Lost for words: Can a vocabulary based intervention increase confidence and attainment in the primary science classroom?

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Abstract

This is a practitioner research study focused on a targeted vocabulary intervention in primary science lessons. It aims to answer three research questions:

1. To what extent can a targeted teaching approach to science vocabulary improve pupils' understanding of topic specific words?
2. To what extent can a targeted teaching approach to science vocabulary raise pupils' attainment in primary science?
3. To what extent can a targeted teaching approach to science vocabulary increase pupils' confidence in science lessons?

After a review of the research, an intervention was designed to include physical actions to help children to understand topic specific vocabulary. Vocabulary tests were given three times in each intervention unit to track improvements in understanding. End of unit tests were given to track attainment across the two intervention units, and these were compared to the last end of unit test taken pre-intervention. Questionnaires and focus groups were used to track confidence and enjoyment in science lessons.

Initial results suggest that the intervention may have had a positive impact on the understanding of topic specific vocabulary and pupils' confidence. There is some data that suggests it may have also improved attainment.

Contents

1.0 Introduction

Science education seeks to teach complex concepts to children and it is therefore important that these concepts are broken down to aid understanding, however, it has been found that it is important not to remove or fragment this knowledge from the subject discipline (Ofsted, 2021a).

It was also found that acquisition of vocabulary (both scientific and non-scientific) must be a focus of early education as it has been shown that there is a clear relationship between a young child's science knowledge and their future academic performance in their science education. Gaps in knowledge or misconceptions founded in primary education are often carried into secondary education and beyond so it is of the utmost importance that these are addressed or, better yet, avoided during the formative education years (Ofsted 2021a).

The scope of this research project will be to review the teaching of science and how to incorporate explicit vocabulary instruction within an enquiry based science curriculum. The intervention will be trialled initially in four Year 5 classes and the vocabulary teaching will be embedded in the existing curriculum.

All children are taught in mixed ability classes and will be taught by their class teacher. The Year 5 teachers were briefed on the intervention and provided with detailed information about the implementation to try and ensure consistency across the four classrooms. There were regular meetings as a team to discuss the practicality of the implementation of the intervention.

In order to collect data, questionnaires and tests were given to children prior to a unit of teaching and then repeated after the unit's completion to determine increases in confidence, attainment and vocabulary understanding. Focus groups were also conducted to gain a greater understanding of the children's confidence and enjoyment of science and to establish if there is a link between these factors and vocabulary understanding.

1.1 Context

The study school is a large primary school in Surrey. Key Stage One (KS1) is two form entry and Key Stage Two (KS2) is four form entry with children joining the school in Year 3 from a number of local infant schools. This causes difficulties in Lower KS2 with different backgrounds of education bringing different levels of knowledge including their understanding of subject specific vocabulary.

Although the school is in one of the most affluent areas of the country, the immediate catchment area has higher than expected levels of deprivation being the fourth most deprived area of Surrey (Indices of Deprivation, 2021). This has a significant impact on the pupil population with a slightly higher than average (15.5%) percentage of pupils eligible for free school meals (Schools, pupils and their characteristics, 2019). However, other pupils come from much more affluent backgrounds, meaning that there is a significant vocabulary gap between the pupils from lower socio-economic backgrounds when compared with their more affluent peers. Hart and Risley (1995) found that by the age of three children from higher socio-economic households knew 600 more words than their disadvantaged peers. This appears to rise to a gap of about 4000 words by the time children are 11 years old (Biemiller and Slonim, 2001).

In recent years, the school has seen a period of significant instability in the leadership team. The current headteacher was appointed in April 2020 and was preceded by five different headteachers in the previous five academic years. This had led to a lack of consistency in teaching and learning. The first year of the current leadership (2020-2021) was focused on regaining consistency in maths and English and in the current academic year (2021-2022) is focused on science teaching.

As part of this whole school focus, I was asked to work as the deputy lead of science to evaluate current science practice and implement various initiatives to improve science teaching. I have a particular interest in science due to my academic background of science throughout my schooling and into university. During this process, I worked closely with the head of science to identify weaknesses in science teaching and develop interventions to target these areas.

During our initial evaluation, we observed lessons and discussed science teaching with teachers across both KS1 and KS2. It was quickly identified that one big weakness in science teaching was a lack of investigations. In response to this, a scheme of work was developed to enable teachers to include more investigative work into their science teaching.

Once this new scheme was implemented, we saw an improvement in science lessons however in discussions it was clear that the impacts were not being seen in the children's progress. In discussions with both teachers and children, it became clear that a lack of knowledge of science vocabulary was hindering progress. Most year groups were implementing a pre-teach style intervention to try and target vocabulary learning but it was clear that these were not having the desired impact. It is worth noting that the most recent ofsted report noted that children 'love writing now, because they learn new vocabulary' (Ofsted, 2021b) and linked this to an embedded vocabulary process that had been introduced in English lessons. However, this improvement could only be seen in English and not in other subjects.

As a result of our evaluation, it was decided that my focus as deputy science lead would be to investigate ways in which we could effectively include vocabulary teaching in science lessons. It was agreed that my intervention and research project would be focused on improving the teaching of science vocabulary. The literature review will seek to establish what constitutes good science teaching and how vocabulary teaching can be applied within the science classroom and to determine the effectiveness of these techniques in improving not only vocabulary knowledge but also attainment and confidence. This will then allow for the formation of research questions and to aid the design of an intervention.

2.0 Literature Review

In this literature review, I will first focus on what good science teaching looks like in the primary classroom to build a robust view of the elements that should be present within lessons. I will then seek to establish how explicit vocabulary instruction can be incorporated into science lessons and ways in which this can increase pupils' understanding of the necessary vocabulary. Finally, the focus will turn to the benefits of improving vocabulary understanding on children's attainment and confidence in science lessons.

2.1 What constitutes good science teaching?

Science has been labelled as a core subject since 1988 meaning that it is an important subject within the curriculum and one in which children are required to develop an understanding of the products and practices of the discipline (Ofsted, 2021a). There are multiple approaches to science teaching and within this section of this literature review I will be considering what constitutes good science teaching and where the teaching of scientific vocabulary sits within these lessons.

In a review of science teaching by Newton and Newton (2000), they focused on the importance of understanding in science. When considering what understanding is in science, it incorporates connecting facts, integrating new information into already developed schema and relating new information to what is already known (Nickerson, 1985). It has been suggested by Shenk (1997) that understanding is of greater importance as the world moves to more readily available information; the interpretation and understanding of that information is what is of real importance. Since the late 1990s the amount of information available to us has only increased and its availability has only been made more convenient to the majority of students. This could be an important reminder by Shenk (1997) that understanding and criticality are much more important to our learners than learning facts. The question that is still to be answered here is how we can ensure we are teaching lessons to aid understanding?

Newton and Newton (2000) reviewed fifty KS2 lessons to focus on how discourse was being used to aid understanding. They note early in their research that it is important to remember that, unlike simple facts, understanding can not be passed from teacher to child but it is essential that the child is able to make the connections themself. In their research Newton and Newton (2000) found that there was limited push for understanding in the discourse used by teachers. They found that teachers, particularly non-specialist teachers, focused on imparting knowledge and the basic teaching of vocabulary. One big finding in this research was that teachers often lacked subject knowledge which meant that they tended to avoid interactions that may lead to questions or discussions for which they felt unprepared. This is an important consideration in my own research as previous staff questionnaires within the school have shown a lack of confidence in their own science knowledge. It may well be that this has led them to restrict the interactions in their own science lessons which may be what is causing a lack of progress to be seen in pupils' science attainment.

Based on the research by Newton and Newton (2000), it will be important to consider how an intervention focused on teaching science vocabulary can avoid the pitfall of being out of context and lacking in the ability to aid understanding. It will also need to be planned and considered to allow for confidence among teaching staff.

Another important consideration when discussing good science teaching is the use of practical learning in science. As with any area of pedagogy it is important that teachers understand how to effectively incorporate experimentation and practical science into their lessons. Kijkuakul (2018) found that primary school teachers saw experimentation as the only teaching method for science but that they had incomplete ideas as to how to run effective experimentation. They show that it is important for the underlying concepts to be clear when introducing any experimentation or enquiry. This research was carried out in a very different setting to that of my research school. It was looking at the knowledge and opinions of eleven primary teachers in rural Thailand so the differences cannot be overlooked. It is still an important consideration in the study school as the introduction of the enquiry curriculum is relatively new and it is possible that the teachers understanding of the context and basis for some of the investigations is lacking meaning that the effectiveness will be reduced but also that this may impact the use of appropriate vocabulary in context.

Soares, Campos, Thomaz, Pereira and Roehrs (2017) discussed the importance of experimentation in the teaching of science and found that it was an important contributing factor not only for engagement in science but also for meaningful learning. In their research however, they also found that experimentation generally wasn't applied in a way in which students were able to build their knowledge. This shows that although experimentation is often taking place in the classroom it is not providing the benefits that should be expected. Limitations such as teachers not understanding how to link the experimentation to the learning are valid concerns in schools. This again links back to teachers' subject knowledge and their own confidence with the content and vocabulary of science lessons.

There is a wealth of research into what makes for good and effective science teaching. From the research discussed above, it is clear that the discourse used in science lessons is essential in building understanding among pupils and also in ensuring that experimentation is effective. As this discourse plays an important role in science learning, it stands to reason that pupils' understanding of the vocabulary must be sufficient to allow them to participate in discussions and to understand the conversations within the classroom. It will be important when designing an intervention to ensure that teachers' subject knowledge is considered and scaffolds are put in place to support teachers to feel confident in including scientific vocabulary within their classroom.

2.2 How can vocabulary teaching be effectively implemented in science teaching?

Having considered what good science teaching looks like, I will consider where vocabulary teaching can be implemented without detracting from quality science teaching. It is important to ensure that any vocabulary teaching that is included ultimately aids understanding and ideally has some practical element to aid memorisation. To ensure that this is the case, it is necessary to consider various intervention designs and how these will fit with the science teaching within the context of the research school. Yager (1983) found that elementary science classes introduced more new terminology than all other elementary classes combined. This finding shows how important it is to target this area of science to help children to access learning.

Carlisle, Fleming and Gudbrandsen (2000) reviewed incidental word learning in science classrooms. This is something that has been widely relied on to impart knowledge within science classrooms in the study school. It has been suggested that after the third grade (8-9 years old) reading becomes a more important source of vocabulary learning than oral language (Anderson, Fielding and Wilson, 1984). However in many primary classrooms , and particularly in enquiry based science classrooms, there is limited dependence on reading materials and instruction is largely oral and it is therefore important to understand how incidental word learning comes about and whether it is effective in building vocabulary knowledge (Carlisle, Fleming and Gudbrandsen, 2000).

In their study, Carlisle, Fleming and Gudbrandsen (2000) considered the depth of knowledge that is acquired as a result of incidental encounters through teaching. It has been suggested by other researchers that gaps in background knowledge that children bring to lessons may have an effect on the speed or depth of a student's word learning ability when relying on incidental acquisition (Scruggs, Mastropieri, Bakken and Brigham, 1993). This may be of particular importance in the research school as the backgrounds of pupils vary drastically, particularly in KS2 not only due to socioeconomic background but also due to differing educational backgrounds in KS1. Carlisle, Fleming and Gudbrandsen (2000) found similar results and noted that a lack of topical word knowledge at the start of a unit hindered the word learning throughout a unit as pupil's had difficulty in inferring the meaning of words through class discussion. They did however show that overall there was significant growth between the pre-test and post-test through just incidental learning.

This is an important observation as it has been identified that pupils at the research school are lacking in their understanding of science vocabulary and therefore it is possible that more of the children will struggle to pick up vocabulary through in context use in lessons. This points towards the need for explicit vocabulary teaching within science lessons. It is therefore important to consider next, the different forms that this explicit vocabulary teaching could take and which would be most appropriate to apply to the research context.

When considering the design of a vocabulary intervention there are two effects that are often referenced within research. These are the generation effect and the production effect. These effects are phenomena of memory that have been linked to the acquisition of vocabulary understanding.

The generation effect is a memory phenomenon in which generating something, (e.g. a mnemonic or image), while learning, acts to improve memory performance around the particular learning (Rosner, Elman and Shimamura, 2012). Slamecka and Graf (1978) found that in all five of their experiments interventions using the generation effect were superior to simply reading vocabulary for building memory for the words.

The production effect refers to a memory phenomenon in which speaking something aloud while learning enhances the memory of the information over simply reading or writing (MacLeod, Gopie, Hourihan, Neary and Ozubko, 2010). Pritchard, Heron-Delaney, Malone and MacLeod (2020) found that the production effect enhanced recognition of both known and novel words in children 7 to 10 years old. Both of these effects are important to consider in the design of a vocabulary intervention.

Hicks Pries and Hughes (2012) undertook research into the learning of vocabulary in an inquiry based science classroom. This would appear to be a sensible place to start the review of vocabulary specific literature as it reflects the good science practice of inquiry discussed above and also the study schools current science curriculum. Their strategy focused on connecting new words to existing knowledge and providing nonlinguistic representations of the word. Students worked through six stations that had been set up in the classroom. Each station had a word bank with new vocabulary words and two or more objects that demonstrated one or more of the new words. These objects were things that students were familiar with, for example toys or common household objects. This presents an early complication as this may not be possible for all topics particularly where the vocabulary is very specific. This technique was combined with group discussions which introduces the production effect to this study.

Hicks Pries and Hughes (2012) provide an interesting intervention model and they report that these activities became popular with students due to the relaxed atmosphere, where wrong answers weren't penalised and they were able to have open discussions about the vocabulary. Unfortunately, this study is let down significantly by the lack of evidence provided to prove that the intervention was beneficial. Even the claim that students enjoyed these activities is not backed up by any data. There is nothing offered to suggest that this rather time consuming intervention improved word learning or retention of vocabulary. It is therefore difficult to use these results in a constructive way but it does show again that the production effect is included in many interventions and that an inquiry based vocabulary intervention is possible.

Williams, Pringle and Kilgore (2019) also looked at the acquisition of science vocabulary in an inquiry-based classroom. They created a graphic organiser for pupil's to use during lessons. This organiser combined the opportunity to discuss vocabulary (the production effect) and drawing and making links to the vocabulary (the generation effect). Although this study found that they did improve vocabulary acquisition there is no evidence to suggest that it is due to the inquiry based learning and it is likely that it is more connected to the organiser, which does not require inquiry to be successful. It is also important to note that the study was conducted in a classroom with native Spanish speakers learning English science vocabulary so its applicability to native English speakers may be limited.

These two studies by Hicks Pries and Hughes (2012) and Williams and Pringle and Kilgore (2019) may suggest that it is necessary to develop a more traditional, non-inquiry based, vocabulary intervention to sit within the context of an inquiry based classroom. This is supported by research of Van der Graaf, Van de Sande, Gijsel and Segers (2019) who found that a combination of direct instruction and teacher’s verbal support through inquiry offered benefits for vocabulary learning while neither strategy alone offered the same benefits.

One option when considering explicit vocabulary teaching is to carve out a part of science lessons to focus only on vocabulary and meaning. Shore (2015) compared three methods of vocabulary instruction in a number of science units in the 7th grade (12-13 years old): dictionary, involving copying vocabulary and meaning; pictionary, involving pupils drawing simple pictures based on the word’s definition and conversation, involving discussing the meaning of the vocabulary with a fellow student. Pupils were tested twice, once immediately after the intervention and then again 2 days later, to establish understanding and retention. It is not established if these tests were already routine classroom practice and therefore the impact of the tests themselves is somewhat of an unknown.

In her research, Shore (2015) split her findings to reflect the reading level of pupils. She found that for those with the highest prior reading level there was little difference between the three interventions although dictionary was slightly favoured. However interestingly, Shore (2015) found that for those with low levels of reading attainment, pictionary worked significantly better than dictionary, which was not helpful in aiding the recall of science vocabulary, but that conversation worked best of all. This may be of particular interest in this study as there has been a significant drop in reading levels in the study school due to the Covid-19 pandemic meaning that more students may now fall into the low levels of reading attainment. This study furthers the suggestion that the generation effect (pictionary) and production effect (conversation) both offer greater benefits than simply learning vocabulary reading by rote (dictionary).

One significant weakness of Shore's (2015) study is that the testing only focused on definition and did not test pupil's comprehension of the words learnt. This is a significant weakness as defining a word without comprehension of their meaning is of little use in terms of improving science teaching. It is also noted that the original sample size was small and it was reduced further by students missing tests and therefore being omitted from the research. Shore (2015) ended with a sample of just 193 participants so it is difficult to generalise from these results. It is also important to note that the pupils were older than those to be included in the research school and therefore, due to developmental differences, these results may not be applicable to this research group.

Further research by Shore, Ray and Goolkasian (2013) built on the idea of the generation effect and production effect being important in the teaching of science vocabulary. In this study they combined the generation and production effects together and asked students to discuss vocabulary and generate answers to questions. In using this more active teaching strategy, they found that a combination of the production and generation effect aided students' understanding and retention of the information.

However, an interesting observation that Shore, Ray and Goolkasian (2013) noted was that words with morphologically similar beginnings were more often confused and incorrectly explained. There was no increase in the understanding or retention of meaning of these words when drawing the words or when discussing the words which suggests that the words were too close for comfortable storage in the memory. Shore, Ray and Goolkasian (2013) do suggest that learning generally takes 24 hours to embed and that it appears that sleep is an important factor of memory retention. It could be that separating the learning of morphologically similar words could aid retention.

Interestingly, a similar difficulty with understanding vocabulary in science was suggested by Milanick (2020) in which he discusses the difficulties faced by learners due to the unusual uses of common words within science. However, this discussion falls outside of the scope of this literature review and is likely to have little impact in the research setting due to the simple nature of the science vocabulary to be covered.

In research looking at the impact of an imagery intervention, Cohen and Johnson (2010) found that when splitting words into three categories; science topic words, musical instrument words and generic science terminology, there was no difference in acquisition of vocabulary between the three groups. However, when comparing those in the ‘dual coding’ group, in which a picture was paired with a word, word only group, who were given the word alone and the image creation group, in which pupils were asked to create their own image of the vocabulary in their mind and then on paper, there was an increase in words learnt in the generic science terminology between the image creation and word only groups. This again may suggest that the generation effect may be facilitating the learning of new vocabulary in this case. Interestingly, pupils also said that the imagery creation made it easier for them to learn vocabulary.

It is worth noting however that there were no statistically significant differences in the words learnt in the topic specific or musical instrument vocabulary sets and there were no statistically significant differences between the ‘dual coding’ and the image creation groups in the generic science vocabulary either. One suggestion that Cohen and Johson (2010) gave to explain this lack of significance within the other groups is that it is possible that the generic science vocabulary presented more of a challenge for the learners and they therefore needed to rely on intervention methods to support their learning of this vocabulary more than in the other categories. This may mean that it is easier to facilitate this intervention within the existing structure of a science lesson as it may only need to be applied to a fraction of the topic words reducing the time burden of any intervention.

One particularly interesting study was conducted by Skoning, Wegner and Mason-Williams (2017) in which they combine both the generation and production effect in a unique way. The intervention in this study is a movement-based approach to teaching third grade (8-9 years old) science vocabulary. It has been shown that movement or dance can improve learning in maths (Werner, 2001) and writing lessons (Smith, 2002). Skoning, Wegner and Mason-Williams (2017) built on this existing research to establish its effectiveness in the science classroom. They compared the traditional method of vocabulary teaching focusing on verbal strategies to teach vocabulary to a dance intervention to teach vocabulary. Both styles of teaching were carried out in the same classroom which means that the sample of students was the same eliminating some of the external factors that could impact the findings. However, they were used in different units meaning that the results are not able to be directly compared.

In their study, Skoning, Wegner and Mason-Williams (2017) found that pupils were more engaged in the movement-based intervention and were more engaged in the vocabulary throughout the topic, not just for the vocabulary based lesson. They also found that pupils made significantly more gains in their vocabulary understanding when the movement-based intervention had been used when compared to the typically taught unit.

Again, a restriction of this study is that it was a very small scale study with all the research being carried out in one classroom with a sample size of just 22 pupils. This makes it hard to generalise from these results. That being said, the pupils in this study were of a similar age as the children in this research project. It is also worth noting that the pupil population of the school is not dissimilar to that of the study school and therefore the results may be more applicable than other studies.

In a similar study by Shoval and Shulruf (2011) found that students' behaviours in cooperative movement tasks filtered them into three groups; students who were active with objects and took a lead in discussions, students who interacted and communicated with others and students who primarily listened. Interestingly, they found that at the beginning of their study the passive pupils demonstrated higher achievements with little difference being seen between the active and social groups. However, by the end of the study the active group had the highest scores. As the clusters in this study were based on behaviour and not on initial test scores this suggests that active learning may support the learning of all children regardless of initial achievements and scores.

Having reviewed these research papers, it is clear that one thing that the effective interventions have in common is the combination of both the generation and production effect. It will therefore be important to incorporate both of these phenomena into the design of my intervention. Another interesting observation from these studies is that the studies carried out in a similar age range to the children in this research all provided definitions and allowed the generation effect process to come from the generation of something else (e.g. physical definitions). This is an important consideration when designing an intervention for students in the primary classroom. It becomes even more important when we consider the subsequent roll out across the school particularly when considering the inclusion of KS1.

2.3 What benefits are seen from improving vocabulary understanding?

Having discussed what good science teaching looks like and how it might be possible to integrate an effective vocabulary intervention into the primary science classroom, in this section

I will be considering the potential benefits of improving children's scientific vocabulary. To be introduced into our classrooms, interventions should be able to offer some tangible benefit to the children that we teach. In this section, I will review the literature on the benefits of improving pupils' vocabulary with a particular focus on science. I will also briefly touch on the importance of science literacy and its growing significance in a world where information is readily available.

2.31 The importance of vocabulary in academic achievement and science lessons

When considering the teaching of vocabulary in any subject it is important to discuss the vocabulary gap that can be seen between disadvantaged pupils and their peers. It has been shown that by the time a child turns three years old there is already a vocabulary gap with a child from a disadvantaged family knowing just 300 to 600 words compared to around 1200 words of a more well off peer (Hart and Risley, 1995). Graves (2009) suggested that by the time a child begins secondary school they need to know 50,000 words to be successful and so it is important that this gap is actively addressed to ensure that all pupils are able to achieve. When considering my own experience in science lessons, there is a definite divide within the study school and this can be largely lined up to the social-economic background of the children.

It has also been shown that an increased general vocabulary can support children's attainment not only in reading but across the curriculum at school (Clark, Woodley and Lewis, 2011). In a study by Lucas and Norbury (2015) they suggest that vocabulary is the most significant factor when helping children to increase their ability to make inferences from a text that they are reading. While traditional inferences in primary reading, such as how a character may be feeling, are somewhat irrelevant in science lessons, it is important to consider inference skills as science reading will often expect children, particularly in KS2, to infer from data or evidence presented to them. In the science scheme used within the study school, it has been noted that there are lots of websites and videos used that require some level of inference to make conclusions from data. It is also worth noting that we also rely on a pupil's inference skills to help them when approaching unknown vocabulary.

When considering this vocabulary gap in relation to science, it has been suggested that knowledge of content specific vocabulary can act as a proxy for background knowledge on a subject (Taboada, 2011). Although Taboada (2011) focused largely on students that were learning English alongside learning in English, her research still shows the importance of building the knowledge of science vocabulary within the classroom to act as this prior knowledge. While the percentage of students with English as an additional language is low in the study school, there are pupils with definite gaps in the prior knowledge expected and therefore would benefit from focused, content-specific vocabulary intervention to fill this gap. Groves (1995) suggested that vocabulary is particularly important in science as many of the terms presented within science teaching are key to understanding concepts that may be completely new to students.

The ultimate aim of an intervention like the one being discussed in this study is to improve teaching and learning for pupils. It has been shown that an in depth knowledge of science vocabulary and particularly the morphological knowledge of vocabulary can improve achievement (Townsend, Bear, Templeton and Burton, 2016). It is suggested that acquiring the building blocks of the scientific language may help students to understand any independent reading better and allow them access to vocabulary dense papers (Townsend, Bear, Templeton and Burton, 2016). Although this shows the importance of science vocabulary it is important to note that spelling of words was a big focus of the study and this led to a more in depth look at morphological understanding than the majority of the interventions discussed would allow for. It is difficult to separate the morphological understanding from the vocabulary more generally and therefore these benefits may not be seen in other interventions that focus less on morphology.

In a further study by Dundar-Coecke and Tolmie (2019) they found that a better knowledge of scientific vocabulary improved attainment in children aged 5 to 10 years old. This is an important finding within my context as this covers the age range of pupils within my study and therefore may give an indication as to the benefits that can be expected by improving vocabulary knowledge. They found that scientific vocabulary was more significant in predicting outcomes and in predicting a child's reasoning skills in science than generic vocabulary, however, one particular weakness of this study is that they didn't assess the pupils' understanding of vocabulary directly but instead relied upon observations of the vocabulary that the children happened to use in their work. Although the level of vocabulary in a child's work is likely to reflect their understanding of vocabulary more generally it is hard to draw any generalised conclusions from this study due to this limitation.

In another study, Ardasheva, Carbonneau, Roo and Wang (2018), found that a focus on science vocabulary teaching may also bring the benefit of reducing science anxiety. Science anxiety has been defined as being 'feelings of tension and stress that interfere with…the development of science skills and ability' (Britner, 2008 p. 690). Although it is likely that there are lots of factors that may contribute to science anxiety, including academic aspiration, socio-economic background and previous experiences in science lessons it is possible that by targeting the understanding of vocabulary within science lessons we can help to reduce the anxiety and therefore boost pupil's confidence. It also appears from this study that by reducing science anxiety it can help to boost pupil's attainment in science as well (Ardasheva, Carbonneau, Roo and Wang, 2018).

From the evidence in the literature discussed in this section, it is possible to see that the benefits of improving pupils' understanding of vocabulary may include both increases in attainment in science and reductions in science anxiety meaning that students are more confident in science lessons. In order to see these benefits, we must ensure that this vocabulary is taught in a non-threatening learning environment and through an intervention tailored to the pupils' needs.

2.32 The importance of vocabulary learning on future Science Literacy

An increasingly important issue that links the idea of science vocabulary to the lives that our students will live in the future is that of science literacy. The idea of science literacy is complex. It refers to the idea that science is complex and therefore to be able to engage in science, whether that is as a researcher or otherwise as a member of the general public, a person needs a level of familiarity with the processes and knowledge of science (Snow and Dibner, 2016). While this may seem somewhat irrelevant to those who are not interested in pursuing a career in science it is becoming ever easier to access information about science and particularly about health related matters through the media and online which means that science literacy is something that will impact on most people's understanding of these articles. Science literacy is also closely linked to health literacy which I will discuss in more depth further on in this section of the literature review.

Interestingly, Snow and Dibner (2016, p17) state that ‘individuals with fewer economic resources and less access to high-quality education have fewer opportunities to develop science literacy and health literacy.’ This is a particularly important consideration within my context as the families that we work with are often disadvantaged and furthermore some of our families have limited educational backgrounds. This could mean that science literacy is lacking in the homes of our children meaning that they may overhear misconceptions or not be able to discuss scientific concepts with adults at home.

When considering how to improve science literacy it is important to consider the components of science literacy. Miller (2004) suggested that science literacy for the general population is the understanding of basic scientific vocabulary and terms that are science specific together with a general understanding of scientific inquiry. In my context, the understanding of inquiry is being developed through the science teaching scheme that is used and therefore an intervention focusing on vocabulary teaching of science terms may be able to help develop the other side of science literacy.

Although some studies have shown limited impact on individuals of their science literacy (Snow and Dibner, 2016), He, Chen, Xiong, Zou and Lai (2021) looked further into the relationship between science literacy and the belief of health related rumours. They found that an individual's science literacy can have a protective effect when considering how likely someone is to believe a health related rumour. They go even further than this and suggest that improving science literacy can help to dispel myths and may control panic caused by health rumours. This is an interesting observation as we have recently experienced an ‘infodemic’ during the COVID-19 pandemic in which too much information (both correct and incorrect) has made its way into the public domain making it difficult for people to find reliable information (WHO, 2020). This suggests that an individual's science literacy is likely to become ever more important.

Having considered the importance and the benefit of science literacy it is necessary to consider how we can help to develop this science literacy in our classrooms. Although largely outside the scope of this study it is interesting to consider if by introducing a vocabulary based intervention to try and promote understanding could we also help our students to develop lifelong science literacy?

2.4 Summary of the literature

Having considered the current research on science teaching and in particular the teaching of vocabulary within science it is clear that this is an area in which an intervention may be able to be of benefit but one in which there is a lot to consider and in certain areas limited research to currently provide much insight.

In the first section of this literature review, it was seen that the discourse used in science lessons is crucial in building understanding more broadly in science lessons and to ensure effective science teaching. In order to optimise this discourse it is necessary for teachers to be confident in their own ability in these discussions and to confidently use vocabulary throughout science lessons. However, using scientific vocabulary is not effective if pupils do not understand the vocabulary.

When considering the teaching of vocabulary it was discussed that children have limited success in learning vocabulary just through exposure alone and that direct vocabulary teaching appears to be necessary. One thing that does appear to be important is the inclusion of the production effect or the generation effect. Those studies that implemented interventions with these effects included showed the most convincing evidence of the benefit of vocabulary interventions. Those in which there were elements of both the production and generation effect seem to give the greatest benefit. As a result it will be important to ensure that these effects are planned into the intervention that is designed in this study.

In the final section of the literature review, the benefits of increasing the understanding of science vocabulary were discussed. While there is some evidence that improving pupils' vocabulary understanding can, not only improve pupils ability to define topic specific vocabulary but also lead to increases in attainment in science lessons and possibly even increase confidence by reducing science anxiety the evidence supporting these conclusions are limited. Although an interesting consideration, it will not be possible in this study to measure any impact on science literacy.

When considering the context in which this intervention will take place, it is likely that the socio-economic factors impacting the pupils will make a vocabulary intervention even more significant as the evidence discussed above shows that there is the possibility of a vocabulary gap that this could help to address. To ensure that the intervention is as effective as possible it is important to carefully consider the research questions and intervention design in the light of this literature.

3.0 Research Questions

Having considered a range of literature written about the teaching and importance of vocabulary within the science classroom, it is clear that there are a number of different ways in which to implement effective vocabulary teaching in science. The literature also points to the idea that implementing dedicated vocabulary teaching can improve pupils' understanding of subject and topic specific vocabulary. Interestingly there is also some limited evidence to suggest that implementing a vocabulary teaching may also increase students' confidence in science lessons.

Within my context, it has been identified that pupils' understanding of the vocabulary is generally weaker than would be expected in both KS1 and KS2 and so, together with the benefits seen in the literature, this would suggest it would be a sensible and worthwhile intervention to target this area of science teaching. Based on the context and the current scheme of work that is used with the study school, an active approach to vocabulary is likely to be the most appropriate style of vocabulary intervention. This will allow me to take advantage of the benefits of both the generation effect and the production effect.

To ensure that my research is fully focused I have developed three research questions around which the data collection will focus. The research questions at the centre of this research project will be as follows:

1. To what extent can a targeted teaching approach to science vocabulary improve pupils' understanding of topic specific words?
2. To what extent can a targeted teaching approach to science vocabulary raise pupils' attainment in primary science?
3. To what extent can a targeted teaching approach to science vocabulary increase pupils' confidence in science lessons?

By focusing on these three questions, I will be able to understand the benefits of a targeted approach to vocabulary and gain an insight as to whether it improves outcomes for the children when compared to relying on the largely passive approach currently used with the study school.

4.0 Methodology

In this section, I will first discuss the intervention design to be implemented and detail why this was felt to be the most appropriate intervention within the context of the school. I will then move on to consider the data collection methods alongside the analysis methods and discuss why these have been chosen for this study. To conclude this section I will discuss the potential limitations to this study and the ethical considerations that have been accounted for within this research.

4.1 Intervention Design

After reviewing the available literature about the teaching of vocabulary, it was necessary to seek collaborations from my colleagues to decide on the most appropriate intervention within our context. To gain a range of views I was able to discuss my understanding of the literature with the sixteen KS2 teachers to find out what they felt would work and, equally as important, what they thought wouldn't work within their year groups. Within the KS2 discussion, it was decided that the intervention would be trialled in UKS2 and more specifically started just in Year 5.

Prior to the intervention pupils were to be given a quiz on the vocabulary to be targeted during the unit to see the baseline of understanding. At the same time, pupils would also complete a short questionnaire about their feelings and confidence in science. In the intervention, it was decided that pupils would have vocabulary groups within science lessons. These groups would consist of four to six pupils depending on the size of the class and would be made up of pupils with mixed abilities. At the start of a topic, pupils' would be given a selection of topic specific words (maximum four) and investigation words (maximum three) within their vocabulary group. In the first lesson, to take advantage of the production effect they would discuss the words given within their groups and check with an adult in the class that they fully understood the words.

Once this understanding had been established, they would move to the second section of their vocabulary intervention and create an action that would show the definition of the word that they were focused on. As a group, they will then demonstrate their action to the rest of the class to see if they can work out the meaning. Once the meaning has been revealed, the whole class will then repeat the word while demonstrating the action. At the end of this session all pupils will complete the same vocabulary quiz taken prior to the unit. At the start of each science lesson a selection of the vocabulary, with its associated action, will be practised and adults will use the actions throughout the unit when using words during teaching.

At the end of the unit pupils will repeat the quiz and also repeat the short questionnaire about their feelings and confidence in science. Their attainment more generally in science will be tracked through the end of unit tests that are built into the scheme. Tests taken during the intervention will be compared to general levels of attainment in previous end of unit tests taken prior to the intervention to track any improvements. To enable pupils to expand on their answers given in the questionnaire a sample of children will be included in focus groups. The same children will be selected to take part in focus groups after the first and second confidence questionnaire in each topic. A summary of the structure of the intervention can be seen below in figure one.

Week Number	Activities Completes
Zero (pre intervention)	Pre-intervention vocabulary quiz, confidence questionnaire and focus groups completed.
One	Intervention teaching completed and first post intervention teaching vocabulary quiz completed.
Six	Final end of unit test, vocabulary quiz, confidence questionnaires and focus groups completed.

Figure One: A table to show the various activities completed in each key week of the intervention units.

While I will be regularly reviewing the data and running this intervention it will be essential to work closely with a number of colleagues. There are three other Year 5 teachers who will be collaborating on the intervention itself and running it in their own classrooms. These teachers will be met at least once a week for the duration of the intervention and discussions will involve what is working well, any changes that need to be made and any observations that they are making in their classrooms. In addition to these three teachers there are seven Teaching

Assistants (TAs) working in the year group and supporting science teaching. It was agreed that I would meet with the TAs in week 0, week 3 and week 6 of each intervention unit to ensure that they were clear on the intervention, happy with their role in science lessons and to review any observations that they had made. Finally, there will be close collaboration with the Head ofScience. In regular fortnightly meetings, the intervention and any data will be discussed. As the intervention progresses discussions will also include the implications for the wider school community with a presentation to the whole teaching staff scheduled for the end of the summer term 2022.

4.2 Questionnaire

The first research method that I will discuss will be the use of questionnaires. The confidence questionnaire, which can be found in appendix one, will fit within the model of a questionnaire for the purpose of this research.

There are many benefits to using questionnaires within research, they are generally quick and easy for participants to complete as well as enabling the researcher to obtain answers from a large sample with greater ease (Cohen, Manion and Morrison, 2018). However the design of the questionnaire must be carefully considered and there are a number of elements to consider to ensure that the data collected is useful and accurate.

My questionnaire was designed to establish the pupils' feelings towards science lessons and their confidence in science lessons and so as a result, along with three short answer questions, it was established that there would need to be a scale for most questions to allow pupils to respond. There were a number of considerations behind the design of this scale.

The first of these considerations were the end-point descriptors. It has been suggested that the wording of these descriptors is important and that if they are too extreme (for example, terrible and marvellous) then participants are likely to avoid these selections (Friedman and Amoo, 1999). As a result it was decided that questions would run from either strongly agree or very confident to strongly disagree or very unconfident depending on the question.

Another consideration into the design of the questionnaire was that all the points would be labelled, as can be seen in appendix one, as this has been shown to reduce the need for interpretation and improve consistency (Krosnick and Presser, 2010). It was also important to ensure that these point descriptions did not skew towards one end of the scale or the other as this could be seen as introducing unethical interference (Friedman and Amoo, 1999). To allow for this the questionnaire includes an equal number of positive and negative responses. It was also important to ensure the questions were clear and addressed just one point. This was refined through a small sample questionnaire.

One final consideration to mention is that it has been found that the layout of the questions are likely to influence selections. Hartley and Betts (2010) suggest that participants are likely to be biassed towards the left-hand side of a scale. The suggested solution for this is to vary which side is the positive and negative selections however when trialled with a small number of Year 5 pupils this proved to add confusion to the questionnaire and so it was decided that the positive and negative selections should remain on a constant side. However it is worth noting as this may introduce a limitation into the research.

4.3 Tests

In relation to the vocabulary quiz, which can be found in appendix two, this would fit the research method of being a test and was designed to show understanding of the words given to students. As a result this means that there are correct answers and there is no need for scaling questions as there was in the confidence questionnaire.

This test will be set up to concern the pupils' achievement in relation to the science vocabulary being studied. The test will require children to match the word to its definition and will be a multiple choice test. An important consideration when designing a test is the time considerations (Cohen, Manion and Morrison, 2018). This was a point discussed with all the Year 5 teachers and it was decided that the vocabulary test would not have a time limit as it was not needed to assess pupils' understanding of the words and it was not designed to be a speed test.

This test was conducted on a computer and as a result there is a final consideration to discuss. There is an added mental process required to complete a test on the computer which could compromise the reliability of the test (Cohen, Manion and Morrison, 2018). However, the pupils within the study school have individual chromebooks and often complete small tests similar in nature to the vocabulary quiz in this research study and so, after discussion, this was thought to be a negligible risk.

The end of unit tests that were to be used to track changes in attainment are published tests which have been designed and tested by teachers that produce the scheme and also in numerous schools who use the scheme to teach science. As a result these tests are likely to have a higher reliability inbuilt into their design.

4.4 Focus Groups

The final research method to discuss is the use of focus groups. One main ethical consideration when conducting these groups is the power imbalance between the interviewer and the participants (Cohen, Manion and Morrison, 2018). This is likely to be important to consider in relation to these groups as there is an innate power imbalance between teacher and pupil. To help to combat this impacting on the findings the groups will be conducted with a known adult to ensure that students are comfortable when expressing their ideas.

In discussions, individual interviews were considered however these were decided against in favour of focus groups. Despite some complications introduced in group interviews such as the influence of others and those suggested by Watts and Ebbutt (1987) who found group interviews are of very little use when interviews are about personal matters or opinions it was decided that due to the age of the children and as the matters covered were not personal in nature that group interviews would be best.

These focus groups will be set up as semi-structured, meaning that although they will follow a general plan, which can be seen in appendix three, they will still allow for themes that are brought up by the participants to be discussed in more detail. The answers given in the questionnaires will feed in and may alter or add to the plan.

All focus groups will be recorded to enable transcription and analysis to be conducted. In each group, the participants will be informed that the session is being recorded and told why the recording is necessary. They will also be given a chance to ask questions and they will be able to withdraw from the group and this will be made clear to them in both sessions. On top of consent from the pupils, a letter was written to the selected pupils' parents, which can be found in appendix four, to inform them about the focus groups and give them a chance to withdraw their child from participation. All recordings were stored on school devices and deleted once key areas were transcribed.

An additional factor that was considered during the planning of the focus groups was the fact that the participants are children. It has been suggested that many children like the chance to participate in interviews like this as they feel that they are being taken seriously and that their views are valued (Jansen, 2015) but it is still important to be aware of anxiety regarding an unfamiliar situation. All focus groups will be conducted within a familiar school environment with a familiar adult to ensure children are reassured and comfortable throughout the interviews.

One final consideration when planning the focus groups was the wording of the questions to avoid any leading questions or questioning based on assumptions (Arksey and Knight, 1999). To ensure that this did not impact on the answers, questions were kept simple and the wording always sought to elicit an opinion or asked the participant to tell the researcher about a certain topic from their point of view.

4.5 Data Analysis

This research is using a mixed methods research (MMR) approach. When collaborating with colleagues in Year 5 and Year 6, it was discussed what we thought would be useful to obtain from the data collected and it was decided that we needed to know not only if the children were improving their knowledge of the words and increasing attainment and confidence but also if these changes were coming about as a result of the vocabulary intervention. An in depth discussion was had to determine the best way to do this was to include quantitative data to get a good idea of the improvements we hoped to see but to also back this up with qualitative data to gather opinions on the causes of any improvements. It was felt that this was particularly important when considering attainment and confidence as it would be less obvious if any changes seen in these were due to the vocabulary intervention or other factors.

In relation to the quantitative data, scores will be collected from the vocabulary tests and the end of unit tests. These will be recorded as raw scores and also as percentages for each participant. Once all participants have completed the tests and the vocabulary quizzes, the mean score will be calculated with a standard deviation. This will allow me to describe any overall increases in scores which will be particularly important when comparing the three vocabulary tests in each unit.

The quantitative data from the confidence questionnaire will be processed according to the Likert scale (Likert, 1932). Responses will be scored from 1 (Very unconfident/strongly disagree) to 5 (very confident/strongly agree). From these scores, a mean and standard deviation will be found to enable me to describe any changes in the confidence of the participants and to show the average confidence among the cohort.

There will also be qualitative data which will be obtained through the focus groups. The recordings of these interviews will be transcribed and the transcriptions of the interviews will be coded to help identify common themes. This qualitative data will then be used to provide explanations for any changes seen in the quantitative data. For example, it will not be possible to attribute causation to changes seen in the quantitative data in the confidence questionnaire alone as there are a number of reasons why confidence could be increasing, however, through the use of the qualitative data from the focus groups it may be possible to start to suggest the causes of changes seen.

4.6 Limitations

When planning any research project it is important to consider the limitations of a study. In this section I will consider limitations of the various research methods being used as well as limitations of the study more generally.

One limitation with the study as a whole is that the sample size is very small and is limited in its diversity. The study will comprise of 112 Year 5 pupils in the study school. The pupils are in four classes that are mixed ability. With the sample size and the fact that all the children are in the same year group, it means that the results that are found in this study can really only be applied to this group of children. They may provide some interesting suggestions for other year groups and other schools but further investigation would be needed to confirm this.

When considering both the confidence questionnaires and the vocabulary test, these have been designed for this study and this could introduce a lack of reliability. To reduce this limitation both the questionnaire and the test have been developed with colleagues and then shared with and checked through by colleagues who hadn't been involved in the development process. This allowed us a chance to test for clarity as colleagues were asked to identify what was being tested or asked in each question, if a disparity was found in their answers the question was reworked to improve clarity. This helped to increase the reliability of these research methods. However this is a very small test and so this does introduce a limitation into the research study.

One other limitation with questionnaires is that often there is a low response rate (Cohen, Manion and Morrison, 2018), however, this should be less of an issue in this study as lesson time will be given for the completion of the tests and of the questionnaires. There are still likely to be some students that are absent from school and therefore miss the chance to complete the test or questionnaire. If the child returns to school the day after the missed test or questionnaire then they will be provided with time to complete the missed elements but if they are absent for a longer period of time they will be removed from the study to ensure that all pupils included in the results of the study have completed the same number of tests. This will, however, further limit the sample size.

While the answers in the vocabulary test and end of unit tests are either right or wrong, the questions on the confidence questionnaire are subjective and opinion based. It is difficult with these kinds of questionnaires to verify answers and establish whether pupils are given honest opinions or providing answers that they believe their teachers are looking for. This could reduce the reliability of the results of these questionnaires. The focus groups may help to expose any reliability issues with the questionnaire but with only a sample of pupils being interviewed it won't be possible to eliminate this limitation.

In the focus groups, limitations again revolve around the truthfulness of answers given. It may be that pupils give answers that they think the teacher wants to hear rather than giving their honest opinions and thoughts. This is likely to be made more of an issue due to the power imbalance between teachers and students. To try and reduce this, all of the interviews will be carried out by a teacher that is well known to the students. It is also worth noting that within the context of the research school pupils are asked for their opinions weekly in 'class forum' meetings where they are encouraged to suggest improvements as well as discussing what is working well. This may allow the pupils more confidence to express their honest opinions in these interviews as well.

4.7 Ethical Considerations

In this final section about the methods in this project I will discuss the ethical considerations of the study as a whole as well as discussing the ethical considerations of the research methods selected.

This research project is being conducted in line with the British Education Research Association (BERA) ethical guidelines (2018). While planning this intervention and research, ethical approval was applied for, the completed application form can be found in appendix five, and received from the University of Oxford, Department of Education. As part of this ethical consideration for the whole study, a letter was written to the headteacher of the school, which can be found in appendix six, to ask for consent for the study to take place within the school.

It was important to consider the voice of the child. The children in the study will be informed of the research that is being undertaken and the information that will be collected. They will be advised of the parts from which they can withdraw, the confidence questionnaire and the interviews, and the parts that will be included as part of their teaching, the vocabulary quiz and the end of unit test, from which they won't be able to withdraw but that they can ask for their score not to be included within the research.

In regards to the questionnaire and tests, an ethical consideration that needed to be considered was the impact of the questionnaire on the participants. This was limited as the pupils were given class time to complete the questionnaire however we had to consider the emotional impact on the respondents as well (Cohen, Manion and Morrison, 2018). One of these impacts could have been on those with limited literacy skills. Pupils that would struggle with the questionnaire could have the questions read to them and emotion faces were included to help them answer the questionnaire. This was also a consideration with the tests and again pupils could have the questions and the choices read to them and they could answer theses verbally. This not only helped to reduce emotional stress but also helped to reduce the impact of reading skills on the results of the study.

As well as the ethical consideration regarding power imbalance in the interview discussed earlier, there is also the emotional impact of interviews to be considered. The pupils participating in the interviews will be informed of the purpose of the interviews and given opportunities to withdraw at the start of any interview. If the interviewer senses that a participant is becoming unhappy or stressed during an interview then the group will be terminated at that point.

The final ethical consideration that I will discuss is regarding the data collection and storage. The vocabulary tests and end of unit tests will be collected initially by class teachers and at this stage the data will not be anonymised as it will be needed to inform teaching and planning by the Year 5 teachers. However, when it is included in the study this data will be anonymised and each participant will be assigned a number and they will not be identifiable in the study. The data of the confidence questionnaire will be collected in the same way to ensure that the child's tests and confidence questionnaire can be compared. The data from the interviews will be transcribed and saved under the child’s participant number. All data will be stored initially on school devices until fully anonymised.

Having fully considered the research methods, data collection and data analysis, the intervention will run for two units of science within the study school and include all 112 Year 5 pupils currently on roll unless they choose to withdraw or are removed due to missing data.

5.0 Findings

In this section, I will discuss the findings of this research and address how these link to the research questions that were set out in section 3.0. The intervention was planned during the autumn term of 2021 and it was implemented across four Year 5 classes during the Spring term 2022. In total there are 112 pupils on roll in the Year 5 cohort, of these children 108 are included within the research. The four children not included were taken out of the research as they did not have a full data set as detailed in section 4.1.

Data were collected for two science units, life cycles and space. Both units ran for six weeks and the data were collected at the start, during and at the end of the units. Confidence questionnaires were conducted at the start and the end of each unit and followed shortly after by the focus groups. Twenty children, five from each of the four classes, were selected to take part in the focus groups. Unit tests were conducted at the end of each unit in line with the school policy. Vocabulary tests were conducted three times through each unit, at the start, after initial intervention and learning and at the end. The results collected will be discussed in the following sections. The data collected from the vocabulary tests will be discussed in section 5.1, the data collected from the end of unit tests will be discussed in section 5.2 and the data from the confidence questionnaires and the focus groups will be discussed in section 5.3.

5.1 To what extent can a targeted teaching approach to science vocabulary improve pupils' understanding of topic specific words?

In this section I will discuss in detail the results from the vocabulary tests completed throughout the intervention to start to establish an answer to my first research question regarding improving childrens' understanding of topic specific vocabulary. Vocabulary lists were created in collaboration with the other teachers in Year 5. The word lists and definitions for both units can be found in appendix seven.

The vocabulary tests were administered using an online form, a format that is widely used within the school and one which the children are comfortable using. The questions were given as a multiple choice format and the children had to select the correct definition from four definitions, one which was correct and four similar definitions that had previously caused confusion. The results were recorded as raw scores and a mean found from the year groups results, the range and standard deviation were also calculated for each test. The life cycles vocabulary test was scored out of 10 and the space vocabulary test was scored out of 12, this reflected the number of words that were part of the intervention for each unit.

	Pre-Intervention Test	Week 1 Post Intervention Test	Week 6 Post Intervention test
Mean Raw Score (out of 10)	1.88	7.18	8.74
Standard Deviation of Scores	1.49	1.82	1.37
Range of Raw Scores (out of 10)	0-7	3-10	4-10

Figure Two: The Average scores, standard deviation and range of raw scores that were calculated from the vocabulary tests that were taken during the Life Cycles unit in which the first intervention was performed.

In figure two, the results for the vocabulary tests in the first of the two intervention units, Life Cycles, can be found. From the mean raw scores, shown in figure two, it is possible to see that the pre-intervention test score was, predictable, low with a mean score of 1.88 out of ten. Once the intervention had taken place and the children had had the opportunity to be introduced to the topic words and developed actions to help them to understand the words and their definitions the score initially rose to a mean score of 7.18 out of 10. This test was taken after the initial intervention teaching but before the main science teaching had taken place. In the final vocabulary test, which took place after both the intervention teaching and the main science unit teaching where the actions were used frequently, the mean score rose again slightly to 8.74 out of 10. These results seem to suggest that the intervention alone was the more significant factor in improving the children’s understanding of the vocabulary; however, it’s difficult to establish if the same improvements would have been seen by the end of the unit regardless.

When looking at the standard deviation for the first unit of the intervention, it is possible to see that the scores were generally grouped and there were fairly minimal deviations meaning that it is likely that the changes seen are fairly reliable in showing an improvement between each test. As the standard deviations seen in tests one and test two are smaller than the difference between the means in these two tests this may suggest that there is a significant improvement between the two tests and again point to the intervention having a significant impact on improving vocabulary understanding. This is supported by a p value < 0.00001. The standard deviation seen in test two and three are much closer to the difference between the means with the standard deviation in test two being bigger than the difference in mean scores between test two and test three. This may point to the normal science teaching, even with the addition of the intervention actions, not making a significant difference to the children's understanding of science vocabulary. These findings will be discussed further in section 6.1.

	Pre-Intervention Test	Week 1 Post Intervention Test	Week 6 Post Intervention test
Mean Raw Score (out of 12)	1.81	8.90	10.41
Standard Deviation of Scores	1.46	2.06	1.49
Range of Raw Scores (out of 12)	0-7	4-12	6-12

Figure Three: The mean scores, standard deviation and range of raw scores that were calculated from the vocabulary tests that were taken during the Space unit in which the first intervention was performed.

In figure three, the results for the vocabulary tests in the second of the two intervention units, Space, can be found. Again, predictably, the mean raw score seen in the pre-intervention test was low at just 1.81 out of 12. Once the intervention had been completed but before the main science unit had been started, the mean score rose to 8.90 out of 12 and once the intervention and the science unit had been taught the mean score rose again to 10.41. Like in the life cycle unit the biggest increase was seen between the pre-intervention test and the week 1 post-intervention test with only a relatively small increase seen between week 1 and week 6. Again, this might suggest that it is the intervention that is increasing understanding of the vocabulary more than the teaching of the science unit. However, in both interventions the improvements are maintained across the six week unit and in both units the improvements did increase slightly between week 1 and week 6 which could suggest that the use of the intervention actions are helping to reinforce learning.

Interestingly, when looking at the standard deviations calculated from the results of the vocabulary tests in the second unit, the standard deviation in both the pre-intervention test (1.46) and in the week 6 post-intervention test (1.49) are quite small meaning that the results were generally grouped quite closely, however the standard deviation for the week 1 post-intervention test is noticeably higher at 2.06 which shows that there was more of a spread generally in the results and therefore it might be harder to generalise with the mean for this test than with the mean of the other two tests. Once again, when considering the results from the intervention in the second unit, the standard deviation in test one and test two are smaller than the difference between the means calculated for test one and test two so this suggests that this might be a significant increase. This is supported by a p value <0.00001. However, the standard deviation for test two and test three are both bigger than the difference between the means calculated for test two and test three meaning that this could be an unreliable increase and is likely to not be significant. These results will also be discussed further in section 6.1.

5.2 To what extent can a targeted teaching approach to science vocabulary raise pupils' attainment in primary science?

In this section I will be discussing the results from the end of unit test taken by the children at the end of the two intervention units, Life Cycles and Space, and the end of unit test for the science unit prior to the intervention being introduced, Forces, to try and begin to answer the second research question regarding improving pupils' attainment in science. These end of unit tests are part of a standardised scheme and they are completed across all year groups in the school at the end of a teaching unit. To try and establish if there was an improvement in pupils' attainment after the introduction of a vocabulary intervention the mean score (as a percentage) was calculated from the scores in Year 5 along with a standard deviation and a range.

To establish if there was a change in attainment after the intervention had been implemented these parameters were calculated for the end of unit test that was taken in the last unit taught before the start of the intervention as well to act as a comparison. The results for all three units can be found in figure four below.

	Forces (Pre-Intervention Unit)	Life Cycles (Intervention Unit)	Space (Intervention Unit)
Mean score (%)	60.85	70.61	74.65
Standard Deviation of scores	18.48	16.03	15.39
Range of scores (%)	12-100	20-100	18-100

Figure Four: The mean scores, standard deviation and range of scores that were calculated from the end of unit tests that were taken during the two intervention units, Life Cycles and Space, and the unit prior to the intervention, Forces.

As seen in the Mean scores, found in figure four, the mean score increased by almost 10% between the pre-intervention unit and the first intervention unit and it rose again, albeit by a far smaller amount, in the second intervention unit. This suggests that the vocabulary intervention may have had a positive impact in increasing pupils' attainment, however, when considering the standard deviations these are all relatively high. The increase in the mean score is not bigger than any of the standard deviation making it an unreliable increase, however, when comparing both the life cycles test ($p=0.000024$) and the space test ($p<0.00001$) to the forces test the p values show that there is a significant increase in scores.

When considering the ranges of scores seen there is a relatively consistent range across all three end of unit tests. This suggests that any benefit to attainment from the intervention was being seen mainly in those children who were scoring in the mid-range to begin with. The children that were scoring at the top range were unable to show any improvement in understanding or attainment in these end of unit tests as they were already scoring 100%. It could be that their understanding has deepened but this won't be measured on the standardised tests. In order to establish data to support or reject this theory, they would need to be offered a more open-ended way to show their understanding of a topic. However, when looking at the raw data, there was an increase in the number of children scoring 100%. In the pre-intervention unit only one pupil scored 100% however in the both intervention units there were six children that scored 100%. This could suggest an improvement in attainment of those that were already scoring well in end of unit tests.

When considering the lower end of the spectrum, there is also little change in the range meaning that some children showed no improvement in attainment in the end of unit tests after the intervention was implemented. This suggests that the intervention had limited impact on the children that were finding science the most difficult to understand. However when reviewing the raw data there was a change in the number of children scoring less than 40% in the end of unit tests. In the forces tests, taken before the intervention was implemented, 13 children scored less than 40%. This was reduced in both of the intervention units with only 5 children scoring less than 40% in the life cycles test and just 1 child scoring less than 40% in the space topic. There was initially a very small number of children included in this subsection and so it is difficult to make meaningful comments on the impact of the intervention however there does seem to be an improvement in attainment at this lower end that is not necessarily seen when looking at the range.

The significance of all of these results and the potential limitations to what we can learn from them will be discussed further in section 6.2.

5.3 To what extent can a targeted teaching approach to science vocabulary increase pupils' confidence in science lessons?

In this section I will discuss the data collected from the confidence questionnaire and the data that was collected from the focus groups to begin to answer the third research question regarding increasing pupils' confidence in science lessons. The Confidence questionnaire contained four questions that used the Likert scale, these questions can be seen in figure five. From these questions in the confidence questionnaire, a mean score was calculated together with a standard deviation, these can be seen in figure six. There were three short answer questions that were coded to look for common themes. These common themes then influenced the focus groups which were recorded for transcription purposes. The transcripts of these interviews were then also coded to look for common themes.

Question One	How confident do you feel in science lessons?
Question Two	I am happy when I see Science on the timetable
Question Three	How confident are you when using science vocabulary?
Question Four	I enjoy science lessons
Question Five	What helps you to feel confident in science?
Question Six	Can you describe your feelings towards science in 3 words?
Question Seven	Is there anything else you want to tell us about science lessons?

Figure Five: The questions included in the confidence questionnaire. The first four used the Likert scale to establish opinions and feelings of the participants while the last three were short answer questions.

The confidence questionnaire was given via an online form which the children are familiar with and which is used frequently within the study school. The Likert scale was set up to run from 1 to 5, with one being on the left side as it was thought that this would be least confusing for the children as it is how they are used to seeing number lines. Each of the points were labelled as discussed in section 4.2. The mean scores and standard deviations can be found below in figure six.

	Pre-Intervention Answers		Post Unit One Answers		Pre Unit Two Answers		Post Unit Two Answers	
	Mean Score	Standard Deviation	Mean Score	Standard Deviation	Mean Score	Standard Deviation	Mean Score	Standard Deviation
Question One	2.00	0.85	3.58	1.14	3.39	1.11	4.06	0.83
Question Two	2.98	1.46	3.55	1.16	3.33	1.14	4.02	1.14
Question Three	2.72	1.33	3.38	1.11	3.56	1.11	4.15	0.82
Question Four	3.02	1.43	3.61	1.13	3.68	1.14	4.06	1.04

Figure Six: The mean scores and standard deviations calculated from the responses to the first four questions in the confidence questionnaire. (See figure five for details of the questions)

When considering the data from these four questions, it is possible to see that there was an increase across the study period in all four areas. Question one, which focused on pupils' confidence in science lessons, saw the biggest rise from 2.00 in the initial survey to 4.06 in the final questionnaire. In both cases the standard deviation is less than the difference between these two means (2.06), which suggests that there was a significant shift in the confidence children felt in science lessons. This may suggest that the vocabulary intervention did help to improve children's confidence in science lessons generally. Question three, which looked at the confidence with science vocabulary also saw a sizable increase from 2.72 in the first questionnaire to 4.15 in the final questionnaire and, again, this increase (1.43) is bigger than the standard deviation suggesting a significant shift in the pupils' confidence with the science vocabulary. Both the p values for confidence in science lessons ($p<0.00001$) and confidence with science vocabulary ($p<0.00001$) suggest that there is a statistically significant increase between the start and the end of the intervention.

When considering questions two and four, which looked at the enjoyment of science lessons, there is also an increase between the first questionnaire and the final questionnaire. In question two, which looked at how happy children were to see science on the timetable, saw an average rise of 1.04 across the study period however this increase is less than the standard deviation seen in the results for this question so this suggests that there was no a significant increase in the results for this question. When considering question four, which looked at enjoyment of science lessons, there was an average rise of 1.04 which is also less than or equal to the standard deviations for this question results which again suggests that there was no significant increase in enjoyment in science lessons during the study period.

When looking at the results from the second and third questionnaire, we can see that the results are very similar. This is likely to be due to the timings of these tests, questionnaire two was conducted at the end of the first unit of work and questionnaire three was conducted just before starting unit two. These two questionnaires were separated by a half term holiday but there was no teaching of science or vocabulary between the two questionnaires and therefore it is to be expected that there was little variation in the results. All the results of the questionnaire will be discussed in more detail in section 6.3.

All the data currently presented within sections 6.1, 6.2 and 6.3 relates to the quantitative data collected as part of this study. The final data collected was the qualitative from the questionnaires and the focus groups which I will present in the final part of this section.

Included in the questionnaire were three short answer questions, question 4 to question 7, as seen in figure five. These questions allowed the children to expand or provide more varied responses to help us to understand their thoughts and feelings towards science lessons. The answers from these three questions were collated and then coded to pull out common themes.

When considering question four, regarding what made the children feel confident, there was an interesting change across the four questionnaires. Initially a commonly stated resource to help improve confidence was a word list, these were previously given with the schools old curriculum, however by the final questionnaire only three children of the 108 included in the study mentioned that they felt word lists would increase their confidence. This was noted and included in the final set of focus groups to try and establish why this change had been seen. The other common theme seen in the answers to question four, were to do with the speed of teaching and the number of practical activities in the lesson, mentions of these remained consistent throughout the four questionnaires.

There were also increases in positive words when considering question five, regarding words the children selected about their feelings towards science lessons. These responses were coded within the Year 5 team and it was collaboratively decided whether words were considered positive, neutral or negative. In the first questionnaire 52.5% (170 out of 324) of the words were considered to be positive but this had risen to 65.1% (211 out of 324) of the words being classed as positive.

These results, together with anything that was mentioned in response to question seven, helped to inform the questions in the focus groups, the plans for which can be found in appendix three. There were twenty pupils included in the focus groups and they were selected to cover a range of current attainments for all four classes. The responses given by the children were much more varied in the first focus groups when compared to the last focus groups.

In the first of the focus groups, there were nine children who spoke about being nervous or anxious in at least some science lessons because they were struggling to fully understand. By the final focus groups, this had dropped to just three children saying that they had been nervous or anxious in science lessons in the most recent unit. Of the six children that no longer felt nervous or anxious, four children stated that the actions and way that they were learning vocabulary had helped them to feel more confident in lessons, two children spoke about the practical lessons helping to increase their confidence. This is a promising sign that the intervention helped to increase confidence in some children.

Of the twenty children participating, when asked about the vocabulary intervention, they all thought that it was fun to be able to work in a group to create actions and seventeen of the children said that they had enjoyed teaching the class, and their teacher, their actions to help everyone understand the word. When asked about the vocabulary directly, children were confident talking about their groups vocabulary and actions however they were less confident, with five children being reluctant, when talking about vocabulary and actions that were developed by other groups. This is something that may need to be reflected upon further in relation to any future interventions that take on a similar design.

The results from the confidence questionnaire and the focus groups will be discussed in detail in section 6.3 to consider how they can help us to answer research question three to establish if a vocabulary intervention can help to increase confidence in science lessons.

6.0 Discussion

In this section I will discuss the results, which were presented throughout section 5, in more detail. Using these results, I will consider whether there is enough evidence to suggest answers to my research questions as well as discussing any limitations to the results or any compounding factors that may have influenced the results from outside of the intervention implemented.

6.1 To what extent can a targeted teaching approach to science vocabulary improve pupils' understanding of topic specific words?

In this section, I will be discussing how the results of this study begin to answer my first research question. As seen in section 5.1, the results of the vocabulary test can be used to start to answer my first research question.

In the vocabulary test there were promising results which showed that the children improved throughout each of the two units. The biggest increase was seen between the pre-intervention test and the test taken within the week of the intervention taking place. This is to be expected as these were topic specific words that it is possible that the children had not been exposed to before. The pre-intervention scores were generally lower than expected among the Year 5 teachers, particularly in the space topic, as there were a handful of words that we would have expected Year 5 to correctly be able to define before any intervention however, as seen in the mean scores for both life cycles (1.88) and space (1.81) the majority of children were scoring very low if they scored at all before the intervention. While this was a surprise to us as teachers, it does support the whole school's findings that the children's knowledge of vocabulary is an area of weakness. When considering the literature these surprisingly low initial scores could explain the lack of progress being seen in science across the school as Carlisle, Fleming and Gudbrandsen (2000) noted that a lack of initial understanding meant that children struggle to follow discussions and therefore cannot fully participate in lessons. This is something that will be important to review moving forward.

It is therefore a pleasing result to see that after the intervention teaching these mean scores rose significantly in both the life cycles (7.18) and the space (8.90) units. These scores from tests taken a short time after the intervention do suggest that the dedicated vocabulary teaching has improved pupils' understanding of topic vocabulary. This finding falls inline with the research of Shore, Ray and Goolkasian (2013) who found that the generation effect, seen in this intervention through the creation of actions, combined with the production effect, seen in the group discussion while creating actions, aided memorisation of vocabulary definitions. However, as the whole year group was doing the same intervention, it is not possible to relate this directly to the design of the intervention as it is possible that with any focused vocabulary teaching the same results would have been seen. To identify whether it was particularly this style of intervention that helped to improve understanding, more research would be needed in which the participants were split into different interventions and results were compared.

At this point, it is also worth mentioning that prior to the implementation of the interventions for this study there were no vocabulary tests being taken in science classes. It is therefore possible that the same results would have been seen through the teaching of the science unit with children reaching the same understanding with no intervention. It would be interesting to have run the vocabulary tests in another year group that was not undergoing any vocabulary intervention to establish if this was the case. It is also possible that the vocabulary tests themself improved retention of the definitions. However, when considering the increase in understanding between test two and test three there is not a significant increase suggesting that teaching alone, even with the addition of the intervention actions, does not increase understanding which again suggests that the targeted approach to vocabulary teaching does improve understanding of topic specific vocabulary above that expected in the course of a science unit. Again this falls in line with the findings of Carlisle, Fleming and Gudbrandsen (2000) who noted that incidental vocabulary learning did occur through teaching but that the depth of learning is limited. This could suggest that even with the actions unless the children already remember the words definition that they are relying on inference and incidental learning which limits the depth of their understanding.

Another interesting observation was made by one of the Year 5 teachers participating in the intervention. They noticed that the children were accurately using more scientific vocabulary in their written work than they had been prior to the introduction of the interventions. As a year group team, we worked through the books to try and establish if we were seeing this pattern across the whole year group and across all attainment levels. We found that those that had previously been scoring at or above age related expected in end of unit tests had increased their use of scientific vocabulary, although largely limited to the topic specific words included in the intervention, in their written work and these words were largely used correctly and in the correct context. This suggests that it is possible that the intervention not only helped the children to increase their ability to define the words included but to actually understand the vocabulary that had been taught.

When considering the books of children that had previously scored below age expected in end of unit tests, there was still an increase in the amount of times that the intervention words were being seen, however, they were much less consistent with the correct use of the words. This might suggest that, although generally there was an increase in the number of words these children were able to define, they still didn't understand the words enough to be able to accurately use them in a sentence. When considering the research of Shore (2015) it was shown that those with a low reading attainment benefited from the production effect most and that they saw an increase in vocabulary understanding. While this seems to be echoed in this study one previously noted limitation of Shore (2015) is the focus on the defining vocabulary my research suggests that when focusing further on comprehension and the ability to apply vocabulary that the production effect combined with the generation effect is not sufficient to improve understanding in lower attaining pupils. Further research would need to be carried out to establish if this was the case across all units and continued to be a limitation after interventions had been implemented for longer periods of time. This could possibly suggest that the intervention alone was insufficient to increase topic specific vocabulary in the children who were below age expected in science prior to the intervention.

The results of this research seems to fall in line with the research of Skoning, Wegner and Mason-Williams (2017) who found that a similar intervention utilising movement increased vocabulary understanding. Although these initial results seem to be promising and appear to show that a targeted teaching approach to science vocabulary can improve pupils' understanding of topic specific vocabulary it is difficult to draw any conclusions. There is limited data to analyse and although there seems to be a suggestion of significance between vocabulary test one and test two in both units further and more detailed statistical analysis of a wider range of data would be needed to confirm this. It is also not possible to say whether the intervention would show similar positive results in other year groups or in other settings. More research is required to further investigate the results found in this study before drawing any firm conclusions.

6.2 To what extent can a targeted teaching approach to science vocabulary raise pupils' attainment in primary science?

In this section I will further discuss the results and findings in relation to my second research question. As seen in section 5.2, the end of unit tests were used to track attainment in the intervention units and these scores were compared to the last pre-intervention end of unit test to identify any increased rates of attainment.

From the results presented in section 5.2, we can see that there was an increase in the mean score achieved in the end of unit tests in the intervention units when compared with the unit prior to the intervention starting, however, this was not a significant increase. The standard deviation being bigger than the increase shows that although there appears to be an increase it could be a false positive as two thirds of the data will fall within one standard deviation of the mean and when one standard deviation from the original mean takes us above the new mean it suggests that there has not been a significant increase. Despite this, there is an increase and it is seen in both the intervention units which could suggest that the intervention might be influencing these increases. These increases could show that this research falls in line with the finding of Taboada (2011) in which it was found that an understanding of topic vocabulary acted as a proxy for general background knowledge which allowed for greater progress, however, more research would be required to confirm this.

It is worth noting that in the two intervention units there were also pre-planned experience days, a trip to a local wildlife centre with a workshop for life cycles and a visiting space dome for space. It is not possible to ascertain the influences of these experiences on the children's learning and therefore how much of an impact they had on any increases in attainment that are seen in these units. An experience like this was noticeably missing in the forces unit that preceded the intervention. It is therefore possible that the vocabulary intervention had limited impact on attainment but instead it was the experience days that made the learning more memorable for the children that is reflected in the increased mean scores in the end of unit tests.

It is also important to acknowledge that the highest mean score in the end of unit tests was seen in the space unit (74.65%) which was run as an entire topic for the half term. This is in contrast to both forces (the pre-intervention unit) and life cycles which were both run as part of a larger topic which linked together with geography and history. This meant that there was much more of a focus on science in the space unit, with writing and reading lessons both being linked to the topic, than in the other units. However, when considering the research of Townsend, Bear, Templeton and Burton, 2016 they found that it is possible that vocabulary interventions may allow children to fully access the cross curricula readings which could still point to the intervention helping to support attainment. It is likely that this increased exposure to the topic across a much wider range of lessons impacted the childrens' learning. It is not possible, from the data collected, to work out the impact that this had on the results seen in this study.

However, in section 6.1, I discussed an increase in the number of children accurately using science vocabulary within their written work in class. This finding is not dissimilar to the findings of Dundar-Coecke and Tolmie (2019) who observed pupils' work to establish how increased understanding of vocabulary can increase science attainment in primary aged children. When reviewing the childrens' work across the two intervention untis there is a clear increase in the quality of science work when compared to the previous units work. More of the work is clearly explained and hypotheses and outcomes of investigations are more clearly discussed. The standard of work across the year group has been moderated by the head of science and it has been found that the work is now at or above age related expectation for the majority of the children for whom this should be expected. In previous moderations, it was found that for a large proportion of the children that should be working at or above age related expectations their written work was falling below the expected standard. This could suggest that the targeted vocabulary intervention did increase attainment in science even though there is not enough evidence to support this from the end of unit test. Of course the compounding factors discussed in this section could still be impacting these findings.

While there are some promising observations in regards to the attainment of the participants of the intervention, it is not possible to clearly link the improvements seen to the intervention implemented. There are too many influencing factors to be able to establish a correlation. Further investigation over a longer period of time would be needed to establish whether targeted vocabulary teaching can raise pupils' attainment in science.

6.3 To what extent can a targeted teaching approach to science vocabulary increase pupils' confidence in science lessons?

In this section, I will discuss the findings in relation to my third research question. In order to establish any increases in confidence I will be focusing on the results from the confidence questionnaire and the focus groups which were presented in section 5.3.

In section 5.3, I first presented the findings from the confidence questionnaire. While the increase between each individual questionnaire is not significant when comparing the first set of answers to the final answers it is possible to see that there has been an increase in all areas of the questionnaire. While this is a promising sign as it appears to suggest that over the course of the intervention children have become more confident in the vocabulary used in science lessons as well as feeling more confident generally in science lessons, the answers in the questionnaire itself are unable to provide a link between increasing confidence and the vocabulary intervention.

As presented in section 5.3, there was a reduction in the number of children saying that they would feel more confident using word lists in science lessons between the first and last questionnaire. This could indicate that they no longer felt that they required the word lists due to feeling more confident with the vocabulary as a result of the intervention but it is also possible that as the children became used to the new scheme of work they stopped thinking of the word lists that had previously been used in the old scheme of work. Together with the increased confidence seen in the questionnaires and reiterated in the focus groups, these initial results do seem to support the work of Ardasheva, Carbonneau, Roo and Wang (2018) in such a way that they suggest that the vocabulary intervention has been somewhat protective against science anxiety. Further data is needed to establish a direct link between the vocabulary intervention and the potential increase in confidence seen, it is likely that there would need to be further qualitative data collected to fully understand the changes.

To try and establish a link between changes in the answers given in the confidence questionnaire, focus groups were conducted to allow a sample of the children to expand on answers from the questionnaire. One limitation of these interviews was the selection of children to participate. Class teachers were asked to select five children across a range of previous attainments to participate in the interviews; however they were asked to pick children in whom this would not cause any anxiety. This is likely to have swayed teachers to select more confident children in general and therefore may have given a skewed view of opinions towards the more confident end of the scale.

From the focus groups, it was found that the intervention had increased vocabulary confidence for the majority of the children. The children had enjoyed the intervention and were willing to explain their own groups actions and vocabulary in detail however the same was not seen when explaining other groups actions. As each group only looked at a small number of the words there may be room to improve the intervention by dedicating more time to vocabulary allowing children to create their own actions for all words and therefore possibly further increasing vocabulary confidence. This may also start to increase the science literacy of our pupils as Miller (2004) suggests that understanding of vocabulary is an important factor in this, however, a much more in depth and longer study would be needed before making any claims of increased science literacy.

Another interesting development that came out of the focus groups was relating to investigation. At the start of the 2021/2022 academic year, the school moved to an investigation based science curriculum. Prior to the intervention the children had only completed one unit of this scheme, forces, meaning that this was still very new to them. In the focus groups eighteen of the twenty children spoke about the investigations and having more autonomy over their learning had led to an increase in their confidence. Due to the timing of this scheme's introduction, it isn’t possible to dismiss this as the cause of the increased confidence seen.

While the results of the confidence questionnaire are promising, it is not possible to link the increases in confidence seen to the vocabulary intervention. It is likely that the increases in confidence that directly relate to confidence with vocabulary are due to the intervention as this was discussed and suggested as part of the focus groups, however with such a small sample used for the groups it is only possible to suggest that this is the cause for the twenty children included in the focus groups. To establish if this was more of a general opinion more interviews would need to be carried out with a wider range of pupils.

It is not yet possible to associate the increase in confidence more generally in science with the vocabulary intervention. Generally the literature is more sparse in this area and while this study shows it is possible that direct vocabulary teaching did increase the confidence more generally in science lessons, with a change in teaching style introduced in a relatively similar time period it isn’t possible to eliminate this as the reason for increasing confidence. To try and establish if the vocabulary teaching was the cause of increased confidence it would be necessary to repeat the questionnaires and intervention in another year group in the new academic year once the scheme of work is embedded.

7.0 Implications

In this section, I will discuss the implications of the intervention and findings of this study for the research school and schools in the wider trust. I will first discuss the initial implication of the intervention on the teaching of science vocabulary within KS2 before discussing what this might mean for the KS1 teaching of science within the study school and finally the potential implications for schools within the same trust as the study school.

The results of this study do seem to suggest that direct teaching of vocabulary can have a positive impact on children's understanding of topic specific vocabulary and that it may also have a positive impact on attainment and confidence although more evidence is needed to prove a correlation in these areas. This study has been presented at a whole school staff meeting to discuss how we might be able to roll this out to the rest of the school and establish if the benefits seen in this small study can be translated to other year groups to improve science teaching and in particular science vocabulary teaching across the school.

When discussing how to bring the intervention to more year groups, it has been decided that the intervention would be suitable for KS2 in its current form. As a result, I am now working with the teachers in Year 3, Year 4 and Year 6 to ensure that they are able to apply this intervention to all their science units in the next academic year. Working in collaboration with year group teams, we have written vocabulary lists with child-friendly definitions for each of the six units that the year group needs to teach. We have now developed the word lists for all twenty-four science units that are run in KS2 and these have been shared with all KS2 teachers to ensure that there is clear progression and that vocabulary was not repeated, this was particularly important where topics are repeated higher up the school (for example electricity is taught in both Year 4 and Year 6).

The intervention will run in the same way as it has in Year 5 this year in all of the year groups. Vocabulary tests will be given three times in each unit and end of unit tests will be conducted as is standard within the school. It has been decided that there will be an initial confidence questionnaire taken in September and then these will be repeated at the end of each unit but not conducted at the start of units. This decision was taken as a result of finding that there was little benefit of having the results from the third set of questionnaire results as there was no significant time lapse or teaching between the two questionnaires. Due to time limitations there will be no focus groups conducted.

During the initial staff meeting, in which the intervention was discussed, it was decided that the intervention would need to be reworked to benefit KS1. There was an agreement that KS1 pupils would struggle to use definitions given to them to create actions and to fully understand the words. It was decided that in Year 1 and Year 2 they would follow a similar style of intervention but that definitions would be discussed as a whole class led by the teacher and actions developed as a whole class. KS1 will also not carry out vocabulary tests due to varying levels of reading ability limiting their effectiveness, instead they will use children's written work to establish if the words are being used correctly. They will also continue to administer end of unit tests in line with the science scheme to track attainment. Again, due to varying reading levels, confidence questionnaires will not be carried out in KS1.

Word lists and definitions were still created for the twelve KS1 science units and, again, these were shared with the rest of the teaching team to ensure clarity and progression. It will be interesting to see if the KS1 classes are able to use more of the words more confidently in their work as they will be involved in the creation of all the actions and in the focus groups conducted in the study it was noted that children were more confident with the vocabulary than had been assigned to their group and for which they therefore created the action.

As well as implications for the study school, there are also implications for the other schools within the same trust as the study school. The results of this study and future plans for the study school are to be presented to the rest of the trust in the autumn term of the 2022/2023 academic year with the view to potentially introducing similar interventions to their science lessons from January 2023.

As we move into the next academic year, data on the benefits of this targeted vocabulary teaching will continue to be collected. It is hoped that with a bigger data set and over a longer period of time it might be possible to assign more significance to the results found as well as being able to link any increases in confidence (in KS2) and attainment (in KS1 and KS2) to the intervention itself. Looking further ahead to the spring term of 2023, there is the possibility to track the benefits of this intervention in other catchment areas and with different cohorts with different demographics. As there were little perceivable differences between the vocabulary scores of the children from lower socio-economic backgrounds and their more affluent peers within this study, it will be particularly interesting to track the benefits in the schools with lower percentages of pupil premium to see if it is of benefit to all pupils regardless of any potential vocabulary gap.

8.0 Conclusion

In this final section, I will be concluding this assignment by discussing how my findings in this research agree or disagree with the literature discussed in detail in section 2 before concluding my research questions and summarising this project.

When reviewing the research in section 2 of this assignment, I discussed the suggestion of Hicks Pries and Hughes (2012) that traditional vocabulary teaching should be placed in the context of an inquiry based science classroom. This is the model that I have followed in this intervention and it appears to have had a positive impact. Although the intervention was perhaps slightly less traditional than the dictionary intervention discussed by Shore (2015) it was still a targeted approach to vocabulary that was not rooted in the inquiry based learning of the classroom.

Shore (2015) also found that pictionary, which used the generation effect, was the best method for low attaining students to learn vocabulary. In this research, I saw similar increases in the ability of low attaining students to define vocabulary while participating in the intervention, which used both the production and the generation effect. However, Shore (2015) looked purely at the pupils' ability to define vocabulary and while this was also seen in my research I found that the lower attaining pupils had learnt definitions but in their written work they showed a lack of understanding through their inability to use the vocabulary correctly in explanations. As Shore (2015) didn't explore the understanding and only looked at the ability to define it would have been interesting to know if there were similar observations with their pupils.

Having designed an intervention that included both the generation and production effect, I have been able to track pupils' understanding and their retention throughout the intervention. Similar to the findings of Shore, Ray and Goolksain (2013), who found that this combination increased understanding and retention, I found that the pupils were not only able to define the focus vocabulary but they were showing greater understanding of the topic specific vocabulary through their written work. Although my study was over a relatively short amount of time, the scores of the vocabulary tests, given in week one and then repeated in week six, seem to suggest that the pupils are retaining and even improving on their vocabulary knowledge over this time.

It is also worth mentioning a similarity that I have found between my own research and that of Skoning, Wegner and Mason-Williams (2017). They found that action based interventions increased engagement in vocabulary throughout a unit and this increased gains in vocabulary understanding. During the focus groups that were conducted as part of my research the participants were noticeably engaged in their vocabulary learning. This is something that was also seen in science lessons with children joining in with actions when the vocabulary was used during teaching inputs. This seems to support the finding of Skoning, Wegner and Mason-Williams (2017) and suggests that engagement in vocabulary could be an important factor in understanding, however, further research is needed to confirm this theory.

In regards to my own research questions, I am able to suggest answers to all of the questions posed in this research however more data is needed to fully answer these questions. When considering the first of my three research questions, the data collected suggests that the targeted intervention designed for this study was successful in increasing the understanding of the topic vocabulary in the participants. However, there were some suggestions from the children's written work that those previously working below age expected expectations had increased their ability to define these words but not their understanding of these words.

In relation to my second research question, the evidence is less convincing. The rise of the mean test score seen between the pre-intervention and intervention units is not a significant enough increase from which to draw a conclusion. However, there were suggestions after moderation of written work that the standard of science learning had increased and this could mean that the intervention was successful in raising attainment in science. With the data collected in this research, it is not possible to draw stronger conclusions as to whether a targeted vocabulary intervention can raise attainment in science lessons.

When discussing my third research question, the evidence suggests a positive impact on confidence levels but it is not possible to come to a solid conclusion from the limited data collected. While there was an increase in confidence seen in the questionnaires, it is not possible to make a positive correlation between the intervention and this increase due to the change of science scheme having an unknown impact on the pupils' confidence and enjoyment of science lessons. When considering the focus groups, there is a suggestion that the vocabulary intervention did have an impact in increasing confidence however as this is only based on the opinion of twenty children it is not possible to generalise these findings to the other participants.

It is also noted that this study was conducted with a very small sample of just 108 pupils and that these pupils were only recruited from one year group in the study school. The further investigations discussed in section 7.0 are needed to make more generalised statements regarding the benefits of vocabulary interventions on vocabulary understanding, attainment and confidence.

9.0 Appendices

In this section, the appendices referred to throughout this research can be found.

9.1 Appendix One - Confidence Questionnaire

Below are the questions included within the confidence questionnaire. Question one to four were scored on the Likert scale whereas question five to seven were short answer questions that were free typed.

Question One	How confident do you feel in science lessons?
Question Two	How happy are you when you see Science on the timetable?
Question Three	How confident are you when using science vocabulary?
Question Four	How much do you enjoy science lessons?
Question Five	What helps you to feel confident in science?
Question Six	Can you describe your feelings towards science in 3 words?
Question Seven	Is there anything else you want to tell us about science lessons?

9.2 Appendix Two - Vocabulary Quiz

Below is an example of the vocabulary tests given. This example is the vocabulary test that was used for life cycles during the intervention. The children were given the word and then had to select the correct definition from the four given. The quizzes were given via an online form.

Word	Definitions to select from
	The young of an animal before it becomes an adult
	The length of time a mammal is pregnant with their young
	The adult form of an animal that can reproduce
juvenile	Young wingless form of an insect (e.g. caterpillar)
	The process through which living thing (animals or plants) create offspring or young
	Causing pollen to transfer from one flower to another to allow for reproduction.
	When a seed sprouts its first shoot
gestation	The length of time a mammal is pregnant with their young
	The process through which living thing (animals or plants) create offspring or young
	Causing pollen to transfer from one flower to another to allow for reproduction.
	When a seed sprouts its first shoot
reproduction	The length of time a mammal is pregnant with their young
	The process through which living thing (animals or plants) create offspring or young
	Causing pollen to transfer from one flower to another to allow for reproduction.
	When a seed sprouts its first shoot
pollination	The length of time a mammal is pregnant with their young
	The change that occurs when a baby and adult of the same species look very different (e.g tadpoles and frogs)
	The process through which living thing (animals or plants) create offspring or young
	When a seed sprouts its first shoot
metamorphosis	Young wingless form of an insect (e.g. caterpillar)
	The change that occurs when a baby and adult of the same species look very different (e.g tadpoles and frogs)
	The stage of an insect's life when it undergoes metamorphosis inside the cocoon.
	The young of an animal before it becomes an adult
Pupa	Young wingless form of an insect (e.g. caterpillar)
	Young wingless form of an insect (e.g. caterpillar)
	The young of an animal before it becomes an adult
	The change that occurs when a baby and adult of the same species look very different (e.g tadpoles and frogs)
larva	The young of an insect that doesn't undergo metamorphosis
	The young of an insect that doesn't undergo metamorphosis

nymph

	The stage of an insect's life when it undergoes metamorphosis inside the cocoon.
	The young of an animal before it becomes an adult
	Young wingless form of an insect (e.g. caterpillar)
	The journey of change that takes place throughout the life of a living thing including birth, growing up etc.
	The process through which living thing (animals or plants) create offspring or young
	The length of time a mammal is pregnant with their young
life cycle	The stage of an insect's life when it undergoes metamorphosis inside the cocoon.
	The process through which living thing (animals or plants) create offspring or young
	Causing pollen to transfer from one flower to another to allow for reproduction.
	When a seed sprouts its first shoot
germination	The length of time a mammal is pregnant with their young

9.3 Appendix Three - Semi-structured Interview Plan

Below is the basic outline of the semi-structured interviews to be conducted with a small sample of pupils.

Interviews with Pupils Regarding Science Lessons

You MUST start by reviewing ethics each time - Free to withdraw, can opt out of answer and won't need to give a reason, interviews to be recorded (explicit permission required) and won't be identifiable in the data or the research.

- Can you tell me what you think about science lessons?
- Can you give me some examples of things that make you feel confident in science lessons ?
    - If not organically covered ask about confidence with vocabulary
- How do you think our vocabulary actions help your learning?
- What has/could help you to increase your confidence?
- What benefits do you see from learning vocabulary?
    - If not brought up:
        - Does it help your investigations?
        - Does it help your written work?
- Is there any area of science in which you think we could improve teaching to help you feel confident and learn more?

At any point in the interview tangents can be followed to allow the interviewer to gain a better understanding of the participants' views. Where this arises the interviewer will return to the pre-planned questions at a suitable point and once the tangent has been exhausted.

Aim for interviews to last roughly 15mins and all are to be conducted in person with five interviews being conducted in an afternoon.

9.4 Appendix Four - Letter sent to parents/carers of interview participants

[redacted]

Dear Parents/Carers,

We are reviewing our science teaching this year in Year 5 and, as you will know, the children's views are incredibly important to us at [redacted]. In order to understand the children's views better we are going to be undertaking some focus groups with a number of children in the year group. I am writing to you as we would like to invite your child to take part in these focus groups.

These focus groups will all be conducted within school hours and will be conducted by [redacted]. The aim of these groups will be to explore the children's perceptions of science lessons, the teaching of science vocabulary and their confidence in the subject. They will be carried out in groups of between three and five children and take roughly 20 minutes each. These groups will also have been discussed with your child today to ensure that they are happy to participate.

If you have any further questions or do not want your child to participate please contact [redacted] via email ([redacted]).

Many thanks

[redacted]

[redacted]

9.5 Appendix Five - Ethical approval Form

Below is the CUREC form submitted to the education department to obtain ethical approval for the intervention carried out in this research.

SECTION A: Filter for CUREC 2 application		
This section determines whether the application for ethics review should be made using the this form (CUREC 1A) or the CUREC 2 form (for research with more complex ethical issues).		
Please indicate with an 'X'.	**Yes**	**No**
1. Does the research involve the deception of participants?	☐	×
2. Are the research participants vulnerable in the context of the research, or classed as people whose ability to give free and informed consent is in question? For example, ● Participants aged 16 or under (also answer question A5); ● Participants aged 16 – 18 (refer to competent youths for guidance); ● adults at risk; Note the University's Safeguarding Guidance and Code of Practice and its implications for researchers involving young people or adults at risk.	**X**	☐
3. By taking part in the research, will participants be at risk of criminal prosecution or significant harm?	☐	×
4. Does your research raise issues relevant to the Counter-Terrorism and Security Act (the Prevent Duty), which seeks to prevent people from being drawn into terrorism? Best Practice Guidance 07 on the Prevent Duty provides further guidance.	☐	×
If you answered **'No'** to all the questions above, go to Section B. If you answered **'Yes'** to any question above, continue to question 5 below.		
5. Is your project covered by a CUREC Approved Procedure?	×	☐
If yes, list the CUREC Approved Procedure(s) you will follow	MSc modus operandi	
If you answered '**Yes**' to ANY of questions 1-4, and answered '**No**' to question 5, **stop** completing this form and do not submit it for ethical review. You will instead need to submit a CUREC 2 application form. If you answered '**Yes**' to **any** of questions 1-4, and your project is covered by an Approved Procedure, **go on to Section B**. If more than one Approved Procedure applies, contact the SSH IDREC or your DREC for advice on whether a CUREC 2 form should be submitted instead.		

SECTION B: Researchers

1. Name of Principal Investigator or student's supervisor	[redacted]
2. Department or Institute	[redacted]
3. University of Oxford telephone number	
4. University of Oxford email address	[redacted]
Copy and paste the following six rows as necessary to complete for each additional researcher who will be involved in this study, including student(s) and those external to the University.	
5. Name of researcher or student	[redacted]
6. Department or Institute	[redacted]
7. University of Oxford telephone number	
8. University of Oxford email address	[redacted]
9. Role in research	Researcher/Teacher practitioner
10. Degree programme, if student research	MSc Learning and Teaching
The whole research team	

11. Have the researchers undertaken research ethics and integrity training?	**Yes X**	**No ☐**

12. Please provide details of any research ethics and integrity training undertaken, including the dates of the training. Alternatively state relevant research experience.	Research methods seminar including ethics
13. State any conflicts of interest and explain how these will be addressed.	None

SECTION C: The research project	
1. Title of the research project	
A study into the teaching of scientific vocabulary in a primary classroom.	
2. Anticipated start date of the aspect of the research project involving human participants and/ or personal data (**dd/mm/yy**).	**04/01/2022**

3. Anticipated research end date (**dd/mm/yy**).	**31/08/2022**

4. Provide a brief lay summary of the aims and objectives of the research. This should cover the questions it will answer and any potential benefits. (max 300 words)
I am an MLT student and this study is a small scale research and development project. I will be getting the written consent of the headteacher to complete this study (see letter included). The study aims to look at the research around effective teaching of vocabulary and in particular of science vocabulary. It will look at effective classroom practices and seek to implement a new way of teaching vocabulary. The study will consist of a questionnaire before the new teaching is implemented to assess children's confidence in using and understanding scientific vocabulary. Children will repeat the same questionnaire at the beginning and end of each unit. This will look at their knowledge of vocabulary as well as including questions about their confidence. It will also look at enjoyment of science units. The study will aim to establish if implementing vocabulary teaching will improve the students understanding, attainment or enjoyment of science lessons. Both understanding (of vocabulary) and enjoyment will be assessed through the study questionnaire. Attainment and understanding of the unit will be assessed through a preplanned end of unit quiz. Focus groups will be used to dive into the results of the questionnaire. It will be semi-structured and questions planned from the themes of the questionnaire. The intervention will be implemented at the start of science lessons and focus largely on unit specific vocabulary. There will be short focused vocabulary sessions at the start of lessons. The potential benefits of this study may be to increase pupils' understanding of both topic related vocabulary and more general science vocabulary. This may allow them to find more enjoyment in the enquiry based lessons as cognitive load will not be overloaded by vocabulary. This will also allow them to get more from their science lessons and increase attainment. Pupils won't be able to opt out of the intervention itself as this will take place in science lessons however they can opt out of the questionnaires and focus groups.

5. Please indicate the methods to be used (indicate with an '**X**'):	
Analysis of existing records	☐
Snowball sampling (recruiting through contacts of existing participants)	☐
Use of casual or local workers e.g. interpreters (refer to guidance in BPG 01: Researcher safety)	☐
Participant observation	☐
Covert observation	☐
Observation of specific organisational practices	☐
Participant completes questionnaire in hard copy	☐
Participant completes online questionnaire or other online task (refer to guidance in BPG 06: Internet-mediated research)	X

Using social media to recruit or interact with participants (refer to guidance in BPG 06: Internet-mediated research)	☐
Participant performs paper and pencil task	X
Participant performs verbal or aural task (e.g. for linguistic study)	☐
Focus group	X
Interview (refer to guidance in BPG 10: Conducting research interviews)	☐
Audio recording of participant (you will generally need specific consent from participants for this)	X
Video recording of participant (you will generally need specific consent from participants for this)	☐
Photography of participant (you will generally need specific consent from participants for this)	☐
Others (please specify below)	☐

6. Provide a brief summary of the research design and methods. What will research participants be asked to do? (max 300 words)
   Please also submit a copy of the questions participants will be asked, if applicable, or some information about the sorts of topics that will be covered.

Participants will be provided with information about the study in a year group assembly and told that they will be able to withdraw from being included in the study data. They will still participate in the vocabulary sections of the lesson but they will not take part in the questionnaires or focus groups. They will continue to complete the end of unit quiz but their scores will not be included in the study.
Children participating in the study will complete a questionnaire testing their knowledge of the vocabulary for the unit (and any included enquiry vocabulary) at the start of the unit . This will then be repeated at the end of the unit. They will also answer some questions about their enjoyment of science lessons and how they have felt about the teaching of vocabulary in the unit - the questions on the questionnaire will vary slightly between units as it will take into consideration that unit's teaching. (See example questionnaire included)
A small sample of the participants will be selected for focus groups. 5 children in each of the four classes will be included in these interviews. They will ask questions that arise from the questionnaire - for example to look deeper at the reasons for children's enjoyment in science and what might be limiting this. Most of the focus group will be led by the children and their discussions. These interviews will be audio recorded. Children will be told that this will be happening and they will be told that this is for transcription purposes only. Children will have a chance to ask questions about the audio recording and consent will be collected. Focus groups will focus around the same themes as question 4-7in the example questionnaire.

7. List the location(s) where the research will be conducted, including any other countries.	Primary School in Surrey
8. Clarify which parts of the research will be conducted in-person and which will take place remotely, e.g. online.	All research to be completed in person. Questionnaires to be completed online but in school time.

9. If your research involves fieldwork or travel and your department requires a travel risk assessment, will you have completed and returned a risk assessment form beforehand? Please indicate with an '**X**'. (This must be approved by your department before you travel. If you are travelling overseas, you are advised to take out University travel insurance.) Refer to guidance available from your Department, the Safety Office, the Social Sciences Division, and the Humanities Division, and on travel for University business.	Yes	☐
	No	**X**
	Not required in this instance	☐

10. In the case of international or collaborative research, explain how you will address any ethical issues specific to the local context. Please provide details of the local review, approval or permission obtained or required. Refer to the BPG 16: Social science research conducted outside the UK. If there will be no local review, explain why not. Please also address any physical or psychological risks for Oxford researchers and local fieldworkers in Section G.
Not applicable

11. Name of departmental/ peer reviewer (if applicable)	Not applicable
12. External organisation funding the research and grant reference (if applicable)	Not applicable
13. Please refer to the CUREC Best Practice Guidance and list any that have been used to develop your research.	BERA ethical guidance will be used throughout.

SECTION D: Recruitment of research participants	
1. Number of participants	Approx 120 participants Focus groups - 20 participants (5 per class)

2. How was the number of participants decided?	Enough to give a good amount of data and to keep consistent teaching across a year group without causing issues of too much data.	
3. Age range of participants	9-10 years old	
4. Inclusion criteria	Currently in Year 5 at the study school	
5. Exclusion criteria	None	
6. Indicate with an '**X**' all intended recruitment methods **Please submit copies of the recruitment material that will be used, e.g. advertisement text, introductory email text.**	Poster advert	☐
	Flyer	☐
	Email circulation	☐
	Social media (e.g. Twitter, Facebook)	☐
	Website	☐
	In-person approach	**X**
	Snowball sampling	☐
	Recruitment sites (e.g. Mechanical Turk)	☐
	Existing contacts or volunteer database	☐
	Other (please specify):	X
	In the year group already	
7. How will potential participants be identified and approached?	Participants will be in the four Year Five class at the study school. The research will be explained to all children at the start of the spring term.	
8. Will informed consent be obtained from the research participants or their parents/ guardians? If not, please explain why not.	Children will be informed of the questionnaire use and will be able to opt out of this if wanted but they will still be included in the lessons as these will take part as part of routine science lessons. Children will be able to opt out of being included in the research.	

9. For each activity or group of participants, explain how informed consent will be obtained from the participants themselves and/ or their parents/ guardians, if applicable. How will their consent be recorded?	Children will be told about the study in a year group assembly. They will be told about the vocabulary intervention, the data that will be collected and how this data will be used. They will be able to come and talk to me about the study and to inform me that they don't wish to take part. A google form will be used to collect consent from the children for their data to be included in the study. All children will still participate in the lessons regardless of whether they are taking part in the study or not.
10. Provide details of any payments and incentives and the rationale for providing these. Further guidance in Best Practice Guidance: 05 Payments and incentives in research.	None
11. Describe how participants ● may withdraw from the study ● may withdraw any personal information they have provided from the study State any limits to withdrawal, for example once the data has been anonymised or at some other specified stage prior to publication. Make sure participants are aware of any withdrawal limits.	Children already know me as a year group teacher so they will be able to withdraw from being included in the research by speaking to me. They will still participate in the lessons included in the study but data will be removed before making it anonymous. Once data has been anonymised children will no longer be able to withdraw as it will be impossible to identify their data. Children will be told when this is going to happen and that withdrawal will no longer be possible

SECTION E: Research data

All information provided by participants is considered research data for the purpose of this form. Any research data from which participants can be identified is known as personal data; any personal data which is sensitive is considered special category data. Management of personal data, either directly or via a third party, must comply with the requirements of the UK General Data Protection Regulation (UK GDPR) and the Data Protection Act 2018, as set out in the University's Guidance on Data Protection and Research.

In answering the questions below, please also consider the points raised in the Data Protection Checklist and Data Protection Screening Assessment and whether, for higher-risk data processing, a separate Data Protection Impact Assessment may also be required for the research. Advice on research data management and security is available from Research Data Oxford and your local IT department. Advice on data protection is available from the Information Compliance team.

For guidance on conducting internet-mediated research, refer to CUREC's Best Practice Guidance 06: Internet-mediated research.

1. What data will be collected? (Indicate with an '**X**')

Screening documents	☐	Task results (e.g. questionnaires, diaries)	X
Consent records (e.g., written consent forms, audio-recorded consent, assent forms)	X	IP addresses (refer to Best Practice Guidance 09: Data collection, protection and management for guidance)	☐
Contact details for the purpose of this research only	☐	Field notes	☐
Contact details for future use (guidance)	☐	Photographs	☐
Opt-out forms	☐	Information about the health of the participant (including mental health)	☐
Audio recordings	X	Previously collected (secondary) data	☐
Video recordings	☐	Data already in the public domain. Specify the source of the data:	☐
Transcript of audio/ video recordings	X	Other, please specify:	☐

2. During the course of the research, where will **each type of** research data be stored?	Questionnaire results will be stored securely within the school drive. All other data relating to the study will be collated in a secure folder within the school drive.
3. Who will have access to the research data during the project?	Questionnaire responses will only be visible to the researcher. Lesson plans and assessment data will only be accessed by the research teacher and any class teachers who require access for the purposes of teaching and assessing their participating classes.

4. Please complete this section if your research involves the use of secondary (i.e. previously collected) data.	**Please indicated with an 'X'.**	**Yes**	**No**
	Are data access agreements in place for access to and use of this secondary data? (If so, please attach these.)	☐	☐
	Did the individuals agree that their data could be used for this purpose?	☐	☐
	Could anyone (including members of the research team) link the data back to an individual or individuals? If this is a possibility, please explain how the associated ethical issues will be addressed:	☐	☐
5. How do you intend to share the research data at the end of the project?	Depositing in a specialist data centre or archive	☐	
	Submitting to a journal to support a publication	☐	
	Depositing in an institutional repository	☐	
	Dissemination via a project or institutional website	☐	
	No plans to share the data	X	
	Other (please specify):	☐	
6. How do you intend to report and disseminate the results of the research? (Indicate with an 'X')	Thesis publication	☐	
	Publication in a peer reviewed journal	☐	
	Publicly available report	☐	
	Conference presentation	☐	
	Publication on a website	☐	
	Report to a research funder	☐	
	Providing participants with a lay summary of the results	☐	
	Submission for academic assessment	X	
	Other (please specify):	☐	

7.	Explain what will happen to the data at the end of the research project. This question must be answered for each type of data, including completed consent forms.
	Data will be kept securely on the school drive for 3 years after the study is completed. It will be held anonymously and not include any personal data. After 3 years, the data will be deleted.

SECTION F: Protection of research participants and their personal data		
1. How identifiable will the participants be from the **research outputs**? (Indicate with an 'X')	Directly identifiable from the information included	☐
	Pseudonymised/ indirectly identifiable	☐
	Not identifiable – data is anonymous	X
	Other, please specify:	☐
2. To what extent will the **data** be de-identified? How identifiable will any individuals be from the research data? Describe any measures you will take towards assuring confidentiality, potential risks to confidentiality.	Data collected by questionnaire will be anonymised when collected Data from end of unit quizzes will be anonymised when included in the study research. These quizzes are part of routine classroom practice and so cannot be anonymised on collection. Focus groups will be anonymised as the transcript is written.	
3. How will you ensure that third parties (e.g., interpreters and transcribers) are aware of and adhere to the measures described in this form?	No third parties will be used.	

SECTION G: Risks and benefits of the research
1. Will the research involve topics that could be considered sensitive? If so: a. Please provide more detail or supporting information (such as the interview questions) to show the range of questions; b. Explain what steps will be taken to reduce risk of distress; c. Consider seeking advice from within your Department or from the ethics committee including whether the application might benefit from additional ethics review (e.g., via a CUREC 2 application).
No
2. Describe any additional burden or risks to the participants and the steps you will take to address these.
Not applicable
3. Describe any physical or psychological risks to the researcher(s) (including local fieldworkers or research assistants) and the steps you will take to address these.
Not applicable
4. Describe any benefits of the research, both to participants and to others.
The benefits of the study will be to show the effects of vocabulary teaching on understanding in science as well as enjoyment of enquiry based science teaching. If the benefits are apparent in the study group then the format will be rolled out to other year groups.
5. Give details of any other ethical issues or relevant information.
There is currently no formal vocabulary teaching included in science lessons. There will be no other changes to science teaching so there is limited chance of harm. All other ethical issues are accounted for elsewhere in the form.

SECTION H: Professional guidelines
Please indicate with an '**X**' at least one set of professional guidelines you will follow.

Research specialism/ methodology	Association and guidance	
Anthropology	Association of Social Anthropologists of the UK	☐
Computer Science	ACM Code of Ethics and Professional Conduct	☐
Criminology	British Society of Criminology Statement of Ethics	☐
Education	British Educational Research Association Ethical Guidelines for Educational Research	X
Geography	American Association of Geographers Statement on Professional Ethics	☐
History	Oral History Society of the UK Ethical Guidelines	☐
Internet-mediated research	Association of Internet Researchers Ethical Guidelines British Psychological Society: Ethics Guidelines for internet-mediated research Association for Computing Machinery Code of Ethics and Professional Conduct	☐
Management	Academy of Management Code of Ethics	☐
Political Science	American Political Science Association (APSA) Guide to Professional Ethics in Political Science	☐
Politics	Political Studies Association. Guidelines for Good Professional Conduct	☐
Psychology	British Psychological Society Code of Ethics and Conduct	☐
Social research	Social Research Association: Ethical Guidelines	☐
Socio-legal studies	Socio-Legal Studies Association: Statement of Principles of Ethical Research Practice	☐
Sociology	The British Sociological Association: Statement of Ethical Practice	☐
Visual research	ESRC National Centre for Research Methods Review Paper: Visual Ethics: Ethical Issues in Visual Research	☐
Other professional guidelines		☐

SECTION I: Endorsements and signatures

Please ensure this form is endorsed by the Principal Investigator (or student's supervisor), the Head of Department (or nominee) and, if student research, by the student themselves. **The SSH IDREC Secretariat accepts either option below. If you have a DREC, check which signature option it prefers.** ● **Option 1: direct email endorsements** Each of the signatories should submit an email from a University of Oxford email address, indicating their acceptance of the responsibilities listed below. ● **Option 2: signatures** Please scan the signed form and email it to us as a PDF. Pasted images of signatures cannot be accepted.
Endorsement by the Principal Investigator/ student supervisor and student, if applicable
I/ we the researchers understand my/ our responsibilities as Principal Investigator (and student, if applicable) as outlined in the guidance on the CUREC website. I/ we declare that the answers above accurately describe the research as presently designed, and that the ethics committee will be informed of any changes to the project which affect the answers to this form. I/ we will inform the relevant IDREC if the Principal Investigator changes.

Name of Principal Investigator	[redacted]
Principal Investigator's signature	See email
Date	15/11/21
Name of student (if applicable)	N/A
Student's signature	N/A
Date	N/A

9.6 Appendix Six - Letter to Headteacher of the school regarding the intervention

Below is the letter sent during the autumn term to the school's headteacher regarding the intervention being carried out in the school.

[redacted]

Dear [redacted]

I am writing to enquire about conducting research in school this academic year. As you know, I am studying for the Master's in Learning and Teaching at Oxford University, supervised by [redacted]. In my final research project 'A study into the teaching of scientific vocabulary in a primary classroom' I will explore the impact of targeted vocabulary teaching within an enquiry based science curriculum.

The research will take place within Year 5 as part of their science lessons. I am developing ways of encouraging a deeper understanding of vocabulary in science and how this can then help to support science teaching and increase pupils' enjoyment of science. My research focus is on students' scientific vocabulary and how teachers can develop this. [redacted], as the head of science, and the Year 5 team have agreed to collaborate with me on this.

By participating in the research, the school would be contributing to a project that will deepen our understanding of scientific vocabulary learning for our students, and so contribute towards developing ways of improving scientific understanding for similar students in the school in the future. It will also contribute to Scientific education more widely.

I hope to conduct this research between January 2022 and July 2022. I would conduct questionnaires at the start and end of the science units to investigate the impact of the vocabulary teaching on understanding and enjoyment of science lessons. I would use interviews with audio recording to get more information on pupils' understanding and their enjoyment of science linked to vocabulary. I would also use the routine end of unit scores to assess pupils' understanding of the topic.

Oxford University has strict ethical procedures on conducting ethical research, consistent with current British Educational Research Association guidelines. The University also recognises, however, that my study is a piece of practitioner research, and that schools already operate with the highest ethical standards. Therefore only <u>your</u> formal consent as headteacher is necessary, and not that of individual parents or staff. However, throughout the research, students and other teachers will be able to refuse to participate in any research activities at any time.

All participants, including students, teachers and the school, would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor [redacted] and me, and only used for academic purposes. It will be kept for as long as it has academic value.

If you are happy for me to proceed with this study, please confirm that using the attached reply form. If you have any concerns or need more information about what is involved, please contact me or my supervisor. Further, if you have any questions about this ethics process at any time, please contact the chair of the department's research ethics committee, though: research.office@education.ox.ac.uk

I look forward to hearing from you.

Yours sincerely,

[redacted]

9.7 Appendix Seven - Word lists with definitions

Below are the word lists used in this intervention. The First table shows the Life cycle word list and the second table shows the space word list.

Life cycles word list	Life cycles definitions
juvenile	The young of an animal before it becomes an adult
gestation	The length a mammal is pregnant with their young
reproduction	The process through which living thing (animals or plants) create offspring or young
pollination	Causing pollen to transfer from one flower to another to allow for reproduction.
metamorphosis	The change that occurs when a baby and adult of the same species look very different (e.g tadpoles and frogs)
pupa	The stage of an insect's life when it undergoes metamorphosis inside the cocoon.
larva	Young wingless form of an insect (e.g. caterpillar)
nymph	The young of an insect that doesn't undergo metamorphosis
life cycle	The journey of change that takes place throughout the life of a living thing including birth, growing up etc.
germination	When a seed sprouts its first shoot

Space word list	Space Definitions
orbit	The path an object takes around a particular point in space - normally elliptical (circular) in shape.
atmosphere	The layer of gas (often called the air) that surrounds a planet.
The Solar System	The sun and everything that orbits it including the eight planets.
Universe	Everything that exists.
Galaxy	A huge collection of gas, dust and stars held together by gravity.
constellation	A group of stars together in a pattern
rotate	To turn around a centre point
eclipse	A complete (or partial) hiding of the sun caused by the moon moving between the Earth and the Sun
celestial body	Any object that exists outside the Earth's atmosphere
satellite	A small object that orbits a larger object - these can be manmade or natural
spherical	Having the form of a sphere (ball)
axis	An imaginary line that an object rotates around

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