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The Language of Biology: Does the introduction of language-learning techniques in Year 12 biology lessons increase students' understanding in areas that are cognitively demanding due to high quantities of technical vocabulary?

Jaya Tamber

(PGCE Biology, 2018-2019)

email: jkt34@cantab.ac.uk

Abstract

The extent to which precisely defined terms are used within science lessons has been well documented as a significant barrier towards learning. However, despite numerous studies highlighting the importance and difficulties associated with semantic understanding in science, how this barrier could be overcome has received much less attention. Therefore this investigation will not only explore students' perception towards precisely defined vocabulary, but as an action research study will investigate the effectiveness of methods drawn from subjects where learning vocabulary is of primary importance. In so doing it will be argued that such methods facilitate both students' precise understanding of key terms, as well as their wider conceptual understanding of whole processes.

The Language of Biology: Does the introduction of language-learning techniques in Year 12 biology lessons increase students' understanding in areas that are cognitively demanding due to high quantities of technical vocabulary?

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Introduction

Too often individual subject areas are taught as discrete entities, especially in a secondary school setting. However, there are similarities between them, which tend to be overlooked. One of these similarities is the use of specialist language within a particular subject area. However, despite this, a clear focus on language is found associated with some subject areas more so than others. This applies to the overarching theme of this investigation, which will be to investigate the understanding of the language used in the science classroom, the barriers which are created as a result of this language of science, and how such obstacles may be overcome using methods which feature in other disciplines.

The language of science is well-documented as being cognitively demanding for students, particularly due to large amounts of precisely defined vocabulary. However, as opposed to subjects where language is more explicitly taught, rehearsed and practised, such as during English or modern foreign language (MFL) classes, careful attention towards the introduction of new vocabulary in science is often lacking. This, as will be explored, is particularly problematic to students, given that to access scientific concepts they must be able to navigate, understand and recreate the language of science for themselves.

As the science curriculum is particularly content heavy, a lack of time allocated towards vocabulary and literacy skills has been suggested as one potential reason for students' poor understanding (Winterbottom & de Winter, 2017). Another suggestion is that language acquisition is not addressed with trainee teachers at the start of their careers (Feez & Quinn, 2017). Consequently, this investigation aims to explore how science teachers can attend to the demand that language acquisition poses for students, using methods from across the curriculum. In order to achieve these aims, this study will first involve a critical analysis of prior research exploring the challenges associated with the language of science. As well as this, insights from classroom observations have been used to inform the development of an action research study, to investigate practical solutions to the aforementioned issue. The details and results of which will be analysed alongside existing research and used to inform future research and practice, with regards to how the use of language in biology lessons should be addressed, arguing for the merit of a greater vocabulary focus.

Literature Review

> "One of the most important pieces of technology used by scientists, and one that is often overlooked, is language,"
>
> (Martin, 1993).

Acknowledgments towards the role of language in science, as Wellington and Osborne (2001) explore, have been prevalent since the 1970s, when the issue was brought to the forefront of educational affairs. At this time, the idea that all teachers should see themselves as language teachers was brought to attention, and more formally declared within a governmental report written by Sir Alan Bullock, entitled *A Language for Life* (Bullock, 1975). By 1995, despite the Department of Education's requirement for a use of language section in all key stages, recognition of language as a barrier to students' learning, as Wellington and Osborne (2001) comment, still appears to be lacking within the classroom, providing good cause for this very investigation.

It is estimated that within each GSCE science lesson at least six new words are introduced (Winterbottom & de Winter, 2017), which will inevitably mount up over the course of a term. In MFL classes, learning new vocabulary is indicated as of primary importance, and therefore time is allocated towards developing confidence. Trainee language teachers are provided with a toolkit of methods to introduce new language to students through a multitude of engaging methods.

A traditional approach to language acquisition is through the presentation, practice, production (PPP) method (Pachler & Field, 2001). The PPP method is a teacher-led framework, which since emerging in the 1970s has persisted as a durable and practically viable method (Anderson, 2016). It is built up from a view that sees learning as a linear process, through which knowledge is understood, internalised and activated. Consequently, while progressing through the levels, not only are the chosen activities different, lending themselves towards distinct aims, but the role of the teacher also changes through gradually relinquishing support (Pachler & Field, 2001). Initially popular in its introduction as a method to increase communication within lessons, the method has received a number of criticisms during the 1990s. As Anderson (2016) discusses, criticisms of the model included ideas that through being predominantly teacher-led, the method thus neglected students' needs and individual challenges. A further argument arose, involving the belief that the model was too inflexible. However, Donn Byrne whose initial publication in 1976 first featured the PPP method commented on the model's flexible nature (Byrne, 1986, cited in Anderson, 2016), presenting it as just one of a number of ways to construct a lesson. The latter therefore may explain how the model has since regained popularity and remains a staple framework for trainee language teachers (Anderson, 2016). Taking this method as a template, it is plausible to hypothesise that this is a method that could facilitate students' understanding of scientific language.

In support of applying language acquisition methods towards learning scientific vocabulary, Feez and Quinn (2017) explain how many scientific words have been derived from Greco-Latin terms, such as ecosystem and quadrant. However, when learning a new language, often visual images are used to depict the meanings of the familiar objects being presented (Feez & Quinn, 2017). Interestingly with scientific vocabulary, the sense of visual familiarity may be missing entirely, as many scientific terms accompany abstract and unfamiliar imagery. Scientific vocabulary also encompasses normalised everyday terms, but imposes a precise definition upon them. For these very reasons, Wellington and Osborne (2001) even go as far as to suggest that learning scientific vocabulary may be *more* difficult. This could be particularly apparent given the constant switching between everyday and scientific terms that occur within a single lesson (Feez & Quinn, 2017).

It is possible to separate scientific vocabulary into two categories. The first is technical vocabulary, which encompasses words that are specifically related to science and at first presentation will be unfamiliar in sound and meaning. The second is non-technical vocabulary. Words in this category are likely to have familiar everyday meanings, as well as specific and unfamiliar scientific ones. In order to assess the aforementioned barrier students face when learning science, due to the use of specialist language (both technical and non-technical), numerous studies have been conducted on the topic, highlighting this very issue.

It was the work of Gardner in 1972, who through testing 700 students' understanding of a total of 600 popular words used by science teachers, found that even the most popular words were not understood by many students (Farrell & Ventura, 1998). In response to this initial study, British researchers Cassels and Johnstone began to conduct follow up studies from 1975, in response to the problematic nature of non-technical vocabulary (Farrell & Ventura, 1998). In 1985 Cassels and Johnstone refined their research towards 95 of the most problematic non-technical terms, to which less than 70% of students responded correctly (Cassels & Johnstone, 1985). The study entitled, *Words that Matter in Science*, involved checking the understanding of non-technical vocabulary, through the use of a multiple choice test, which assessed the ability of students to identify the meaning of these words when presented within a sentence. This was a particularly large-scale study, involving over 200 schools and 30,000 students, from the first year of secondary school until sixth form. The study found that very few words were understood to a satisfactory level, and that if unsure students displayed a tendency to select the opposite meaning (ibid.). Students also tended to be confused by words that sounded and looked alike, and appeared to perform poorly when precision was required in the definition (ibid.). In response, Cassels and Johnstone (ibid.) commented that, "In science the precise meaning of a word is required, but in normal parlance a woolly use is often acceptable" (p.14). The study concluded that much of the language used by teachers was inaccessible to students and highlighted the danger in both the teacher and student assuming each other's understanding of a particular word was the same. As a consequence, this would have a detrimental impact upon concept development, rendering the teaching *meaningless* (ibid., p.15).

Given the results of such a large-scale investigation, later research highlighted this field as an area of international importance. For instance, an American study conducted by Meyerson, Ford, Jones and Ward, (1991) tested 269 students using a common core list of words extracted from textbooks, finding that students often confused everyday terms that had a particular scientific meaning. In Papua New Guinea, Marshall, Gilmour, and Lewis (1991) selected 45 words from the list of 95 shortlisted in the Cassels and Johnstone (1985) study. Multiple-choice tests were used to assess the understanding of non-technical words from 2,111 students (629 female, 1477 male, 5 undeclared) ranging from 13-27 years, but focussed on those of A-level age. Each word was tested in four different formats, representing a different context and level of difficulty (Marshall et al., 1991). The findings were similar to those expressed by Cassels and Johnstone (1985), with a high number of students confusing words that were phonetically and semantically similar, as well as often choosing the opposite meaning. Marshall et al. (1991) further reported students performing better when non-technical terms were presented within a science context. The study suggested that this might be because a scientific context is where these words may first have been seen (ibid.), however this remains unclear in the absence of asking students where they first encountered such terms.

In addition to the studies mentioned above, which were predominantly based on issues surrounding the dual meaning of non-technical vocabulary in science, in Tasmania, Lynch et al. (1979, cited in Farrell & Ventura, 1998) used multiple choice tests to conduct a study on 1,635 12-16 years olds. The study tested 16 technical terms related to the topic of nature and matter, and similarly to previous studies, they also reported an alarming frequency of misunderstandings. In identifying a cause for a non-technical focus, Marshall et al. (1991) claim that teachers are likely to define technical terms when first presented. However, given the frequency of misunderstandings as identified by Lynch et al. (1979, cited in Farrell & Ventura, 1998), it appears that these initial acknowledgements may be insufficient to instil and retain meaning.

Building upon these findings, a further study conducted by Farrell and Ventura (1998) involved an analysis of both technical and non-technical vocabulary in Maltese A-level physics students. The test involved 306 students with an average age of 17, and was split into two parts. The first part involved students receiving the full list of 75 words frequently used by physics teachers (50 non-technical, 25 technical) and indicating *yes* or *no* as to whether they could define them. The second part involved students receiving a sample of the full vocabulary list with which they had to write a definition for a selected word that had been displayed within a sentence. However, as Farrell and Ventura (1998) comment, unlike prior studies that utilised multiple-choice answers, many of the responses were subjective. Nevertheless the study not only found that many students struggled to define the given terms, but that the percentage of students who actually were able to correctly define a particular word was less than the percentage who claimed they could. The latter was analysed using a statistical test known as a paired t-test to comment of the significance of the data collected, which expressed a low correlation between actual and claimed results. Through the novel use of predicted and actual scores, the study confirmed assumptions made by prior studies, in that semantic understanding cannot be assumed from mere familiarity with such terms.

Many of the studies discussed have tended to focus on the later school years, some even indicating difficulties faced by students about to enter university education (Marshall et al., 1991). It may be expected that students at this level would be competent with the language of science at this point, but interestingly this does not seem to be the case. A-level teaching is also often taught in a more lecture-style manner. Even within MFL classes where a higher frequency of interactive activities are often found, during the higher key stages there appears to be a transition from interactive to instructive methods (D'Arcy, 2006). In response to this shift, D'Arcy (2006) presents the possibility that it is due to a focus on obtaining higher grades. However, drawing from ideas as introduced by Stones (1979, cited in D'Arcy, 2006, p. 25) that, "classroom interaction allows teacher and pupil experiences to come together to create new understandings of concepts," if the cognitive demand of new language sill exists higher up the key stages, surely a place for interactivity remains.

A further theme prevalent from prior research studies is that they all focus on misunderstandings in physics or science more generally. However, one particular A-level biology topic that is often subject to misconceptions is one that explores the transport mechanisms in plants. Not only does this topic involve a large quantity of technical vocabulary, but students must also use this vocabulary competently to describe a range of conceptual multi-stage processes. Furthermore, as mentioned by Clifford (2002), the teaching and learning of plant transport processes such as translocation, is not only reliant on the understanding of a number of keywords, but is often subject to misconceptions found within the textbooks themselves. Therefore, it appears all the more imperative that students fully understand the vocabulary being used in order to grasp complex concepts and reduce the possibility of confusion.

From the analysis of literature thus far, there are a number of elements that stand out regarding this area of investigation, particularly involving the lack of research into students' understanding of technical vocabulary and especially in the field of biology. It is also apparent that difficulties with understanding scientific language are prevalent even at higher levels of education. Finally, while the issue of a lack of understanding with regards to scientific language has been clearly indicated, there appears to be a real need to investigate practical solutions. Consequently, this investigation aims to draw upon methods used in prior studies to explore how techniques inspired by practices used within MFL classes, where language is made a priority, could enforce a greater vocabulary focus in A-level biology lessons, in areas where the cognitive demand imposed by technical vocabulary is high.

Methodology and Methods

Methodology: Action Research

This study draws on the principles of action research. Action research takes an active approach towards conducting a small-scale research study in order to inform future practice. As a cyclical process (seen in Figure 1), it relies on the premise of change, both being indicative of the way things currently work and also as a vehicle for further knowledge. Starting with a reflective analysis of professional practice, the practitioner selects a particular area to be improved. The process then involves consulting with the existing literature, before using this initial research to inform the planning of a well-informed study. The identified strategy for change is then investigated in practice, and reflected upon by the practitioner, who will use these findings to inform future professional practice, as well as future research in the field (Denscombe, 2010).

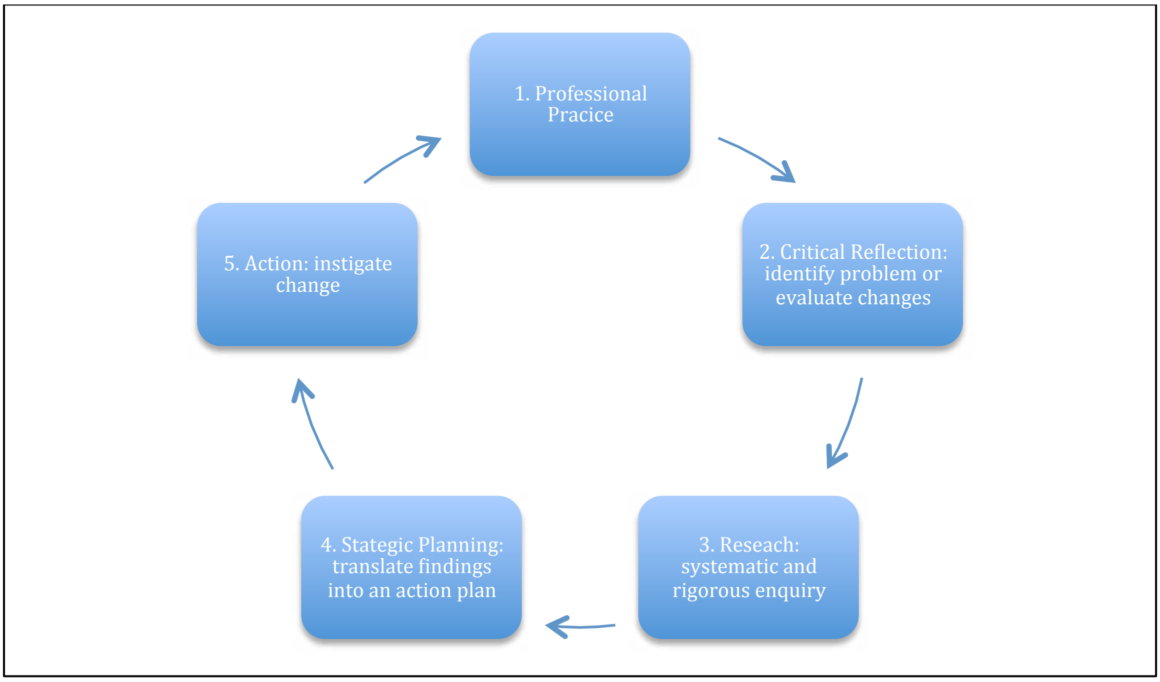

Figure 1: Action research as a cyclical process (redrawn from Denscombe, 2010, p.129).

Strengths and limitations of action research

The major advantage of action research is that it is practical, and provides results that feed directly into future development. As a result the practitioner of the research is directly involved in a process that contributes to their own continual professional development. However, due to small sample sizes, the scope for generalisations is limited. In addition, action research does not allow for comparison with a control sample because conclusions are limited to the class in question (as the purpose is about one teacher's development); therefore the measures taken are conducted within routine activity rather than alongside it (Denscombe, 2010). A further limitation of this model involves impartiality, which is difficult to obtain given that the individual conducting the study will have a vested interest in the study itself. Consequently such limitations need to be taken into consideration when assessing the outcome of the study.

Reasons for conducting an action research study

The need to conduct an action research study was initially inspired by classroom observations. For example, when coming to the end of a particular topic, a Year 13 student commented on the cognitive load associated with the amount of vocabulary associated with it. Reflecting on this instance, it occurred that addressing unfamiliar key terms, through incorporating a greater literacy focus, could help to relieve the overwhelming sensation felt by students found reviewing the content at the very end of a lesson sequence. With a particular area identified with scope for change, action research provided a suitable method to draw upon in order to measure the effectiveness of a specific intervention.

Context

The study involved a Year 12 biology group of 15 participants, within a British all girls' school. As part of a consortium the A-level class was of mixed gender, however with only 1 male student. The topic covered during the teaching sequence investigated the transport mechanisms within plants. Within the A-level syllabus this is a relatively concise topic area, but encompasses a significant quantity of technical vocabulary, as well as some quite challenging concepts. In this case a background understanding of key terms would be essential towards understanding complex processes such as transpiration and translocation.

Details of the intervention

The components of the intervention have been drawn from both existing research in the field and classroom observations. The focus of these initial observations was to gauge the extent of the use of technical vocabulary in biology lessons and to list the techniques used to consolidate the understanding of key terms within MFL classes.

Initial observations

Modern Foreign Languages:

From a particular key stage 3 French lesson, the use of activities to consolidate an understanding of key terms could clearly be identified as meeting presentation, practice and production requirements. For instance, new vocabulary was clearly presented on the board. The practice element comprised of repetition, gap fill and matching exercises, before students were asked to finally produce sentences of their own. Throughout the lesson there appeared to be an emphasis on gaining as much practice as possible. Moreover, phrases used in the lesson were used throughout and never once just mentioned and then moved on from.

A-level Biology Lessons:

During observations of A-level biology lessons, covering a range of topics, the number of technical terms mentioned by the teacher was recorded. It is unknown how many of these terms had been introduced to students previously, however during a total of five observed lessons, an average of 9.4 technical terms were referred to per lesson, with the expectation that students understood their meaning.

Interventions within the lesson sequence

Before the lesson sequence began, a number of technical terms were selected from the biology textbook in relation to the topic. Like the study by Farrell and Ventura (1998), students were presented with a baseline test that initially required them to assess their ability to define each of the 12 selected terms, before doing so using a multiple-choice format.

Throughout the lesson sequence, a number of activities were conducted in order to increase students' familiarity with key terms. The activities used throughout the study followed the PPP model. When and where these methods were utilised within the sequence is displayed in Table 1 below; a sample lesson plan displaying the sequence of such activities within lesson one can be found in Appendix 1.

Lesson 1: Structure and function of the vascular bundle		
Presentation	Practice	Production
Keywords - highlighted on PowerPoint slides Glossary of key terms	Students asked to give key definitions. Biology bingo	Students carried out a microscope study and identified key structures.
Lesson 2: Movement of water through the roots		
Presentation	Practice	Production
Keywords highlighted Key definitions slide	Mini-test *What am I* quiz Student recall	Use of keywords to describe water transport (using current knowledge)
Lesson 3: Transpiration		
Presentation	Practice	Production
Keywords highlighted Keyword glossary	Revision -labelling the structures of a leaf	Describe water movement (follow-up after being taught the model) Xylem modelling
Lesson 4: Factors Affecting Transpiration		
Presentation	Practice	Production
Keywords highlighted and underlined (with definitions)	Mini-test Keywords and definitions buzzer quiz	5 - mark transpiration question Homework - Exam questions on transpiration
Lesson 5: Xerophytes and Hydrophytes		
Presentation	Practice	Production
Keywords and definitions Dingbats Keywords broken down to understand their meaning	Definitions game Transpiration loop activity True or false quiz	Deducing the adaptations of marram grass from an image Exam questions on xerophytes and hydrophytes
Lesson 6: Translocation		
Presentation	Practice	Production
Keywords with definitions Glossary of key terms given	Mini-test Xerophyte or hydrophyte quiz Student recall	Explaining evidence for and against mass flow during translocation.
Lesson 7: Revision		
Presentation	Practice	Production
Key definitions slides	Mini-test Translocation loop activity Plant adaptations quiz Revision activities: Board game	Exam questions Revision maps

Table 1: Presentation, practice and production interventions per lesson

In terms of *presentation*, all keywords were highlighted on the PowerPoint slides alongside model definitions; but were removed from student hand-outs for students to fill in throughout the lesson.

After roughly ten terms were covered, these were collated into glossaries and were presented to students at the end of the lesson.

The *practice* segment was comprised of a range of elements. Students were given short vocabulary tests following the receipt of a keyword glossary, at the start of the following lesson. Students were warned of these tests, and so were able to revise in anticipation. The tests were also presented in a familiar format, emulating the multiple-choice nature of the initial baseline assessment. Less formal practice methods were also utilised throughout the sequence, which included quizzes, concept loop activities, biology bingo and a variety of revision activities at the end of the topic.

In terms of *production*, the final element of the linear scale towards developing competency, tasks were largely based on descriptive and investigative elements. For instance, such tasks involved using keywords to describe the movement of water through a plant before and after the lesson, allowing students to reflect on their progress and their increased ability to utilise keywords correctly. Additionally, investigative tasks allowed students to access and demonstrate higher levels of thinking, while consolidating and showing an understanding of a foundation of key terms. This involved carrying out microscope studies and identifying key structures, creating and analysing tree models and drawing conclusions based on evidence from a series of studies.

Research Design and Methods

The over-arching research question for this study was as follows:

> Does the introduction of language-learning techniques in Year 12 biology lessons increase students' understanding in areas that are cognitively demanding due to high quantities of technical vocabulary?

This broad, over-arching question was broken down into a number of smaller sub-questions (Research Questions (RQ) 1 - 3), and assessed using a variety of methods. The methods used in this investigation can be seen in Table 2 below, from which it is possible to see how each method attends to each of the research sub-questions, along with a time of data collection and the method of data analysis.

Sub-questions	Data Sources			
	Method A		Method B	Method C
	Baseline vocabulary and confidence test	End of topic vocabulary and confidence test	Pupil feedback questionnaire	Group Interview
RQ1 Does the use of language-learning techniques aid the understanding of biological terms?	✓	✓	✓	✓
RQ2 Does the use of language-learning techniques increase students' ability to apply learned vocabulary?			✓	✓
RQ3 Does the use of language-learning techniques affect confidence towards learning?	✓	✓	✓	
Time of data collection	During the first lesson	At the end of the topic	At the end of the topic	At the end of the topic
Data analysis	Displayed graphically, used to assess pre-sequence ability and confidence	Displayed graphically, used to assess post-sequence ability and confidence	Quantitative data displayed graphically and coding of qualitative data	Coding of qualitative responses

Table 2: Research grid displaying how the methods attend to each of the research sub-questions

Method A: Vocabulary Assessment

The methods used to assess students' knowledge of key technical terms within the topic both before and after the lesson sequence were inspired by prior research in the field. Drawing on the work of Farrell and Ventura (1998), the vocabulary assessment was conduced in two parts. Prior to the study, students were given an initial survey, which required them to tick whether they believed they could define twelve key technical terms. Similarly to Meyerson et al. (1991) terms were selected on the chosen topic from within the textbook. Without prior knowledge, students were then asked to define the terms and were provided with multiple-choice answers to do so. Unlike prior studies, this assessment was then repeated following the lesson sequence, allowing for comparisons to be made, pre- and post- lesson sequence. Table 3 (below) presents a sample of each of these two assessment methods for the first two of the twelve items (Xylem and Phloem).

Part 1 Keyword	Yes	No
Xylem		
Phloem		

Part 2 Keyword	Definition
Xylem	a) The vascular tissue in plants which transports amino acids from the roots to the leaves. b) The vascular tissue in plants which transports water from the roots to the leaves. c) The vascular tissue in plants which transports water from the leaves to the roots. d) The vascular tissue in plants which transports sugar from the roots to the leaves.
Phloem	a) The vascular tissue in plants which carries water from the roots to the leaves. b) The vascular tissue in plants which carries nitrate ions from the leaves to the roots. c) The vascular tissue in plants which carries sugars from the roots to the leaves. d) The vascular tissue in plants which carries organic molecules to growing regions of the plant.

Table 3: Example of the two parts of the vocabulary assessment

Method B: Questionnaire

As a method of data collection, questionnaires allow for a standardised data set to be collected quickly from numerous participants. Questionnaires tend to be based on a combination of open and closed questions, the ratio of which will vary in order to alter the range of individual responses. Furthermore, given that participants answer questionnaires for themselves, the researcher will be unable to check responses or request further detail (Denscombe, 2010).

A questionnaire (presented in Appendix 2) was used following the lesson sequence to assess, using a combination of open and closed questions, students' perception towards the cognitive demand created by the extent of new vocabulary in science lessons, as well as their opinions towards the methods employed to overcome such a demand.

Method C: Group Interview

Interviews are useful tools that allow researchers to gain a deeper insight into the thoughts and feelings of the participants through face-to-face questioning. The interview may involve a formal set of questions or vary in the flexibility of the questions delivered. The number of participants may also vary depending on the data the researcher wishes to collect. Through collecting more in depth responses, coding will be required in the analysis of a range of non-standard responses. Furthermore, it is important to take into account that the use of recording devices, as well as the perceptions participants have towards the interviewer, could influence the responses (Denscombe, 2010).

Within this investigation, a group interview was used to gain a greater insight into the responses provided in the questionnaire following the lesson sequence. The group nature of this interview enabled students to listen to each other's comments and either support or challenge. All participants were informed about the nature of the interview prior and given the right to withdraw. Within the interview itself, students were introduced to a number of questions addressing each of the major research elements of the study and were prompted when in need of clarification, detailed in Appendix 3.

Analysis

Analysis of quantitative data

Discrete data generated from the vocabulary and confidence assessments has been displayed graphically. Paired t-tests were conducted to identify the statistical significance of both the difference in test score (actual attainment), as well as the difference in confidence (perceived attainment) pre- and post-intervention. From the student questionnaire (see Appendix 2), any nominal data has also been displayed graphically for comparison.

Analysis of qualitative data

A significant amount of qualitative data was obtained from open questions within the questionnaire and from the group interview. In relation to the questionnaire, all responses were collated into a table and the qualitative responses were colour coded based on seven key categories (facilitated the learning of key terms, facilitated the understanding of general/wider concepts, affected confidence, encouraged revision, encouraged engagement, concerns and suggestions) from which the first three were based upon the research questions and the latter four emerged from common responses. The coded group interview transcript is presented in Appendix 4 and its outcome is expanded on within the Results section.

Validity and Reliability

Validity and reliability are both measures used to make assessments on the credibility of the research. Validity not only refers to how accurate and precise the data is, but also assesses how appropriate the data is in order to attend to the research questions. Whereas reliability assesses whether the same results could be expected if carried out again by a different individual (Denscombe, 2010).

In order to ensure that the data presented within this investigation is valid, a number of steps have been taken. Firstly, the method used to measure student progress with regards to understanding was taken from numerous prior studies, considered as major works within the field. Secondly, regarding the vocabulary assessment and the closed questionnaire questions, only a small set of answers could be given, limiting the range of responses and also ensuring that multiple individuals would draw the same conclusions. It was also important for the qualitative data to be interpreted by multiple researchers in the same way; therefore a deductive framework was developed, such that seven specific themes were identified, thus allowing the data collected to be considered in relation to these pre-generated themes.

With regards to reliability, to remain consistent all the vocabulary tests were presented to students in exactly the same format. The predicted and actual attainment tests provided at the start of the lesson sequence were exactly the same as those presented to students at the end. Furthermore, neutrality in questioning became an especially important aspect of the questionnaire and of the group interview, in order to avoid identifying the intentions of the researcher.

Ethics

This study was carried out according to the guidelines set out by the British Education Research Association (2018). Prior to the study, gatekeepers (class teacher and head of science) were consulted about the nature of the investigation and had given the study full approval and consent to be conducted on an allocated group of students. Additionally, before students were asked to complete the first vocabulary assessment, students were made fully aware of the nature of the study and the reasoning behind it, thus providing full transparency.

During the study data such as students' names were associated with documents used within the data collection stages of the project, however from the point of analysis, all students have been anonymised and will henceforth be referred to using an allocated code made up of the number 12 (as an indication of the year group), followed by a letter (A-O for each of the 15 participants), 12A for example. Similarly the school in which this study took place has also been anonymised.

Results

Quantitative Data

Perceived and Actual Attainment Data

Two measures were conducted with the attainment data taken from the baseline and post sequence tests and have been displayed graphically within Figure 2 (next page). The first graph involves comparing students' perceived attainment towards being able to correctly define a number of terms, before and after the sequence. The second graph in this figure displays students' actual attainment, the number of terms correctly defined, before and after the sequence. Both graphs represent each student as single letters (A-O) along the x-axis (n=15). Additionally, as mentioned above, when referring to each student, this letter will also be combined with the number 12, to create a code that also indicates their year group.

From the first graph (Figure 2a), it is possible to see a marked increase in the number of terms students believed they could define at the end of the sequence, in comparison to the start, with the average increase in predicted self-attainment for the cohort being 5.9 terms. Similarly, from the second graph (Figure 2b), with the comparison of the test scores before and after as a measure of students' actual attainment, all students showed an increase in the number of terms correctly defined. Although not as dramatic as the predicted scores, the average increase in test scores was

3.3 terms. However, while some students only increased by one mark (Students 12A, 12B and 12E), other Students 12F and 12L, showed a more drastic increase of 6 and 5 terms respectively.

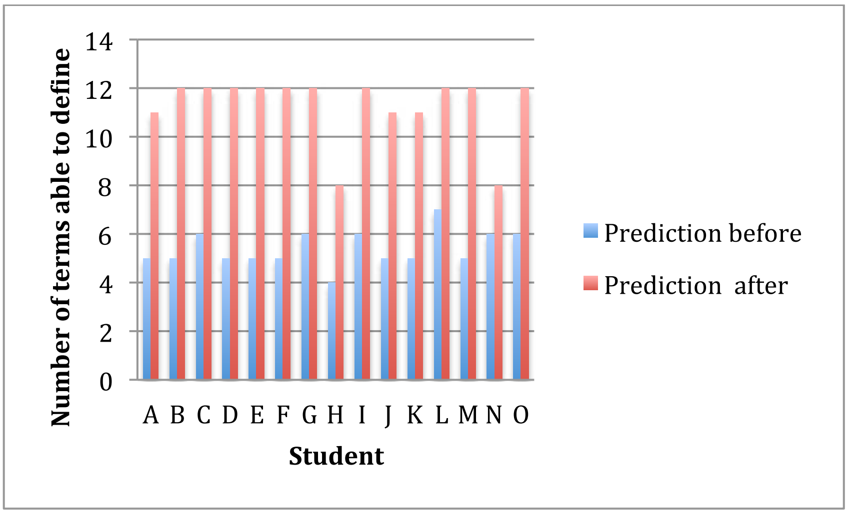

Figure 2a: Students' perceived attainment towards being able to correctly define a number of terms, before and after the sequence (n=15)

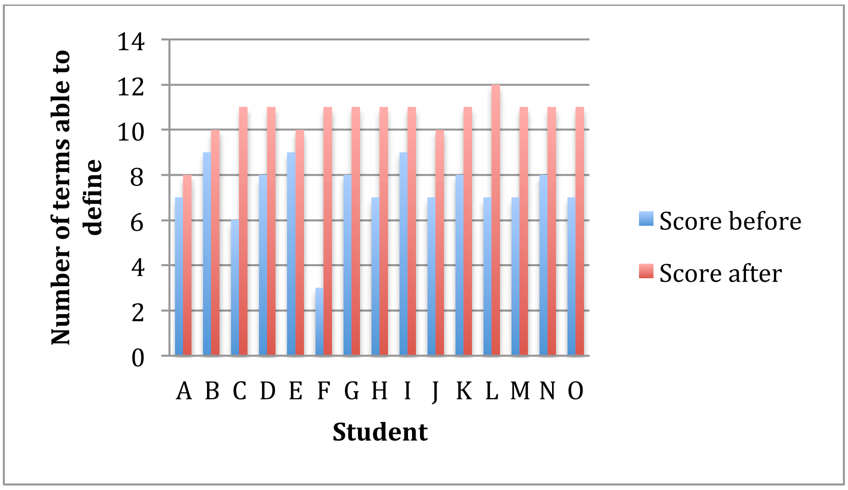

Figure 2b: Students' actual attainment, before and after the sequence (n=15)

In order to assess whether the difference in both the perceived and actual attainment data is statistically significant, paired t-tests have been used, as this study tests the same group of students twice. The outcome of a t-test results in a p-value. This value determines whether the null hypothesis (a statement which concludes that there is no relationship between two sets of data) can be either accepted or rejected. With a critical value of 0.05, if the p-value is less than 0.05, when conducting the test 100 times, the null hypothesis can be rejected in 95% of cases and the change observed between two sets of data can be assumed to be statistically significant. For this investigation, the p-value for the change in self perceived attainment was calculated as $1.16x10^{-10}$ and $6.04x10^{-6}$ for the change seen in students' actual attainment. Therefore with p-values below 0.05, both increases can be assumed to be statistically significant.

A further analysis involved comparing students' predicted and actual test scores prior to as well as after the lesson sequence. The results are presented in the two graphs in Figure 3 below.

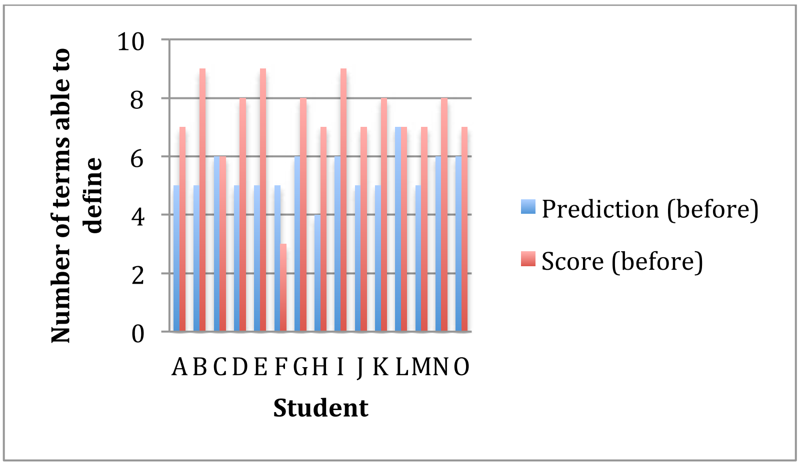

Figure 3a: Comparison between students' perceived and actual attainment before the sequence (n=15)

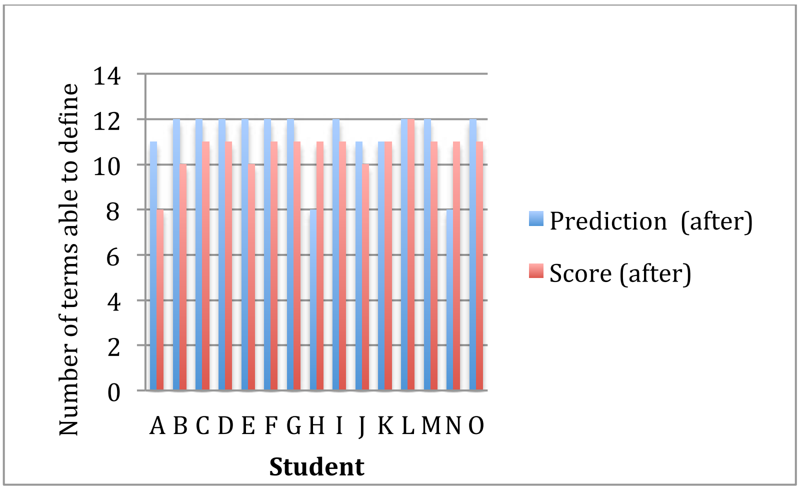

Figure 3b: Comparison between students' perceived and actual attainment after the sequence (n=15)

From the two graphs in Figure 3 above, it is evident that at the start of the sequence for the majority of students, their predicted scores were initially dramatically below their test scores. However, towards the end of the study, for the majority, their self perceived attainment scores were now above or equal to their test score (with the exception of Students 12H and 12N), with tests scores on the whole higher than at the start.

During the analysis of the vocabulary test data, the frequency of correct responses for each term was also recorded before and after the lesson sequence (see Table 4 below). It is clear that terms 2-6 were less familiar to students at the start of the study, in comparison with the rest. However, unlike the remaining less familiar terms which appeared to increase in familiarity by the end of the sequence, only three more students were correctly able to define term 3 (phloem) by the end of the lesson sequence.

Term	Word	Frequency at the start	Frequency at the end
1	Xylem	15	15
2	Phloem	4	7
3	Plasmodesmata	4	13
4	Symplast pathway	4	15
5	Apoplast pathway	5	14
6	Casparian strip	2	15
7	Transpiration	12	14
8	Xerophyte	10	15
9	Stomata	13	14
10	Hydrophyte	13	15
11	Translocation	15	15
12	Cohesion	12	14

Table 4: Frequency of correct responses for each of the terms at the start and end of the sequence.

Questionnaire

The questionnaire used in this investigation involved the quantitative assessment of six measures, which have been displayed graphically in Figure 4 (next page).

Within the sampled cohort of 15 students, it is evident that the majority of students (12) find the extent of the vocabulary in biology challenging at times (Figure 4 Graph A). With individuals either reporting that they find technical and non-technical vocabulary equally difficult (6) or specifically that technical vocabulary (5) was the most challenging (Figure 4 Graph B). Unlike the studies conducted previously, which focussed on non-technical vocabulary, interestingly few students (1) in this cohort indicated non-technical vocabulary as being a particular area of difficulty, over that of the technical vocabulary, which they also need to learn.

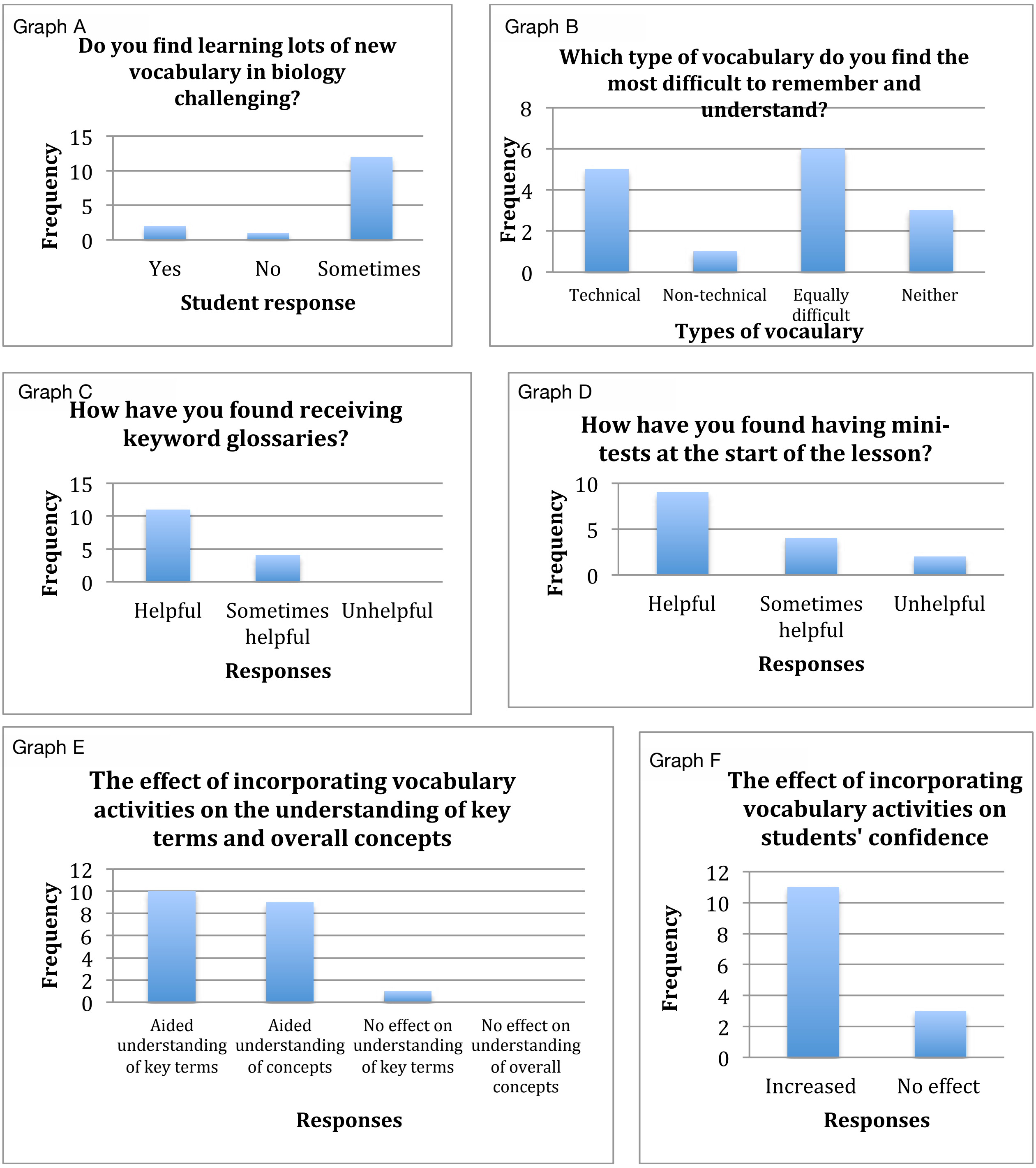

Figure 4: Bar charts to visually present the quantitative data generated from the student questionnaire based on six measures (n=15)

In terms of the interventions used, all students found that receiving keyword glossaries was helpful, either always or sometimes (Figure 4 Graph C). Additionally the majority also found that the mini-tests at the start of the lesson were also always or sometimes helpful (13), with only two students reporting the mini-tests as unhelpful (Figure 4 Graph D). As a result, the majority of students reported that the use of vocabulary activities within lessons either increased their understanding of the key terms (10), whole concepts (9) or both (Figure 4 Graph E). Only one student reported no effect. The final measure asked students to reflect on their confidence in relation to the topic, to which 11 students reported an increase in confidence as a result of an increased vocabulary focus and 3 reported no effect (Figure 4 Graph F).

Qualitative Data

In order to gain an insight into the responses provided, the group interview and open questions included in the questionnaire gave students the opportunity to explain their answers. These responses have since been coded in relation to seven key categories (facilitated the learning of key terms, facilitated the understanding of general/wider concepts, affected confidence, encouraged revision, encouraged engagement, concerns and suggestions) as may be seen in Appendix 4. The qualitative data generated through this investigation will therefore be analysed in relation to each of these themes.

Facilitated the learning of key terms (Research Question 1)

Within the questionnaire the effect of the more formal practice activities such as the keyword glossaries and mini-tests were directly investigated. In response to the use of mini-tests, Student 12I commented that the mini-tests provided a "*quick review to solidify new key terms*." Additionally the use of keyword glossaries was reported to help "*learn the definitions quicker*" (Student 12J), possibly through "*reinforced meanings*" (Student 12K). The keyword glossaries also encompassed an element of the presentation segment of the PPP intervention, to which during the group interview Student 12M pointed out that clear presentation "*helps us to understand the terms and it helps with multiple choice questions which are easy marks*."

Facilitated the understanding of general/wider concepts (Research Question 2)

The second research question focussed on whether the use of activities to encourage the learning of technical vocabulary also aided the understanding of the overall concepts being addressed. Some students for instance found that the keyword glossaries helped with "*background general knowledge"* (Student 12F). Furthermore, Student 12M stated, "*It was easier to understand processes using definitions.*" Similar sentiments appear to be apparent from the group interview, for instance Student 12L commented that the vocabulary focus "*helps with being more concise with longer answer questions*." With Student 12M adding "*it also helped to relate words to the concepts*."

More specifically during the group interview students were asked how the activities used attended towards the development of conceptual understandings, during which Student 12F explained how the use of a particular practice activity was beneficial by commenting that "*the buzzer quiz helped to apply definitions as you were more confident with what they meant*."

Effect on confidence (Research Question 3)

Within the questionnaire students were asked to comment on whether the interventions had affected their confidence towards the topic. Following this, there was also space for students to elaborate on their reasoning. Student 12I commented that the increased vocabulary focus "*provided confidence with basic concepts, which allowed me to build and understand harder concepts*." This was reinforced by the following comment from Student 12E who found that the activities helped "*to consolidate the words which made me more comfortable/confident using them*."

Those that reported towards the interventions having no effect on their confidence (Students 12A, 12H and 12C) did not comment or elaborate in both the questionnaire and group interview. However, earlier in the questionnaire Student 12H and Student 12C had indicated that they did not struggle with scientific vocabulary prior to the study.

Encouraged revision

A further recurring theme that became evident through the students' comments was towards the usefulness of elements of the intervention with regards to facilitating revision. One intervention in particular that seemed to have a significant impact was the use of keyword glossaries. Student responses brought forth remarks including that it "*reminded me of the topic so it was easier when it came to revising*" (Student 12G). A particular common theme that was repeatedly highlighted referred to collating information into manageable sections, through comments such as "*the vocab was in the same place*," (Student 12C) and that it was "*good to split the vocab into smaller sections*," (Student 12K).

Further comments were also provided in terms of the mini-tests, with students mentioning that prior to continuing with the content of the lesson, the mini-tests "*helped to refresh memory*," (Student 12E) that it "*made sure I went over the work*," (Student 12L) and that it provided an "*encouraging review of words before the lesson*." (Student 12O). Within the group interview the merit of the mini-tests was further reinforced. For instance, Student 12F felt "*like the tests were quite repetitive, which meant we were recapping the vocabulary often*," and for Student 12L "*the tests made you revisit the content*."

In addition to these more formal initiatives, another particular intervention, the use of a concept loop question/answer activity, was raised as a particularly useful revision tool. Within their questionnaire responses, Student 12J and Student 12K identified the concept loop activity as useful in helping them to describe the transpiration stream. Further qualitative data and reasoning towards how this activity facilitated understanding was offered by Student 12L within the group interview, who provided the reasoning that "*it was inclusive as everyone had to contribute and it forced you to revise as you didn't want to struggle to answer your question*."

Encouraged engagement

A number of student responses from both qualitative data sets converged on the theme of encouraging engagement. For instance, Student 12G found that the use of vocabulary activities "*made lessons more fun when I could have lost focus*," and Student 12I commented that they provided "*fun ways to make links between new words and definitions*." When students were later asked about elements of the action research initiatives, further comments came to light. Student 12M expressed a preference towards the practice activities commenting that "*the practice activities were a nice change from just reading and learning that way*." Again as mentioned previously the loop activity also appeared to promote engagement due to its inclusive nature.

Throughout the initiative students were provided with hand-outs with gaps to fill in. Particularly during the group interview when discussing elements students would like carried forward, the distribution of hand-outs was a particular favourite. Furthermore when asked whether they would like the gaps to remain, the majority did with Student 12G suggesting that it "*forced you to concentrate*."

Concerns

In comparison to students who found the mini-tests helpful and welcomed revision, two individuals found the mini-tests to be unhelpful, with Student 12C providing their reasoning being that the activity provided "*too much stress*." Student 12N also reported a concern with the formatting, suggesting that the "*vocab test match-ups were not helpful*." Interestingly during the group interview with regards to the multiple-choice nature of the mini-tests, Student 12L commented that "*the tests made you revisit the content, but you didn't need to know the definition as you could just guess or work it out by process of elimination, like by knowing translocation involved nutrients, you could remove two of the options*."

Additionally Student 12G identified potential concerns with the timings of the chosen interventions such that they reported that "*the buzzer quiz was helpful but for the people that did not know, they may not have benefitted from the fast pace. It could be more useful later on when people are more confident*." Student 12L reinforced this issue with the use of dingbats, suggesting that by moving at speed "*maybe not everyone got it*."

A final issue was related towards concept development, and whilst a previous theme discussed the merits of a more isolated vocabulary focus towards conceptual development, Student 12I raised a concern towards the use of key terms in isolation through stating "*I found that the games sometimes took the words out of context, which if you weren't sure could be confusing*."

Suggestions

One particular merit of the group interview was that students were more forthcoming in offering suggestions towards the future use of the interventions featured during the test period. For instance, with regards to the mini-tests Student 12K was supportive but suggested towards alternate formats in that they "*could be mixed with also writing your own definitions*. " Student 12G also suggested an alternative in that "*you could also maybe match the definitions on one side with words on another*." Interestingly, Student 12K made comparisons with the use of regular testing in MFL classes, through stating "*In French if you don't get a certain grade you have to retake that section. This could be applied to the mini-tests, where you need to score above a certain amount*." Given that for some the mini-tests were too stressful, for others it was seen as one of the more favourable initiatives.

Discussion

In assessing the results of this action research study the data collected will be discussed in regards to each of the three research sub-questions, with reference to existing literature. Doing so will allow an assessment of whether integrating cross-curricular language-learning techniques into biology classes can facilitate students' understanding.

Does the use of language-learning techniques aid the understanding of biological terms?

Consistently with larger studies conducted by Marshall et al. (1991) and Farrell and Ventura (1998), the initial baseline tests highlighted that A-level students *do* struggle with word meanings. Following a number of interventions across a 7-lesson sequence, a comparison of data from the baseline and follow up assessments showed that all students presented an increase in test scores by the end of the lesson sequence, with the majority (11) correctly defining 11 terms or more. According to Cassels and Johnstone (1985, p.18) "teacher-pupil communication will still be less than it should be as long as a word understanding falls below 100%," while this remains the case, the increase in test scores does display that teacher-pupil communication had increased over the course of the sequence.

Within their research study Cassels and Johnstone (1985) also highlighted that students were prone to struggle with definitions when high levels of precision was required. This was also evident from this investigation, as students consistently struggled to define the term 'phloem' both before and after the lesson sequence, which is possibly due to the level of detail required in the answer. As a reoccurring theme, it appears that further work is required to fine tune students' technical definitions inline with scientific requirements.

The increase in test scores, particularly for those who performed well within the baseline assessment, had not increased as dramatically as for students who performed less well in the initial baseline test. One possible reason for this is that at the start of the study the familiarity of the twelve selected terms was unknown. Prior to Cassels and Johnstone's (1985) study, as well as those which drew from it, a large number of terms had been sampled and 95 were then selected as particularly difficult for the majority. Therefore in relation to this investigation, it could be that testing twelve novel or more troublesome terms may have produced slightly different results, as more dramatic increases in understanding were visible with terms that were less well known at the start.

While quantitative data provides a limited insight into the usefulness of the methods employed, the supporting qualitative data provided by students does suggest that the language-learning initiatives were useful in facilitating an overall familiarity and understanding of these terms, possibly even cementing more precise definitions for those who were more familiar. For instance, through opportunities for feedback, students commented on the use of glossaries and mini-tests as particularly favourable presentation and practice techniques, which supported revision.

Does the use of language-learning techniques increase students' ability to apply learned vocabulary?

A major concern identified within prior studies including that of Cassels and Johnstone (1985), discussed the dangers associated with a lack of semantic knowledge towards students' conceptual understanding. However, this was neither measured nor investigated further. Given that this investigation consistently demonstrated a lack of semantic understanding in A-level students, similar concerns towards conceptual development were reinforced.

Throughout the study, students were presented with many opportunities to apply the newly acquired vocabulary to a variety of questions and tasks. Students' ability to apply learned vocabulary in a conceptual manor was assessed through data and comments generated using the student questionnaire and group interview. Although the sample size was small, many students had expressed that the activities used had facilitated their understanding of key concepts, especially through referring to certain interventions specifically aiding their conceptual understanding of processes within the topic. Additionally from the group interview, comments included aspects such as the ability to construct more concise answers to longer answer questions, and suggestions towards developing the ability to use key terms more confidently, reinforcing the usefulness of the methods towards conceptual understanding.

It was also raised that taking the terms out of context sometimes caused confusion when determining where they belonged within a particular process. In the study conducted by Marshall et al. (1991) it was determined that non-technical terms were more often correctly defined when applied to a scientific context. Consequently, given that all terms were presented within a scientific context throughout, care must be taken in order to ensure that keywords are not isolated completely but referenced in terms of their conceptual role. This could explain the merit of the loop activity, where key terms were referenced and highlighted within the context of the conceptual process they are used to describe.

Does the use of language-learning techniques affect confidence towards learning?

Interestingly from the comparison of students' perceived and actual attainment before the lesson sequence, in accordance with Farrell and Ventura (1998), students were initially unable to accurately predict their attainment scores. However, whilst Farrell and Ventura presented that students were more likely to predict their attainment scores to be higher than their actual test score, within this investigation the reverse was seen. For students in this cohort, 75% scored higher than their initial predictions. From such data it appears that students initially presented with low self-confidence towards their own perceived attainment. However, given the small sample size, such results may be localised to this particular sample of students.

On the other hand, following the lesson sequence a marked increase in the self-perceived attainment of the cohort was evident, with the cohort's predicted attainment either higher or more accurately representative of their actual scores. Where students did fall below their predicted score, it was largely due to failures in the precision of their chosen response.

Such quantitative data was supplemented with the use of a questionnaire, in which the majority of students reported that it was in fact the increased vocabulary focus that had contributed towards an increase in their confidence in relation to the topic. From the comments, students spoke particularly favourably of activities that facilitated revision and were inclusive of all members of the class. Students were less keen on activities that favoured those who might at the time have been more confident fairly early on. From these comments, it appears that activities should be tailored towards gradually building students' confidence, ensuring that early practice activities build familiarity and confidence with the majority of the cohort, to avoid leaving individuals behind.

A few students had reported no increase in their confidence due to the interventions utilised over the course of the topic, but they like the other members of the class had shown an increase in their perceived attainment regardless. Given students own preferences towards their learning, it is unsurprising that the chosen activities did not suit everyone, and unfortunately such students were not forthcoming in offering further reasoning beyond indicating that they had not previously struggled with vocabulary in science. However, from the data provided, the merit of such a focus remains prevalent.

Conclusions

Usefulness of methods and limitations

The methods used in this investigation enabled a substantial amount of data to be collected and analysed, allowing for a clear insight into the possible usefulness of incorporating a larger vocabulary focus within A-level biology lessons.

While the methods used were well thought-out, with key elements inspired by influential pieces of literature, limitations still remain. For instance, the use of a sixth-form group resulted in an especially small sample size, with the cohort also fairly biased in terms of gender. Additionally, the study was only conducted over seven lessons and despite the ability to collect insightful data within this time frame, conducting the study for a longer period of time would allow students to become more familiar with the new initiatives.

Implications for practice

By further highlighting the difficulties students encounter due to the quantity of technical language in biology, this study has clearly identified a requirement to incorporate targeted initiatives within lessons that support students' semantic understanding of key technical terms. With students repeatedly speaking favourably of aspects such as the keyword glossaries, mini-tests and loop activities, as well as offering suggestions towards their future use, it appears that the increased uptake of presentation and practice components of the PPP model were noticeably beneficial to students and should remain a staple element of classroom practice. In line with student feedback, the use of further practice activities, carefully introduced in order to build confidence, should also be considered.

Although the focus appears to be on the retention of presentation and practice initiatives, this does not mean that production activities should be discarded, as the opportunity to enable students to use terms independently remains important. It could also be the case that the production activities used were more familiar to students, however the use and emphasis of presentation and practice activities had noticeably increased.

Implications for research and future perspectives

This research study contributes towards the relatively small sample of literature that investigates students' ability to comprehend technical vocabulary in biology. Through identifying clear merit in integrating cross-curricular language-learning methods within A-level biology classes, this study has also identified a number of avenues for future action research in the field. For instance, with some students finding the mini-tests an additional cause of stress, but with the usefulness of such an exercise apparent and favourable amongst many students, the next cycle of action research would involve investigating a range of exercises that could be employed towards finding a more favourable method of regular testing. For example, rephrasing the tests as 'quizzes' or presenting them in a less formal way, may alter students' perception towards the task.

During this further round of action research towards refining the use of mini-tests, the methods selected could also be aimed towards non-technical vocabulary, as inaccuracies are experienced in relation to both groups. A final point would be to continue the research for a longer period of time, with a larger cohort and set of particularly challenging terms. Given that the results of this study are especially promising, further insights into practical solutions to overcome the barrier posed by the language of biology should continue to be explored.

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Appendix 1

Sample Lesson Plan -

Plant Transport – Lesson 1: Structure and function of the vascular bundle

Plant Transport - Lesson 1: Structure and function of the vascular bundle
Learning Objectives Describe the need for transport systems in multicellular plants. Be able to describe and explain the structure and function of the vascular system in plants. Examine plant tissue to investigate the structure of the xylem and phloem in plants.

Time	**Activity**	**Teacher / Student**
15 mins	**Starter**	Students use the images to guess the topic
	Pre sequence ability assessment	Students given list of words to assess their ability to define them. Students given a multiple choice assessment based on the previous terms.
	Learning Intentions and AFL checkpoint	Presentation - keywords in green and underlined
5 mins	**Why plants need a vascular system**	Elicit suggestions from students, images to help, then go through the answers. Students explain why plants need certain things (gases, water, minerals and ions).
5 mins	**Xylem and Phloem introduction**	Ask students what they know and explain basics - go through key definitions. Vascular bundle in the stem (explain what a dicot is), roots and leaves.
15 mins	**Adaptations of the xylem**	Show students an image of a xylem - highlight key features and ask students to discuss in pairs why and how these structures relate to its function. Go through answers.
	Adaptations of the phloem	Show students an image of a phloem vessel - highlight key features and ask students to discuss in pairs why and how these structures relate to its function. Go through answers.
5 mins	**Sieve tube elements and companion cells**	Explain, highlighting keywords with images.
15 mins	**Xylem and Phloem Practical**	Students carry out a microscope study on plant tissue and identify structures, draw and label their images and further annotate with description of function.
10 mins	**Biology Bingo**	Practice. Read out definitions and students cross out the word if in their grid.
	AFL Checkpoint 2	Students given glossary to write definitions to keywords.

Appendix 2

Student Questionnaire

Question number	Question	Possible responses	Open/ Closed
1.	Do you find learning lots of new vocabulary in biology challenging?	A. Yes B. No C. Sometimes **D.** Never	Closed
2.	Which type of vocabulary do you find the most difficult to remember and understand?	A. Technical vocabulary (e.g specific biological terms like plasmodesmata, apoplast, xerophyte) B. Non-technical vocabulary (everyday terms with specific biological meanings e.g mass flow, pit, sink) A. They're both equally as difficult **B.** I don't struggle with either	Closed
3.	How have you found receiving keyword glossaries?	A. Helpful B. Unhelpful **C.** Sometime helpful	Closed
	How were they helpful/unhelpful?		Open
4.	How have you found having mini-tests on key vocabulary at the start of the lesson?	A. Helpful B. Unhelpful **C.** Sometimes helpful	Closed
	How were they helpful/unhelpful?		Open
5.	Complete with your mini-test results:		
6.	Circle all that apply: The use of vocabulary activities in the lesson (e.g. biology bingo, dingbats, loop activities, mini vocab tests, quizzes)…	A. has aided my understanding of the vocabulary being taught. B. has aided my understanding of the overall concepts being addressed. C. has had no effect on my understanding of the vocabulary being taught. D. has had no effect on my understanding of the overall concepts being addressed.	Closed
	How were they helpful/unhelpful?		Open
7.	The increased focus on vocabulary has…	A. increased my confidence in relation to the topic. B. had no effect on my confidence in relation to the topic.	Closed
	If you answered A – which aspect/s did you find the most beneficial:		Open
8.	Any other comments: (e.g aspects of the plant transport topic which you liked/disliked/found useful/thought were less useful)		Open

Appendix 3

Group interview questions and prompts

Questions	Prompts
Do you think it's necessary to have a vocabulary focus in lessons? For instance rather than mentioning key terms in passing, formally take time to address them.	
How effective were the various vocabulary activities in terms of helping you to learn key terms?	I've split up the activities into three parts presentation, practice and production. Starting with the presentation activities, how did you find the use of highlighted keywords and the keyword glossaries?
What about the practice activities?	So, to remind you, this included: - mini-tests - dingbats - biology bingo - loop activities - buzzer quizzes - board games and revision activities - random questioning by the teacher
Lastly how did you find the production activities?	This included answering longer answer exam questions, analysing the model during the giant redwood challenge and describing the movement of water through a plant using keywords.
How effective were the various vocabulary activities in terms of helping you to explain key concepts and apply your knowledge?	For example, to explain larger processes and answer exam questions.
Overall, which activities did you find the most useful?	
Overall which activities did you find the least useful?	
Are there any aspects that you would like to see carried through to future lessons?	With or without gaps? (In response to students mentioning hand-outs).
Is there anything else you would like to see carried forward?	

Appendix 4

Coded group interview transcript

Key to Text Colours:
Facilitated the learning of key terms (Research question 1)
Facilitated the understanding of general/wider concepts (Research question 2)
Effect on confidence
Encouraged revision
Encouraged engagement
Concerns
Suggestions

Group Interview

Interviewer: Do you think it's necessary to have a vocabulary focus in lessons? For instance rather than mentioning key terms in passing, formally take time to address them.

'Majority nod'

M: Yes, it helps us to understand the terms and it helps with multiple-choice questions which are easy marks.

L: Helps with being more concise with longer answer questions.

M: It also helped to relate the words to the concepts.

Interviewer: How effective were the various vocabulary activities in terms of helping you to learn key terms?

I've split up the activities into three parts presentation, practice and production.

Starting with the presentation activities, how did you find the use of highlighted keywords and the keyword glossaries?

Presentation
- glossaries
- highlighted keywords on handouts and on the PowerPoint

L: Presenting the keywords helped to familiarise the terms which would have been vague.

K: The glossaries were good to split the vocab into smaller sections

What about the practice activities? So, to remind you, this included:
- mini-tests
- dingbats
- biology bingo
- loop activities
- buzzer quizzes
- board games and revision activities
- random questioning by the teacher

G: I found that the buzzer quiz wasn't helpful if you were less confident with the terms, because the activity was quite quick and you'd move on. It could be more useful later on when people are more confident.

F: I liked that the tests were quite repetitive, which meant we were recapping the vocabulary often.

M: The practice activities were a nice change from just reading and learning that way.

L: The tests made you revisit the content but you didn't need to know the definition as you could just guess or work it out by process of elimination, like by just knowing translocation involved nutrients, you could remove two of the options.

Interviewer: Ok, so lastly how did you find the production activities?

This included answering longer answer exam questions, analysing the model during the giant redwood challenge and describing the movement of water through a plant using keywords?

G: I find longer answer questions helpful as it targets gaps in your knowledge
L: I preferred the exam questions

Interviewer: How effective were the various vocabulary activities in terms of helping you to explain key concepts and apply your knowledge? For example, to explain larger processes and answer exam questions.

I: I found that the games sometimes took the words out of context, which if you weren't sure could be confusing.
F: The buzzer quiz helped to apply definitions as you were more confident with what they meant.

Interviewer: Overall, which activities did you find the most useful?

G: Mini-tests
F: I liked the buzzer quiz
L: The loop activities. It was inclusive as everyone had to contribute and it forced you to revise as you didn't want to struggle to answer your question. Fear of embarrassment.

Interviewer: So, overall which activities did you find the least useful?

I: Buzzer quiz
L: Dingbats, due to speed, you moved on and maybe not everyone got it.

Interviewer: Are there any aspects that you would like to see carried through to future lessons?

G: Handouts

Interviewer: With or without gaps?

G: with gaps, it forced you to concentrate.
B: Sometimes the gaps were too small.

Interviewer: Anything else you'd like to see carried forward?

K: The keywords tests but this could be mixed with also writing your own definitions.
G: You could also maybe match the definitions on one side with the words on another.
K: In French if you don't get a certain grade you have to retake that section. This could be applied to the mini-tests where you need to score above a certain amount.

Interviewer: Great, is that all? (Pause) Thank you for your contributions today.

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