Research to Support Understanding of Evolution and Inheritance in the National Curriculum at KS1 and KS2: Evaluation of impact

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Contents

Background

The feedback from teachers reported here relates to their involvement in the Nuffield Foundation funded 'Research to support understanding of Evolution and Inheritance in the National Curriculum KS1-2', (Nuffield EDU/41491). The project classroom activity ran for the calendar year 2014. Study 1 was the first of two linked pieces of research involving two different, non-overlapping samples of teachers. The project undertook to conduct research that would inform and support all stakeholders' understanding of the implications of Evolution and Inheritance in the KS1-2 National Curriculum: teachers, children, policymakers, assessment developers and others.

Project teachers

Twelve teachers across KS1-2 were initially recruited to the project in schools geographically situated in the following Local Authorities: Liverpool, Wirral, Warrington, Rochdale, Fylde, Lancashire, Blackburn with Darwen, Flintshire and Conway. During the project, there were minor changes in personnel due to pregnancy, workload issues and promotion. In one instance, the school offered another teacher to continue its involvement. The researchers were also able to identify one replacement teacher and the project ran its course with eleven teachers participating throughout.

Evaluation approach

The intention of this evaluation was to report on the impact of the Nuffield-funded 'Evolution and Inheritance' project on the practice of the teachers involved. This feedback has to be seen in the context that the project was not designed to attend primarily to the professional development of the participating teachers. The broader intention was to explore the possibility of integrating underpinning Darwinian evolutionary theory through the primary phase of education. The research was to explore if this was possible while ensuring continuity and progression in pupils' experience. That would be achieved by describing developmental learning progressions in general and within these, specific teaching and learning strategies. We stopped short of describing the latter as 'teaching materials', but undertook to generate evidence to inform optimal learning and teaching sequences within a compilation of strategies that teachers might adopt to move pupils' learning forward. The teachers' *pre-existing* professional experience made an essential contribution to the delivery of project outcomes.

In the course of the Nuffield Foundation's consideration of our subsequent proposal for Study 2 (a cross key stage follow up) the request was made to incorporate an evaluation of teachers' views of the impact of the proposed second phase on Study 2 teachers' practices. At the same time, the request was to revisit Study 1 teachers to ascertain their views of the impact the research might have had on their practice. Thus, between the completion of Study 1 classroom work and the invitation to teachers to provide feedback (i.e. between December 2014 and September 2016) there was a gap of 21 months. Study 1 teachers' feedback was collected throughout the school year 2016-17.

A brief questionnaire was developed (see Appendix 1) and the agreement of respondents to provide feedback was established. Data were collected through school visits in cases in which direct face-to-face contact with individuals could be arranged, otherwise by telephone or email. Relocation and non-response reduced the number of returns to nine. Of the two non-returns, one had left teaching and not left contact details with the school; the second had made two career moves and did not respond to phone and email attempts to make contact.

Aims of the questionnaire

The questionnaire probed teachers' views of the impacts of involvement in the project on i) their practice of teaching science in general and ii) their specific approach to teaching evolution and inheritance. Additionally, questions explored any perceived impacts on pupils' learning and any wider influences involvement in the project might have had across the school.

Responses to open questionnaire questions

Responses to the qualitative open questions are reported in full in this section. (Responses to the questionnaire's rating scale questions are reported in the following section.)

'What lasting impact on your practice do you consider your involvement in the project has had?'

Use of practices akin to formative assessment. All the respondents mentioned lasting changes to their practice, six suggesting that the project had provided them with an increased awareness of the importance of children's initial ideas for learning. They described their newly emerging approaches as more flexible, open ended and being less teacher led so that they could adapt plans to take account of children's interests and emerging ideas. These responses showed awareness of the important formative potential of children's ideas in shaping subsequent teaching interventions.

> *I found I had a greater insight into how the children think and as a result could adapt my teaching of the subject*. (Y3 & 6)
> *I am able to address children's misconceptions with greater confidence.* (Y6)
>
> *It impacted greatly on the way I approached planning and teaching science. E.g. When teaching Animals, including humans in Year One, I started from the children's ideas. 'What is a wild animal?'* (Y1-2)
>
> *To deliver fewer teacher led sessions and teacher-pupil 'ping pong' in discussions.* (Y6)
> *Topics became far more open ended and followed the children's interests*. (Y2)
> *The project has changed the way I approach teaching new topics and concepts. I now always include plenty of time for sharing and discussing ideas before finding out more through research and/or investigation.* (Y1-2)
> *Children were given greater freedom to explore their environment and express ideas in different ways*. (R-Y2)
>
> *I have improved my ability to structure the teaching and learning of science through the process of including argumentation at key stages of a science topic.* (Y1-2)

Use of novel project strategies. Six teachers indicated that, following the project, they are able to draw on the wide range of creative strategies developed during the research to engage children's interest and to support learning. Sequenced drawings back through time, using real objects as the focus for discussion and engaging in debates in which exchanges of claims were between children rather than through the teacher, were all mentioned. These were seen as particularly fruitful, creative and reusable pedagogical approaches that were readily adopted. There was some evidence in teachers' feedback that the influence of the project had extended to approaches to curriculum areas beyond science.

> *I used toys for sorting and picture cards. Whenever it was appropriate, I used creative activities and role play to sustain the interest and reinforce the learning.* (Y2)
>
> *While Supply teaching, I am interested to see how 'fossils' are taught and have yet to see a jar with sedimentary layers that my class enjoyed so much! The children's books used were interesting starting points too.* (Y2)
>
> *The project highlighted the importance of scientific investigations even with children in Reception. Often these experiences get lost amongst literacy and numeracy activities and I will certainly be ensuring that the children get a full and varied curriculum with a wide range of experiences*. (R-Y2)
>
> *I continue to teach children in my class the skill of argumentation and how to discuss and respond to ideas in a productive and respectful way. This skill can then be applied to all other aspects of the curriculum.* (Y1-2)
>
> *I also gained many valuable ideas for lessons and topics from other colleagues who were involved in the project*. (Y1-2)
>
> *The use of pictorial representation to demonstrate the children's thinking. I have used this idea in several other teaching areas since the project.* (Y4)
>
> *I now have a more diverse approach to delivering this topic and feel confident to allow children to have a more experimental approach.* (Y6)
>
> *To teach science much more creatively.* (Y3 & 6)

Increased confidence in teaching science. Six teachers referred to their increased confidence and knowledge of science and science teaching because of participating in the project. One suggested that her increased understanding helped her teaching of evolution while another explained the research involvement helped her to explain difficult concepts. Another teacher believed that the research had challenged her view of science as body of knowledge and as a result of this reassessment of her view of the nature of science, she had become more reflective about her science teaching.

> *It has developed my knowledge and confidence. It has raised the profile of Science in my mind and therefore in that of the school as I am the Science Coordinator.* (Y4-5)
>
> *Deepened personal understanding of chronology which helps when teaching topics such as the Stone Age.* (Y4)

Confidence in subject knowledge. (Y3 & 6)
I have been able to become more thoughtful and reflective about areas of Science which before I have just taught as a body of knowledge. (Y4)
Ability to explain tricky concepts more easily. (Y4)
It increased my confidence in teaching the topics covered during the project and reinforced my belief in child centred education. (Y2)
It has built my confidence and subject knowledge when teaching science. It has reminded me that much of what the children experience is from television and video games and that they do have many common misconceptions that need to be cleared up. (R-Y2)
I am enthusiastic when approaching a new topic thinking how I could make this interesting and meaningful for the children. (Y2)

Raised expectations of pupil performance. The feedback strongly suggested that the project had made unexpected demands on pupils that had in turn, caused some teachers to reassess and extend the challenges they offered to children at KS1 and 2. Four believed they might have underestimated children's achievements in the past and were of the view that the project had raised pupils' attainment and raised their expectations for their pupils. Some mentioned that their research involvement had improved the quality of learning and had helped them to understand progression in children's understanding. This new awareness helped them to break down tasks in developmentally appropriate ways.

Not to cap my expectations of the children's abilities. (Y6)
I have learnt a lot about myself as a teacher and the limitations that perhaps I put on children by setting too many closed tasks, teacher led tasks or a glass ceiling for achievement. (Y3 & 6)
My mind was opened to understanding children's thinking at a higher level. I had previously assumed children would not be able to show an understanding of 'big' ideas, or have the vocabulary to explain thinking. (R-Y2)
It has enhanced the children's learning through additional experiences and teaching. (Y5)
Breaking difficult concepts down into steps that can be realistically taught to the children in a way that will understand, enjoy and remember. (Y4)
Often the 'hill' – normal curve of distribution, came into mind in discussions of achievement and attainment! (Y2) (This comment refers to an important transitional vocabulary that a child invented to describe the heights of plants arranged in a normal distribution curve, described as 'hill-shaped'.)

Teachers' feedback suggested their research involvement had helped them to appreciate the importance of children's ideas for learning, brought about improvements in their science curricular and pedagogical knowledge and helped increase their awareness of the differences they might make to pupils' learning. Teachers reported being surprised and impressed by the depth and quality of understanding revealed in pupil learning outcomes.

'What impact has the project had for your pupils' learning?'

More active and engaged learning. Three teachers mentioned that, following the project, their pupils take a much more active role in their learning than previously. Being active might require pupils to engage in metacognitive reflection on current ideas and be aware of how their own understanding might be developed. Some responses described learners as being able to reflect on their thinking and as having acquired the ability and confidence to challenge and learn from each other. The open-ended and exploratory activities were viewed as helpful in giving children some control of their learning.

> *Children are more active in their learning whereas before they were quite passive learners (I've now realised!) Children are engaged and enjoy what is a difficult topic for many.* (Y6)
>
> *They realise that the science can be learnt/discussed etc. through stories and art.* (Y3 & 6)
>
> *That the educational programmes they watch help shape and foster their ideas.* (Y6)
>
> *That they can question, challenge and learn from each other.* (Y6)
>
> *The children have been able to reflect on their own thinking, have been able to develop their thinking towards an understanding of accepted Scientific beliefs*. (Y4)
>
> *I was pleased with the enjoyment and enthusiasm shown by the children. It was easy to measure their progress against their starting points.* (Y2)

Several teachers described pupils as enjoying their learning of evolution despite it being recognised as a difficult area of learning. The open ended and exploratory style of some of the activities were thought to contribute to children's enthusiasm, engagement and learning.

Use of argumentation. The project encouraged argumentation - that is discussion sessions in which children exchanged ideas as 'claims' with the requirement to support these with evidence. Two highlighted features were the importance of listening to others and of learning to challenge each other's ideas. This might happen in pairs, small groups and in class discussions. Science argumentation was understood by the researchers to be novel and challenging for teachers and children, though other discussion techniques might have been more familiar. The wider implications for pupils' development across the curriculum were recognised. Several teachers pointed to the importance and value of partner and group work, discussion and the exchange of ideas in argumentation sessions.

> *The children and I really enjoyed taking part in the project and both I and the pupils have continued to use and develop the skill of argumentation to support the learning and understanding of science.* (Y1-2)
>
> *The children are motivated by sharing their own ideas and listening to others. This process adds depth and meaning to learning as they take greater ownership from developing and investigating their own ideas rather than working on teacher led tasks/investigations. The*

children also enjoy and benefit greatly from listening to others and developing their ability to respond in a suitable way. (Y1-2)

Use of argumentation as a strategy across curriculum. (Y4)

The children enjoyed the investigative style of working and benefitted greatly from practical, hands on activities. The project highlighted the need to develop partner and group work skills as well as the children's language and scientific vocabulary. This is something we will continue to work on as a school. (R-Y2)

Evidence from feedback suggests the project activities such as argumentation, had influenced pupils' enjoyment, engagement and learning of what appeared initially to be difficult concepts associated with understanding evolution. Several teachers indicated that the project had highlighted children's needs and that they continued to use and develop the ways of supporting children's learning that were highlighted by the project.

'What impact has the project had for the school?'

Teachers' project activities carried benefits for the school. All respondents described how the practices developed in the research were helpful to the school. One emphasized the timing of the project and concerns about the newly introduced science curriculum area. She summarised the project's value in terms of the benefits to children and staff in helping them to address this innovation. She felt it helped to address children's needs in the context of the new science curriculum as well as helping staff to develop teaching strategies in a concept area around which there might have been initial misgivings. The importance of the timing of the project, its focus on a newly introduced curriculum area and its anticipation of teacher and pupil needs proved to be important considerations for schools.

The whole project was very helpful for our school to begin to address the needs of the children with the new Science curriculum areas. It allowed us to develop practical and thoughtful ways of teaching areas which appeared at first rather dry and contentious. (Y4)

Sharing project activity with colleagues. All but one of the teachers described how the teaching approaches promoted by the project were shared with colleagues to support professional development and to encourage wider use of the project approaches across the school. Just one teacher explained that her own school made no provision for sharing her project. Instead, she shared her new-found expertise with friends who were teachers. In one instance, the sharing of project expertise was extended to other schools as one of the project teachers progressed to a role of supporting other schools in science.

As a school we have developed our topics to include a collecting information phase at the beginning of each topic which always begins with an opportunity to share and discuss ideas. (Y1-2)

I am able to help my colleague who is not comfortable teaching this topic. All Year 6 children therefore perform better. (Y6)

Improved teaching and learning across the upper year's unit as I have shared and carried out team teaching using some of the ideas suggested by the project. (Y4)

Professional development for staff. (R-Y2)

My class had the benefits and this was recognised by a senior member of staff. Unfortunately, I was given no opportunity to feed back to the other staff and sadly the senior management showed little interest in my involvement or how the school could benefit. I have shared not in my school but with friends who are teachers. (Y2)

I am now using it (sequenced drawings) when teaching children in other schools as I am now a PSQM hub leader. Many of the ideas will be taken forward and shared with schools applying for PSQM. (Y4)

Other benefits to the school mentioned by respondents included links with other schools that might endure beyond the life of the project, increased awareness of resources such as books, and finally, the project's ability to raise the profile of science across the school and with parents**.**

Links made with other local small schools. (R-Y2)

A more creative approach to science. (Y6)

Better resources, books, etc. (Y4)

My class had the benefits and this was recognised by a senior member of staff, also the school benefited from the books. (Y2)

To bring science to the forefront again and to make science fun and engaging as it is these type of activities/lessons that the children remember. (R-Y2)

It has raised the profile of Science throughout school and in the eyes of parents. (Y5)

Respondents suggested that the project had wider influences beyond their own practice to other colleagues in school and to colleagues in other schools. These professional development opportunities tended to be supported and encouraged by the school through team teaching and shared planning. In other instances, they occurred informally in discussions between colleagues and friends. The timing of the project - just before the introduction of this novel area of the science curriculum - seems to have provided valuable support to schools in the form of developmentally appropriate, practical and engaging teaching approaches having an impact on the quality of learning which could be shared within and across schools.

Responses to the closed (rating scale) questions

Teachers' ratings of the impact of the project on their teaching generally

Teachers were invited to respond to a series of question in the form of four-point rating scales. These questions addressed their view of the project's impact on their teaching of science and their teaching in general. In response to each question a choice was offered between 'strongly agree', 'agree', 'disagree' and 'strongly disagree'. These choices were scored +2, +1, -1 and -2 respectively and overall means from responses were generated to allow comparisons between

each of the seven statements. (See Table 1, where mean ratings have been ordered from the more to less positive.)

Table 1: Teachers' ratings of the impact of the project on their teaching (science) generally

Statement	Mean score
The project helped me to recognise the importance of children's ideas as starting points for my teaching.	2.0
Asking for the reasons behind ideas and using 'argumentation' helped to develop children's 'working scientifically'	1.9
Involvement in the project was beneficial for me as a teacher	1.8
The project activities have helped my teaching of science generally	1.8
The project gave me new ideas for teaching science	1.8
The project offered opportunities to network with other teachers to develop my practice	1.6
I have shared some of the activities with other teachers in the my school	1.2

Views about the project's impacts on their teaching were overwhelmingly positive, with all but one response showing 'strong agreement ' or 'agreement' with the statements presented to them. Teachers were unanimous in their 'strong agreement' that the project helped them recognise the importance of children's ideas as starting points for teaching (mean score 2). They overwhelmingly agreed (mean score of 1.9) that the argumentation practices developed in the course of the research helped develop children's 'working scientifically'. This is very encouraging given the initial lack of familiarity with this way of working in science.

The majority (6) 'strongly agreed' - and two confirmed 'agreement' - that the project involvement benefitted them as a teacher, helped their teaching of science generally and gave them new ideas for science. These three statements - all achieving a mean score of 1.8 - suggest that the respondents recognised impacts on their practice were not limited to teaching of evolution but also contributed positively to their teaching of science in general and their teaching in other curriculum areas.

While all agreed that the project offered opportunities to develop practice through networks with other teachers, only six of the nine respondents 'strongly agreed' (mean 1.6) with this possibility.

The lowest mean score, 1.2, was in the context of views of sharing approaches with colleagues in their schools. All but one of the teachers 'agreed' that they had shared project approaches with other teachers in their school. The fact that only four teachers offered 'strong agreement' and four offered 'agreement' appears to be the result of lack of opportunity rather than inclination. The respondent who was unable to confirm any examples of sharing expertise within her own school clarified that this was because of senior managers had not provided opportunity for dissemination. School leaders' support for the development of practice is acknowledged to be important (OECD, 2013; Stoll, 2015) to the achievement of lasting change. Head teachers at all participating schools were contacted and briefed at the outset and the purposes of the research were explained fully. This was acknowledged by teachers to be helpful in ensuring their active participation in the research and release for meetings. Notwithstanding teachers' overall positivity and the fact that the majority managed to ensure some wider impact of the project across their school, on reflection, perhaps the project could have done more to inform senior managers about activities and progress, rather than leave this responsibility with the teachers. The assumption was that a school's signing up to project involvement was sufficient evidence of ongoing commitment and interest. Ensuring that head teachers or senior managers are informed of the implications of outcomes for schools perhaps requires more attention.

Teachers' ratings of how the project has influenced their teaching of Evolution and Inheritance

Seven of the nine teachers responded to the invitation to rate how the project had influenced their teaching of evolution and inheritance. Two of the nine questionnaire respondents explained that their school curriculum delivery plans meant that they were not designated to year groups receiving teaching about the aspects of evolution and inheritance that were the focus of attention.

Teachers were invited to respond by rating the statements for each of the five domains - Variation, Fossils, Deep Time, Inheritance and Selective Breeding and (Macro)-evolution. A similar four-point scale was used as in the earlier questions, with an invitation to add elaborating comments alongside each rating.

All teachers responded to indicate that they 'agreed' or 'strongly agreed' that involvement in the project had influenced their teaching of each of the defined sub-domains of evolution and inheritance. Table 2 summarises mean ratings using the same scaling as previously explained (+2, +1, -1, -2) in descending order of magnitude. While all responses are positive, they were slightly more so in relation to their teaching of Variation, Fossils and (Macro)-evolution than Deep Time. Responses to teaching about Deep Time is a special case, as one elaborated response indicates. This teacher confirmed less use of strategies for teaching Deep Time as compared with other domains, but pointed out that this difference must be understood against a background of no previous attempts to teach this concept.

> *I have used these ideas less, but I wouldn't have even considered the idea of even delving into this area before the project'*. (Y4)

Our research acknowledged that Deep Time is not explicit in the science national curriculum and suggested that this omission is deserving of attention. As a result, it may not be included in many of the school science curriculum plans which teachers are obliged to follow.

Table 2: Teachers' ratings of the value of the project to current teaching of the five domains

Statement	**Mean rating**
The project has helped my teaching of ***fossils***	1.7
The project has helped my teaching of ***variation***	1.7
The project has helped my teaching of ***evolution***	1.7
The project has helped my teaching of ***inheritance and selective breeding***	1.6
The project has helped my teaching of ***deep time***	1.4

Elaborating comments about project influence on teaching the five specific themes.

Several teachers added further comments to throw light on their rating of the five specific themes. These are summarized below.

fossils

Brushed up my subject knowledge. (Y3 & 6)

Helped indentify good cross curriculuar links – history, English, ICT, art. (Y6)

I have used the ideas to teach fossils to the Year 3 classes for the following 2 years. (Y4)

Although I did not teach this topic again in KS1, It helped in my discussion with children when fossils were brought into class or arose in story books. (Y2)

variation

I do not teach these subjects currently as we follow the Lancashire Plans for Science now. (Y4/5)

Introduced me to a breadth of ideas to teach the concept. (Y3 & 6)

I have taught the year 6 children variation using the project ideas and have trained the Y 6 teachers to use the ideas as well. (Y4)

inheritance and selective breeding

Bringing everyday real life children's experiences into the classroom to really spark their imagination. (Y6)

The creative activities reinforced their ideas and introduced new ideas, e.g.thinking about the characteristics needed for a guide dog or a guard dog. (Y2)

evolution

Seeing how a book can be a great starting point for a science topic and make a difficult concept easier for the children to understand. (Y3 & 6)

The book 'One Smart Fish' was an excellent starting point for Year 2. (Y2)

deep time

Refining my thinking of it. (Y3&6)

I have used these ideas less, but I wouldn't have even considered the idea of even delving into this area before the project. (Y4)

The project has helped my teaching of deep time. (Y6)

Conclusion

The project was deliberately timed to inform responses to schools' and teachers' need for guidance in the operationalisation of this new area of national curriculum science in England (DfE, 2016). We have argued elsewhere (Russell & McGuigan, 2016) that our design-based research (DBR) orientation ensures the practical and applied utility of research outcomes and this principle was central to the research proposal to the Nuffield foundation. It must be borne in mind that the project was *not* designed to prioritise the professional development of the collaborating teachers. Rather, their participation was to draw upon and bring to the project their pre-existing professional expertise, to inform the development and 'field testing' of curricular and instructional thinking in the face of novel demands.

We note the observations of Timperley et al. (2014) who argue that professional learning activities require time to become embedded in practice.

> *The professional learning research evidence indicates that the integration of substantial new knowledge requires a minimum of a year of focused collaborative effort to make a difference. Two years is much better. With three years of intensive engaged effort, movement towards a transformed learning environment is usually well under way.* (P16, 2014)

The project to which the reported feedback relates was conducted in a much more restricted timescale than advocated by Timperley and colleagues. In this light, the feedback from teachers, gathered up to 24 months afer the completion of classroom activity, suggests that the project had a valuable and enduring impact on their practice:

i) developing teachers' formative assessment practices by increasing awareness of the formative potential of finding out children's ideas for teaching and learning

ii) developing teachers' pedagogical knowledge by creating novel domain-specific, practical strategies, along with more general approaches such as argumentation, having value across the curriculum

iii) developing teachers' confidence and science content knowledge of evolution and inheritance

iv) raising teacher expectations of children's capabilities within the domain of evolution and inheritance; improving the quality of learning and increasing the challenges presented to pupils in the course of teaching and learning

v) bringing to teachers' and schools' awareness the possibilities for use of novel and engaging cross-curricular support materials such as narrative fiction.

References

Department for Education. (2016). Standards for teachers' professional development. London.

OECD (2013). Innovative Learning Environments, Educational Research and Innovation, OECD Publishing http://dx.doi.org/10.1787/9789264203488-en

Russell, T. and McGuigan, L. (2016). Exploring science wih young children. London, Sage.

Stoll, L. (2015). Three greats for a self-improving system - pedagogy, professional development and leadership. Research report Nottingham National College for Teaching and leadership.

Timperley, H. Kaser, L. and Halbert, J. (2014). A framework for transforming learning in schools: Innovation and the spiral of enquiry. Centre for strategic education. Victoria. Australia.

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Appendix I: Additional unsolicited views of project's impacts on teachers' practices

Additional unsolicited teachers' views of the impact on the project expressed via emails and in teachers' writing was collected during the classroom-based part of the project in the period January–December 2014. Illustrative comments are organised below according to the main themes explored in the evaluation questionnaire.

Primary core group: Impacts on teachers' practice

Background science, curricular understanding and confidence

It has pushed my thinking as well as the children's. (Y1-2)

I know from informal discussions with group members we have all greatly enjoyed this opportunity and it has impacted significantly on our teaching. It would be good to put together an evaluation, I feel the experience has been positive and it would be nice to let the powers that be know yourself and Terry have made a real difference at ground level! Thanks again for this wonderful opportunity. (Y1-2)

Thank you for today and thank you for encouraging me so much with the project. I have learned so much and made some new friends too! (Y2)

You were lovely to work with and I was totally impressed by you both. (R-Y2)

Will miss your little visits. It was lovely working with you both and interesting too. (R-Y2)

Insight into children's developing understanding

It provided me with a real insight into the children's thinking and understanding and how topics such as dinosaurs can really engage every child. (R-Y1)

Reception children's prior understanding of fossils was much wider, but also more varied, than I originally thought it would be. Many of their ideas seemed to come from things that they had seen on T.V. and they had lots of different ideas and misconceptions about how fossils were formed and where they might be found. (R-Y1)

Even the parents commented that the children had been recalling dinosaur facts at home. (R-Y1)

The children gained massively from looking at each other's plants, realising that all flowers grow at different rates and sometimes not at all. (R-Y1)

It has made me aware that the children's knowledge and understanding is still very limited at this age and there are certain concepts e.g. time that need lots of explanation. (R-Y1)

The children were able to engage with each other, with us and with their parents and were so proud of the things they were learning and remembering. (R-Y1)

Children's prior understanding of fossils was much wider, but also more varied, than I originally thought it would be. (Y4)

Children's sustained enthusiasm in the topic. (Y6)

The diverse knowledge in the class surprised me. (Y3 & 6)

I think much of the work we have undertaken has enabled both me and the children to become willing to share ideas and to explain our thinking better. (Y4)

Certain children surprised me by being able to shine when the subject matter suited them e.g. a timid girl in maths came to life when the data was about whippets as she loves animals and felt safe within this concept. (Y3-6)

I was amazed at how engrossed the children were when presented with actual fossils. I honestly thought we would have a 10-minute discussion and they would lose interest. The discussion went on for about an hour. (Y6)

The creation and use of developmentally appropriate teaching strategies

It has made me realise just how stereotypical we can be in the early years (e.g. yellow ducks and white sheep) and I want to much more work on drawing and painting from real-life objects, looking at colour, shape and texture. (R-Y1)

It has confirmed that whatever the concept or the topic, the most vital part of science in the early years is for the children to experience things first hand and to have the chance to explore and investigate freely. (Y1-2)

Finding so many exciting and creative ways to teach it. I can see how these activities can be adapted for any age group. (Y6)

I am certain that practical exploration and investigation are what inspired the children to be so engaged in this topic. I would definitely recommend having 'real' animals for the children to see and to talk about and I would even look into asking the children to bring in some of their pets from home e.g. Lennox and his pet rats. (R-Y1)

We are definitely going to utilise these ideas! (Y6*)*

One year on from project conclusion: *I have been wondering how the project was coming along and I will be so interested to see how it all comes together. Could you let me know how to access it? I have just found out I am in year 3 from September so feel a bit disappointed to be leaving early years. I am sure that when I am with the children it will be good and one of the science units is rocks and soils -fossils so that will be interesting with a new group of children.* (Y2)

One year on from project conclusion: *I thought I would let you both know that I had an amazing science lesson with my new Y6s this afternoon where I introduced them to the idea of argumentation. They were so, so, so, so, brilliant - I wish you had been there. They debated with each other, questioned each other, clarified each other's thinking, picked up on each other's points, etc. etc. In fact, everything I'd hope they would do. The discussion was amazing. So thank you for showing me the light!* (Y3 & 6)

Comments from KS3-4 teachers who participated in the 'secondary readiness' feedback are available in the report, 'Understanding of Evolution and Inheritance at KS1 and KS2: Report on feedback from KS3-KS4 biology teachers.' available on the Nuffield Foundation website.

Appendix II : 'Evaluation of impact' questionnaire protocol

Teacher name **School**

Age group of children in current class (Tick ✔the box (es) that apply)

Reception	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6

1. What lasting impact on your practice do you consider your involvement in the project has had?

2. What do you think have been the benefits of being involved in the project ?

i. for your practice?

ii. for your pupils' learning?

iii. for the school?

3. Please give your impression of the impact of the project on your teaching generally.

(Please tick ✔one box in each row.)	strongly agree	agree	disagree	strongly disagree
Involvement in the project was beneficial for me as a teacher.	☐	☐	☐	☐
The project offered opportunities to network with other teachers to develop my practice.	☐	☐	☐	☐
The project activities have helped my teaching of science generally	☐	☐	☐	☐
The project helped me to recognise the importance of children's ideas as starting points for my teaching.	☐	☐	☐	☐
The project gave me new ideas for teaching science	☐	☐	☐	☐
Asking for the reasons behind ideas and using 'argumentation' helped to develop children's 'working scientifically'	☐	☐	☐	☐
I have shared some of the activities with other teachers in the my school	☐	☐	☐	☐

4. Please give your impression of how the project has influenced your teaching of Evolution and Inheritance

(Tick ✔one box in each row and add a comment below each statement.)	strongly agree	agree	disagree	strongly disagree
The project has helped my teaching of ***fossils***	☐	☐	☐	☐
Comment:				
The project has helped my teaching of ***variation***	☐	☐	☐	☐
Comment:				
The project has helped my teaching of ***inheritance and selective breeding***	☐	☐	☐	☐
Comment:				
The project has helped my teaching of ***evolution***	☐	☐	☐	☐
Comment:				
The project has helped my teaching of ***deep time***	☐	☐	☐	☐
Comment:				

Any other observation of impacts you would like to add?

Thank you for the time you have spent responding to this questionnaire. Your responses will be used to evaluate the longer term impacts of the project. All responses will be confidential.