What is the impact of incorporating a focused approach to subject discipline in primary science?

Orchard School, Upper Key Stage Two Phase

Abstract

This study was designed to investigate the impact of bringing the world of work and real life contexts into the classroom. Upper phase aimed to assess the effectiveness of methods to help pupils make connections. Linked to this, there also was a focus on making links from prior to new knowledge and understanding. In Ofsted's 2019 review, the importance of knowing more and remembering more was a new element - this is now an integral part of their new framework. This framework is then used to assess school's usefulness in delivering a meaningful and purposeful curriculum.

Each teacher included information about a relevant scientist to the area of study to the beginning of each of their science lessons for the entirety of a topic, this happened for two, six week half terms. At the end of the topic, the classes completed an end of unit evaluation, whereby they answered an essay question. This is usual practice and class teachers use it as a summative assessment. Five target children from six classes were chosen to provide data, these children were randomly selected.

Introduction

To put this study into context, Orchard Primary School is a multi-cultural primary school situated in Hackney, London. The proportion of pupils eligible for the pupil premium is higher than average and a significant number of children enter Nursery and Reception below the expected level for their age across a number of areas of learning. In addition, the proportion of pupils from minority ethnic groups and those who speak English as an additional language are much higher than the national average. Orchard Primary School is part of a three-school federation.

Following recent reviews of science in primary education, Upper Phase class teachers discussed how, as professionals, it is possible to improve the delivery of the Science curriculum. Through professional dialogue, the phase of six teachers evaluated the science curriculum, planning and teaching. Then they questioned what could be implemented to further improve the pupil's experiences. It was concluded that although the planning and delivery of lessons are of a high standard, the relationship between learning science in schools and a pupil's understanding of its wider-world context is not clear.

> *'A high-quality science education provides the foundations for understanding the world... Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods, processes and uses of science.'* (Ofsted, 2013)

In the summary of Ofsted's 2023 report (*Finding the Optimum: the science subject report*), evaluating common strengths and weaknesses of science in the schools that were inspected, it stated that primary schools must 'embed disciplinary knowledge within the most appropriate substantive content'. This report makes direct reference to biologists working scientifically to learn more about the world around us and how this disciplinary knowledge is essential to children's learning of science.

Fundamentally, science in primary education can be simplified down into two areas of knowledge: substantive knowledge and disciplinary knowledge. Substantive knowledge is referred to in the National Curriculum as 'scientific knowledge and conceptual understanding'. Recent focus on 'knowing more, remembering more' dictates that this knowledge base should be built upon, this will ensure it is committed to long-term memory. This research wanted to prove that with an emphasis on disciplinary knowledge and showing children 'working scientifically' into a 'real-world' context, children's memory of what they have learnt not only improves but engagement increases also.

Disciplinary knowledge is defined as 'knowledge of how scientific knowledge generates and grows. This is specified in the National Curriculum as 'working scientifically. Although it is heavily woven into the medium-term and weekly planning in our schools, in the form of experiments or field work, Upper Phase teachers believe that the children's knowledge of how science uses evidence to develop explanations could be greatly improved. This would have a lasting impact on understanding, retention of substantive knowledge and attitudes to learning.

Research Process

The project was co-ordinated by the class-based Phase Leader and supported by five other teachers within the Upper Phase. There were six classes involved in the study in total and it spanned two half term units of science in spring term (appendix 1 and 2). At the beginning of the research project, the Phase Leader met with class teachers to discuss how best to implement and test the identified area. The teachers met to discuss the science medium-term planning and the key threads that emerged; teachers identified the disciplines, key skills and experiments that are relevant to the unit. The appropriate scientists were agreed upon (appendix 3) as a collective to ensure no repetitions and so the choices would represent the cyclical curriculum i.e. Living Things and their habitats, to portray the disciplinary knowledge and best demonstrate working scientifically. Key vocabulary was also identified at this stage to ensure that the choice of scientists complimented the existing planning.

All teachers agreed that the pupil-facing, ActivInspire flipcharts were the best way to deliver the identified information and added one slide to the beginning of each lesson, as seen below in Figure 1 and 2.

Fig. 1 Hidden Figures

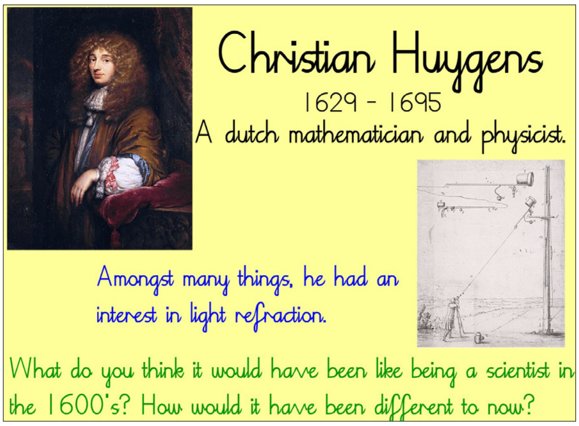


Fig. 2 Christian Huygens

Teachers were instructed to highlight how the scientists had impacted the world's knowledge of their discipline: physics, biology or chemistry. Teacher's emphasised how they 'worked scientifically' to contribute to scientific discovery and achievement. Information about the scientists or scientific events were built upon over the course of the unit. At the end of each unit, children were asked to answer an essay-like question (see appendix 4). for the teacher's summative assessment, see example below:

Year 5 Science (Spring 2) end of topic review

Living things and their habitats

R= I have not shown this yet **A=** I can show this with adult help **G=** I can show this all on my own

How Well Have I Done?	**Me**	**My Teacher**
I can describe the life cycle of the frog.		
I can examine how animals reproduce		
I can compare and contrast the life cycles of different animal kingdoms		
I can investigate the parts and functions of a flower		
Why do we call life cycles life cycles, rather than life lines? Why is it vital they are circular? How do they vary? Explain your answer using examples.		

This structure is already embedded, so was not a new experience for the children in the study. Children are asked to grade their confidence and ability, by looking back at the unit of work in their exercise books using a traffic light system. Teachers use the same system for their assessment of the child's understanding.

Weekly feedback during phase meetings provided an opportunity for dialogue between the professionals who were undertaking the project. This provided essential insight to how well the project was working in different classrooms and how children were responding to the information given. Throughout the research teachers reported that children's engagement in whole class discussion had improved and the articulation of scientific vocabulary, in relation to scientists and working scientifically, seemed much more confident across all ability groups. At the end of the project, the Phase Leader met with teachers to discuss their thoughts regarding the effectiveness of the implementation. Teachers provided evidence to support this.

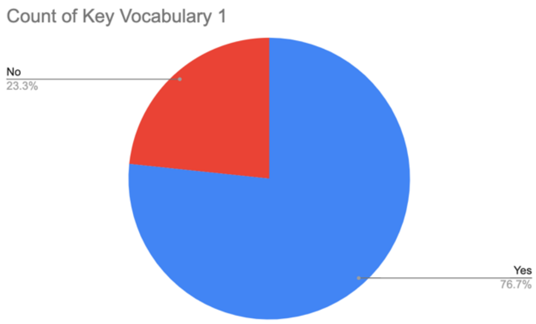
Findings

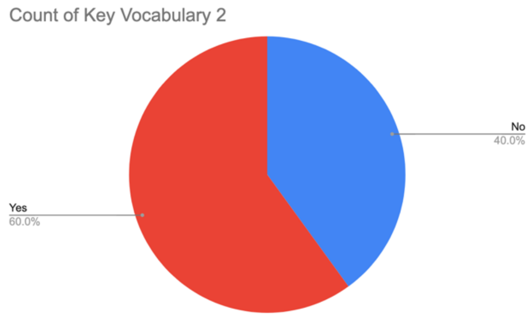
Five children from each class were selected at random to collect raw data due to the size of the phase (107 pupils). Teachers were asked to elicit initial understanding of the science content at the beginning of the topic and assign either 'working towards' (WTS), 'expected standard' (EXS) or 'greater depth' (GDS). Although these values are used in a different capacity usually, it was important to ensure teachers were comfortable with assessment and assessment vocabulary throughout the process.

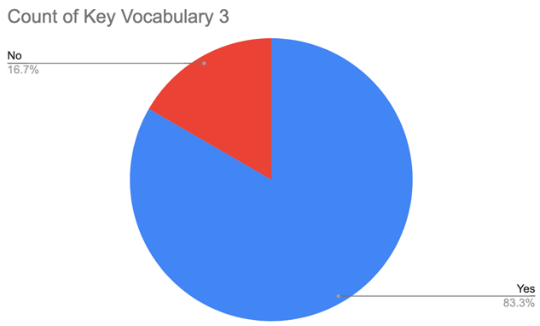
Teachers were then asked to complete a tick sheet whilst marking the five chosen books to identify vocabulary used in relation to the scientists studied and conceptual understanding (example given in appendix 5).

These forms were collected by the Phase Lead and the data was collated for analysis.

As well as teacher feedback, the data supports that the project had impact. As shown by the following pie chart an average of 73% of children used the three identified words in their assessment response.

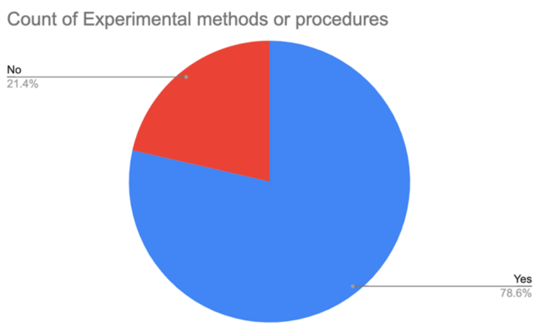


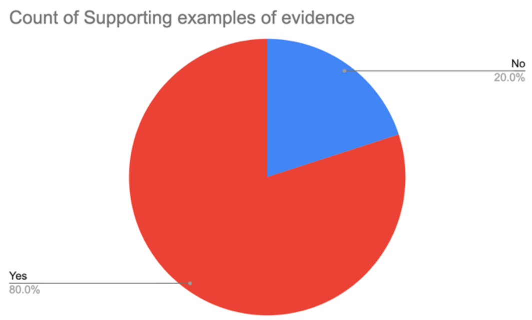


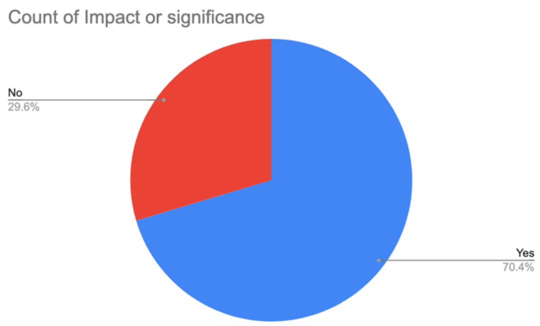


The research considers that there is no control sample, which would strengthen the data's validity, however alongside the scientific concepts, there is strong trends within the data.

The project wanted to specify how exactly to identify the inclusion of the scientists in writing. This method is difficult to quantify so it was compartmentalised into three fields. Teachers understood that although all children may not mention the figures by name, there were multiple ways to use what they had learned in their evaluation. As a result, this was added to the tick list during marking as: understanding of experimental methods, supporting examples, impact of research designed and carried out by the scientists. Again, as there was no control it was important that this was rigorous. The Phase agreed that this set of data would be a lot less likely to have been included in writing responses prior to the research. The results in Spring 1 were as follows:



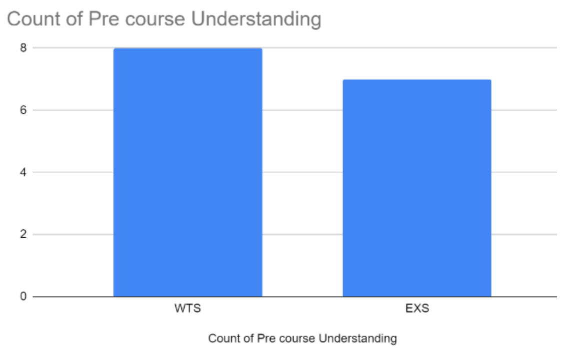


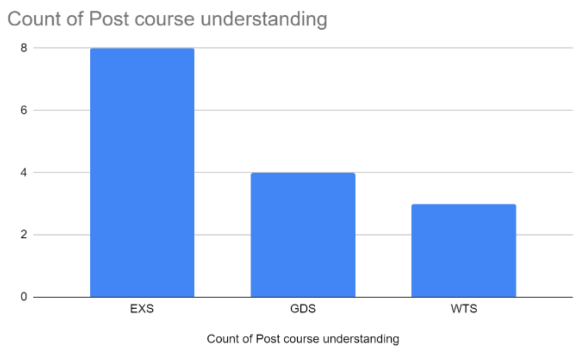


Spring 2 data reflected a very similar data set. Across the sample taken for analysis, there were three children who were identified that were not expected to be able to communicate their understanding in written form. Two of the three were able to articulate their understanding and memory of what had been taught. Although this impacted the data, there was no fair method to include this given that the written form was the chosen method of recording data. This does however support the impact on engagement in each unit. General feedback from both teachers, teaching assistants and pupils were all positive. Children could confidently articulate how their study of specific scientists related to their topic of learning. They also shared a new understanding of how important a scientist's work is to humans understanding of the world we live in.

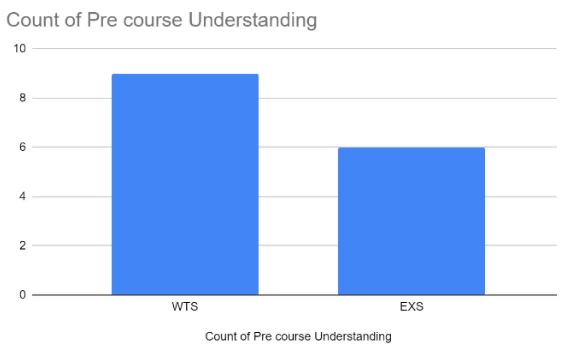
In addition, general data shows an increase in understanding before and after the research project.

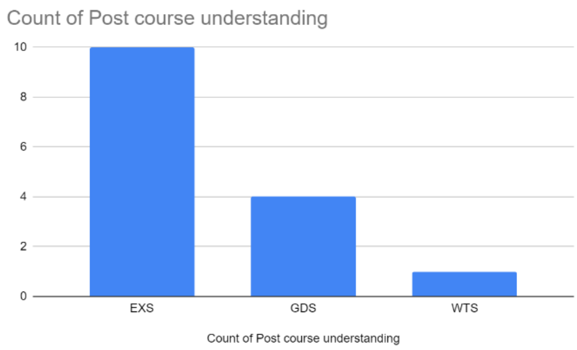
Year 5 understanding before and after research period.





Year 6 understanding before and after research period





Impact and Conclusion

In conclusion, this research project was successful and engaged learners in investigating the impact of bringing the world of work and real-life contexts into the classroom. Upper phase aimed to assess the effectiveness of methods to help pupils make connections and from the perspective of the professionals involved, deemed the methods highly effective. The analysis of impact was not uncomplicated, however the methods used proved successful. Ideally the whole data set of writing would have been included, however, to manage workload for teachers it was a necessity to reduce the sample.

The action research shows that including explicit teaching about scientific events throughout history and the study of scientists improves children's understanding of the context of the science curriculum. Arguably, the teaching prior to the project also progressed attainment in science, however the teachers involved with the study agreed that engagement was positively impacted, and the quality of writing improved.

On reflection, after the research period ended teachers questioned whether it would be more effective to study multiple scientists across a unit, building up a better picture across a discipline of science. This would have a higher chance of appealing to more children, particularly those who were already working towards the expected standard in science and writing.

References

https://www.gov.uk/government/publications/subject-report-series-science/finding-the-optimum-the-science-subject-report--2

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/425618/PRIMARY_national_curriculum_-_Science.pdf

Badham, R. (2022) https://cogscisci.wordpress.com/2022/02/21/disciplinary-knowledge-intent/

Appendices

Appendix 1. Year 5 Science curriculum map

	Autumn 1	Autumn 2	Spring 1	Spring 2
Science	Sound	Animals including Humans	Earth and Space	All Living Things

Appendix 2. Year 6 Science curriculum map

	Autumn 1	Autumn 2	Spring 1	Spring 2
Science	Evolution and Inheritance	Animals including Humans	All living things	Light

Appendix 3. Scientist mapper

	Topic	**Scientist/Research**
Year 5 *Spring 1*	Space (Earth, moon and Sun)	Hidden Figures **physicists**: Mary Jackson Katherine Johnson Dorothy Vaughan
Year 5 *Spring 2*	Living Things and their habitat (Life cycles)	Research by **Oxford University** (2019): https://www.ox.ac.uk/news/2019-07-09-scientists-map-huge-variety-animal-life-cycles
Year 6 *Spring 1*	Living Things and their habitat (Microorganisms)	**Fanny Hesse** Microbiologist
Year 6 *Spring 2*	Light (How light travels and how we see)	**Christian Huygens** Physicist

Appendix 4. End of unit evaluation questions

	End of unit evaluation question
Year 5 *Spring 1*	Why do we have days, months and years? Remember to make reference to the movement of the earth.
Year 5 *Spring 2*	Why do we call life cycles, life cycles, rather than life lines? Why is it vital they are circular? How do they vary? Explain your answer using examples.
Year 6 *Spring 1*	Resources on earth are running low: you need to find a new planet for all types of living things to thrive. What conditions would you be on the lookout for and why?
Year 6 *Spring 2*	You want to sabotage your rival's submarine periscope. What different ways could you tamper with it to stop it from working?

Appendix 5. Example of collated responses from teachers.

Ranking scale		**Yes or no answers**					
Teacher ranked		**Did they use key vocabulary in their response?**			**Did the teacher deem the student demonstrated in their essay response?**		
Pre course Understanding	Post course understanding	Key Vocabulary 1	Key Vocabulary 2	Key Vocabulary 3	Experimental methods or procedures	Impact or significance	Supporting examples of evidence
WTS	EXS	Yes	No	Yes	Yes	Yes	No
EXS	GDS	Yes	Yes	Yes	Yes	Yes	Yes
WTS	EXS	No	No	No	No	No	No