooms within and between schools.

## **Facilitator feedback on developing and delivering the Bringing Cutting Edge Science to the Classroom Programme**

During the telephone interviews with researchers/scientists and course facilitators, evidence was gathered about their experiences of developing and delivering the various Cutting Edge Programme courses. The feedback from the facilitators and scientists involved in delivering the Cutting Edge programme courses was generally very positive. They are dedicated to enabling teachers to take the

latest research back to students and many talked about their personal commitment (and using their own free time) to delivering high quality courses which are engaging both to teachers and their students.

The key messages from these discussions are summarised here.

➤ **Developing the courses.**

All of the researchers and educationalists reported that they had really positive experiences working together to develop and deliver their courses. They valued the skills that their counterparts could bring: researchers welcomed insight into the sorts of topics that teachers would find interesting and useful, and advice on how to pitch their research input. Likewise, the educationalists valued the researchers' ability to communicate and share the complicated science topics in a way that translated easily to a teacher audience, as well as the detailed specialist expertise that they brought to the CPD.

➤ **Recruiting participants.**

In some cases, facilitators said that they were disappointed by the fact that their course did not recruit as successfully as they hoped it would. They found that the time and resource required to develop a Cutting Edge Programme course was disproportionately high if only six or seven participants attended it. In addition, such low recruitment figures meant that they found it difficult to justify persuading the right calibre of scientist to take time out of their day job to deliver the course. Though no-one reported that a scientist refused to be part of the course as a result of low attendance, facilitators did describe feeling self-conscious that they had not managed to get more teachers to attend.

➤ **Delivering the courses.**

Researchers and educationalists recognised the importance of a varied, interactive programme for the day. They recognised the challenge of pitching the content at the right level for teachers to be of use and to challenge them, whilst also ensuring that it remained relevant to the curriculum. Equally, they described how important it was to allow time for teachers to digest, question and discuss the content of the course, and facilitators in particular observed that additional time for teachers to network with each other would also be beneficial.

➤ **Embedding the learning.**

Some researchers and educationalists described how they made use of the feedback and impact data from their course to refine and improve their it for the future. For example, some explained how they had responded to teachers' requests for more practical activities (including ideas for conducting activities and experiments and access to lab equipment where possible), ideas for fieldwork and for resources they could share virtually. However, they did acknowledge that such reflection and adjustment took time.

## Recommendations

The following three recommendations are ways in which STEM Learning and RCUK might maximise the delivery and effectiveness of future Cutting Edge Programme courses:

➤ **Facilitate better collaboration across the Network to ensure better recruitment to Cutting Edge programme courses.**

Both course participants and facilitators raised concerns about the low volumes of people attending the majority of the courses in this study. The exception to this was Expedition Iceland, which is

reportedly always over-subscribed and has a waiting list most of the time. The Bringing Cutting Edge programme attendance data for courses scheduled between January 2015 and January 2016 shows that 257 participants attended 20 courses which gives an average of 13 participants per course. However, several of the courses included in the evaluation ran with 7 participants or below (e.g. Medical imaging with 6 participants, Astrophysics with 7 participants). During that same period, 36 courses had been planned of which only 20 ran, with 16 being cancelled.

Given the amount of preparation work that facilitators and researchers put into developing Cutting Edge programme courses, low numbers of attendees were often a disappointment. One course facilitator provided an example where she had managed to recruit a high calibre, famous scientist to contribute to the day, but was then also only able to recruit 6 or 7 teachers to take part in the CPD. Course participants also observed that a larger group of teachers would encourage wider and deeper discussions during the sessions.

STEM Learning and RCUK could support course facilitators in improving the recruitment picture in a number of ways:

- Advise facilitators on how to maximise attendance on their courses by selecting the most appropriate time of the academic year to run it, and giving participants maximum notice of a course taking place;
  - Encourage facilitators to consider the possibility of running events in evening as twilights, for example, to minimise the time needed for attendees to be out of the classroom;
  - Make use of the full network's resources, channels and links into schools to recruit participants as widely as possible; and
  - Tap into the potential networks that those people who were first-time users of STEM Learning CPD when they took part in the Cutting Edge course: 7 out of 10 teachers had not attended any other CPD before, of whom the large majority were very positive about their experiences.
- **When promoting the programme, articulate the link between the inspiring, cutting edge content and the new curricula and specifications in each country.**

Participants reported how difficult it was, in the current climate with limited budgets for CPD and increased pressure in the classroom, to be able to leave school to participate in external courses. They explained how important it was to be able to ensure that any CPD they did take part in was directly relevant to equipping them to teach the new curricula and course specifications, and to address any gaps in their knowledge (particularly so for non-specialist teachers). STEM Learning and RCUK should consider any messaging relating to the promotion of Cutting Edge Programme courses carefully, and:

- Highlight the relevance to the new curriculum;
  - Emphasise how well these courses will support teachers to quickly develop the subject knowledge and confidence to be able to teach the more challenging topics included in new specifications;
  - Demonstrate how the courses provide real tangible examples for teachers to take back to the classroom and use straight away; and
  - Consider how Cutting Edge Courses are titled, and investigate whether this relevance to the curriculum can form part of future course names.
- **Give teachers more resources and practical activities to use when they return to school.**

Teachers frequently reported how much they valued both resources and practical activities they could use back in the classroom. They were able to provide examples of how they continued their learning

from the course back in the classroom, sharing content with both students and colleagues. STEM Learning could maximise the continued impact that Cutting Edge Courses have on participants by:

- Ensuring teachers always have electronic copies of the presentations used during the courses (data protection rules permitting);
- Where possible, sending teachers back to school with ideas for practical demonstrations, activities and experiments with their students (which are also cost effective);
- Signposting teachers to further sources of information online and elsewhere;
- Encouraging scientists to share their live research data, (where possible), to allow teachers and students to make use of it for investigations when they return to school;
- Making use of the online community resource associated with the programme, to continue discussions, share materials, engage participants, and maximise learning opportunities; and
- Consider filming course lectures, and share them online so that teachers who are unable to attend courses are still able to benefit from the cutting edge content.

## Conclusion

This evaluation sought to establish whether the Bringing Cutting Edge Science to the Classroom Programme was successfully delivering its aims, and to investigate the impact that Cutting Edge programme courses had upon course participants, their students and colleagues.

The programme is being delivered in a wider context of needing support teachers to deliver changing curricula in STEM subjects, alongside the need to bring new scientific developments into the classroom. There are clear benefits to schools of teachers attending courses to increase their knowledge of the latest scientific developments, but at the same time it is a challenge to recruit teachers to courses because of the budget and time constraints faced by schools.

The feedback provided by teachers, course facilitators and researchers during this evaluation consistently demonstrated that the Cutting Edge programme is indeed delivering what it set out to achieve which is to deliver the latest knowledge, new contexts and practical activities to teachers by engaging with scientists involved in cutting edge research. There is evidence of the courses impacting positively on all three key groups, and teachers have provided a wealth of examples to illustrate this. Participants' feedback was very positive about the Cutting Edge courses they had attended. They reported being more confident, engaged and using the learning and resources from the courses with their students. Students of those attending the programme are also reported to have improved knowledge and understanding of cutting edge concepts and increased enthusiasm and interest in STEM. Teachers share their learning from the programme and resources have been widely shared with colleagues and built into schemes of work in their schools. This formal and informal learning means that a wider group of teachers and students are also learning about the latest cutting edge science. Senior leadership teams in course participants' schools are supportive of teachers attending Cutting Edge programme courses, however teachers frequently described the difficulty of getting permission to attend external CPD due to budget constraints. In addition to delivering the programme aims this evaluation found additional benefits: the courses also improve many of the participants' teaching skills and improve their understanding of STEM study and career pathways and in turn their students' understanding and motivation to pursue these pathways.

There are some defining characteristics to the Cutting Edge Programme that stand it apart from other subject-specific CPD: the access teachers get to expert scientists working alongside educationalists to deliver the course; opportunities for teachers to attend courses in inspiring and relevant settings where they can get hands-on experience; and enabling teachers to understand the most challenging aspects of the STEM curriculum. This report recommends that those characteristics are capitalised upon in order to continue the success of the programme to date. In addition, there are actions STEM Learning and RCUK might implement in order to maximise the future impact of Cutting Edge programme courses including: facilitating better collaboration across its network to ensure better recruitment to courses; clearly articulating the link between the cutting edge content and the new curricula content; and ensuring courses give teachers more resources and practical activities to support their teaching. Acting upon these recommendations will better enable teachers to make the case for attending the CPD and will ensure even greater and wider dissemination of the course content.

We hope that the Bringing Cutting Edge Science to the Classroom programme continues to enjoy similar, and even greater success in the future, and that this evaluation contributes to that.

## Appendix

### List of courses

Courses attended	Total number of survey responses
NS215 A14: Asteroids: detection and deflection 31st March 2015	2
NS212 A13: Astrophysics 18th March 2014	2
NS501 A14: Astrophysics: bringing cutting edge science into the classroom 25th March 2015	2
NW200B13: Astrophysics: Bringing Cutting Edge Science into the Classroom 11th April 2014	1
RA451A01: Astrophysics: Bringing Cutting Edge Science into the Classroom (27th July 2015)	4
RA451F03: Astrophysics: Bringing Cutting Edge Science into the Classroom (20th November 2015)	4
RC451 G01: Astrophysics (From Quantum to the Cosmos): Bringing Cutting Edge Science into the Classroom 17th March 2015	1
RE451 A01: Astrophysics: Bringing Cutting Edge Science into the Classroom 4th February 2014	2
RE451 A02: Astrophysics: Bringing Cutting Edge Science into the Classroom (Bespoke) 1st July 2014	1
NN204A13: Biodiversity, Statistics and Ecosystem Services 17th June 2014	2
RC452 A01: Biodiversity - Evolution: Bringing Cutting Edge Science into the Classroom 11th March 2014	1
RE452 A03 Biodiversity: Bringing Cutting Edge Science into the Classroom 11th February 2015	1
NS500 A14 Support for CfE higher biology at Roslin 19th March 2015	6
NN202A13: Applications of Recombinant DNA Technology 25th February 2014	3
RB457L01: Genetics: Bringing Cutting Edge Science into the Classroom (29th January 2015)	9
RE457 A01: Genetics: Bringing Cutting Edge Science into the Classroom (focus on plants) 3rd June 2014	1
NW500A14: Case studies: geographical research (16th June 2015)	5
RA463 G02: Getting to the heart of matter 25th June 2014	2
RC463A03: Expedition Iceland (May): Wonders of Iceland (8th May 2015)	4
RC463A04: Expedition Iceland (October): Northern Lights (27th October 2015)	3
NS504A15: The wonders of PCR: understanding the genome (12th November 2015)	5
NS505A15: Quantum physics (26th November 2015)	8
RD219K01: Secondary School Science Department Conference (Bristol Green Capital of Europe 2015) (27th June 2015)	3
NS503 A14: Stem cells and regenerative medicine 27th March 2015	3
RC463 E02: STEM Study Visits 22nd November 2013	1
RD463J03: STEM study visits 6th February 2015	1
RE463 K01: STEM Study Visit - Crossrail London 28th March 2014	1
NY233A14: York Physics day (26th June 2015)	2
NS208 A13: Stem Cells 6th March 2014	2